NATIONAL EDUCATION POLICY-2020

Common Minimum Syllabus for all Uttarakhand State Universities and Colleges for First Three Years of Higher Education

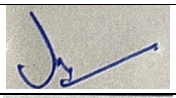
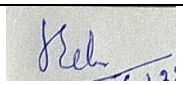
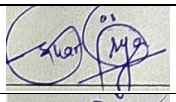
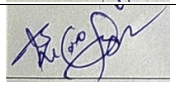
PROPOSED STRUCTURE OF
UG - MATHEMATICS
SYLLABUS

2021

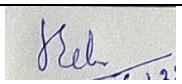
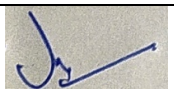
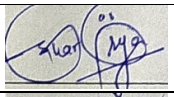
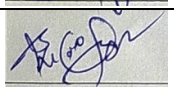
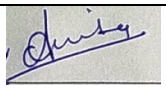
Curriculum Design Committee, Uttarakhand

Sr.No.	Name & Designation	
1.	Prof. N.K. Joshi Vice-Chancellor , Kumaun University Nainital	Chairman
2.	Prof. O.P.S. Negi Vice-Chancellor , Uttarakhand Open University	Member
3.	Prof. P. P. Dhyani Vice-Chancellor , Sri Dev Suman Uttarakhand University	Member
4.	Prof. N.S. Bhandari Vice-Chancellor, Soban Singh Jeena University Almora	Member
5.	Prof. Surekha Dangwal Vice-Chancellor, Doon University, Dehradun	Member
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member
7.	Prof. K. D. Purohit Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member

SYLLABUS EXPERT COMMITTEE

S. No.	Name	Signature
1	Prof. Anita Tomar, HoD, Department of Mathematics, Sri Dev Suman Campus, Rishikesh	
2	Prof. Jaya Upreti, HoD, Department of Mathematics, S. S. J. Campus, Almora	
3	Dr. Shankar Kumar, Assistant Professor, Department of Mathematics, Govt. P. G. College, Ranikhet.	
4	Dr. Sundar Kumar Arya, Assistant Professor, Department of Mathematics, Govt. P. G. College, Pithoragarh.	

SYLLABUS PREPRATION COMMITTEE

S. No.	Name	Signature
1	Prof. Jaya Upreti, HoD, Department of Mathematics, S. S. J. Campus, Almora	
2	Prof. Anita Tomar, HoD, Department of Mathematics, Sri Dev Suman Campus, Rishikesh	
3	Dr. Shankar Kumar, Assistant Professor, Department of Mathematics, Govt. P. G. College, Ranikhet.	
4	Dr. Sundar Kumar Arya, Assistant Professor, Department of Mathematics, Govt. P. G. College, Pithoragarh.	
5	Dr. Anita Kumari, Assistant professor, Department of Mathematics, D. S. B. Campus, Almora.	

SEMESTER WISE TITLES OF THE PAPER IN UG MATHEMATICS COURSE					
YEAR	**SEMESTER**	**COURSE CODE**	**PAPER TITLE**	**THEORY/ PRACTICAL**	**CREDIT**
CERTIFICATE COURSE IN BASIC MATHEMATICS					
FIRST YEAR	**I**	**UGMAT101T**	Matrices, Trigonometry and Differential Calculus	THEORY	**4**
		UGMAT102P	Practical	PRACTICAL	**2**
	II	**UGMAT201T**	Integral Calculus and Vector Analysis	THEORY	**6**
DIPLOMA IN MATHEMATICS					
SECOND YEAR	**III**	**UGMAT301T**	Group Theory and Analytical Geometry	THEORY	**6**
	IV	**UGMAT401T**	Ordinary Differential Equations and Ring Theory	THEORY	**6**
DEGREE IN MATHEMATICS					
THIRD YEAR	**V**	**UGMAT501T**	Real Analysis, Functions of several variables and Partial Differential Equations	THEORY	**5**
		UGMAT502T	Any one of the following- (i) Mathematical Methods and Graph Theory (ii) Number Theory and Relativity (iii) Numerical Analysis and Operations Research	THEORY	**5**
	VI	**UGMAT601T**	Complex Analysis and Mechanics	THEORY	**5**
		UGMAT602T	Linear Algebra and Metric Spaces	THEORY	**5**

