DEPARTMENT OF MATHEMATICS AND STATISTICS, DDU GORAKHPUR UNIVERSITY GORAKHPUR-273009 (U.P.) INDIA

National Education Policy-2020

Syllabus

of

MATHEMATICS

(Effective from Academic Session 2021-2022)

For

Three Years B.A. /B.Sc. Programme

Course Structure of Mathematics as Major Subject in B.A. /B.Sc. Programme

SEMESTER-WISE TITLES OF THE PAPERS OF MATHEMATICS AS MAJOR SUBJECT IN B.A. /B.Sc. PROGRAMME				
YEAR	**COURSE CODE**	**PAPER TITLE**	**THEORY/PRACTICAL**	**CREDITS**
FIRST		**SEMESTER-I**		
	MAT 101	BASICS OF MATHEMATICS	THEORY	**2**
	MAT 102 (B030101T)	DIFFERENTIAL CALCULUS AND INTEGRAL CALCULUS	THEORY	**4**
	MAT 103 (B030102P)	PRACTICAL	PRACTICAL	**2**
		SEMESTER-II		
	MAT 104 (B030201T)	MATRICES AND DIFFERENTIAL EQUATIONS	THEORY	**3**
	MAT 105 (B030201T)	GEOMETRY	THEORY	**3**
SECOND		**SEMESTER-III**		
	MAT 201 (B030301T)	ALGEBRA	THEORY	**3**
	MAT 202 (B030301T)	MATHEMATICAL METHODS	THEORY	**3**
		SEMESTER-IV		
	MAT 203 (B030401T)	DIFFERENTIAL EQUATIONS	THEORY	**3**
	MAT 204 (B030401T)	MECHANICS	THEORY	**3**
THIRD		**SEMESTER-V**		
	MAT 301 (B030501T)	RING THEORY AND LINEAR ALGEBRA	THEORY	**4**
	MAT 302 (B030502T)	TENSOR ANALYSIS	THEORY	**3**
	MAT 303 (B030502T)	DIFFRENTIAL GEOMETRY	THEORY	**3**
		SEMESTER-VI		
	MAT 304 (B030601T)	METRIC SPACES AND COMPLEX ANALYSIS	THEORY	**4**
	MAT 305 (B030602T)	NUMERICAL ANALYSIS AND OPERATIONS RESEARCH	THEORY	**4**
	MAT 306 (B030603T)	PRACTICAL	PRACTICAL	**2**

Subject Prerequisites:
To study this subject a student must had the subject(s) Mathematics in class 12^{th}.

Program Outcomes (POs)

PO1: It is to give foundation knowledge for the students to understand basics of mathematics including applied aspects for the same.

PO2: It is to develop enhanced quantitative skills in pursuing higher mathematics and research as well.

PO3: Students will be able to develop solution-oriented approach towards various issues related to their environment.

PO4: Students will become employable in various government and private sectors.

PO5: Scientific temper in general and mathematical temper in particular will be developed in students.

Year	Semester	Program Specific Outcomes (PSOs)
First	SEM-I	**PSO1**. Student should be able to possess recall basic idea aboutmathematics which can be displayed by them.
	SEM-II	
Second	SEM-III	**PSO2**. Student should have adequate exposure to many aspects ofmathematical sciences.
	SEM-IV	
Third	SEM-V	**PSO3**. Student is equipped with mathematical modeling ability, critical mathematical thinking, problem solving skills, etc. and apply his/her skill and knowledge in various field of studies including Science, Engineering, Commerce and Management etc.
	SEM-IV	

SEMESTER WISE PAPER TITLES WITH DETAILS					
Year	**Semester**	**Paper**	**Paper Title**	**Prerequisite for Paper**	**Elective for Major Subjects**
FIRST	**SEM-I**	Theory Paper - I	BASICS OF MATHEMATICS	Mathematics in 12th	Open to ALL
		Theory Paper - II	DIFFERENTIAL CALCULUS AND INTEGRAL CALCULUS		
		Practical Paper - III	PRACTICAL (Practicals to be done using SageMath/Mathematica/ MATLAB / Maple /Scilab / C programming/ R programming/ Python etc.)		
	SEM-II	Theory Paper - I	MATRICES AND DIFFERENTIAL EQUATIONS		
		Theory Paper - II	GEOMETRY		
SECOND	**SEM-III**	Theory Paper - I	ALGEBRA	Mathematics as Major Subject in B.A. /B.Sc. first year Programme	Open to ALL
		Theory Paper - II	MATHEMATICAL METHODS		
	SEM-IV	Theory Paper - I	DIFFERENTIAL EQUATIONS		
		Theory Paper - II	MECHANICS		
THIRD	**SEM-V**	Theory Paper - I	RING THEORY AND LINEAR ALGEBRA	Mathematics as Major Subject in B.A. /B.Sc. second year Programme	Statistics, Physics, Computer Sc. / App Chem., Bio-Chem, Geography, Economics, Defence & Strategic Studies, BCA, BBA B.Tech(Engg / Tech)
		Theory Paper - II	TENSOR ANALYSIS		
		Theory Paper - III	DIFFERENTIAL GEOMETRY		
	SEM-VI	Theory Paper - I	METRIC SPACES AND COMPLEX ANALYSIS		
		Theory Paper - II	NUMERICAL ANALYSIS AND OPERATIONS RESEARCH		
		Practical Paper- III	PRACTICAL (Practicals to be done using SageMath/Mathematica/ MATLAB / Maple /Scilab / C programming/ R programming/ Python etc.)		

B.A. /B.Sc. I (SEMESTER-I) PAPER-I

BASICS OF MATHEMATICS

Class: B.A. /B.Sc.	**Year: FIRST**	**Semester: FIRST**
Subject: MATHEMATICS		
Course Code: MAT 101	**Course Title: BASICS OF MATHEMATICS**	

Course outcomes:

CO1: The program outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.

CO2: By the time students complete the course; they will have wide ranging application of the subject and have the knowledge of relations, functions along. They will also be able to know about Differentiation of functions, geometrical and physical significance of derivatives. Also, they have knowledge about Determinants and its applications, matrix theory, Integration of functions, properties of indefinite integrals.

