DEPARTMENT OF HIGHER EDUCATION

RAJA MAHENDRA PRATAP SINGH STATE UNIVERSITY, ALIGARH

According to

National Education Policy-2020

Common Minimum Syllabus

in

MATHEMATICS

FOR FIRST THREE YEARS OF HIGHER EDUCATION (UG)

For

Certificate/ Diploma/ Degree Course

SYLLABUS DEVELOPED BY				
S.N.	**NAME**	**DESIGNATION**	**DEPARTMENT**	**COLLEGE/UNIVERSITY**
1	**PROF. SHUBHNESH KUMAR GOYAL**	Professor	Mathematics	**D.S.(P.G.) COLLEGE, ALIGARH**
2	**DR. VISHAL KUMAR YADAV**	Assistant Professor	Mathematics	**D.S.(P.G.) COLLEGE, ALIGARH**
3	**DR. SATYAM KUMAR SHARMA**	Assistant Professor	Mathematics	**D.S.(P.G.) COLLEGE, ALIGARH**
4	**DR. MANJUBALA**	Associate Professor	Mathematics	**S.V. COLLEGE, ALIGARH**
5	**DR. ANUP GUPTA**	Assistant Professor	Mathematics	**GANJDUNDWARA COLLEGE, GANJDUNDWARA**
6	**DR. MRADUL DIXIT**	Assistant Professor	Mathematics	**S.D. COLLEGE, HATHRAS**

SEMESTER WISE TITLES OF THE PAPER IN UG MATHEMATICS COURSE					
YEAR	**SEMESTER**	**COURSE CODE**	**PAPER TITLE**	**THEORY/PRACTICAL**	**CREDIT**
CERTIFICATE COURSE IN APPLIED MATHEMATICS					
FIRST YEAR	**I**	RB030101T	Differential Calculus & Integral Calculus	THEORY	**4**
		RB030102P	Practical using MATLAB/SCILAB / GRAPH TOOLS/ DESMOS etc.	PRACTICAL	**2**
	II	RB030201T	Matrices, Differential Equations and Geometry	THEORY	**6**
DIPLOMA IN MATHEMATICS					
SECOND YEAR	**III**	RB030301T	Algebra & Mathematical Methods	THEORY	**6**
	IV	RB030401T	Differential Equation & Mechanics	THEORY	**6**
DEGREE IN MATHEMATICS					
THIRD YEAR	**V**	RB030501T	Group & Ring Theory and Linear Algebra	THEORY	**5**
		RB030502T	Any one of the following- (I) Number Theory & Game Theory (II) Graph Theory & Discrete Mathematics (III) Differential Geometry and Tensor Analysis	THEORY	**5**
		RB030503R	MINOR RESEARCH PROJECT	Project	**-**
	VI	RB030601T	Metric Space & Complex Analysis	THEORY	**4**
		RB030602T	Numerical Analysis & Operations Research	THEORY	**4**
		RB030603P	PRACTICAL	PRACTICAL	**2**
		RB030604R	MINOR RESEARCH PROJECT	Project	**6**

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 APPLIED MATHEMATICS	**FIRST YEAR**	**SEMESTER – I**	**Paper-1**	4	4	4x 15= 60	**Differential Calculus & Integral Calculus** **Part A: Differential Calculus** **Part B: Integral Calculus**	**Part A** Unit I (9) Unit II (7) Unit III (7) Unit IV (7) **Part B** Unit V (9) Unit VI (7) Unit VII (7) Unit VIII (7)	Mathematics in 12th	Engg. and Tech. (UG), Chemistry/Biochemistry/ Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/BCA, B.Sc. (C.S.)
			Paper-II Practical	2	2 Lab Periods (2Hours Each)	2x2x 15= 60	**Practical** (Practical's to be done using any MATLAB/SCILAB / GRAPH TOOLS/ DESMOS etc.		Mathematics in 12th	Engg. and Tech. (UG), B.Sc.(C.S.)
		SEMESTER – II	**Paper-1**	6	6	6 x 15= 90	**Matrices & Geometry** **Part A: Matrices** **Part B: Geometry**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Mathematics in 12th	Engg. and Tech. (UG), B.Sc.(C.S.)