PROPOSED STRUCTURE OF UG MATHEMATICS SYLLABUS AS PER NEP 2020 GUIDELINES GENERAL OVERVIEW

B.A./B.Sc. I

PROGRAMME	YEAR	SEMESTER (15Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
CERTIFICATE COURSE IN BASIC MATHEMATICS	FIRST YEAR	SEMESTER – I	**Paper-1**	**4**	4	4x15=60	**Matrices, Trigonometry and Differential Calculus** **Part A: Matrices** **Part B: Trigonometry** **Part C: Differential Calculus**	**Part A** Unit I (8) Unit II (7) Unit III (5) **Part B** Unit IV (6) Unit V (6) **Part C** Unit VI (7) Unit VII (6) Unit VIII (8) Unit IX (7)	Mathematics in 12^{th}	Engg. and Tech. (UG), Chemistry/ Biochemistry/ Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/ BCA, B.Sc. (C.S.)
			Paper-2 Practical	**2**	**2 Lab Periods (2 Hours Each)**	2x2x15=60	**Practical** (Practicals to be done using Mathematica/MATLAB / Maple /Scilab /Maxima etc.)		Mathematics in 12^{th}	Engg. and Tech. (UG), B.Sc. (C.S.)
		SEMESTER – II	**Paper-1**	**6**	**6**	15x6=90	**Integral Calculus and Vector Analysis** **Part A: Integral Calculus** **Part B: Vector Analysis**	**Part A** Unit I (12) Unit II (11) Unit III (12) Unit IV (11) **Part B** Unit V (11) Unit VI (12) Unit VII (11) Unit VIII (10)	Mathematics in 12^{th}	Engg. and Tech. (UG), B.Sc. (C.S.)

B.A./B.Sc. II

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DIPLOMA IN MATHEMATICS	SECOND YEAR	SEMESTER – III	Paper-1	6	6	6x15=90	**Group Theory and Analytical Geometry** **Part A: Group Theory** **Part B: Analytical Geometry**	**Part A** Unit I (12) Unit II (20) Unit III (13) **Part B** Unit IV (11) Unit V (12) Unit VI (12) Unit VII (10)	Certificate Course in Basic Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)
		SEMESTER – IV	Paper-1	6	6	6x15=90	**Ordinary Differential Equations and Ring Theory** **Part A: Ordinary Differential Equations** **Part B: Ring Theory**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (11) Unit VI (10) Unit VII (12) Unit VIII (12)	Certificate Course in Basic Mathematics	Economics (UG/PG), B.Sc. (C.S.) Engineering and Technology (UG), Science (Physics-UG)

B.A./B.Sc. III

PROGRAMME	YEAR	SEMESTER (15Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DEGREE IN MATHEMATICS	THIRD YEAR	SEMESTER–V	Paper-1	5	5	5x15=75	**Real Analysis & Functions of several variables and Partial Differential Equations** **Part A: Real Analysis** **Part B: Functions of several variables and Partial Differential Equations**	**Part A** Unit I (8) Unit II (8) Unit III (7) Unit IV (7) Unit V (7) **Part B** Unit VI (8) Unit VII (8) Unit VIII (7) Unit IX (8) Unit X (7)	Diploma in Mathematics	Engg. And Tech.(UG), Economics (UG/PG), B.Sc.(C.S.)
			Paper-2	5	5	5x15= 75	**(i) Mathematical Methods & Graph Theory** **Part A: Mathematical Methods** **Part B: Graph Theory**	**Part A** Unit I (8) Unit II (10) Unit III (10) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech.(UG), BCA, B.Sc.(C.S.)

DEGREE IN MATHEMATICS	**THIRD YEAR**	**SEMESTER–V**	Paper-2	**5**	**5**	5x15= 75	**(ii) Number Theory & Relativity** **Part A: Number Theory** **Part B: Relativity**	**Part A** Unit I (16) Unit II (11) Unit III (12) **Part B** Unit IV (14) Unit V (12) Unit VI (10)	Diploma in Mathematics	Engg. and Tech. (UG), BCA, B.Sc. (C.S.)
			Paper-2	**5**	**5**	5x15= 75	**(iii) Numerical Analysis & Operations Research** **Part A: Numerical Analysis** **Part B: Operations Research**	**Part A** Unit I (9) Unit II (9) Unit III (10) Unit IV (10) Unit V (9) **Part B** Unit VI (16) Unit VII (12)	Diploma in Mathematics	Engg. and Tech. (UG), Economics(UG/PG), BBA/BCA, B.Sc.(C.S.)
DEGREE IN MATHEMATICS	**THIRD YEAR**	**SEMESTER–VI**	Paper-1	**5**	**5**	5x15=75	**Complex Analysis & Mechanics** **Part A: Complex Analysis** **Part B: Mechanics**	**Part A** Unit I (9) Unit II (9) Unit III (10) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)

DEGREE IN MATHEMATICS	**THIRD YEAR**	**SEMESTER–VI**	Paper-2	**5**	**5**	5x15= 75	**Linear Algebra** **&** **Metric Spaces** **Part A: Linear Algebra** **Part B: Metric Spaces**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) Unit V (9) **Part B** Unit VI (6) Unit VII (11) Unit VIII (12)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)

Programme Outcome/Programme Specific Outcome

Programme Outcome:

PO1: It is to give in-depth knowledge of geometry, algebra, calculus, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas such as computer science and other allied subjects.
PO2: The skills and knowledge gained in this program will be helpful for modeling and solving of real life problems.
PO3: Students will become employable in various government and private sector.
PO4: The completing this programme develop enhanced quantitative skills and pursuing higher mathematics and research as well.
PO5: The completion of this programme will enable the learner to use appropriate digital programmes and softwares to solve various mathematical problems.