CO3: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of basic mathematics he/she learns to solve a variety of practical problems in science and engineering.

CO4: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him/her well towards taking more advance level course in mathematics.

Credits: 2	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: As per UGC/ University CBCS norm.**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0

Unit	Topics	No. of Lectures
	Assignment on "Indian Ancient Mathematics and Mathematicians" should be included under Continuous Internal Evaluation (CIE).	
	BASICS OF MATHEMATICS	
I	Set theory: Definition of sets, representation of sets, universal set, empty set, singleton set, finite and infinite set, equal set, cardinal number of finite set, equivalent set, set of set, subsets, proper subset, superset, power set, improper set, comparibility of sets, union and intersection of sets, complement of sets, de morgan's law, disjoint sets, difference and symmetric difference, algebra of sets, duality, counting principle, venn diagram and its applications.	8

II	Ordered pair, Cartesian product of two sets, relations, domain, co-domain and range of a relation, types of relations: identity relation, inverse relation, empty relation, universal relation, reflexive relation, symmetric relation, anti-symmetric relation, transitive relation, equivalence relation. Functions or mapping, domain, co-domain and range of a function, composition of functions, types of function: one-one function, many –one function, onto function, into function, one-one into function, one-one onto function, many-one into function, many-one onto function, and invertible functions.	7
III	Differentiation of functions, geometrical significance of derivatives, derivative of the product of functions, derivative of quotient of two functions, derivative of a function of function , Maxima and minima of a function of one variable. Integration of functions, properties of indefinite integrals, integration by substitution, integration by parts, integration of rational functions, integration using partial fractions. Definite integrals and its properties.	8
IV	Principle of mathematical induction, Polynomials, Linear polynomial, quadratic polynomial, cubic polynomial, roots of polynomial, Quadratic equations, Factorisation, Determinants and its applications, matrix theory, types of matrices: Horizontal matrix, vertical matrix, square matrix, row matrix, column matrix, null matrix, identity matrix, diagonal matrix, scalar matrix, sub matrix, triangular matrix, comparable matrix, Operation on matrices: Matrix addition, subtraction, product of matrices, difference of two matrices, transpose of a matrix, inverse of a matrix by adjoint method.	7

Suggested Readings:

1. Senior Secondary School Mathematics, R S Agrawal, Bharti Bhawan, 1995.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley, 2015.
3. Mathematics ,R.D.Sharma,Dhanpat Rai Publications,1998.
4. Mathematics,Sudhir Kumar Pundir,Shri Balaji Publication,2013.
5. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have the subject Mathematics in class12th.

B.A. /B.Sc. I (SEMESTER-I) PAPER-II

DIFFERENTIAL CALCULUS AND INTEGRAL CALCULUS

Class: B.A. /B.Sc.	**Year: FIRST**	**Semester: FIRST**
Subject: MATHEMATICS		
Course Code: MATH 102 (B030101T)	**Course Title: DIFFERENTIAL CALCULUS AND INTEGRAL CALCULUS**	

Course outcomes:

CO1: The program outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.

CO2: By the time students complete the course; they will have wide ranging application of the subject and have the knowledge of real valued functions along with sequence. They will also be able to know about convergence of sequence. Also, they have knowledge about curvature, envelopeand evolutes, Riemann integral.

CO3: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of differential calculus and integral calculus he/she learns to solve a variety of practical problems in science and engineering.

CO4: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him/her well towards taking more advance level course in mathematics.

Credits: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART-A **DIFFERENTIAL CALCULUS**	
I	Definition of a sequence, Theorems on limits of sequences, Bounded and Monotonic sequences, Convergent sequence, Cauchy's convergence criterion, Balzano Weierstrass theorem for sequence, Cauchy sequence, Cauchy's first and second theorems on limits, limit superior and limit inferior of a sequence, Cantor's theorem on nested intervals, subsequence.	8
II	Limit, Continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Uniform continuity, Borel's theorem , Bolzano's theorem, Intermediate value theorem, Extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule.	7
III	Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, and Leibnitz theorem, Maclaurin's and Taylor's series expansion.	8
IV	Partial differentiation, Euler's theorem on homogeneous function, Jacobians and its properties, Asymptotes, Curvature, Envelops and evolutes, Multiple points, Test for concavity and convexity.	7

Unit	Topics	No. of Lectures
	PART-B **INTEGRAL CALCULUS**	
V	Lower and upper bounds, Supremum and infimum of the subsets of R and its basic properties, Completeness of R. Riemann integral and its properties, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.	8
VI	Beta and Gamma functions, Tracing of curves in Cartesian and Polar forms, Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test.	7
VII	Areas of Curve, Lengths of curve, Volumes of solid of revolution, Multiple integrals: Double and Triple integrals, Change of order of double integration, Area as a double integral in Cartesian form, Dirichlet's theorem, and Liouville's theorem for multiple integrals.	8
VIII	Vector Differentiation, Point function, Vector differential operator, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Second order differential operator, Laplacian operator. Vector Integration, Line integral, Circulation, Work done by a force, Surface integral, Volume integral, Gauss, Green, Stokes theorems with prove and related problems.	7

Suggested Readings :(Part-A Differential Calculus)

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.
3. Gorakh Prasad, A text book on Differential Calculus, Pothishala Private Ltd., Prayagraj
4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.
5. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
6. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
7. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings:(Part-B Integral Calculus)

1. T.M. Apostal, Calculus Vol. II, John Wiley Publication
1. Gorakh Prasad, A text book on Integral Calculus, Pothishala Private Ltd., Prayagraj
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have the subject Mathematics in class12th.

B.A./B.Sc. I (SEMESTER-I) PAPER-III

PRACTICAL

Class: B.A. / B.Sc.	**Year: FIRST**	**Semester: FIRST**
Subject: MATHEMATICS		
Course Code: MAT 103 (B030102P)	**Course Title: PRACTICAL**	

Course outcomes:

CO1. The main objective of the course is to equip the student to plot the different graphs and solve the different types of equations by plotting the graphs using different computer software such as Sage Math/Mathematica /MATLAB / /Maple / Scilab /C programming / R programming etc.