B.A./B.Sc. II

PROGRAMME	YEAR	SEMESTER (15Weeks)	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	6 x 15= 90	**Algebra & Mathematical Methods** **Part A: Algebra** **Part B: Mathematical Methods**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV(11) **Part B** Unit I (12) Unit II (11) Unit III (11) Unit IV (11)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)
		SEMESTER – IV	Paper-1	6	6	6 x 15= 90	**Differential Equation & Mechanics** **Part A:** **Differential Equation** **Part B: Mechanics**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV(11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.) Engineering and Technology (UG), Science (Physics-UG)

B.A./B.Sc. III

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)
DEGREE IN MATHS	THIRD YERAR	SEMTER – V	Paper-1	5	5	5x 15= 75	**Part A: Group and Ring Theory** **Part B: Linear Algebra**	**Part A** Unit I(10) Unit II(10) Unit III(9) Unit IV(9) **PART-B** Unit V(10) Unit VI(9) Unit VII(9) Unit VIII(9)	Diploma in Mathematics	Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.)
			Paper-2	5	5	5x 15= 75	**Any one of the following-** **i. Number Theory & Game Theory** **ii. Graph Theory & Discrete Mathematics** **iii. Differential Geometry and Tensor Analysis**	**Part A** Unit I(10) Unit II(10) Unit III(9) Unit IV(9) **PART-B** Unit V(10) Unit VI(9) Unit VII(9) Unit VIII(9)	Diploma in Mathematics	Engg. and Tech.(UG), BCA, B.Sc.(C.S.)
		SEMESTER – VI	Paper-1	4	4	4x 15= 60	**Metric Space** **&** **Complex Analysis** **Part A: Metric Space** **Part B: Complex Analysis**	**Part A** Unit I(9) Unit II(7) Unit III(7) Unit IV(7) **PART-B** Unit V(9) Unit VI(7) Unit VII(7) Unit VIII(7)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)
			Paper-2	4	4	4x 15= 60	**Numerical Analysis** **&** **Operations Research** **Part A: Numerical Analysis** **Part B: Operations Research**	**Part A** Unit I(9) Unit II(7) Unit III(7) Unit IV(7) **PART-B** Unit V(9) Unit VI(7) Unit VII(7) Unit VIII(7)	Diploma in Mathematics	Engg. and Tech. (UG), Economics(UG/PG), BBA/BCA, B.Sc.(C.S.)
			Paper-3	2	2	2x15x2=60	PRACTICAL IN MATLAB/MATHEMATICA	Practical	Diploma	
			Paper-4 Research Project	6	**In one of the major subjects chosen by the student:** A Minor Research Project has to be submitted by a group of four to six students or by every student in the end of the year under the supervision of Mentor assigned by the Department			Diploma In Maths	Engg. and Tech. (UG), B.Sc.(C.S.)

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

Detailed Syllabus

OF

MATHEMATICS

FOR

CERTIFICATE COURSE

B.A./B.Sc. I (SEMESTER-I) PAPER-I Differential Calculus & Integral Calculus

Programme: Certificate **Class:B.A./B.Sc.**	**Year: First**	**Semester: First**
Subject: Mathematics		
Course Code: RB030101T	**Course Title: Differential Calculus& Integral 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 real valued functions such as sequence and series. They will also be able to know about convergence of sequence and series. Also, they have knowledge about curvature, envelope and evolutes and trace curve in polar, Cartesian as well as parametric forms.

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: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Part- A
Differential Calculus

Unit	Topics	No. of Lectures
I	Definition of a sequence, Theorems on limits of sequences, Bounded and Monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, Subsequence. Series of non-negative terms, Convergence and Divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's Logarithmic test, De'Morgan's and Bertrand's tests, Alternating Series, Leibnitz's theorem, absolute and conditional convergence.	**9**
II	Limit, continuity and differentiability of function of single variable, Rolle's theorem, Lagrange and Cauchy Mean value theorems, Mean value theorems of higher order, Taylor's theorem with various forms of remainders.	**7**
III	Indeterminate forms, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series, Partial Differentiation, Euler's theorem on homogeneous function.	**7**
IV	Tangent and Normal, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms.	**7**

Part-B
Integral Calculus

Unit	Topics	No. of Lectures
V	Riemann Integral, Fundamental theorem of Integral Calculus, Mean value theorems of Integral Calculus, Differentiation under the sign of Integration.	**9**
VI	Improper integrals, Their classification and convergence, Comparison test, μ-test, Abel', Dirichlet's & Quotient test. Beta and Gamma functions.	**7**
VII	Rectification, Volumes and Surfaces of Solid of revolution, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.	**7**
VIII	Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration, Theorems of Gauss, Green, Stokes 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. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc.,2002.
5. G.B. Thomas and R.L. Finney, Calculus, Pearson Education,2007.
6. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS
7. Course Books (text/reference) 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
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS
5. Course Books (text/reference) published in Hindi may be prescribed by the respective universities at local level.