Programme Specific Outcome:

PSO1: Student should be able to think in a critical manner and develop problem solving skills.
PSO2: Students should be able to recall basic facts about mathematics and display knowledge of conventions such as notations, terminology etc.
PSO3: Students are able to formulate and develop mathematical arguments in a logical manner.
PSO4: Students are motivate and prepare for research studies in mathematics and related fields.
PSO5: Student should be able to apply their skills and knowledge in various fields of studies including, science, engineering, commerce and management etc.

B.A./B.Sc. I (MATHEMATICS)

Detailed Syllabus For

CERTIFICATE

COURSE IN

BASIC MATHEMATICS

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

Matrices, Trigonometry and Differential Calculus

Programme: Certificate Class: B.A. / B.Sc.	Year: First	Semester: First
Subject: Mathematics		
Course Code: UGMAT101T	Course Title: Matrices, Trigonometry and Differential Calculus	

Course outcomes:

CO1: The programme 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 matrices and basics of differentiation.
CO3: The student will be able to sum the trigonometric series of real and complex numbers and separate the trigonometric function in form of A+iB.
CO4: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.
CO5: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.

Credits: 4	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures-Tutorials – Practical (in hours per week): L-T-P:4-0-0	

Part-A
Matrices

Unit	Topics	No. of Lectures
I	Matrix introduction, matrix operations with their properties, symmetric, skew-symmetric, Hermitian and skew- Hermitian matrices, idempotent, nilpotent, involuntary, orthogonal and unitary matrices, singular and non-singular matrices, elementary operations on matrices, adjoint and inverse of a matrix, singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix.	8
II	Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices.	7
III	Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations.	5

Part-B
Trigonometry

Unit	Topics	No. of Lectures
IV	Trigonometric or circular and hyperbolic function of complex variable together with their inverses, De Moivre's Theorem and its applications, Euler's theorem, relation between trigonometric and hyperbolic function, Exponential function of a complex variable, Logarithms of complex variable, Properties of logarithmic function, Separation into real and imaginary parts	6
V	Gregory's series, Value of π by different series, Summation of Trigonometric series by C+iS method based on Arithmetic Progression, Geometric Progression, Logarithms and Binomial expansions, Summation of Trigonometric series by difference method.	6

Part-C

Differential Calculus

Unit	Topics	No. of Lectures
VI	Functions of one variable, Limit of a function (ε-δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of singe variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems.	7
VII	Successive Differentiation, n^{th} Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.	6
VIII	Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normals of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula).	8
IX	Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection.	7

Suggested Readings (PART-A Matrices):

1. Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008
2. Fuzhen Zhang, Matrix Theory- Basic Results and Techniques, Springer, 1999
3. Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (PART-B Trigonometry):

1. Margaret L. Lial, John Hornsby, David I. Schneider, Trigonometry, Addison-Wesley, 2001
2. Robert Moyer,Frank Aryes, Schaum's Outline of trigonometry, 2012
3. I. M. Gelfand, Mark Saul, Trigonometry, Birkhäuser; 2001st edition (June 8, 2001)
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part- C Differential Calculus):

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1999
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc., 1974
3. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2019
4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication. 1992
5. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007
6. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Chemistry/ Biochemistry/ Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/ BCA, B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S.N.	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course perquisites: To study this course a student must have subject Mathematics in class 12^{th}.

Suggested equivalent online courses:

Further Suggestions:

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

Practical

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: First**
Subject: Mathematics		
Course Code: UGMAT102P	**Course Title: Practical**	

Course outcomes:

CO1: The main objective of the course is too familiar the student with different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc.

CO2. The students will be able to compute various operations on matrices by using different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc.

CO2. The students will also be able to compute n^{th} derivative of various functions by using different computer software.

Credits:2	**Core Compulsory/Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

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 practical to be done using R/Python/Mathematica/MATLAB/Maple/Scilab/Maxima etc. 1. Introduction to the software and commands related to the topic. 2. Computation of addition and subtraction of matrices, 3. Computation of multiplication of matrices. 4. Computation of Trace and Transpose of Matrix. 5. Computation of Rank of matrix. 6. Computation of Inverse of a Matrix. 7. Solving the system of homogeneous and non-homogeneous linear algebraic equations. 8. Finding the n^{th} Derivative of e^{ax}, trigonometric and hyperbolic functions. 9. Finding the n^{th} Derivative of algebraic and logarithmic functions. 10. Finding the n^{th} Derivative of $e^{ax}\sin(bx + c)$, $e^{ax}\cos(bx + c)$. 11. Finding the Taylor's and Maclaurin's expansions of the given functions.	**60**

Suggested Readings:

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S.N.	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course a student must have subject Mathematics in class 12^{th}.