CO2. After completion of this course student would be able to know the Plotting the graphs.

CO3. Student would be able to Sketching parametric curves: Trochoid, Cycloid, Epicycloid..

CO4. Student would be able to find numbers between two real numbers and plotting of finite and infinite subsetof R, Matrix operations.

Credits: 2	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Unit	Topics	No. of Lectures
	• **Practical / Lab work to be performed in Computer Lab.** • **List of the practicals to be done using Sage Math / Mathematica /MATLAB / Maple / Scilab / R programming / Python / C programming etc.**	**60**
I.	Plotting the graphs of the following functions: I. ax II. $[x]$ (greatest integer function) III. $x^{2n}; n\epsilon\ N$ IV. $x^{2n-1}; n\epsilon\ N$ V. $\frac{1}{X^{2n-1}}; n\epsilon\ N$ VI. $\frac{1}{X^{2n}}; n\epsilon\ N$ VII. $\sqrt{ax+b}$,$\lvert ax+b\rvert$ VIII. $\lvert x\rvert\ for\ x \neq 0$ IX. $e^{x}\ for\ x \neq 0$ X. $e^{-x}\ for\ x \neq 0$	
II.	Plotting the graph of the following functions: $\log_e x$, sin x, cos x, tan x, sin hx, cos hx, tan hx.	

III.	Sketching parametric curves: Trochoid, Cycloid, and Epicycloid.	
IV.	By plotting the graph find the solution of the equation: $x = e^x$, $x^2 + 1 = e^x$, $1 - x^2 = e^x$, $x = \log_{10}(x)$, $\cos(x) = x$, $\sin(x) = x$, $\cos(y) = \cos(x)$, $\sin(y) = \sin(x)$.	
V.	Plotting the graphs of polynomial of degree 2, 3, 4 and 5.	
VI.	Find numbers between two real numbers and plotting of finite and infinite subsetof R	
VII	Matrix operations: I. Addition, II. Multiplication, III. Inverse, IV. Transpose.	
VIII	Complex number and their representations: I. Addition, II. Multiplication, III. Division, IV. Modulus.	

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Practical Internal Evaluation shall be based on Practical File/Record, Class test, Viva-voce and Overall performance. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Test (Descriptive /Objective Questions)	5
2	Presentation of any one Practical / Class Interaction	5
3	Viva-voce	5
4	Practical File/Record	10

External Evaluation Methods (Max.Marks: 75)

Practical External Evaluation shall be based on Viva-voce, Practical File/Record and Practical Exercises. The marks shall be as follows:

Practical Exercise : 01 x 25 Marks	25 Marks
Practical File/Record/ Overall Performance	20 Marks
Viva-voce	30 Marks

There shall be 04 Practical Exercises in Examination comprising 01 as Compulsory.

Course prerequisites:

To study this course, a student must have the subject Mathematics in class12th.

Any remarks:

- At least two Computer Programmers and two Computer Operators must be assigned in computer lab.
- There should be a Computer Lab with minimum of 25 computer systems for 50 students with licensed and Free Open Source softwares related to this course.

B.A./B.Sc. I (SEMESTER-II) PAPER-I

MATRICES AND DIFFERENTIAL EQUATIONS

Class: B.A. /B.Sc.	**Year: FIRST**	**Semester: SECOND**
Subject: MATHEMATICS		
Course Code: MAT 104 (B030201T)	**Course Title: MATRICES AND DIFFERENTIAL EQUATIONS**	

Course outcomes:

CO1: The topics of the course are included in such a way that they focus on developing mathematical skills in matrices and eigen values from basic level to depth of knowledge.

CO2: The student will be able to find the rank, eigen values of matrices and study the Differential Equations, Formation of differential equations.

CO3: The students will be capable of learn and visualize the fundamental ideas about the rank, eigen values of matrices and Orthogonal Trajectories.

CO4: On successful completion of the course students have gained knowledge about matrices, differential equations and their properties. They have the foundation for higher course in Matrices and differential equations.

Credits: 3	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	Topics	No. of Lectures
	MATRICES AND DIFFERENTIAL EQUATIONS	
I	Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form or Canonical form of a Matrix, Inverse of a Matrix by elementary operations. Complex matrix, Conjugate of matrix, Transpose of Conjugate of matrix, Hermitian matrix and Skew-, Hermitian matrix , Periodic matrix, Idempotent matrix, Unitary matrix. System of linear homogeneous and non-homogeneous equations, Consistency and Inconsistency of a system of linear equations, Theorems on consistency of a system of linear equations, Cramer's Rule.	12
II	Vector, Linear Dependence and Independence of vectors, Dependence and Independence of vectors of vectors by rank method. Eigen values, Eigen vectors and characteristic equation of a matrix, Orthogonal Vectors. Algebraic Multiplicity, Geometric Multiplicity, Regular eigen value, Caley-Hamilton theorem and its use in finding inverse of a matrix, Diagonalisation of square matrix, Power of matrix by Diagonalisation.	11
III	Order and Degree of a Differential Equations, Formation of differential equations, General Solution, Particular Solution, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Equation Reducible to Variable separable form, Homogeneous differential equations, Equations Reducible to Homogeneous form.	11
IV	Exact differential equations and equations reducible to the exact form, Linear differential equations, Equations Reducible to Linear form; First order higher degree differential equations solvable for p, y, x. Clairaut's differential equation, Singular Solutions, Determination of singular solution, Orthogonal Trajectories, Trajectories in Cartesian form and Polar form.	11

Suggested Readings :

1. Felix R. Gantmacher, The Theory of Matrices, AMS Chelsea Publishing.
2. Roger A. Horn, Charles R. Johnson, Matrix Analysis, Cambridge University Press.
3. Thomas S. Shores, Applied linear algebra and matrix analysis, Springer
4. G.F. Simmons, Differential Equations, Tata Mcgraw Hill Publishing Company Ltd.
5. M. D. Rai Singhania, Ordinary and Partial Differential Equations, S. Chand and Company Ltd., New Delhi.
6. Richard Bronson, Gabriel B. Costa, Schaum's Outline of Differential Equations, McGraw-Hill Education
7. Zafar Ahsan, Differential equations and their applications, PHI.
8. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follow

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have the subject Mathematics in class12th.