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

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**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-I) Paper-II Practical

Programme: B.A./B.Sc.	**Year: First**	**Semester: 1st**
Subject: Mathematics		
Course Code: RB030102P	**Course Title:** Practical using Mathematica /MATLAB /Maple /Scilab/Maxima/ DESMOS etc.	
Credits: 2	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		

Course outcomes:

CO1: The main objective of the course is to equip the student to plot the different graph and solve the different types of equations by plotting the graph using different online computer software such as Mathematica /MATLAB /Maple /Scilab /Maxima/ Graph Tools-DESMOS etc.

CO2: Indian Ancient Mathematics and Mathematicians: The main objective of the course is to be able to know for the students about Historical background of the Great Indian Mathematician and their Outcomes

Unit	Topics	No. of Lectures
I	**Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE)**	
II	1. Plotting the graphs of the following functions: I. ax II. [x] (greatest integer function) III. x^{2n} ; $n \in N$ IV. x^{2n-1} ; $n \in N$ V. $x^{\frac{1}{2n-1}}$; $n \in N$ VI. $x^{\frac{1}{2n}}$; $n \in N$ VII. $\frac{\lvert x\rvert}{x}$ VIII. $\sin\frac{1}{x}$ IX. $x\sin\frac{1}{x}$ X. e^x for $x \neq 0$ XI. e^{-x} for $x \neq 0$ 2. Observe and discuss the effect of changes in the real constants "a" and "b" on the graphs: $e^{ax+b}, \log(ax+b)$, $\sin(ax+b), \cos(ax+b), \lvert\sin(ax+b)\rvert, \lvert\cos(ax+b)\rvert, \sqrt{}ax+b, \lvert ax+b\rvert, c \pm \lvert ax+b\rvert$ etc. 3. By plotting the graph find the solution of the equation $x = e^x, x^2+1 = e^x, 1-x^2 = e^x, x = \log_{10}(x), \cos x = x, \sin x = x, \cos y = \cos x, \sin y = \sin x$ and many other transcendental equations in one variable. 4. Plotting the graphs of polynomial of degree 2,3, 4 and 5, and their first and second derivatives. 5. Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid etc 6. Tracing of conic in Cartesian coordinates and polar coordinates. 7. Find numbers between two real numbers and plotting of finite and infinite subset of R. 8. Study the convergence of sequences through plotting. 9. Cauchy's root test by plotting *n*-th roots. 10. Ratio test by plotting the ratio of *n*-th and (*n* + 1)th term.	**60**

Suggested Readings-

1. A GUIDE TO MATLAB BY B.R. HUNT, R.L. LIPSMAN & J.M. ROSENBERG, CAMBRIDGE UNIV. PRESS.
2. MATLAB FOR BEGINNERS BY PETER ISSA KATTAN, 2008.

This course can be opted as an elective by the students of following subjects: B.SC./B.A./B.COM. STUDENTS.

Suggested Continuous Evaluation Methods: Max. Marks: 25

B.A./B.Sc. I (SEMESTER-II) PAPER-I Matrices and Differential Equations & Geometry

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: Second**
Subject: Mathematics		
Course Code: RB030201T	**Course Title: Matrices and Differential Equations & Geometry**	

Course outcomes:

CO1: The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give in depth knowledge of geometry, calculus, algebra and other theories.

CO2: The student will be able to find the rank, eigen values of matrices and study the linear homogeneous and non-homogeneous equations. The course in differential equation intends to develop problem solving skills for solving various types of differential equation and geometrical meaning of differential equation.

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.

Credits: 6	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0	

PART-A
Matrices and Differential Equations

Unit	Topics	No. of Lectures
I	Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.	**12**
II	Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix. Complex functions and separation into Real and Imaginary parts, Exponential and Logarithmic functions, Inverse Trigonometric and Hyperbolic Functions.	**11**
III	Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.	**11**
IV	First order higher degree equations solvable for x, y, p, Clairaut's equation and Singular Solutions, Orthogonal Trajectories, Ordinary Differential equation of higher order with constant coefficients, Cauchy- Euler form.	**11**

PART-B

Geometry

Unit	Topics	No. of Lectures
V	System of conics, Confocal conics, Polar equation of conics and its properties.	**12**
VI	Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimensions (Cartesian and vector form).	**11**
VII	Sphere, Cone and Cylinder.	**11**
VIII	Central Conicoid and Paraboloids.	**11**

Suggested Readings (PART-A Matrices and Differential Equations):

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1. Stephen H. Friedberg, A.J Insel & L.E. Spence, Linear Algebra, Person
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course in Differential Equations, Narosa
3. D.A. Murray, Introductory Course in Differential Equations, Orient Longman
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
5. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Geometry):

1. Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.