Suggested equivalent online courses:

Further Suggestions:

B.A. / B.Sc. I (SEMESTER-II) PAPER – I
Integral calculus and Vector Analysis

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: Second**
Subject: Mathematics		
Course Code: UGMAT201T	**Course Title: Integral calculus and Vector Analysis**	

Course outcomes:

CO1: The Programme 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 surface area and volume of shapes.

CO3: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he 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 well towards taking more advance level course in mathematics.

Credits: 6	**Core Compulsory/Elective**
Max. Marks: 25+75	**Min. Passing Marks:**
Total No. of Lectures – Tutorials – Practical (in hours per week): L-T-P: 6-0-0	

PART-A

Integral Calculus

Unit	Topics	No of Lectures
I	Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation and integration under the integral sign.	**12**
II	Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.	**11**
III	Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Drichlet's theorem and its Liovelle's extension.	**12**
IV	Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	**11**

PART- B

Vector Analysis

Unit	Topics	No. of Lectures
V	Triple product, Reciprocal vectors, Product of four vectors, General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes.	**11**
VI	Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line, Intersection of three planes, Transformation of coordinates.	**12**
VII	Ordinary differentiation of vectors, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl.	**11**
VIII	Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem (without proof).	**10**

Suggested Readings (Part- A Integral Calculus):

1. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc., 1974
2. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part- B Vector Analysis):

1. Murray R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill.
2. N. Saran and S. N. Nigam: Introduction to Vector Analysis, Pothishala Pvt. Ltd. Allahabad.
3. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course a student must have subject Mathematics in class 12^{th}.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. II (MATHEMATICS)

Detailed Syllabus For

DIPLOMA
IN
MATHEMATICS

B.A./B.Sc. II (SEMESTER-III) PAPER-I Group Theory and Analytical Geometry

Programme: Diploma Class: B.A./B.Sc.	Year: Second	Semester: Third
Subject: Mathematics		
Course Code: UGMAT301T	Course Title: Group Theory and Analytical Geometry	

Course outcomes:

CO1: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of Group and their properties.
CO2: This course will lead the student to basic course in advanced mathematics and geometry.
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: 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.
CO5: On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going for higher studies and research.

Credits: 6	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures - Tutorials-Practical (in hours per week): L-T-P:6-0-0	

Part-A

Group Theory

Unit	Topics	No. of Lectures
I	Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence Modulo n, Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups	12
II	An Alternative set of postulates of groups, Subgroups, Permutations, Cyclic Permutations, Even and odd permutations, group of Permutations alternating group, Integral power of an element of a group, Order of an element of a group, Group homomorphism, Isomorphism on groups, the relation of isomorphism in the set of all groups Complexes and subgroup of a group, theorems on subgroups, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem, Cyclic group, generating system of group.	20
III	Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.	13

Part-B
Analytical Geometry

Unit	Topics	No. of Lectures
IV	Polar Equation of conics, Polar coordinate system, Distance between two points, Polar equation of a Straight line, Polar equation of a circle, Polar equation of a conic, Chords, Tangent and Normal to a conic	11
V	Curvilinear coordinates, Spherical and Cylindrical coordinates, Definition and equation of a sphere, Plane section of a sphere, Intersection of two spheres, Intersection of a sphere and a line, Power of a point, tangent plane, Plane of contact, Polar plane, Pole, Angle of Intersection of two spheres, Radical plane, Co-axial system of spheres.	12
VI	Definition and equation of a cone, Vertex, Guiding curve, Generators, Three mutually perpendicular generators, Intersection of a line with a cone, Tangent line and tangent plane, Reciprocal cone, Right circular cone, Definition and equation of a cylinder, Right circular cylinder, Enveloping cylinder.	12
VII	General equation of second degree, Tangent plane, Director sphere, Normal, Plane of contact, Polar plane, Conjugate plane and conjugate points	10

Suggested Readings (Part-A Group Theory):

1. J. B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
3. Thomas W Hungerford, Abstract Algebra–An Introduction, Sauders College Publishing, 1990
4. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
5. V. K. Khanna and S. K. Bhambri, A course in Abstract Algebra, Vikas Publishing House Pvt (Ltd), 2014.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Analytical Geometry):

1. Robert J.T Bell, An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd., 1923
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson, 2013
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London. 2018
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Certificate Course in Basic Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. II (SEMESTER-IV) PAPER-I Ordinary Differential Equations and Ring Theory

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester: Fourth**
Subject: Mathematics		
Course Code: UGMAT401T	**Course Title: Ordinary Differential Equations and Ring Theory**	

Course outcomes:

CO1: The objective of this course is to familiarize the students with various methods of solving differential equations of first and second order 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 wave equation, heat equation, diffusion equation, gas dynamics, nonlinear evolution equation etc.
CO3: Ring theory is one of the building areas of modern algebra. Objective of this course is to introduce students to basic concepts of Ring, Integral domain and other structures with their properties. This course will lead the student to basic course in advanced mathematics and Algebra.