B.A./B.Sc. I (SEMESTER-II) PAPER-II

GEOMETRY

Class: B.A. /B.Sc.	**Year: FIRST**	**Semester: SECOND**
Subject: MATHEMATICS		
Course Code: MAT 105 (B030201T)	**Course Title: GEOMETRY**	

Course outcomes:

CO1: The topics of the course are included in such a way that they focus on developing mathematical skills in geometry and three-Dimensional Coordinates from basic level to depth of knowledge.

CO2: The student will be able to find the concepts of three-Dimensional geometry. The course in geometry intends to develop problem solving skills for solving various types of concepts in three-Dimensional geometry.

CO3: The students will be capable of learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surfaces by using analytical geometry.

CO4: On successful completion of the course students have gained knowledge about regular geometrical figures and their properties. They have the foundation for higher course in Geometry.

Credits: 3	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	Topics	No. of Lectures
	GEOMETRY	
I	Three-Dimensional Coordinates in space, Distance between two points, Direction cosines and direction ratios, Projection of a segment on a straight line, Projection of the join of two points on a straight line, Angle between two lines, Distance of a point from a line.	12
II	Plane, General equation of plane ,Equation of the plane in various forms, Equation of a plane through given points, Straight line in three dimensions, Coplanar lines, The image of a point in a plane, Shortest distance between two lines.	11
III	Sphere, Equation of a sphere whose centre is given, Intersection of two spheres, Intersection of sphere and a straight line, Cone ,Equation of cone, Equation of right circular cone, enveloping cone.	11
IV	Cylinder, Right circular cylinder, Enveloping cylinder, Central conicoid, properties of the central conicoid in standard form, the ellipsoid, the hyperboloid one sheet, the hyperboloid of two sheets, intersection of line and a central conicoid, tangent plane, condition of tangency, director sphere, normal to a conicoid, polar plane, diametral plane.	11

Suggested Readings :

1. R. J. T. Bell, An Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., New Delhi, 1994.
2. Shanti Narayan, P.K. Mittal, Analytical Solid Geometry, S. Chand & Company, New Delhi, 2008.
3. M.M. Tripathi, Coordinate Geometry: Polar Coordinates Approach, Narosa Publishing House, New Delhi
4. P.R.Vittal,Analytical Geometry 3D,Pearson.
5. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

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- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
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- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have the subject Mathematics in class12th.

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B.A./B.Sc. II (SEMESTER-III) PAPER-I

ALGEBRA

Class: B.A. / B.Sc.	**Year: SECOND**	**Semester: THIRD**
Subject: MATHEMATICS		
Course Code: MAT 201 (B030301T)	**Course Title: ALGEBRA**	

Course outcomes:

CO1: Group theory is one of the building blocks of modern algebra. Objective of this course is tointroduce students to basic concepts of Group theory and their properties.

CO2: A student learning this course gets a concept of Integers, Group and their properties.This course will lead the student to basic course in advanced mathematics particularly in Algebra.

CO3: The course gives emphasis to enhance students' knowledge of Permutation groups and Normal subgroups.

CO4: On successful completion of the course students would have acquire knowledge about Integers, Group and will help him/her in going for higher studies and research.

Credits: 3	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	**Topics**	**No. of Lectures**
	ALGEBRA	
I	Properties of Integers, Divisor, Division algorithm. Greatest Common Divisor, Euclidean algorithm, Fundamental theorem of arithmemetic, Congruences and residue classes. Euler $\emptyset -$ function and its properties, Euler's, Fermat's and Wilson's theorem.	12
II	Algebraic Structure, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups, Order of an element of a group, Centre of group.	11
III	Permutation groups, Cyclic permutation, Transposition, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences.	11
IV	Homomorphism and isomorphism, Kernel of homomorphism, Normal subgroups, Simple group, Quotient groups, Fundamental theorem of homomorphism, Theorems on isomorphism.	11

Suggested Readings :

1. I. N. Herstein , Topics in Algebra, Wiley Eastern Ltd, New Delhi, 1975.
2. Joseph. A. Gallian, Contemporary Abstract Algebra, Cengage Learning India Private Limited, Delhi., Fourth impression, 2015.
3. P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, First Course in Linear Algebra, Wiley Eastern Ltd., New Delhi, 1983.
4. S. Singh and Q. Zameeruddin, Modern Algebra, Vikas Publication House, India.
5. David M. Burton, Elementary Number Theory, Wm. C. Brown Publishers, Dubuque, Iowa 1989.
6. Course Books published in Hindi may be prescribed by the Universities.

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- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.First Year Programme.

B.A./B.Sc. II (SEMESTER-III) PAPER-II

MATHEMATICAL METHODS

Class: B.A. / B.Sc.	Year: SECOND	Semester: THIRD
Subject: MATHEMATICS		
Course Code: MAT 202 (B030301T)	**Course Title: MATHEMATICAL METHODS**	

Course outcomes:

CO1: Laplace transforms and Fourier transforms is one of the building blocks of modern mathematics. Objective of this course is tointroduce students to basic concepts of limit and continuity of function of two variables, Fourier series and their properties.

CO2: A student learning this course gets a concept of Laplace transforms, Fourier transforms and their properties. This course will lead the student to basic course in advanced mathematics particularly in function of two variables.

CO3: The course gives emphasis to enhance students' knowledge of function of two variables, Laplace transforms and Fourier series, Fourier expansion of piecewise monotonic functions, Calculus of variations ,Fourier series for even and odd functions.

CO4: On successful completion of the course students would have acquire knowledge about function of two variables**,** Laplace transforms, Fourier series, Calculus of variations and will help him/her in going for higher studies and research.