2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson.

3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company,London.

4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.

5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs

6. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses:

Further Suggestions:

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

Detailed Syllabus

of

MATHEMATICS

for

DIPLOMA COURSE

B.A./B.Sc.II (SEMESTER-III) PAPER-I Algebra & Mathematical Methods

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester: Third**
Subject: Mathematics		
Course Code: RB030301T	**Course Title: Algebra & Mathematical Methods**	

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, Ring theory and their properties.

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

CO3: The course gives emphasis to enhance student knowledge of Laplace Transforms, Fourier Series.

CO4: On successful completion of the course student should have knowledge about mathematical method and abstract algebra.

Credits: 6	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0	

Part- A

Algebra

Unit	Topics	No. of Lectures
I	Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups.	**12**
II	Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset Decomposition, Lagrange's theorem and its consequences.	**11**
III	Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of Homomorphism, Theorems on Isomorphism.	**11**
IV	Rings, Subrings, Integral Domains and Fields, Ideal and Quotient rings, Ring Homomorphism, Field of quotient of an Integral domain.	**11**

Part- B
Mathematical Methods

Unit	Topics	No. of Lectures
V	Limit and Continuity of functions in two variables, Differentiation of function of two variables, Necessary and Sufficient condition for Differentiability of functions in two variables.	**12**
VI	Maxima and Minima for functions of two variables, Lagrange Multiplier Method, Jacobians, Concept of Dependent and Independent Variables using Jacobian.	**11**
VII	Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Inverse Laplace transforms, Convolution theorem, Solution of the differential equations and Integral Equations using Laplace Transforms.	**11**
VIII	Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range Expansions. Fourier transforms (finite and infinite), Fourier integral.	**11**

Suggested Readings (Part-A Algebra):

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-Weley
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCS
4. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

Suggested Readings (Part- B Mathematical Methods):

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGrawHill
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCs
4. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

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

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. II (SEMESTER-IV) PAPER-I Differential Equations & Mechanics

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester:** **Fourth**
Subject: Mathematics		
Course Code: RB030401T	**Course Title: Differential Equations & Mechanics**	

Course outcomes:

CO1: The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of first order 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, non linear evolution equation etc. These entire courses are important in engineering and industrial applications for solving boundary value problem.

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: 6	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0	

Part- A

Differential Equations

Unit	**Topics**	**No. of Lectures**
I	Second order linear differential equations with variable coefficients: Use of a known solution to find another, Normal form, Method of undetermined coefficient, Method of Variation of Parameters.	**12**
II	Series Solutions of differential equations, Power Series method, Bessel and Legendre functions and their properties, Recurrence Relations and Generating relations.	**11**
III	Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution.	**11**
IV	Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Cauchy's Form, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution.	**11**

Part- B

Mechanics

Unit	Topics	No. of Lectures
V	Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.	**12**
VI	Centre of Gravity, Virtual work, Stable and Unstable equilibrium, Common Catenary.	**11**
VII	Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion in Resisting Medium, Constrained Motion (Circular and Cycloidal Motion only)	**11**
VIII	Central orbit, Kepler's Laws of Motion.	**11**

Suggested Readings (Part-A Differential Equations):

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. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs
6. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

Suggested Readings(Part-B Mechanics):

1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers
2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers
3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill
4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs
6. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

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

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

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

Suggested equivalent online courses:

Further Suggestions:

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

Detailed Syllabus

Of

MATHEMATICS

for

DEGREE COURSE

B.A./B.Sc. III (SEMESTER-V) PAPER-I Group Theory & Ring Theory and Linear Algebra

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: RB030501T	**Course Title: Group Theory & Ring Theory and Linear Algebra**	

Course outcomes:

CO1: Linear 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 andsome of its applications.

CO2: The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**

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

PART-A

Group Theory & Ring Theory

Unit	Topics	No. of Lectures
I	Review of basic Group Theory, Normal subgroups, Quotient groups, Homomorphism and Isomorphism, Fundamental theorem of Homomorphism, Theorems on Isomorphism.	10
II	Automorphism, Inner Automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups, Conjugacy classes, The class equation.	9
III	Review of Basic Ring Theory, Theorems on Ring Homomorphism, Quotient Ring, Quotient Field, Maximal and Prime Ideals.	9
IV	Polynomial rings over commutative rings, Division algorithm and consequences, Principal Ideal Domains, Primitives and Irreducibility of Polynomials, Irreducible and Prime Element, Factorization of Polynomials, Reducibility and Irreducibility tests, Eisenstein criterion, Unique factorization in Z[x], Unique factorization domains, Euclidean domains. Factorization of Polynomials, Divisibility in Integral domains.	9