Credits: 6	**Core Compulsory/Elective**
Max. Marks: 25+75	**Min. Passing Marks:**
Total No. of Lectures - Tutorials-Practical (in hours per week): L-T-P:6-0-0	

Part-A

Ordinary Differential Equations

Unit	Topics	No. of Lectures
I	Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution dy/dx= f(x,y).	**12**
II	Differential equations of first order and first degree, Separation of variables, Homogeneous linear Equations, Exact Equations, Integrating Factor, Linear Equation, Equation of First order but not of first degree, Various methods of solution, Clairaut's form, Singular solutions, Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves.	**11**
III	Linear differential equations with constant coefficients, Complementary function, Particular integral, Working rule for finding solution of linear differential equations with constant coefficients, Homogeneous linear equations or Cauchy-Euler equations.	**11**
IV	Simultaneous differential equations, Differential equations of the form dx/P= dy/Q= dz/R where P, Q, R are functions of x, y, z. Exact differential equations, Total differential equations, Series solutions of differential equations, Linear differential equations of second order with variable coefficients, Initial and boundary value problems.	**11**

Part-B

Ring Theory

Unit	Topics	No. of Lectures
V	Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings.	11
VI	Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring.	10
VII	Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorisation Domain, Euclidean rings.	12
VIII	Polynomials over a ring, Degree of a polynomial, Zero, Constant and monic polynomials, Equality of polynomials, Addition and multiplication of polynomials, Polynomial rings, Embedding of a ring R into R[x], Division algorithm, Euclidean algorithm, Units and associates in polynomials, Irreducible polynomials.	12

Suggested Readings (Part-A Differential Equations):

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGraw Hill, 2002
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa, 2002
3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication, 2013
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific. 1970
5. M. D. Raisinghania, Ordinary and Partial Differential Equations, S Chand, 2018.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Ring Theory):

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
3. Thomas W Hungerford, Abstract Algebra – An Introduction, Sauders College Publishing, 1990
4. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Economics (UG/PG), B.Sc. (C.S.) Engineering and Technology (UG), Science (Physics-UG)

Suggested Continuous Evaluation Methods: Max. Marks:25

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Certificate Course in Basic Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (MATHEMATICS)

Detailed Syllabus For

DEGREE
IN
MATHEMATICS

B.A./B.Sc. III (SEMESTER-V) PAPER-I Real Analysis, Functions of several variables and Partial Differential Equations

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code: UGMAT501T	Course Title: Real Analysis, Functions of several variables and Partial Differential Equations	

Course outcomes:

CO1: Students will be able to know the basic concepts and developments of real analysis which will prepare the students to take up further applications in the relevant fields.

CO2: On successful completion of the course students should have knowledge about real analysis and will help him in going for higher studies and research.

CO3: The main objective of the course is to equip the student with necessary analytic and technical skills.

CO4: The course in partial differential equation intends to develop problem solving skills for solving various types of partial differential equation especially hyperbolic, parabolic and elliptic types of PDE.

Credits: 5	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0	

PART-A

Real Analysis

Unit	Topic	No. of Lectures
I	**Continuity and Differentiability of functions:** Continuity of functions, Uniform continuity, Differentiability, Taylor's theorem with various forms of remainders.	8
II	**Integration:** Riemann integral-definition and properties, integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.	8
III	**Sequence and Series:** Sequences, theorems on limit of sequences, Cauchy's convergence criterion, infinite series, series of non-negative terms, Absolute convergence, tests for convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's, Logarithmic test, De Morgan's Test, Alternating series, Leibnitz's theorem.	7
IV	**Improper Integrals:** Improper integrals and their convergence, Comparison test, Dritchlet's test, Absolute and uniform convergence, Weierstrass M-Test, Infinite integral depending on a parameter.	7
V	**Uniform Convergence:** Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Dritchlet's test, Convergence and uniform convergence of sequences and series of functions.	7

PART-B

Functions of several variables and Partial Differential Equations

Unit	Topic	No. of Lectures
VI	**Functions of several variables:** Limit, continuity and differentiability of functions of several variables.	8

VII	**Partial Derivatives:** Partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, Jacobians, Chain rule, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables.	**8**
VIII	**Maxima and Minima:** Maxima and minima of functions of several variables – Lagrange's method of multipliers.	**7**
IX	**Partial differential equations:** Partial differential equations of first order, Charpit's method, Linear partial differential equations with constant coefficients. First-order linear, quasi-linear and non-linear PDE's using the method of characteristics: know how to obtain explicit solutions.	**8**
X	**Partial differential equations of 2nd-order:** Classification of 2nd-order linear equations in two independent variables: hyperbolic, parabolic and elliptic types (with examples).	**7**