Credits: 3	Core Compulsory / Elective
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	Topics	No. of Lectures
	MATHEMATICAL METHODS	
I	Limit and Continuity of functions of two variables, Differentiation of function of two variables, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method. Exponential functions, hyperbolic functions, logarithm of a complex number, general exponential function. Inverse Circular function of complex quantities, inverse hyperbolic functions.	12
II	Laplace transform, Existence theorem for Laplace Transform, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Heaviside expansion formula. Initial and Final value theorem, Unit step function and their properties. Laplace transform of periodic function, Unit impulse function, Inverse Laplace transforms, Convolution theorem, Solution of ordinary differential equation by using Laplace transform.	11
III	Periodic functions, Fourier series, Fourier expansion of piecewise monotonic functions, Fourier series for even and odd functions, Half - range expansions. Fourier transforms (finite and infinite) and properties of fourier transform.	11
IV	Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives.	11

Suggested Readings :

1. T.M. Apostal, Mathematical Analysis, Pearson
2. G. F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGrawHill
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. A.C.Srivastava, Engineering Mathematics, PHI Publication.
5. N. Kumar, An Elementary Course on Variational Problems in Calculus, Narosa Publications, New Delhi.
6. A. S. Gupta, Text Book on Calculus of Variation, Prentice-Hall of India, New Delhi.
7. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.First Year Programme.

B.A./B.Sc. II (SEMESTER-IV) PAPER-I

DIFFERENTIAL EQUATIONS

Class: B.A. / B.Sc.	**Year: SECOND**	**Semester: FOURTH**
Subject: MATHEMATICS		
Course Code: MAT 203 (B030401T)	**Course Title: DIFFERENTIAL EQUATIONS**	

Course outcomes:

CO1: The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations and to have qualitative applications.

CO2: A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on differential equations. These entire courses are important in engineering and industrial applications for solving boundary value problems.

CO3: The object of the course is to give students knowledge of basic differential equations, partial differential equations such as Simultaneous Differential Equation and Total differential equation.

CO4: The student, after completing the course can go for higher quality problems in Differential Equation. This will be helpful in getting employment in industry.

Credits: 3	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	**Topics**	**No. of Lectures**
	DIFFERENTIAL EQUATIONS	
I	Linear differential equation with constant coefficients, Homogeneous Linear differential equation with constant coefficients, Equation Reducible to Homogeneous form.	12
II	Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, Changing the independent variable, method of variation of parameters.	11
III	Ordinary Simultaneous Differential Equation, Method of solving simultaneous linear differential equation with constant coefficients, Solution of simultaneous differential equation in a different form	11
IV	Total differential equation, Necessary and sufficient condition for Integrability of total differential equation, Methods for solving the total differential equation: Solution by inspection, one variable regarded as constant, homogeneous equations, method of auxiliary equations.	11

Suggested 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
3. M. D. Rai Singhania, Ordinary and Partial Differential Equations, S. Chand and Company Ltd., New Delhi.
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.
5. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.First Year Programme.

B.A./B.Sc. II (SEMESTER-IV) PAPER-II

MECHANICS

Class: B.A. / B.Sc.	Year: SECOND	Semester: FOURTH
Subject: MATHEMATICS		
Course Code: MAT 204 (B030401T)	**Course Title: MECHANICS**	

Course outcomes:

CO1: The objective of this course is to familiarize the students with various methods of finding Forces in three dimensions. Poinsot's central axis. Wrenches. Null lines and null planes. Conjugate lines and conjugate forces and to have qualitative applications.

CO2: A student doing this course is able to model problems in nature using Statics & Dynamics. After completing this course, a student will be able to take more courses on Virtual work, Stable and unstable equilibrium, Catenary, Catenary of uniform strength etc. These entire courses are important in engineering and industrial applications.

CO3: The object of the course is to give students knowledge of basic mechanics such as motion under other laws and forces.

CO4: The student, after completing the course can go for higher quality problems in mechanics such as hydrodynamics. This will be helpful in getting employment in industry.

Credits: 3	Core Compulsory / Elective
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	Topics	No. of Lectures
	MECHANICS	
I	Forces in three dimensions. Poinsot's central axis. Wrenches. Null lines and null planes. Conjugate lines and conjugate forces.	12
II	Analytical conditions of equilibrium of coplanar forces, Virtual work, Stable and unstable equilibrium, Catenary, Catenary of uniform strength.	11
III	Motion in a straight line: velocity and acceleration, Accelerations in terms of different coordinate systems. Elastic and inelastic collisions between two objects, The coefficient of restitution, Motion in a plane: velocity and acceleration along radial and transverse direction, velocity and acceleration along tangential and normal directions, Elastic strings.	11
IV	Motion in resisting medium, Projectile motion in resisting medium Moments and products of inertia. The momental ellipsoid.Equimomental systems. Principle axes. Central orbits. Apses and apsidal distances.Kepler's laws of planetary motion, Motion of a particle in three dimensions.	11

Suggested Readings :

1. R.C. Hibbeler, Engineering Mechanics-Statics, Pearson.
2. S L Loney, The Elements of Statics & Dynamics Part-I (Statics), Arihant.
3. S L Loney, The Elements of Statics & Dynamics Part-II (Dynamics), Arihant.
4. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill
5. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill
6. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

This course can be opted as an elective by the students of following subjects: Open to all

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.First Year Programme.

B.A./B.Sc. III (SEMESTER-V) PAPER-I

RING THEORY AND LINEAR ALGEBRA

Class: B.A. / B.Sc.	Year: THIRD	Semester: FIFTH
Subject: MATHEMATICS		
Course Code: MAT 301 (B030501T)	**Course Title: RING THEORY AND LINEAR ALGEBRA**	

Course outcomes:

CO1: Objective of this course is to sustain the students in Abstract Algebra of almost Advanced Level.

CO2: Ring theory and Linear Algebra is a basic course in almost all branches of science. The objective of this course is tointroduce a student to the basics of Abstract Algebra, Linear Algebra and some of its applications.

CO3: After successful completion of course, students will enable themselves to knowledge of Polynomial rings over commutative rings, vector spaces**.**

CO4: Student will use this knowledge in computer science, finance mathematics and industrial mathematics. After completion of this course students will appreciate its interdisciplinary nature.