PART-B
Linear Algebra

Unit	Topics	No. of Lectures
V	Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space.	10
VI	Linear transformations, The Algebra of linear transformations, Rank Nullity theorem, Linear Transformation representation as matrices.	10
VII	Linear functionals, Dual space, Dual Basis, Annihilators and their related Results.	9
VIII	Inner Product Spaces and Norms, Cauchy-Schwarz Inequality, Orthogonal Vectors, Orthonormal sets and bases, Bessel's inequality for Finite Dimensional Spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.	9

Suggested Readings:

1. Topics in Algebra by I. N. Herstein.
2. Linear Algebra by K. Hoffman and R. Kunze.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
4. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

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

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment (Indian Ancient Mathematics and Mathematicians)**	**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) Number Theory & Game Theory

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: RB030502T	**Course Title: Number Theory & Game Theory**	

Course outcomes:

CO1: Upon successful completion, students will have the knowledge and skills to solve problems in elementary number theory and also apply elementary number theory to cryptography.

CO2: This course provides an introduction to Game Theory. Game Theory is a mathematical framework which makes possible the analysis of the decision making process of interdependent subjects. It is aimed at explaining and predicting how individuals behave in a specific strategic situation, and therefore help improve decision making.

CO3: A situation is strategic if the outcome of a decision problem depends on the choices of more than one person. Most decision problems in real life are strategic.

CO4: To illustrate the concepts, real-world examples, case studies, and classroom experiments might be used.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0	

Part- A

Number Theory

Unit	Topics	No. of Lectures
I	**Theory of Numbers** Ceiling and Floor Function, Divisibility; Euclidean algorithm; Primes; Congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.	**10**
II	**Congruences** Congruence modulo powers of prime; Primitive roots and their existence; Quadratic Residues; Legendre symbol, Gauss' lemma about Legendre symbol, Jacobi symbol.	**9**
III	**Diophantine Equations** Solutions of ax + by = c, $x^n + y^n = z^n$; Properties of Pythagorean triples; Sums of two, four and five squares.	**9**
IV	**Primality and Primality test** Primality test of a number	**9**

Part- B
Game Theory

Unit	Topics	No. of Lectures
V	Introduction, Overview, Uses of Game theory, Some applications and examples and formal definitions of the Normal form, Payoffs, Strategies, Pure Strategy.	10
VI	Introduction, characteristic of Game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.	10
VII	Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving Rectangular Games.	9
VIII	Relationship between rectangular game and Linear Programming Problem, Solving rectangular game by Simplex method, Reduction of m x n game and solution of 2x2, 2 x m, and n x 2 cases by graphical method, Algebraic and Linear Programming solution of m x n Games.	9

Suggested Readings (Part-A Number Theory):

1. Niven, I., Zuckerman, H. S. and Montegomery, H. L. (2003) An Int. to the Theory of Numbers (6th edition) John Wiley and sons, Inc., New York.
2. Burton, D. M. (2002) Elementary Number Theory (4th edition) Universal Book Stall, New Delhi.
3. Balakrishnan, V. K. (1994) Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory, Schaum's Outline.
4. Balakrishnan,V. K. (1996) Introductory Discrete Mathematics, Dover Publications.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
6. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Game Theory):

1. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003
2. Vijay Krishna, Game Theory, Academic Press.
3. Prajit Dutta, Strategies and Games, MIT Press, (Website 1) http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html
5. Allan MacKenzie, Game Theory for Wireless Engineers, Synthesis lectures on Communications, 2006
6. Suggested digital plateform:NPTEL/SWAYAM/MOOCS
7. Course Books published in Hindi may be prescribed by the Universities.

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

SN	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) Graph Theory and Discrete Mathematics

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: RB030502T	**Course Title: Graph Theory and Discrete Mathematics**	

Course outcomes:

CO1: Upon successful completion, students will have the knowledge and skills to solve problems in elementary graph theory.

CO2: This course covers the basic concepts of graph theory i.e. isomorphism and homomorphism of graphswhich is a very important tool used in computer science.

CO3: This course covers the basic concepts of discrete mathematics used in computer science and other disciplines that involve formal reasoning. The topics include logic, proof, counting, discrete probability, relations, graphs, trees, and Boolean algebra.