Suggested Readings (Part-A Real Analysis):

1. Walter Rudin: Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, 1976, International Student Edition.
2. K. Knopp: Theory and Application of Infinite Series.
3. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
4. P. R. Halmos: Naive Set Theory, Van Nostrand, 1960.
5. S. C. Malik and Savita Arora, Mathematical Analysis , New Age International Pvt. (Ltd), 2012.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Functions of several variables and Partial Differential Equations):

1. W. Fleming: Functions of several variables, Springer
2. R P Agrawal: Ordinary and Partial Differential Equations, Springer
3. K Sankar Rao: Partial Differential Equations, PHI
4. M. D. Raisinghania, Ordinary and Partial Differential Equations, S Chand, 2018.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. And Tech.(UG), Economics (UG/PG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S. N.	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (i) Mathematical Methods and Graph Theory

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code: UGMAT502T	Course Title: Mathematical Methods and Graph Theory	

Course outcomes:

CO1: The student will be able to find the integral transform, Laplace transform, inverse Laplace transform and Fourier transform. The course in mathematical methods basically develops a problem solving skill in the students.

CO2: Upon successful completion, students will have the knowledge of various types of graphs, their terminology and applications.

CO3: After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topics include path, circuits, adjacency matrix, tree, coloring. After successful completion of this course the student will have the knowledge graph coloring, color problem, vertex coloring.

Credits: 5	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A

Mathematical Methods

Unit	Topic	No. of Lectures
I	**Integral Transforms:** Definition, Kernel.	8
II	**Laplace Transforms:** Definition, Existence theorem, Linearity property, Laplace transforms of elementary functions, Heaviside Step and Dirac Delta Functions, First Shifting Theorem, Second Shifting Theorem, Initial-Value Theorem, Final-Value Theorem, The Laplace Transform of derivatives, integrals and Periodic functions.	10
III	**Inverse Laplace transforms:** Inverse Laplace transforms of simple functions, Inverse Laplace transforms using partial fractions, Convolution, Solutions of differential and integro-differential equations using Laplace transforms. Dirichlet's condition,	10
IV	**Fourier Transforms:** Fourier Complex Transforms, Fourier sine and cosine transforms, Properties of Fourier Transforms, Inverse Fourier transforms.	9

PART-B

Graph Theory

Unit	Topic	No. of Lectures
V	Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph.	10
VI	Walk and unilateral components, unicursal graph, Hamiltonian path and circuits, Graph coloring, chromatics number, isomorphism and homomorphism of graphs, Incidence relation and degree of the graph.	10

VII	Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, shortest path, Dijkstra's algorithm.	**9**
VIII	Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties.	**9**

Suggested Readings (Part-A Mathematical Methods):

1. Murry R. Spiegal: Laplace Transform (SCHAUM Outline Series), McGraw-Hill.
2. J. F. James: A student's guide to Fourier transforms, Cambridge University Press.
3. Ronald N. Bracewell: The Fourier transforms and its applications, Mcgraw Hill.
4. J. H. Davis: Methods of Applied Mathematics with a MATLAB Overview, Birkhäuser, Inc.,Boston, MA, 2004.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Graph Theory):

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications, 2017.
2. Douglas B West, Introduction to Graph Theory, Pearson, 2018.
3. Santanu Saha Ray, Graph Theory with Algorithms and Its Applications: In Applied Science and Technology, Springer India, 2012.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech.(UG), BCA, B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S. No	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (ii) Number Theory and Relativity

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: UGMAT502T	**Course Title: Number Theory and Relativity**	

Course outcomes:

CO1: The student will be able to solve problems in elementary number theory and also apply elementary number theory to cryptography.

CO2: Upon successful completion, students will be able to describe the basic concepts of the theory of relativity.

CO3: After Successful completion of this course students will be able to discuss postulates of the special theory of relativity and their consequences.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A

Number Theory

Unit	Topic	No. of Lectures
I	Prime Numbers, Unique Factorization theorem, Farey series, Irrational numbers, Congruences, Residues, Quadratic Reciprocity Law, Primitive roots.	**16**
II	Fermet's theorem, Wilson's theorem, Continued fractions, Approximation of irrational of rationals, Hurwitz theorem.	**11**
III	The fundamental theorem of arithmetic in K(1), K(i), K(ρ), Diophantine equation $X^2 + Y^2 = Z^2$, $X^4 + Y^4 = Z^4$, $ax^2 + by^2 + cz^2 = 0$, Quadratic fields, The arithmetic functions: d(n), σ(n), μ(n) and $\varphi(n)$ including elementary result on their order and average order.	**12**