Credits: 4	Core Compulsory / Elective
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART-A **RING THEORY**	
I	Introduction to rings, integral domains and fields, Characteristic of a ring, Ring homomorphism, Ideals and quotient rings.	8
II	Field of quotients of an integral domain, Euclidean domain, Prime and maximal ideals, principal ideal domain, Principal ideal rings, Polynomial rings over commutative rings.	7
III	Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion, Unique factorization in Z[x].	8
IV	Divisibility in integral domains, Irreducible, Primes, Unique factorization domains, Euclidean domains.	7
Unit	**Topics**	**No. of Lectures**
	PART-B **LINEAR ALGEBRA**	
V	Vector spaces, Vector Subspaces, Linear combination, Linear independence and dependence of vectors, same and same spaces, Basis and Dimension, Quotient space.	8
VI	Linear transformations, The Algebra of linear transformations, Rank Nullity theorem, their representation as matrices.	7
VII	Linear functionals, Dual space, Dual Basis and Dimension, Bilinear and Quadratic forms.	8

VIII	Change of basis, diagonal forms, triangular forms, Inner product spaces and norms, Orthogonal vectors, Orthonormal sets and bases.	7

Suggested Readings:(Part-A Ring Theory)

1. I. N. Herstein, Topics in Algebra, Wiley
2. Joseph. A. Gallian, Contemporary Abstract Algebra, Cengage Learning India Private Limited, Delhi.,Fourth impression, 2015.
3. David S. Dummit, & Richard M. Foote, Abstract Algebra (3rd ed.) (2016), Student Edition. WileyIndia.
4. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings: :(Part-B Linear Algebra)

1. K. Hoffman and R. Kunze, Linear Algebra (2nd ed.), Prentice-Hall of India.
2. Gilbert Strang, Linear Algebra and its Applications, Cengage Learning, 2018.
3. Stephen H. Friedberg, Arnold J. Insel, & Lawrence E. Spence (2003). Linear Algebra (4th ed.). Pearson.
4. Serge Lang, Linear Algebra (3rd ed.) (1987), Springer
5. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999
6. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

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

Statistics, Physics, Computer Sc. / App Chem., Bio-Chem, Geography, Economics, Defence & StrategicStudies, BCA, BBA, B. Tech (Engg / Tech).

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.Second Year Programme.

B.A./B.Sc. III (SEMESTER-V) PAPER-II

TENSOR ANALYSIS

Class: B.A. / B.Sc.	**Year: THIRD**	**Semester: FIFTH**
Subject: MATHEMATICS		
Course Code: MAT 302 (B030502T)	**Course Title: TENSOR ANALYSIS**	

Course outcomes:

CO1: The course is aimed at exposing the students to foundations of tensor analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.

CO3: Students will be able to know the concepts of tensor, basic concepts and developments of differential geometry which will prepare the students to take up further applications in the relevant fields.

CO4: The course enables the students the basics of tensor and differential geometry for further application in higher studies**.**

Credits: 3	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: As per UGC/ University CBCS norm.**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	**Topics**	**No. of Lectures**
	TENSOR ANALYSIS	
I	Tensor : Transformation of coordinates, Contravariant and covariant vectors and tensors, Scalar invariants, Mixed tensors, Symmetric and skew –symmetric tensor, Algebra of tensors, Contraction and inner product, Quotient law, Reciprocal tensors.	12
II	Associated tensors, Length of a vector, Unit Vector, Null vector and orthogonal vector, Riemannian Metric and Space and Christoffel symbols.	11
III	Covariant differentiation of vector and tensor, Ricci's theorem, Gradient of scalar, Divergence of a contravariant vector , covariant vector and conservative vector, Divergence of a contravariant tensor of order two, Divergence of a mixed tensor of type (1,1), Laplacian of an invariant ,curl of a covariant vector **.**	11
IV	Riemannian curvature tensor and their properties, Flat space, Ricci tensor and scalar curvature, Einstein space and Einstein tensor.	11

Suggested Readings:

1. David C. Kay, Tensor Analysis, Schaum's Outline Series, McGraw Hill 1988.
2. R. S, Mishra, A Course in Tensors with Applications to Reimannian Geometry, Pothishala Pvt.Ltd, Allahabad.
3. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

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

Statistics, Physics, Computer Sc. / App Chem., Bio-Chem, Geography, Economics, Defence & Strategic Studies, BCA, BBA, B. Tech (Engg. / Tech).

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.Second Year Programme.

B.A./B.Sc. III (SEMESTER-I) PAPER-III

DIFFERENTIAL GEOMETRY

Class: B.A. / B.Sc.	**Year: THIRD**	**Semester: FIFTH**
Subject: MATHEMATICS		
Course Code: MAT 303 (B030502T)	**Course Title: DIFFERENTIAL GEOMETRY**	

Course outcomes:

CO1: The course is aimed at exposing the students to foundations of tensor analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.

CO3: Students will be able to know the concepts of curve, basic concepts and developments of differential geometry which will prepare the students to take up further applications in the relevant fields.

CO4: The course enables the students the basics of tensor and differential geometry for further application in higher studies.

Credits: 3	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: As per UGC/ University CBCS norm.**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-0-0

Unit	Topics	No. of Lectures
	DIFFERENTIAL GEOMETRY	
I	Local theory of curves –space curves, Regular curve and Plane curve, twisted curve, equation of a plane and straight line, equation of curves in space, length of a curve, tangent to curve, Order of contact between curves and surfaces, osculating plane , equation of osculating plane, equation osculating plane at a point of curve of intersection of two surfaces. Tangent, principal normal and binormal, normal plane and rectifying plane.	**12**
II	Curvature and torsion, Serret-Frenet formulae, Direction cosines of the principal normal and binormal, Osculating circle, Osculating sphere. Involutes and evolutes of curves Curve on surface, Regular point and Singularities of surface, transformation of parameters, Parametric curves, tangent plane and normal line, First fundamental form and arc length. Angle between two curves on surface.	**11**
III	Special tensors and its properties, orthogonal trajectories, Differential equation of orthogonal trajectories. Second fundamental form of surface, Geometric interpretation of the second fundamental form, Gauss and Weingarten equation.	**11**
IV	Identities based on Weingarten equation, Normal curvature and its equation, Meusnier's theorem. Definition and Basic Properties of Geodesics, Geodesic Equation.	**11**

Suggested Readings :

1. Somasundaram, Differential Geometry, Narosa Publishing House
2. Andrew Pressley, Elementary Differential Geometry,Springar Verlag,2014
3. M. P. do Carmo, Differential geometry of curves and surfaces, Prentice Hall 1976.
4. Gray, Differential Geometry of Curves and Surfaces, CRC Press, 1998.
5. S. Montiel and A. Ros, Curves and Surfaces, American Mathematical Society, 2005.
6. B. O'Neill, Elementary Differential Geometry, Elsevier 2006 .
7. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

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

Statistics, Physics, Computer Sc. / App Chem., Bio-Chem, Geography, Economics, Defence & Strategic Studies, BCA, BBA, B. Tech (Engg / Tech).