CO4: After successful completion of this course the student will have the knowledge in graph, Combinatorial analysis, Discrete structures, Applications and modeling.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0	

Part- A

Graph Theory

Unit	Topics	No. of Lectures
I	Simple Graph, Multi Graph, Graph Terminology, Adjacency and Incidence Matrix representation of Graph, Operations on Graph, Subgraphs, Vertex and Degrees, Bipartite, Regular, Planar and connected Graphs, Euler's and Hamiltonian's Graph, Isomorphism and Homomorphism of graphs.	**10**
II	Trees: Characterization and Centre of Tree, Counting Tree, Cut, Edges and Bonds, Cut Vertices.	**9**
III	Plane and Planer Graph, Dual Graph, Euler's Formula, Directed Graph, Directed Paths, Directed Cycles.	**9**
IV	Graph Coloring, Edge Chromatic Number, Vertex Coloring, Chromatic Polynomials.	**9**

Part- B
Discrete Mathematics

Unit	Topics	No. of Lectures
V	**Propositional Logic-** Proposition logic, Basic logic, Logical Connectives, Truth Tables, Tautologies, Contradiction, Normal forms (Conjunctive and Disjunctive), Modus Ponens and Modus Tollens, Validity, Predicate Logic, Universal and Existential Quantification, Proof by Implication, Converse, Inverse Contrapositive, Direct proof by using truth table. **Relation-** Definition, Types of Relation, Domain and Range of a Relation, Pictorial representation of Relation, Properties of Relation, Partial Ordering Relation.	**10**
VI	**Boolean Algebra-** Basic definitions, Sum of Products and Products of Sums, Logic Gates and Karnaugh maps.	**10**
VII	**Combinatories-** Inclusion- Exclusion, Recurrence Relations: nth order recurrence relation with constant coefficients, Homogeneous Recurrence Relations, Inhomogeneous Recurrence Relations, Generating Function, Closed form expression, Properties of G.F., Solution of Recurrence Relations using G.F., Solution of combinatorial problem using Generating Function.	**9**
VIII	**Finite Automata-** Basic concepts of automation theory, Deterministic Finite Automation (DFA), Transition Function, Transition Table, Non-Deterministic Finite Automata (NDFA), Mealy and Moore machine, Minimization of finite automation.	**9**

Suggested Readings (Part-A Graph Theory):

1. INTRODUCTION TO GRAPH THEORY BY R.J. TRUDEAU
2. INTRODUCTION TO GRAPH THEORY BY DOUGALAS WEST
3. GRAPH THEORY WITH APPLICATIONS BY NARSINGH DEO
4. GRAPH THEORY WITH APPLICATIONS BY J.A. BONDY

Suggested Readings (Part-B Discrete Mathematics):

1. Discrete Mathematics by C. L.Liu.
2. Discrete Mathematics with computer application by Trembley and Manohar.
3.Discrete Mathematics and Its Applications by Kenneth H. Rosen
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCS
5. Course Books (text/reference) published in Hindi may be prescribed by the Universities.

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

SN	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) Differential Geometry and Tensor Analysis

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: RB030502T	**Course Title: Differential Geometry and Tensor Analysis**	

Course outcomes:

CO1: Upon successful completion of this course, students should be able to determine and calculate curvature of curves in different co-ordinate system.

CO2: This course covers the local theory of curves, local theory of surfaces, Geodesics, Geodesics Curvature, Geodesics Polars, curvature of curves on surfaces, Gaussian Curvature, Normal Curvature etc.

CO3: After successful Completion of this course student should have the knowledge of Tensor Algebra, different types of Tensor, Reimannian Space, Ricci's Tensor, Einstein Space and Einstein Tensor etc.

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**

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

Part- A

Differential Geometry

Unit	Topics	No. of Lectures
I	Local Theory of curves-Space curves, Plane curves with examples, Tangent, Normal and Binormal, Osculating, Normal and Rectifying Plane, Osculating Circle and Sphere, Helices, Serret-Frenet Apparatus, Contact between Curves and Surfaces, Tangent Surfaces.	**10**
II	Involute and Evolutes of curves, Bertrand Curves, Intrinsic Equation, Fundamental existing Theorem for Space curves	**10**
III	Metric: First fundamental form and Arch length, Direction Coefficient, Family of curves, Intrinsic property, Geodesics, Canonical Geodesics equations, Normal properties of Geodesics, Geodesics Curvature, Geodesics Polars.	**9**
IV	Gauss-Bonnet Theorem, Curvature of curves on surface, Gaussian Curvature, Normal Curvature, Meusneir's Theorem, Mean Curvature, Umbilic Points, Line of curvature, Rodrigue Formula, Euler's Theorem.	**9**

Part- B
Tensor Analysis

Unit	Topics	No. of Lectures
V	Tensor Algebra: Contravariant and Covariant vector and Tensors, Mixed Tensor, Symmetric and Skew-Symmetric Tensor, Contraction and Inner Product, Quotient Theorem, Reciprocal Tensor.	10
VI	Christoffel's Symbols, Law of Transformation of Christoffel's Symbols, Covariant Differentiation, Non-Commutativity of Covariant Derivatives.	9
VII	Gradient Scalers, Divergence of Contravariant vector, Covariant and Conservative vectors, Laplacian of an Invariant, Curl of a Covariant vector, Irrotational vector with examples.	9
VIII	Riemannian Space, Riemannian Curvature, Geodesics and Geodesics curvature, Ricci Tensor, Scalar Curvature, Einstein Space and Einstein Curvature.	9

Suggested Readings (Part-A Differential Geometry):

1. T.J. WILLMORE, AN INTRODUCTION OF DIFFERENTIAL GEOMETRY, DOVER PUBLICATION.
2. B.O. NEILL, ELEMENTRY DIFFERENTIAL GEOMETRY, 2ND ED, ACADEMIC PRESS.
3. Course book published by University

Suggested Readings (Part-B Tensor Analysis):

1. Tensor by Z.Ahasan
2. David C. Kay A course of Tensors, Pothishala Pvt. Ltd, Allahabad
3. Course Books (text/reference) published in Hindi may be prescribed by the Universities.

. 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

SN	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 METRIC SPACE & COMPLEX ANALYSIS

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: RB030601T	**Course Title: METRIC SPACE & 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.

Credits: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**

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

Part- A

METRIC SPACE

Unit	Topics	No. of Lectures
I	**Basic Concepts :** Basic properties of Real Numbers, Open and closed Sets, Neighborhood, Interior of a set, Limit point of a Set, Derived set, Closure of a set, Cantor's theorem, Dense set, Bounded Sets, Unbounded Sets, Supremum and Infimum of a Set, Archimedean Property, Heine-Borel Theorem for Real Numbers.	8
II	**Metric spaces:** Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space. Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, Derived set, Closed set, Closure of a set, Diameter of a set, Cantor's theorem, Subspaces, Dense set in Metric Spaces.	8
III	**Continuity & Uniform Continuity in Metric Spaces** Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.	7
IV	**Connectedness and Compactness in Metric Spaces** Connectedness, Connected subsets, Connectedness and Continuous mappings, Compactness, Compactness and Boundedness, Continuous functions on Compact spaces.	7

Part- B
Complex Analysis

Unit	Topics	No. of Lectures
V	**Analytic Functions and Cauchy-Riemann Equations** Functions of complex variable, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.	8
VI	**Conformal Mapping** Introduction of Basic Mapping and Conformal Mapping, Necessary and Sufficient Condition for Conformal Mapping, Bilinear Transformations, Inverse Transformations and Quadratic Transformation with various Examples.	8
VII	**Cauchy's Theorems and Fundamental Theorem of Algebra** Contour and Contour Integrals, Antiderivatives, Proof of antiderivative theorem, Cauchy's Fundamental theorem, Cauchy integral formula; An extension of Cauchy's Integral Formula, Consequences of Cauchy integral formula, Liouville's Theorem and the Fundamental Theorem of Algebra.	7
VIII	**Series and Residues** Taylor series and its examples; Laurent series and its examples, Isolated singular points, Residues, Cauchy's Residue Theorem, Residue at Infinity; Types of Isolated Singular Points, Residues and its examples, Evaluation of Integrals using Residues Theorem.	7

Suggested Readings (Part-A Metric Space):

1. Mathematical Analysis by Shanti Narain.
2. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
3. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
4. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis.Tata McGraw Hill. New Delhi.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.
6.Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

Suggested Readings (Part-B Complex Analysis):

1. Function of Complex Variable by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.
4. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

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

SN	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 Numerical Analysis & Operation Research

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: RB030602T	**Course Title: Numerical Analysis & Operation Research**	

Course outcomes:

CO1: The aim of this course is to teach the student the application of various numerical technique 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 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 in higher Mathematics.

CO3: The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students to apply the basic concepts of operations research.

Credits: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

PART-A

Numerical Analysis

Unit	Topics	No. of Lectures
I	**Calculus of Differences**: Calculus of Differences, Interpolation with equal Intervals, Divided differences Interpolation formula using Differences, Lagrange's Interpolation Formula. **Solution of Equations:** Bisection, Secant, Regular-Falsi, Newton Raphson's Method, Iterative Method.	**8**
II	**Numerical Differentiation & Integration:** Numerical Differentiation, Numerical Integration by various Simpson's Rule, Newton Cotes Formula and Cotes Number. **System of Linear equations:** Direct method for solving systems of linear equations (Gauss Elimination, Gauss's Jordan Method, LU Decomposition, Cholesky Decomposition), Iterative Methods (Jacobi, Gauss Seidel, Relaxation methods).	**8**
III	**The Algebraic Eigen Value Problem:** Jacobi's Method, Power Method. **Numerical solution of Ordinary Differential Equations:** Picard's Approximation Method, Taylor's Series Method, Euler's method, Euler's Modified Method, Runge-Kutta Method, Milne's Method.	**7**
IV	**Introduction of Difference Equation:** Difference Equations and their solutions, Generating Function Techniques to solving Difference Equations.	**7**

PART-B

Operation Research

Unit	Topics	No. of Lectures
V	Introduction of Linear programming problems, Statement and formulation of general linear programming problems, Graphical method, Slack and Surplus variables, Standard and Matrix forms of linear programming problem, Basic Feasible Solution.	8
VI	Convex sets, Fundamental Theorem of Linear Programming, Basic Solution, Simplex Method, Introduction to Artificial variables, Two-Phase Method, Big-M Method and their comparison.	8
VII	Resolution of degeneracy, Duality in Linear Programming Problems, Primal Dual Relationships, Dual-Simplex Method.	7
VIII	Transportation Problems and Assignment Problems.	7

Suggested Readings (Part-A Numerical Analysis):

1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.
2. Introductory methods of Numerical Analysis by S. S. Sastry
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
4.Course Books(text/reference) published in Hindi may be prescribed by the Universities at local levels.

Suggested Readings (Part-B Operation Research):

1. Taha, Hamdy H, "Opearations Research- An Introduction ", Pearson Education.

2. Gupta, Prem Kumar, Initials, " Operations Research", Chand (S) & Co Ltd, India

3. Hillier Frederick S and Lieberman Gerald J., “Operations Research”, McGraw Hill Publication.

4. Winston Wayne L., “Operations Research: Applications and Algorithms”, Cengage Learning, 4th Edition.

5. Hira D.S. and Gupta Prem Kumar, “Problems in Operations Research: Principles and Solutions”, S Chand & Co Ltd.

6. Kalavathy S., “Operations Research”, S Chand.

7. Suggested digital plateform:NPTEL/SWAYAM/MOOCs.

8. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

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

SN	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 Applied Mathematics

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-III PRACTICAL IN MATLAB/MATHEMATICA

Programme: B.A./B.Sc.	**Year: Third**	**Semester: 6th**
Subject: Mathematics		
Course Code: RB030603P	**Course Title: PRACTICAL IN MATLAB/MATHEMATICA**	
Credits: 2	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 33 (With 25 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		

PRACTICAL IN MATLAB/MATHEMATICA

Unit	Topics	No. of Lectures
	Practical / Lab work to be performed in Computer Lab. List of the practicals to be done using computer algebra software (CAS), for example Python/ Mathematica/ Maple/MATLAB /Maxima/Scilab etc **1. Interpolation** i) Lagrange Interpolation ii. Newton's forward, backward and divided difference interpolations **2. Solution of transcendental and algebraic equations by** i) Bisection method ii. Newton Raphson method iii. Regula Falsi method. iv. Iterative Method **3. Solution of system of linear equations** i. LU decomposition method ii. Gaussian Elimination method iii. Gauss-Jacobi method iv. Gauss-Seidel method **ii. Numerical Integration** i) Trapezoidal Rule ii. Simpson's one third rule iii. Simpson's three eighth rule **4. Method of finding Eigenvalue by Power method (up to 4 × 4)** **5. Solution of Ordinary Differential Equation** i. Euler Method ii. Modified Euler Method iii. Runge Kutta Method (order 4)	**60**

Suggested Readings-

1. A GUIDE TO MATLAB BY B.R. HUNT, R.L. LIPSMAN & J.M. ROSENBERG, CAMBRIDGE UNIV. PRESS.
2. MATLAB FOR BEGINNERS BY PETER ISSA KATTAN, 2008.
3. MATLAB PROGRAMMING FOR ENGINEERS BY S.J. CHAPMAN, 1999.

This course can be opted as an elective by the students of following subjects: M.Sc. PHYSICS/ M.Sc. (C.S.)/ M.Sc. CHEM/ MCA/M.STAT.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**