PART-B

Relativity

Unit	Topic	No. of Lectures
IV	**Special Relativity:** Inertial Frames of reference, Michelson-Morley experiment, Doppler effect, Stellar aberration, Simultaneity, Postulates of special relativity, Lorentz transformation, Length contraction, Time dilation, Clock paradox, Addition of velocities and accelerations, Four- dimensional space time, Light cone, Mass variation, Velocity four vector, Momentum and force, Mass-Energy relationship.	**14**
V	**General Relativity:** Geodesics, Geodesic coordinates, Curvature tensor and its algebraic properties, Bianchi's identities, Contracted curvature tensor, Conditions for a flat space time, Displacement of space –time, Killing equations, Groups of motion, Space–time of constant curvature.	**12**
VI	Principal of covariance, Non-inertial frames of reference, Principal of equivalence, Weak field approximation of geodesic equations, Law of gravitation in empty space-time, Canonical coordinates, Schwarzschild solutions.	**10**

Suggested Readings (Part-A Number Theory):

1. G. H. Hardy and E. M. Wright: Introduction to the theory of numbers, Oxford University Press, 4th Edition.
2. D. M. Burton: Elementary Number Theory, 6th Edition, Tata McGraw Hill.
3. Thomas Koshy: Elementary Number Theory with Applications, Academic Press, 2nd Edition.
4. Kenneth H. Rosen: Elementary Number Theory and its Applications, Addison-Wesley Publishing Company, 1986.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Relativity):

1. D. F. Lawden: An Introduction to tensor calculus and relativity.
2. J. V. Narlikar: General relativity and cosmology.
3. R. H. Good: Basic concept of relativity, 1978.
4. A. S. Eddington: Mathematical theory of relativity, 1981.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), BCA, B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S. No	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/Objective Tests**	5
3	**Presentation**	5
4	**Assignment**	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (iii) Numerical Analysis and Operations Research

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: UGMAT502T	**Course Title: Numerical Analysis and Operations Research**	

Course outcomes:

CO1: After Successful completion of this course the student will be able to perform error analysis for arithmetic operations.

CO2: Upon successful completion, students will be able to understand the use of interpolation and curve fitting and finite differences.

CO3: After Successful completion of this course students will be able to use some solution methods for solving the linear programming problems.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A
Numerical Analysis

Unit	Topic	No. of Lectures
I	**Errors in numerical Calculations**: Absolute, Relative and Percentage errors, General Error, Error in series approximation.	9
II	**Solutions of Algebraic and Transcendental Equations:** Bisection method, False position method, Newton-Raphson Method, Picard's iteration method.	9
III	**Linear systems of equations:** Consistency of Linear System of equations, Solutions of Linear Systems by direct method: Guassian elimination and computation of inverse of a matrix, Method of Factorization, Solutions of linear systems by iterative methods: Jacobi method, Gauss-Siedel method.	10
IV	**Interpolation and curve fitting:** Errors in Polynomial interpolation, Finite differences, Differences of a polynomial, Newton's forward and backward interpolation, Central differences, Gauss, Stirling, Bessel's and Everett's Formulae, Lagrange's Interpolation formula.	10
V	**Numerical differentiation and integration**: Numerical differentiation, Newton-Cotes Integration formula, Numerical integration by Trapezoidal rule, Simpson'1/3, Simpson's 3/8, and Romberg Integration.	9

PART-B
Operations Research

Unit	Topic	No. of Lectures
VI	**Basics of OR and LPP**: Development of OR, Definition, characteristics, scope, objectives and limitations of OR, convex sets, Basic feasible solutions, Formulation of LPP, Graphical Method to solve LPP, General LPP, Canonical and Standard forms, Properties of Solutions and Theory of Simplex method, Big M Method and Two phase simplex method, Degeneracy in LPP, Duality in LPP, Duality and simplex method, Dual simplex method.	16

VII	**Transportation and assignment Models**: Formulation of TP, Transportation Table, Finding initial basic feasible solution, Test of optimality, Degeneracy, MODI method, Stepping Stone method, Solutions of Assignment problems, Hungarian method.	**12**

Suggested Readings (Part-A Numerical Analysis):

1. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India.
2. C.F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison- Wesley, 1998.
3. Konte and Debour: Numerical Analysis.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Operations Research):

1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
2. S. I. Gass, Linear Programming: Methods and Applications (4th edition) McGraw-Hill, New York, 1975.
3. Kanti Swaroop, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New
4. Hamdy A. Taha, Operations Research, Prentice-Hall of India, 1997.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), BBA/BCA, B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S. No	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-I Complex Analysis and Mechanics

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: UGMAT601T	**Course Title: Complex Analysis and Mechanics**	

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: Upon successful completion, students will be able to understand the complex variables, analytic functions, complex integration and residues.