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment.The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.Second Year Programme.

B.A./B.Sc. III (SEMESTER-VI) PAPER-I
METRIC SPACES AND COMPLEX ANALYSIS

Class: B.A. / B.Sc.	**Year: THIRD**	**Semester: SIXTH**
Subject: MATHEMATICS		
Course Code: MAT 304 (B030601T)	**Course Title: METRIC SPACES AND COMPLEX ANALYSIS**	

Course outcomes:

CO1: The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.

CO3: Students will be able to know the concepts of metric space, basic concepts and developments of analysis which will prepare the students to take up further applications in the relevant fields.

CO4: The course enables the students the basics of metric spaces and contour integration for further application in higher studies.

Credits: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART-A **METRIC SPACES**	
I	Definition of a Metric Space, Examples of Metric Space, Bounded and Unbounded Metric Space, Pseudo-metric, Subspace of a Metric Space, Diameter of a Subset of a Metric Space, Distance of a Point from a Non-empty set, Distance between two Non-empty Subsets of a Metric Space. Open and Closed Spheres, Neighborhood of a point, Interior Point and Interior of a Set, Open sets, Equivalent Metrics, Exterior, Frontier and Boundary of a Set, Limit Point and Isolated Point, Derived Set, Closed Set, Closure of a Set ,Dense Sets and Separable Spaces.	8
II	Subspace of a Metric Space, Examples, Sequence in a Metric Space, Convergence in a Metric Space Cauchy Sequence, Complete Metric Space, Isometry and Isometric Space.	7
III	Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.	8
IV	Cover, Compact Sets and compact Space, Finite Intersection Property and Compactness, Continuity and Compactness, Sequentially Compactness. Separated Sets, Disconnected Space and Disconnected Sets, Connected Space and Connected Sets, Components.	7

Unit	Topics	No. of Lectures
	PART-B **COMPLEX ANALYSIS**	
V	Complex numbers as ordered pairs, geometric representation of complex number, Stereographic projection, Continuity and Differentiability of complex functions, Analytic functions, Cauchy Riemann equations, Harmonic functions.	8
VI	Complex integration, Cauchy-Goursat theorem, Cauchy's Integral formula, Formulae for first, second and nth derivatives, Cauchy's Inequality, Liouville's Theorem.	7
VII	Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic, De Morgan and Cauchy's condensation test, Taylor Series, Laurent Series and its examples.	8
VIII	Zeroes and poles of order m, Isolated singular points, Types of isolated singular points , Residues, Residues at poles and its examples, Residue at infinity, Cauchy's residue theorem, Evaluation of improper real integrals, Definite integrals involving sines and cosines.	7

Suggested Readings: (Part-A Metric Spaces)

1. Shanti Narayan, A Course of Mathematical Analysis, S. Chand Publication.
2. Satish Shirali and H. L Vasudeva. Metric Spaces, (2009), Springer, First Indian Print.
3. S, Kumaresan. Topology of Metric Spaces (2nd ed.), (2014). Narosa Publishing House. New Delhi.
4. G. F. Simmons, Introduction to Topology and Modern Analysis (2004), Tata McGraw Hill. New Delhi
5. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings: (Part-B Complex Analysis)

1. Shanti Narayan, Theory of Functions of a Complex Variable, S. Chand Publications.
2. J.W.Brown and R.V. Churchill Complex variables and Applications, McGraw-Hill Higher Education.
3. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.
4. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

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

Statistics, Physics, Computer Sc. / App Chem., Bio-Chem, Geography, Economics, Defence & Strategic Studies, BCA, BBA, B. Tech (Engg. / Tech).

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.Second Year Programme.

B.A./B.Sc. III (SEMESTER-VI) PAPER-II

NUMERICAL ANALYSIS AND OPERATIONS RESEARCH

Class: B.A. / B.Sc.	**Year: THIRD**	**Semester: SIXTH**
Subject: MATHEMATICS		
Course Code: MAT 305 (B030602T)	**Course Title: NUMERICAL ANALYSIS AND OPERATIONS RESEARCH**	

Course outcomes:

CO1: The aim of this course is to teach the students the application of various numerical techniques, application of linear programming for variety of problems occurring in daily life. At the end of the course the student will be able to understand the basic concept of Numerical Analysis, the basic concept of linear programming and to solve Algebraic and differential equation.

CO2: The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can opt for advance course in Numerical Analysis and linear programming in higher Mathematics

CO3: The student will be able to solve various problems based on numerical techniques. After successful completion of this paper will enable the students to apply the basic concepts of numerical techniques problems, transportation problems and its related problems to apply in further concepts and application of Numerical Analysis and operation research.

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CO4: After successful completion of this course students have basic knowledge of Numerical Analysis and operation research for higher study and Research.

Credits: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	PART-A **NUMERICAL ANALYSIS**	
I	Error in numerical computations ,Calculus of finite differences, Difference operators, Fundamental theorem of differential calculus, Interpolation with equal and unequal intervals, Newton's forward and backward interpolation formulae, Divided difference interpolation formula, Lagrange's interpolation formula.	8
II	Solutions of algebraic and transcendental equations, Direct and iterative methods,, Bisection method, Regula-falsi method, Newton- Raphson method, Iteration method. Solution of simultaneous linear equations: Gauss-elimination method, Guass-Jordan method, LU decomposition method, Guass-Seidel method.	7
III	Numerical differentiation derivatives using forward and backward formula, Numerical Integration, General Quadrature formula, Trapezoidal rule, Simpson's one-third and three-eight formulae and Weddle's rules.	8
IV	Numerical solution of ordinary differential equation, Picard method, Taylor series method, Euler's method, Modified Euler's method, Runge-Kutta method.	7

Unit	Topics	No. of Lectures
	PART-B **OPERATIONS RESEARCH**	
V	Developing mathematical models, Mathematical programming, Linear programming, Convex sets, Convex and concave functions, Theorems on convexity, Linear programming problem (LPP), Simple and general LPP, Solutions of simple LPP by graphical method, Analytical solution of general LPP, Canonical and standard forms of LPP, Slack and surplus variables.	8
VI	Solution of general LPP by Simplex method. Use of artificial variables in simplex method, Big-M method and Two-Phase method, Concept of duality in linear programming, Theorems on duality, Dual simplex method.	7
VII	Transportation problem, Solution of transportation problem, Methods for finding Initial basic feasible solution of transportation problem, Optimal solution of transportation problem by modified distribution (MODI) method, Degeneracy in transportation problem, Maximization transportation problem. Assignment problem, Balanced and unbalanced assignment problems. Solution of assignment Problem, Hungarian Method, Maximization Assignment problem.	8
VIII	Game Theory: Competitive game, Two-Person Zero-Sum (Rectangular) game, Minimax-maximin criteria, Saddle points, Solution of rectangular game with and without saddle points, Huge rectangular games, Dominance rules, Solution of huge rectangular games using rules of dominance, Graphical method for 2xn and mx2 games without saddle points.	7

Suggested Readings:(Part-A Numerical Analysis)

1. M. K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical Methods for Engineering and scientificcomputation
2. S. S. Sastry, Introductory methods of Numerical Analysis
3. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings : (Part-B Operation Research)

1. Taha, Hamdy H, Opearations Research- An Introduction, Pearson Education.
2. V. S. Verma, Linear Programming and Game Theory, Neelkamal Prakashan, Gorakhpur, 2011.
3. Kanti Swarup , P. K. Gupta , Man Mohan Operations research, Sultan Chand & Sons
4. Hillier Frederick S and Lieberman Gerald J., Operations Research, McGraw Hill Publication.
5. Winston Wayne L., Operations Research: Applications and Algorithms, Cengage Learning, 4th Edition.
6. Hira D.S. and Gupta Prem Kumar, "Problems in Operations Research: Principles and Solutions", S Chand & Co Ltd.
7. Kalavathy S., Operations Research, S. Chand.
8. Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/ Web Links:

- National Programme on Technology Enhanced Learning (NPTEL)
- SWAYAM
- Massachusetts Institute of Technology (MIT) Open Learning
- Uttar Pradesh Higher Education Digital Library (UPHEDL)
- National Digital Library of India (NDLI)

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

Statistics, Physics, Computer Sc. / App Chem., Bio-Chem, Geography, Economics, Defence & StrategicStudies, BCA, BBA, B. Tech (Engg / Tech).

Internal Evaluation Methods (Max. Marks: 25)

Internal Evaluation shall be based on Class test, Presentation and Assignment. The marks shall be as follows:

S.No.	Assessment Type	Max. Marks
1	Class Test-I (Descriptive Questions)	5
2	Class Test-II (Objective Questions)	5
3	Presentation/ Class Interaction	5
4	Assignment	10

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.Second Year Programme.

B.A./B.Sc. III (SEMESTER-VI) PAPER-III

PRACTICAL

Class: B.A. / B.Sc.	**Year: THIRD**	**Semester: SIXTH**
Subject: MATHEMATICS		
Course Code: MAT 306 (B030603T)	**Course Title: PRACTICAL**	

Course outcomes:

CO1. The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, Interpolation, Numerical Integration, ordinary differential equations, ordinary difference equations by using different computer software such as Sage Math/Mathematica /MATLAB / /Maple / Scilab /C programming / R programming etc.

CO2. After completion of this course student would be able to solve the transcendental and algebraic equations.

Credits: 2	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:** As per UGC/ University CBCS norm.

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Unit	Topics	No. of Lectures
	• **Practical / Lab work to be performed in Computer Lab.** • **List of the practicals to be done using Sage Math / Mathematica / MATLAB / Maple / Scilab / R programming / Python / C programming etc.**	**60**
I.	Solution of transcendental and algebraic equations by i. Bisection method ii. Regula Falsi method iii. Newton Raphson method iv. Iteration method	
II.	Solution of system of linear equations by i. LU decomposition method ii. Gaussian elimination method iii. Gauss-Seidel method	
III.	Interpolation by i. Newton's forward Interpolation ii. Newton's backward Interpolation iii. Lagrange Interpolation iv. Divided difference interpolation formula	
IV.	Numerical Integration by i. Trapezoidal Rule ii. Simpson's one third rule	
V.	Numerical Integration by i. Simpson's three-eight rule ii. Weddle's Rule	
VI.	Solution of ordinary differential equations by i. Euler method ii. Runge Kutta method	

VII.	Solution of ordinary difference equations by Picard method.	
VIII.	Solution of ordinary difference equations by Taylor series method.	

Internal Evaluation Methods (Max. Marks: 25)

Practical Internal Evaluation shall be based on Practical File/Record, Class test, Viva-voce and Overall performance. The marks shall be as follows:

S.No.	**Assessment Type**	**Max. Marks**
1	Test (Descriptive /Objective Questions)	5
2	Presentation of any one Practical / Class Interaction	5
3	Viva-voce	5
4	Practical File/Record	10

External Evaluation Methods (Max.Marks: 75)

Practical External Evaluation shall be based on Viva-voce, Practical File/Record and Practical Exercises. The marks shall be as follows:

Practical Exercise : 01 x 25 Marks	25 Marks
Practical File/Record/ Overall Performance	20 Marks
Viva-voce	30 Marks

There shall be 04 Practical Exercises in Examination comprising 01 as Compulsory.

Course prerequisites:

To study this course, a student must have passed Mathematics as Major Subject in B.A. /B.Sc.Second Year Programme.

Any remarks:

- At least two Computer Programmers and two Computer Operators must be assigned in computer lab.
- There should be a Computer Lab with minimum of 25 computer systems for 50 students with licensed and Free Open Source softwares related to this course.