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

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

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A
Complex Analysis

Unit	Topic	No. of Lectures
I	**Complex Variables:** Functions of a complex variable, Limit, continuity and differentiability.	9
II	**Analytic functions:** Analytic functions, Cauchy and Riemann equations, Harmonic functions.	9
III	**Complex Integration:** Complex integrals, Cauchy's theorem, Cauchy's integral formula, Morera's Theorem, Liouville's Theorem, Taylor's series, Laurent's series, Poles and singularities.	10
IV	**Residues:** Residues, the Residue theorem, the principle part of a function, Evaluation of Improper real integrals.	9

PART-B
Mechanics

Unit	Topic	No. of Lectures
V	**Rectilinear motion:** Newton's Laws of Motion, velocity and acceleration, motion under constant acceleration, motion under inverse square law, rectilinear motion with variable acceleration, Simple Harmonic Motion.	10

VI	**Kinematics in two dimension:** Angular velocity and angular acceleration, Components of velocity and acceleration along coordinate axes, Radial and transverse components of velocity and acceleration, tangential and normal components of velocity and acceleration.	**10**
VII	**Motion in resisting medium, constrained motion and Central orbits:** Terminal Velocity, Motion in resisting medium in a straight line, Motion on vertical circle, Cycloidal motion, Central Force, Central orbit, intrinsic equation, Pedal form, apse and apsidal distance.	**9**
VIII	**Statics:** Coplanar Forces, Equilibrium of forces in three dimensions, Common catenary, Catenary of uniform strength, Virtual work.	**9**

Suggested Readings (Part-A Complex Analysis):

1. J. B. Conway: Functions of One Complex Variable, Narosa Publishing House, 1980.
2. E. T. Copson: Complex Variables, Oxford University Press.
3. L. V. Ahlfors: Complex Analysis, McGraw-Hill, 1977.
4. D. Sarason: Complex Function Theory, Hindustan Book Agency, Delhi, 1994..
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Mechanics) :

1. M. Ray: A Textbook on Dynamics, S. Chand.
2. M. Ray: A Textbook on Statics, S. Chand.
3. A. S. Ramsay: Dynamics, Cambridge University Press.
4. S. L. Loney: Dynamics of a particle and of rigid bodies, Cambridge University Press.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S. No	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-II Linear Algebra and Metric Spaces

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: UGMAT602T	**Course Title: Linear Algebra and Metric Spaces**	

Course outcomes:

CO1: Liner algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.

CO2: After Successful completion of this course, students should be able to understand the concept of linear transformation.

CO3: On successful completion of the course students should have knowledge about metric spaces, connectedness and compactness.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A

Linear Algebra

Unit	Topic	No. of Lectures
I	**Vector space:** Introduction, subspaces, Linear combinations, linear spans, Sums and direct sums, Linear dependence and independence, Bases and dimensions, Dimensions and subspaces, Coordinates and change of bases.	10
II	**Linear transformations:** Linear transformations, rank and nullity, Linear operators, Algebra of linear transformations, Invertible linear transformations, isomorphism.	9
III	**Matrix and linear transformation:** Matrix of a linear transformation, Matrix of the sum and product of linear transformations, Change of basis, similarity of matrices.	9
IV	**Linear functional:** Linear functional, Dual space and dual basis, Double dual space, Annihilators, Hyperspace, Transpose of a linear transformation.	9
V	**Eigen values and Eigen vectors:** Eigen vectors and Eigen values of a matrix, product of characteristic roots of a matrix and basic results on characteristic roots, nature of the characteristic roots of Hermitian, skew-Hermitian, unitary and orthogonal matrices, characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.	9

PART-B

Metric Spaces

Unit	Topic	No. of Lectures

VI	Definition and examples of metric space, pseudo metric, discrete and usual metric space, diameter of a set	**6**
VII	Open and closed sets in a metric space, Interior point, Limit point, Adherent point, Closed set, Neighbourhood, Closure of a set, Interior of a set, Bolzano-Weirstrass theorem, Complete metric space, Cauchy sequence, Convergent sequence, Bounded Sequence	**11**
VIII	Separated sets, Connected and disconnected sets, Continuity and connectedness, Compactness, Compactness and uniform continuity, Continuity and Uniform continuity in a metric space.	**12**

Suggested Readings (Part-A Linear Algebra):

1. Hadley: Linear Algebra.
2. Hoffman and Kunze: Linear Algebra, Prentice Hall of India, New Delhi, 1972.
3. H. Helson: Linear Algebra, Hindustan Book Agency, New Delhi, 1994.
4. K. B. Dutta: Matrix and Linear Algebra, Prentice Hall of India.
5. S. Lang: Linear Algebra, Springer.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Suggested Readings (Part-B Metric Spaces):

1. Dhananjay Gopal, An Introduction to Metric Spaces, Chapman and Hall/CRC; 1st edition 2020.
2. Satish Shirali & H. L. Vasudeva, Metric Spaces, Springer, First Indian Print. 2009
3. S. Kumaresan, Topology of Metric Spaces Narosa Publishing House, 2014
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

S. No	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions: