Department of Mathematics

Scheme and Syllabi

For

B.Sc.(Mathematics)/B.Sc.(Hons.) Mathematics/ B.Sc. (Hons.)Mathematics with Research (As per NEP-2020)

Batch-2023

Department of Mathematics

Vision

The department envisions to impart quality mathematics education and to inculcate the spirit of research through innovative teaching and research methodologies. The goal of the department is to provide excellent knowledge of mathematical softwares and tools to equip the students with conceptual understanding and computational skills so that they can become proficient in mathematics to solve real life problems.

Mission

M1: Enhance the capacity for critical thinking, problem-solving skills, and effective communication of mathematical concepts.

M2: Understand the concepts of mathematics for developing the advanced formulation in learning areas of other disciplines.

M3: Provide the knowledge of mathematical tools to equip the students with required skills for research and employability.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

PEO1: To lay the foundation of Mathematics and build up the logical and analytical ability of students.

PEO2: To pave the way for higher education programmes and continue research at institutions of national and international repute.

PEO3: To enhance the capability of students to formulate and analyze the mathematical models in real-life problems.

PEO4: To develop teaching & computational skills and subject knowledge of their course of study, which shall help them to be a successful professional.

PEO5: To inculcate the leadership qualities along with ethical attitude and teamwork skills.

PROGRAMME OUTCOMES (POs)

After the successful completion of undergraduate course, B.Sc./B.Sc. (Hons.)/B.Sc. (Hons.) with Research Mathematics, graduates will be able to:

PO1: Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2: Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3: Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4: Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6: Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PROGRAMME SPECIFIC OUTCOMES (PSO's)

PSO1: To apply, analyze & evaluate using the knowledge and theories of Calculus, Algebra, Mathematical logic, Set theory, Number theory, Analytical Geometry, Abstract structures, Linear Algebra, Analysis, Mechanics etc.

PSO2: To simulate and analyze real time problems using Mathematical models and find solutions using the application of Mathematics in Sciences, Engineering and Technology.

PSO3: To utilize computational tools and software, such as MATLAB, to perform numerical computations, visualize data, and solve mathematical problems efficiently.

Code	Definitions
L	Lecture
T	Tutorial
P	Practical
HS Courses	Humanities & Social Science
BS	Basic Science Courses
ES	Engineering Science Courses
PC	Program Core Courses
PE	Program Elective Courses
OE	Open Elective Courses
EEC	Employment Enhancement Courses (Project/Summer
AEC-C	Internship/Seminar)
VAC-C	Ability Enhancement Course-Common
	Value Added Course-Common

Mapping of PEO with PO

PEOs / POs	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	Y		Y	Y	Y
PO2	Y	Y	Y	Y	Y
PO3	Y		Y	Y	Y
PO4		Y	Y	Y	Y
PO5	Y	Y	Y	Y	Y
PO6	Y	Y	Y	Y	Y
PO7	Y	Y	Y		Y

Mapping of PEO with PSO

PSOs / PEOs	PSO1	PSO2	PSO3
PEO1	Y	Y	Y
PEO2	Y	Y	Y
PEO3	Y	Y	Y
PEO4	Y	Y	Y
PEO5	Y	Y	Y

Credit Details			
S.No.	**Course Category**	**Course Category Abbreviation**	**3-Yr B.Sc. (Credits)**
1.1	Discipline Specific Courses-Core	DSC	67
1.2	Discipline Specific-Skill Enhancement Courses-Core	DS-SEC	2
1.3	Discipline Specific-Value Added Courses-Core	DS-VAC	-
Total of Discipline Specific Core Courses			69
2.1	Minor Courses	MC	-
OR			
2.2	Interdisciplinary Courses	IDC	16
3	Multidisciplinary Courses	MDC	9
4	Ability Enhancement Course- Common	AEC-C	8
5	Value Added Courses-Common	VAC-C	6
6.1	Skill Enhancement Courses- Common	SEC-C	8
6.2	Skill Enhancement Courses-Summer Internship	SEC-SI	4
Total of Skill Enhancement Courses			
Total Credits			**120**

Scheme of Courses- Bachelor of Mathematics

Scheme of Courses- Bachelor of Mathematics

Credit Details				
S.No.	**Course Category**	**Course Category Abbreviation**	**4-Yr B.Sc. (Hons.)/.. (Credits)**	**4-Yr B.Sc. (Hons/.. (Hons. with Res.) (Credits)**
1.1	Discipline Specific Courses-Core	DSC	109	95
1.2	Discipline Specific-Skill Enhancement Courses-Core	DS-SEC	-	2
1.3	Discipline Specific-Value Added Courses-Core	DS-VAC	-	-
	Total of Discipline Specific Core Courses		109	97
2.1	Minor Courses	MC	-	-
OR				
2.2	Interdisciplinary Courses	IDC	16	16
3	Multidisciplinary Courses	MDC	9	9
4	Ability Enhancement Course-Common	AEC-C	8	8
5	Value Added Courses-Common	VAC-C	6	6
6.1	Skill Enhancement Courses-Common	SEC-C	8	8
6.2	Skill Enhancement Courses-Summer Internship	SEC-SI	4	4
6.3	Skill Enhancement Courses-Research Project/Dissertation	SEC-RP	-	12
Total of Skill Enhancement Courses				
Total Credits			**160**	**160**

Semester 1

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT101	Elementary Algebra	4	0	0	4	DSC
2	MAT102	Calculus	4	0	0	4	DSC
3	MAT103	Basics of MATLAB	0	0	4	2	DS-SEC
4		Multidisciplinary Courses	-	-	-	3	MDC
5		Ability Enhancement Course- Common	-	-	-	2	AEC- C
6		Skill Enhancement Courses-Common	-	-	-	2	SEC-C
7		Value Added Courses-Common	-	-	-	3	VAC-C
						20	

L- Lectures T- Tutorial P- Practical Cr. - Credits

Semester 2

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT111	Theory of Equations	4	0	0	4	DSC
2	MAT112	Ordinary Differential Equations	4	0	2	5	DSC
3		Multidisciplinary Courses	-	-	-	3	MDC
4		Ability Enhancement Course- Common	-	-	-	2	AEC- C
5		Skill Enhancement Courses- Common	-	-	-	3	SEC-C
6		Value Added Courses- Common	-	-	-	3	VAC-C
						20	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 3

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT201	Partial Differential Equations	4	0	2	5	DSC
2	MAT202	Analytical Geometry	4	0	0	4	DSC
3	PHS153	Optics and Lasers	3	0	2	4	IDC
4		Multidisciplinary Courses	-	-	-	3	MDC
5		Ability Enhancement Course- Common	-	-	-	2	AEC- C
6		Skill Enhancement Courses- Common	-	-	-	3	SEC-C
						21	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 4

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT211	Group Theory-I	4	0	0	4	DSC
2	MAT212	Elementary Real Analysis	4	0	0	4	DSC
3	MAT213	Numerical Analysis	4	0	2	5	DSC
4	PHS152	Modern Physics	3	0	2	4	IDC
5		Ability Enhancement Course- Common	-	-	-	2	AEC- C
						19	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 5

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT301	Theory of Real Functions	4	0	0	4	DSC
2	MAT302	Group Theory-II	4	0	0	4	DSC
3	MAT303	Probability Theory	4	0	0	4	DSC
4		Electricity and Magnetism and Electronics	3	0	2	4	IDC
5		Internship/Workshop/Training	-	-	-	4	SEC-SI
						20	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 6

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT311	Riemann Integration	4	0	0	4	DSC
2	MAT312	Multivariate Calculus	4	0	0	4	DSC
3	MAT313	Ring Theory and Linear Algebra	4	0	0	4	DSC
4	MAT314	Mechanics	5	1	0	6	DSC
5		Mechanics and Waves	3	0	2	4	IDC
						20	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 7

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT401	Algebra	4	0	0	4	DSC
2	MAT402	Mathematical Statistics	4	0	0	4	DSC
3	MAT403	Metric Spaces	4	0	0	4	DSC
4	MAT404	Number Theory	4	0	0	4	DSC
5	MAT405	Complex Analysis	4	0	0	4	DSC
						20	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 8

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT411	Advanced Linear Algebra	4	0	0	4	DSC
2	MAT412	Riemann Stieltjes Integration and Functions of Several Variables	4	0	0	4	DSC
3	MAT413	Differential Geometry	4	0	0	4	DSC
4	MAT414	Mathematical Methods	4	0	0	4	DSC
5	MAT415	Discrete Mathematics	4	0	0	4	DSC
						20	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 8 with Research

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	MAT411	Advanced Linear Algebra	4	0	0	4	DSC
2	MAT412	Riemann Stieltjes Integration and Functions of Several Variables	4	0	0	4	DSC
3	MAT421	Skill Enhancement Courses-Research Project/Dissertation	-	-	0	12	SEC-RP
						20	

L- Lectures T- Tutorial P- Practical Cr.- Credits

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT101							
Course Title	Elementary Algebra							
Course Outcomes	On the completion of the course the student will be able to **CO1:** Understand De Moivre's theorem and its applications **CO2:** Understand properties of congruence and Fundamental theorem of Arithmetic **CO3:** Discuss the matrices, row and column rank, echelon form, normal form, solution of system of linear equations **CO4:** Determine eigenvalues and corresponding eigenvectors for a square matrix and application of Cayley Hamilton Theorem							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**De Moivre's Theorem**							
•	Deeper look at complex numbers, De Moivre's theorem and its applications							CO1
•	Primitive nth roots of unity							CO1
•	Expansion of in terms of cosines and sines of multiple of θ							CO1
•	Summation of a trigonometric series.							CO1
Unit 2	**Divisibility Theory**							
•	Division algorithm, Greatest common divisor of integers							CO2
•	Euclidean algorithm							CO2
•	Congruence and its Basic properties							CO2
•	Fundamental Theorem of Arithmetic (Statement) and related problems							CO2
Unit 3	**Rank of a Matrix**							
•	Unitary and Orthogonal Matrices and their properties, Similarity of Matrices							CO3
•	Rank of a matrix, Row rank, Column rank, equivalent matrices and their rank							CO3
•	Echelon form of a matrix, normal form of a matrix							CO3

•	Systems of linear equations (homogeneous and non-homogeneous systems), solution sets of linear systems	CO3
Unit 4	**Characteristic Equation**	
•	Characteristic Equation of a matrix, Cayley-Hamilton Theorem.	CO4
•	Eigen values, Eigen Vectors	CO4
•	Diagonalization of Matrices	CO4
•	Eigen values of special (Orthogonal, Unitary etc.) matrices	CO4
Text Books	• Lay, David C. Linear Algebra and its Applications, 5th Ed. Pearson Education Asia, Indian reprint, 2023.	
Reference Books	• Lipschutz, Seymour and Lipson, Marc Schaum's Outline of Linear Algebra, 3rd Edition, Mcgraw Hill Education, 2017. • David M. Burton, Elementary Number Theory, 7th Edition, McGraw Hill Education, 2017. • Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, 2nd Edition, Birkhauser, 2014.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT102							
Course Title	Calculus							
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand concept of limits, continuity and differentiability. **CO2**: Employ the concepts of asymptotes, and inflexion points in tracing of cartesian curves. **CO3**: Evaluate integrals and its application to find arc length and area under curve. **CO4**: Understand continuity and differentiability in terms of limits of vector valued functions.							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Limit, Continuity and Differentiability**							
•	$\epsilon - \delta$ definition of Limit, one-sided limit, limits involving infinity, continuity and differentiability.							CO1
•	Higher order derivatives of hyperbolic and exponential functions.							CO1
•	Leibnitz rule and its applications.							CO1
•	L' Hospital's rule.							CO1
Unit 2	**Tracing of Curves**							
•	Concavity and convexity of the curve.							CO2
•	Inflection points.							CO2
•	Asymptotes of curves.							CO2
•	Curve tracing in Cartesian coordinates.							CO2

Unit 3	**Arc length and surfaces of Revolution**	
●	Parameterizing a curve, arc length, arc length of parametric curves.	CO3
●	Area of surfaces of revolution. Techniques of sketching conics.	CO3
●	Rotation of axes.	CO3
●	General equation of second-degree, classification into conics using the discriminant, polar equations of conics.	CO3
Unit 4	**Vector Valued Functions**	
●	Introduction to vector functions, operations with vector-valued functions, Triple product.	CO4
●	Limits and continuity of vector valued functions.	CO4
●	Differentiation and integration of vector valued functions	CO4
●	Tangent and normal components of acceleration.	CO4
Text Books	● Thomas, George B., and Finney Ross L. Thomas' Calculus. Pearson Education, 12th Ed, 2013. ● Narayan, S. and Mittal, P.K. Integral Calculus. S. Chand and Company Ltd, 2005.	
Reference Books	● Anton, H., and I. Bivens, and S. Davis. Calculus. Singapore: John Wiley and Sons (Asia) P. Ltd., 10th Ed. 2015. ● Courant, R., and F. John. Introduction to Calculus and Analysis. New York: Springer-Verlag (Volumes I & II), 2014.	

In hours			
L	**T**	**P**	**Credit**
0	0	4	2

Course Code	MAT103							
Course Title	Basics of MATLAB							
Course Outcomes	On the completion of the course the student will be able to **CO1**: Make use of arrays in MATLAB **CO2**: Do 2D plotting in MATLAB **CO3**: Do 3D plotting in MATLAB **CO4**: Understand multiple and parametric plots of 2D and 3D							
Examination Mode	Practical							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	-	-	-	**20**	-	**30**	-	**50**
Syllabus								**CO Mapping**
Unit 1	**Matrices and Arrays**							
●	Creation of matrices, operations on matrices.							CO1
●	Complex numbers							CO1
●	Array Indexing							CO1
●	Calling functions							CO1
Unit 2	**2D Plotting**							
●	Plotting of graphs of trigonometric functions, exponential functions, and modulus functions.							CO2
●	Plotting of logarithmic functions, circles, concentric circles.							CO2
●	Plotting of parabola, ellipse, and hyperbola.							CO2
●	Plotting of cardioids, astroids, and circular helix.							CO2
Unit 3	**3D Plotting**							
●	Plotting of sphere, ellipsoid.							CO3

●	Plotting of hyperboloid of one sheet, hyperboloid of two sheets.	CO3
●	Plotting of circular paraboloid, circular cone, circular double cone	CO3
●	Surface plotting of $z = sinx + cosy, x + 2y + 3z = 0,$ $z = xy, x^2 + y^2 + z^2 = k.$	CO3
Unit 4	**Multiple and parametric plots of 2D and 3D**	
●	Plot of two functions and three functions in one graph.	CO4
●	Plot of multiple trigonometric functions.	CO4
●	Plot 2D functions using parametric form	CO4
●	Plot 3D functions using parametric form	CO4
Text Books	● Valentine, D.T. and Hahn, B. D. Essential MATLAB for Engineers and Scientists. 8th edition, Academic Press, 2022. ● Bower, T. Introduction to Computational Engineering with MATLAB. CRC Press, Inc. 2022.	
Reference Books	● Linge, S. & Petter, H., Programming for Computations - MATLAB/Octave: A Gentle Introduction to Numerical Simulations with MATLAB/Octave (Texts in Computational Science and Engineering Book 14) 1st ed. 2016 Edition). ● Gilat, A., MATLAB: An Introduction with Applications, 4th edition, Wiley. ● Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, Oxford University Press, 2010	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT111						
Course Title	Theory of Equations						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Learn general properties of polynomials and equations, nature of roots of an equation and relation between roots and coefficients. **CO2:** Solve the reciprocal equations. Transform the equation according to various given conditions and to. **CO3:** To solve cubic and biquadratic equations Find the sum of the power of the roots of an equation using Newton's Method. **CO4:** Location and nature of roots by Sturm's method. Condition for an equation to have real roots. Obtain integral and real roots of an equation.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**General Properties of Polynomials and Equations**							
•	General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of polynomials, General properties of equations							CO1
•	Fundamental theorem of algebra, Product form of an algebraic equation, Repeated factors, equal roots							CO1
•	Descarte's rule of signs positive and negative rule							CO1
•	Complex roots, Relation between the roots and the coefficients of equations							CO1
Unit 2	**Finding Roots by Transforming Equations**							
•	Symmetric functions, Applications of symmetric functions of the roots,							CO2

•	Transformation of equations, Reciprocal equations, Binomial equations	CO2
•	Solutions of reciprocal equations	CO2
•	Properties of the derived functions	CO2
Unit 3	**Algebraic Solutions and Powers of Roots**	
•	Algebraic solutions of the cubic equations	CO3
•	Algebraic solutions of biquadratic equations	CO3
•	Powers of the roots, Newton's theorem on the sums of powers of roots	CO3
•	Limits of the roots of equations.	CO3
Unit 4	**Nature of Roots of cubic and biquadratic Equation**	
•	Separation of the roots of equations, Strums theorem, Applications of Strum's theorem	CO4
•	Conditions for real roots of an equation	CO4
•	Newton's methods for approximate and integral solutions	CO4
Text Books	• Burnside, W. S. and A. W. Panton. The Theory of Equations. Dublin & London: Dublin University Press, 1954. Print • Turnbull, H.W. Theory of equations. London & New York, Interscience Publishers, Inc., 1947 Print	
Reference Books	• Mac Duffee, C. C. Theory of Equations. John Wiley & Sons Inc., 1954. Print • B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition.	

In hours			
L	T	P	Credit
4	0	2	5

Course Code	MAT112							
Course Title	Ordinary Differential Equations							
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand basic concepts of differential equations and learn different methods to solve them. **CO2**: To find solution differential equations using various methods. **CO3**: Discuss the solution of second order differential equations using various techniques. **CO4**: Form the models of real-life applications using differential equation.							
Examination Mode	Theory + Practical							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Introduction and general solutions of differential equations**							
•	Classification and Formation of differential equations, Order and degree of ODE, Linear and reducible to linear differential equations, Leibnitz and Bernoulli Equations, variables separable and equations reducible to this form.							CO1
•	Homogeneous equations and equations reducible to homogeneous form. Exact differential equations and integrating factors.							CO1
•	Geometrical interpretation of first order differential equation, applications.							CO1
•	Programs to plot the solution of family of first order differential equation.							CO1
Unit 2	**Solution of differential equations using various methods**							
•	Equations solvable for p, equations solvable for x, equations solvable for y.							CO2
•	Equations in Clairaut's form and equations reducible to Clairaut's form.							CO2

•	Tac locus, Node locus, Cusp locus.	CO2
•	Programs to plot the solution of family of first order differential equation under boundary conditions.	CO2
Unit 3	**Solution of second order differential equations using various techniques**	
•	General solution of homogeneous equation of second order, principle of super position for homogeneous equation.	CO3
•	Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients and reducible to constant coefficients.	CO3
•	Euler's equation, method of undetermined coefficients, method of variation of parameters.	CO3
•	Programs to plot the solution of family of second and third order differential equation.	CO3
Unit 4	**Applications of differential equations through modelling**	
•	Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin).	CO4
•	Drug assimilation into the blood (case of a single cold pill, case of a course of cold pills).	CO4
•	Exponential growth of population, limited growth of population, limited growth with harvesting.	CO4
•	Programs of Growth model (Exponential case only), Decay model (Exponential case only), Lake pollution model (with constant/seasonal flow and pollution concentration), Case of single cold pill and a course of cold pills.	CO4
Text Books	• Ross, S.L. Differential Equations, 3rd edition. India: John Wiley and Sons, 2007. • Raisinghania, M.D. Ordinary and Partial Differential Equations. New Delhi: S. Chand and Company, 2024. • Barnes, Belinda and Glenn R. Fulford. Mathematical Modeling with Case Studies: A Differential Equation Approach using Maple and MATLAB, 2nd Ed. London and New York: Taylor and Francis group, 2009.	
Reference Books	• Codington, E.A. An Introduction to Ordinary Differential Equation. New York: Dover Publications, 1989. • Rai, B. Choudhury D.P. and Freedman H.I. A Course in Ordinary Differential Equations. Alpha Science International Ltd. 2012. • William E. Boyce, Richard C. DiPrima , Elementary Differential Equations, Wiley, 10th Edition, 2012.	

In hours			
L	**T**	**P**	**Credit**
4	0	2	5

Course Code	MAT201							
Course Title	Partial Differential Equations							
Course Outcomes	On the completion of the course the student will be able to **CO1:** Observe basic concepts of partial differential equations related to degree, order with its classification as linear and nonlinear. **CO2:** Discuss the solution of first and second order partial differential equations using various techniques. **CO3:** Describe model of physical phenomena using partial differential equations such as the heat, wave and Laplace equations. **CO4:** Analyze the fundamental and elementary solutions of boundary value problems.							
Examination Mode	Theory + Practical							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Introduction and general solutions of Partial differential equations**							
•	Introduction to functions of several variables, Partial Derivatives and their properties							CO1
•	Partial Differential Equations– Basic concepts and definitions, Mathematical problems.							CO1
•	Classification and construction of first-Order Equations: Geometrical Interpretation.							CO1
•	Lagrange's Method of Characteristics for obtaining General Solution of Quasi Linear Equations.							CO1
•	Programs to find Solution of Cauchy problem for first order PDE.							CO1
Unit 2	**Solution of first and second order partial differential equations using various techniques.**							

●	Charpit method for finding complete integral of a non-linear PDE (four standard forms).	CO2
●	Homogeneous linear equations with constant coefficients.	CO2
●	Canonical Forms of First-order Linear Equations.	CO2
●	Programs to find and plot the characteristics for the first order PDE, integral surfaces of a given first order PDE with initial data	CO2
Unit 3	**Derivation of Heat, Wave and Laplace equations**	
●	Derivation of Heat equation, Wave equation, Derivation of Laplace equation.	CO3
●	Classification of second order linear equations as hyperbolic, parabolic or elliptic.	CO3
●	Reduction of second order Linear Equations to canonical forms.	CO3
●	Programs to find solution of one-dimensional heat equation.	CO3
Unit 4	**Analyze the fundamental and elementary solutions of boundary value problems**	
●	Method of separation of variables, Initial Boundary Value Problems,	CO4
●	Non-Homogeneous Wave Equation with boundary conditions.	CO4
●	Solving the vibrating string problem, solving the heat conduction problem.	CO4
●	Programs to evaluate solution of wave equation with associated conditions.	CO4
Text Books	● Raisinghania, M.D. Ordinary and Partial Differential Equations. New Delhi: S. Chand and Company, 2024. ● Ross S.L., Differential equations, 3rd Ed., John Wiley and Sons, India, 2007. ● Pratap, R. Getting Started with MATLAB, Oxford University Press, New Delhi, 2015.	
Reference Books	● Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006. ● Abell Martha L., and James P. Braselton, Differential Equations with Mathematica, 3rd edition. Elsevier Academic Press, 2007. ● Ian N. Sneddon, Elements of Partial differential Equations, Dover Publications, 2006. ● T. Amarnath, An Elementary course in Partial Differential Equations, 2nd Edition, Jones and Bartlett Publishers, 2010.	

In hours			
L	**T**	**P**	**Credit**
4	0	2	5

Course Code	MAT202						
Course Title	Analytical Geometry						
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand concept of pair of straight lines and circles. **CO2**: Understand fundamental concepts and properties of conics. **CO3**: Understand fundamental concepts of sphere and cone. **CO4**: Understand fundamental concepts of cylinders and conicoids.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Pair of straight lines and Circle**							
•	Change of Axes- Translation and rotation of axes, general transformation, invariants							CO1
•	Pair of Straight lines- Homogeneous equation of second degree, angle between pair of straight lines, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve							CO1
•	Circle: General equation of circle, tangents and normal, pair of tangents from a given point, chord of contact, pole and polar, equation of chord in terms of mid-point							CO1
•	angle of intersection and orthogonality of two circles, radical axis, coaxial family of circles							CO1
Unit 2	**Parabola, Ellipse and Hyperbola**							
•	Conics- Standard equations of parabola, tangent and normal, tangents from a point, chord of contact, pole and polar, equation of chord in terms of midpoint, diameter							CO2

•	Standard equations of ellipse, tangent and normal, tangents from a point, chord of contact, pole and polar, equation of chord in terms of midpoint, diameter	CO2
•	Standard equations of hyperbola, tangent and normal, tangents from a point, chord of contact, pole and polar, equation of chord in terms of midpoint, diameter, conjugate diameters of ellipse and hyperbola	CO2
•	The second degree equation $S = ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, reduction of the second degree equation into standard form, identification of curves represented by $S = 0$ (including pair of lines)	CO2
Unit 3	**Sphere and Cone**	
•	Sphere- Equation of a sphere and its properties, the tangent plane, plane of contact	CO3
•	the polar plane, angle of intersection of two spheres	CO3
•	Equation of a cone, enveloping cone of sphere, intersection of cone with a line	CO3
•	Right circular cone	CO3
Unit 4	**Cylinder and Conicoids**	
•	equation of cylinder, enveloping cylinder	CO4
•	Right circular cylinder	CO4
•	Conicoids- General equation of the second degree in three variables	CO4
•	equations of central conicoids (the ellipsoid, hyperboloid of one and two sheets)	CO4
Text Books	• P.K. Jain and Khalil Ahmed: A text book of Analytical Geometry of two dimensions, Wiley Eastern Ltd, 1994. • P.K. Jain and Khalil Ahmed: A text book of Analytical Geometry of three dimensions, Wiley Eastern Ltd, 1999. • Shanti Narayan and P.K Mittal: Analytical Solid Geometry, 17th Revised Edition, S. Chand and Co., New Delhi, 2006.	
Reference Books	• P. R. Vittal, Analytical Geometry*:* 2D and 3D Always learning, Dorling Kindersley (India), 2013. • **S.**L. Loney, The Elements of Coordinate Geometry, Edu Gorilla Prep Experts.	

In hours			
L	**T**	**P**	**Credit**
3	0	2	4

Course Code	PHS153							
Course Title	Optics and Lasers							
Course Outcomes	On the completion of the course the student will be able to **CO1:** To impart students' knowledge of interference and gain insights about the Fraunhofer diffraction in detail. **CO2:** To understand the concept of polarization, and its applications in day to day life. **CO3**: To understand the concept of LASER, its working mechanism and various types and applications. **CO4:** To have hand on training of various optics experiments.							
Examination Mode	Theory+ Practical							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Interference and Diffraction**							
	Types of interference, Young's double slit experiment, Fresnel's biprism, thickness of thin transparent sheet, Interference in thin films, Newton's rings and their application, Application of thin film interference Franunhoffer diffraction at a single slit and its discussion, Fraunhoffer diffraction at double slit, Diffraction of N slits and its discussion Missing orders, dispersive power, Rayleigh Criterion for resolving power, resolving power of a diffraction grating.							1
Unit 2	**Polarization**							
	Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization, Polarization by transmission and reflection, polarisers and analyzers; Malus Law, Brewster's Law, Theory of double refraction, Quarter wave and half wave plates, Elliptically and circularly polarized light production Optical activity, specific rotation. Half shade polarimeter.							2

Unit 3	**LASERs**	
	Interaction of light with matter; Einstein relations; light amplification population inversion; active medium, pumping; metastable states; principle pumping schemes; optical resonant cavityHe-Ne Laser, Ruby Laser, laser beam characteristics and applications, shape and width of spectral lines, line broadening mechanism, natural, collision and Doppler broadening.	3
Unit 4	**Laboratory experiments**	
	1. To determine the wavelength of light using Newton's ring set up. 2. To determine the wavelength of laser source using diffraction of single slit. 3. To study the specific rotation of sugar solution Laurent's half shade polarimeter method 4. Study of C.R.O. as display and measuring device, Study of Sinewave, square wave signals (half wave and full wave rectification) 5. To compare the focal length of two lenses by Nodal slide method. 6. Determination of Plank's constant using photoelectric effect. 7. To measure beam divergence of He-Ne Laser. 8. To determine the refractive index of the material of a given prism using Sodium light	4
Text Books	1. Subramanayam, N.; Lal, B. and Avadhamulu; M. N. Textbook of Optics. New Delhi: S. Chand & Company, 2006. 2. B.Sc. Practical Physics, C. L. Arora.	
Reference Books	1. Jenkins, F.A.; White, H.E. Fundamentals of Optics. USA: McGrawHill Publication. 2. Ghatak,A. Optics. New Delhi:Tata McGraw Hill Publication, 2008	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT211							
Course Title	Group Theory-I							
Course Outcomes	On the completion of the course the student will be able to **CO1:** To recognize the mathematical objects called groups. **CO2:** To understand the concept of Cyclic Groups and to learn cyclic notation for permutations and its types. **CO3:** To explain the significance of the notions of cosets, normal subgroups, and factor groups and to learn Lagrange's theorem and its consequences. **CO4:** Describe about structure preserving maps between groups and their consequences.							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Introduction of Groups**							
•	Symmetries of a regular n-gon							CO1
•	Definition and examples of groups including permutation groups, dihedral groups and quaternion groups (illustration through matrices)							CO1
•	Elementary properties of groups							CO1
•	Subgroups and examples of subgroups.							CO1
Unit 2	**Cyclic Groups and notation for permutations**							
•	Centralizer, normalizer, center of a group							CO2
•	Product of two subgroups							CO2
•	Properties of cyclic groups, classification of subgroups of cyclic groups							CO2
•	Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group.							CO2
Unit 3	**Cosets and Factor Groups**							
•	Properties of cosets							CO3

•	Lagrange's theorem and consequences including Fermat's Little theorem	CO3
•	Normal subgroups	CO3
•	Factor groups	CO3
Unit 4	**Group Homomorphisms and Isomorphisms**	
•	Group homomorphisms, Isomorphisms	CO4
•	Properties of homomorphisms, Properties of Isomorphisms	CO4
•	Cayley's theorem	CO4
•	First, Second and Third Isomorphism theorems.	CO4
Text Books	• J. A. Gallian, Contemporary Abstract Algebra, (4^{th} ed.), Narosa, 2008 • M. Artin, Algebra, (2^{nd} ed.), Pearson, 2024.	
Reference Books	• Bhattacharya, P.B., S.K. Jain, and S.R. Nagpal. Basic Abstract Algebra, (2^{nd} Edition), Cambridge University Press, 2003 • Herstein, I.N. Topics in Algebra, Wiley Eastern Limited, India, 1975. Print. • Fraleigh J.B. A First Course in Abstract Algebra, 7th Ed. Pearson, 2002**.** Print. • Surjeet Singh and Qazi Zameeruddin, Modern Algebra, 8^{th} Edition, Vikas Publishing House, 2006.	

In hours			
L	T	P	Credit
4	0	0	4

Course Code	MAT212						
Course Title	Elementary Real Analysis						
Course Outcomes	On the completion of the course the student will be able to **CO1**: Demonstrate competence with the algebraic and order properties of real numbers. **CO2:** Demonstrate competence with open and closed sets. **CO3:** Demonstrate competence with elementary properties of sequences. **CO4:** Demonstrate competence with the convergence and divergence of series.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**The Real Numbers**							
•	Review of Algebraic and Order Properties of R.							CO1
•	Bounded Sets, Unbounded sets, Suprema and Infima.							CO1
•	The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R.							CO1
•	Countable sets, uncountable sets and uncountability of R.							
•	Characterization of intervals, Cantor Nested Interval Theorem.							CO1
Unit 2	**Sets in R**							
•	Neighborhood of a point. Properties of Neighborhoods. Interior point. Open set.							CO2
•	Limit point and isolated point of a set. Definition of derived set. Illustrations of Bolzano-Weierstrass theorem for sets. Closed set.							CO2
•	Properties of open and closed sets							CO2
•	Dense sets in R. Density of Q and R-Q in R.							CO2
Unit 3	**Sequences**							
•	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems.							CO3

•	Monotone Sequences, Monotone Convergence Theorem.	CO3
•	Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences.	CO3
•	Cauchy sequence, Cauchy's Convergence Criterion.	CO3
Unit 4	**Series**	
•	Convergence and Divergence of infinite series, Cauchy criterion.	CO4
•	Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test.	CO4
•	Alternating series, Leibnitz test.	CO4
•	Absolute and Conditional convergence.	CO4
Text Books	• Malik SC and Arora Savita. Mathematical Analysis, 5th Ed. Singapore: New Age International Publishers, 2017.	
Reference Books	• Bartle, R.G. and D.R. Sherbert. Introduction to Real Analysis, 4th Ed. Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2011. • Rudin, W. Principles of Mathematical Analysis, 3rd Edition. New Delhi: McGraw-Hill Inc., 2023. • Berberian, S.K. A First Course in Real Analysis. New York: Springer Verlag, 1994. • Thomson, B.S., A.M. Bruckner and J.B. Bruckner. Elementary Real Analysis. Prentice Hall, 2nd edition 2008. • Apostol, Tom M., Mathematical Analysis, 2nd Edition, Pearson Education, 2002. • S. K. Mappa, Introduction to Real Analysis, 9th Edition, Levant Books, 2021.	

In hours			
L	T	P	Credit
4	0	2	5

Course Code	MAT213						
Course Title	Numerical Analysis						
Course Outcomes	On the completion of the course the student will be able to **CO1:** understand the methods to solve algebraic as well as transcendental equations and do the programming related to these methods. **CO2:** Learn relations between different operators and interpolation and do the programming related to these methods. **CO3:** Learn numerical integration and do the programming related to these methods. **CO4:** Learn solution of ordinary differential equation do the programming related to these methods.						
Examination Mode	Theory+ Practical						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Solution of algebraic, transcendental equations**							
•	Bisection Method, False Position Method and Secant Methods							CO1
•	Newton Raphson Method and deductions from Newton-Raphson Formula, Graeffe's root squaring method							CO1
•	Gauss Jordan, Gauss Elimination and Jacobi's and Gauss-Seidal methods, Factorization method, Jacobi's method for eigen values and eigen vectors							CO1
•	Write a program to find the real roots using Bisection, False Position Method, Secant and Newton's Methods, Gauss-Seidal and Jacobi's Method							CO1
Unit 2	**Interpolation**							
•	Finite difference and relations between different operators							CO2
•	Newton forward & backward, Newton Divided difference, Lagrange interpolation							CO2

●	Gauss forward and backward interpolations, Derivatives using Newton backwards and forward interpolation.	CO2
●	Write a program to interpolate the given data using Newton's forward, backward and derivatives Using the same methods	CO2
Unit 3	**Numerical Integration**	
●	Newton-Cotes' quadrature formula, Trapezoidal rule	CO3
●	Simpon's one-third rule, Simposn's three-eight rule	CO3
●	Boole's rule and Weddle's rule	CO3
●	Write a program to do numerical integration using Trapezoidal rule, Simpson's one-third rule and Simpson's three-eight rule	CO3
Unit 4	**Solution of Ordinary Differential Equations**	
●	Picard's method and Taylor's series method	CO4
●	Euler's method and Modified Euler's method	CO4
●	R-K Method up to fourth order	CO4
●	Write a program to solve the differential equation using Euler's method and Modified Euler's method and R-K Method of fourth order.	CO4
Text Books	● Grewal B. S., Numerical Methods in Engineering and Science, Khanna Publishers, Tenth Edition, 2015. ● Shastry, S. S. Introductory Methods of Numerical Analysis. New Delhi: PHI Learning Private Limited, 2012.	
Reference Books	● Jain, M.K., Iyenger, S. R. K. and R. K. Jain. Numerical Methods for Scientific and Engineering Computation. Delhi: New Age International Publishers, 2019. ● Gerald C. F., and P. O. Wheatley. Applied Numerical Analysis. India: Pearson Education, 2008. ● Mathews, John H., and D. Fink Kurtis. Numerical Methods using MATLAB 4thEdition. New Delhi: PHI Learning Private Limited, 2012.	

In hours			
L	T	P	Credit
3	0	2	4

Course Code	PHS152							
Course Title	Modern Physics							
Course Outcomes	On the completion of the course, the student will be able to **CO1:** Know the main aspects of the inadequacies of classical mechanics and understand the historical development of quantum mechanics and the ability to discuss and interpret experiments that reveal the dual nature of matter **CO2:** Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, probability density and the normalization techniques, skill development on problem-solving e.g. one-dimensional rigid box, tunnelling through a potential barrier, step potential, rectangular barrier. **CO3:** Knowledge about properties of the atomic nucleus, liquid drop model and nuclear shell model and radioactivity, radioactive decay like alpha, beta, and gamma decay. **CO4:** Correlate between theory and experimental results of basic quantum physics and apply knowledge to find out planck's constant, ionization potential, e/m ratio etc.							
Examination Mode	Theory+ Practical							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Wave Particle Duality**							
	Quantum theory of light, X-rays and their diffraction, Compton effect, particle diffraction, uncertainty principle and its applications. Pair production, Wave Properties of Particles; de Broglie waves, Waves of probability, the wave equation, phase and group velocities							1
Unit 2	**Quantum Mechanics**							
	Difference between classical and quantum mechanics, wave function and wave equations, Schrodinger's equation, time dependent and steady state forms,							2

	Expectation values, Particle in a box, reflection and transmission by a barrier, tunnel effect, harmonic oscillator.	
Unit 3	**Atomic Nucleus and Radioactivity**	
	Nuclear Properties: The neutron, stable nuclei, nuclear sizes and shapes, binding energy, meson theory of nuclear forces, Nuclear Models: liquid drop model, shell model, Radioactivity: Radioactive decay, Half-life, radioactive dating, radioactive series, alpha decay and its theory, beta decay, gamma decay, radiation hazards and radiation units	3
Unit 4	**Modern Physics Laboratory experiments:**	
	1. Determination of Planck's constant using photocell. 2. To find half-life period of a given radioactive substance using GM counter 3. To determine charge to mass ratio (e/m) of an electron by Millikan Oil Drop Method. 4. Study of excitations of a given atom by Franck Hertz set up. 5. To find the ionization potential of mercury using gas filled diode 6. Study of C.R.O. as display and measuring device, Study of Sinewave, square wave signals. 7. To find conductivity of given semiconductor crystal using four probe method. 8. To determine the Hall coefficient and mobility of given semiconductors. 9. Study of Solar Cell characteristics	4
Text Books	1. Shaweta MOHAN and Kulwanr S. Thind , Elements of Modern Physics, Vishal Publications, 2021 2. B.Sc. Practical Physics eBook : CL Arora	
Reference Books	1. A. Beiser, Concepts of Modem Physics: McGraw Hill, 1987 2. Ghatak and Loknatham. Quantum Mechanics:(Springer), 2004. 3. K. Hyde, Basic ideas and Concepts in Nuclear Physics: (Institute of Physics), 2004	

In hours			
L	**T**	**P**	**Credit**
3	0	2	4

Course Code	MAT301						
Course Title	Theory of Real Functions						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Demonstrate competence with the limits and continuity of real functions. **CO2:** Demonstrate competence with differentiation of real functions. **CO3:** Demonstrate competence with mean value theorems and their applications. **CO4:** Demonstrate competence with Taylor's theorem and its applications.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL /PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Limit and Continuity of Functions**							
•	Limit of a function (epsilon-delta approach), sequential criterion for limits, divergence criteria.							CO1
•	Limit theorems, one sided limits, Infinite limits and limits at infinity.							CO1
•	Continuous functions, sequential criterion for continuity and discontinuity, Algebra of continuous functions, Continuous functions on an interval.							CO1
•	Intermediate value theorem, location of roots theorem, preservation of intervals theorem.							CO1
Unit 2	**Uniform Continuity and Differentiation**							
•	Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.							CO2
•	Differentiability of a function at a point and in an interval, Caratheodory's theorem.							CO2
•	Algebra of differentiable functions, Intermediate value property of derivatives, Darboux's theorem.							CO2
•	Monotone functions, Inverse functions, Inverse of Strictly Monotone Functions.							CO2
Unit 3	**Applications of Derivatives**							
•	Rolle's Theorem, Mean value theorem, Cauchy's mean value theorem							CO3

•	Applications of mean value theorem to inequalities and approximation of polynomials.	CO3
•	Relative extrema, interior extremum theorem. First derivative test for extrema.	CO3
•	Indeterminate forms, L'Hospital's Rules.	CO3
Unit 4	**Taylor's Theorem**	
•	Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder.	CO4
•	Relative Extrema, application of Taylor's theorem to convex functions.	CO4
•	Taylor's theorem's application to inequalities.	CO4
•	Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $ln\ ln\ (1+x)$, $1/\ (ax+b)$ and $(1+x)^n$.	CO4
Text Books	• Malik SC and Arora Savita. Mathematical Analysis, 5th Ed. Singapore: New Age International Publishers, 2017. • Bartle, R.G. and D.R. Sherbert. Introduction to Real Analysis, 4th Ed. Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2011.	
Reference Books	• Rudin, W. Principles of Mathematical Analysis, 3rd Edition. New Delhi: McGraw-Hill Inc., 2023. • Berberian, S.K. A First Course in Real Analysis. New York: Springer Verlag, 1994. • Thomson, B.S., A.M. Bruckner and J.B. Bruckner. Elementary Real Analysis. Prentice Hall, 2nd edition 2008. • Apostol, Tom M., Mathematical Analysis, 2nd Edition, Pearson Education, 2002. • S. K. Mappa, Introduction to Real Analysis, 9th Edition, Levant Books, 2021.	

In hours			
L	**T**	**P**	**Credit**
3	0	2	4

Course Code	MAT302							
Course Title	Group theory II							
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand Automorphism group in both finite and infinite cyclic groups and characteristics subgroup **CO2**: Understand directs product of groups and fundamental theorem of finite abelian groups **CO3**: Understand group actions, related notion and application of group actions **CO4**: Understand the fundamental concepts of Sylow p-subgroups, Sylow theorems							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Automorphism Groups**							
•	Automorphism, inner automorphism, automorphism groups							CO1
•	Automorphism groups of finite and infinite cyclic groups							CO1
•	Applications of factor groups to automorphism groups							CO1
•	Characteristic subgroups							CO1
Unit 2	**Direct products**							
•	Properties of external direct products							CO2
•	the group of units modulo n as an external direct product							CO2
•	Internal direct products							CO2
•	Fundamental Theorem of finite abelian groups							CO2
Unit 3	**Group Action**							
•	Group actions, stabilizers and orbits							CO3
•	Permutation representation associated with a given group action							CO3
•	Group Acting on themselves by conjugation							CO3
Unit 4	**Application of Sylow's Theorem**							
•	Class equation and consequences, conjugacy in Sn							CO4

•	p-groups and related theorems	CO4
•	Sylow's theorems and consequences	CO4
•	Cauchy's theorem	CO4
Text Books	• Bhattacharya, P.B., S.K. Jain, and S.R. Nagpal. Basic Abstract Algebra. UK: Cambridge University Press, 2006, Print. • Dummit, David. S., and Richard M. Foote, Abstract Algebra, 3rd Edition. New Delhi: Wiley, 2011.	
Reference Books	• Gallian, Joseph A. *Contemporary Abstract Algebra.* 4th Ed., Delhi: • Herstein, I. N. Topics in Algebra, 2nd Edition. Vikas Publishing House, New Delhi: 2006. • Singh, Surjeet, and Q. Zameeruddin, Modern Algebra, 8th Edition. New Delhi: Vikas Publishing House, 2006. • Malik D. S., J. N. Mordeson and M. K. Sen. Fundamentals of Abstract Algebra, McGraw-Hill, New York: 1997. • Luthar I. S. and I. B. S. Passi, Algebra Vol. 2, Narosa Publishing House, New Delhi: 1999.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT303							
Course Title	Probability Theory							
Course Outcomes	On the completion of the course the student will be able to **CO1:** Understand types of data and their attributes, representation of data. **CO2:** Understand Measures of Central tendency and Measures of Dispersion. **CO3:** Understand Probability, Random variables, Correlation and Regression. **CO4:** Understand Probability Distribution, t-test, Chi-Square test, F-test.							
Examination Mode	Theory							
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**

Syllabus		**CO Mapping**
Unit 1	**Data and its Types**	
●	Classification, tabulation and graphical, representation of data.	CO1
●	Box-plot, Descriptive statistics	CO1
●	Exploratory data analysis	CO1
Unit 2	**Measures of central tendency and Measures of Dispersion**	
●	Mean, Median, Mode, Geometric mean, Harmonic mean	CO2
●	Range, Quartile deviation, Mean deviation, Standard deviation.	CO2
Unit 3	**Probability and Random Variables**	
●	Theory of probability	CO3
●	Random variable and mathematical expectation	CO3
●	Discrete and continuous probability distributions	CO3
●	Baye's theorem and its problem	CO3
Unit 4	**Correlation and regression & Probability Distributions**	
●	Correlation and its properties	CO4
●	Regression and its properties	CO4
●	Binomial, Poisson and their properties	CO4
●	Normal distribution and their properties	CO4

Text Books	● Anderson TW. An Introduction to Multivariate Statistical Analysis. John Wiley. 3rd edition, 2009. ● S.C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, 2020.	
Reference Books	● Goon AM, Gupta MK & Dasgupta B. Fundamentals of Statistics. Vol. I. 2013. ● Hoel PG. Introduction to Mathematical Statistics. John Wiley. 5th edition, 1984. ● Goon AM, Gupta MK & Dasgupta B. An Outline of Statistical Theory. Vol. I. 2016.	

In hours				
L	T	P	Credit	
4	0	0	4	

Course Code	MAT311						
Course Title	Riemann Integration and series of functions						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Demonstrate competence with the concept of Riemann Integration. **CO2:** Demonstrate competence with the properties and applications of Riemann Integration. **CO3:** Demonstrate competence with the concept of Uniform Convergence. **CO4:** Demonstrate competence with the concept of Power Series.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Riemann integration**							
•	Inequalities of upper and lower sums, Riemann conditions of Integrability.							CO1
•	Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions.							CO1
•	Riemann integrability of monotone and continuous functions.							CO1
•	The Class of Riemann integrable functions.							CO1
Unit 2	**Properties and Applications of Riemann integration**							
•	Properties of the Riemann integral, definition and integrability of piecewise continuous and monotone functions.							CO2
•	Intermediate Value theorem for Integrals, Fundamental theorems of Calculus.							CO2
•	**Improper Integrals:** General Value and Cauchy value, type-I. type-II and mixed integrals.							CO2
Unit 3	**Uniform Convergence**							
•	Pointwise and Uniform convergence of sequence of functions. Weierstrass M-Test.							CO3
•	Uniform Convergence and Continuity, Uniform convergence and Integration.							CO3
•	Uniform convergence and differentiation, A Continuous nowhere differentiable function.							CO3

•	Weierstrass Approximation Theorem.	CO3
Unit 4	**Power Series**	
•	Power series, Radius of convergence, Cauchy Hadamard Theorem,	CO4
•	Differentiation and Integration of Power Series, Abel's Theorem.	CO4
•	Multiplication of Two Series, Exponential, Logarithmic and Trigonometric functions.	CO4
Text Books	• Ross, K.A. Elementary Analysis, The Theory of Calculus. Undergraduate Texts in Mathematics, Indian reprint: Springer (SIE), 2004. Print.	
Reference Books	• Bartle, R.G., and D.R. Sherbert. Introduction to Real Analysis. 3rd Ed., Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2002. Singapore. • Denlinger, Charles G. Elements of Real Analysis.Massachusetts: Jones & Bartlett (Student Edition), 2011. Print. • Malik, S. C. and Savita Arora. Mathematical Analysis, 3rd Edition. New Age International Publishers, 2008.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT312						
Course Title	Multivariate Calculus						
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand basic concepts of limits, continuity, partial derivatives and applications of multivariate functions. **CO2**: Get in depth knowledge of techniques for evaluation of extreme value of multivariate functions **CO3**: Learn various applications of double and triple integrals. **CO4**: Understand basics of vector calculus and its applications in interdisciplinary fields.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Functions of Several Variables**							
•	Functions of several variables, limit and continuity of functions of two variables							CO1
•	Partial differentiation							CO1
•	Differentiability and Total differentiability							CO1
•	Sufficient condition for differentiability							CO1
Unit 2	**Properties of Derivatives**							
•	Directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes and normal lines							CO2
•	Extreme values and saddle points							CO2
•	Extrema of functions of two variables							CO2
•	Method of Lagrange multipliers, constrained optimization problems							CO2

Unit 3	**Multiple Integral**	
•	Double integration over rectangular region, double integration over non-rectangular region	CO3
•	Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions	CO3
•	Volume by triple integrals, cylindrical and spherical co-ordinates	CO3
•	Change of variables in double integrals and triple integrals	CO3
Unit 4	**Applications of Multiple Integral**	
•	Line integrals, Applications of line integrals: Definition of vector field	CO4
•	Divergence and curl. Green's theorem, surface integrals	CO4
•	Integrals over parametrically defined surfaces. Stoke's theorem	CO4
•	Divergence theorem	CO4
Text Books	• Thomas, G.B. and R.L. Finney. Thomas' Calculus. 12th Ed., Delhi: Pearson Education, 2005. • Strauss, M.J., G.L. Bradley, and K. J. Smith. Calculus. 3rd Ed., Delhi: Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2007. • Anton, H., I. Bivens, and S. Davis. Calculus Multivariable. 10th Ed., Singapore: John Wiley and Sons (Asia) P. Ltd., 2015.	
Reference Books	• Marsden, E., A.J. Tromba, and A. Weinstein. Basic Multivariable Calculus. Indian reprint: Springer (SIE), 2005. • Stewart, James. Multivariable Calculus, Concepts and Contexts. 8th Ed., USA: Brooks /Cole, Thomson Learning, 2015.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT313							
Course Title	Ring Theory and Linear Algebra							
Course Outcomes	On the completion of the course the student will be able to **CO1:** To describe the fundamental concepts in ring theory such as ideals, quotient rings, integral domains, and fields. **CO2:** To learn structure preserving maps between rings and their properties. **CO3:** To demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples. **CO4:** To identify matrices with linear transformations and the change of coordinate matrix and be able to find the domain, range, kernel, rank, and nullity of a linear transformation.							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Introduction of Rings and Ideals**							
•	Definition and examples of rings, properties of rings, subrings							CO1
•	Integral domains and fields, characteristic of a ring							CO1
•	Ideal, ideal generated by a subset of a ring							CO1
•	Factor rings							CO1
Unit 2	**Ring Homomorphisms**							
•	Ring homomorphisms							CO2
•	properties of ring homomorphisms							CO2
•	Isomorphism theorems I, II and III							CO2
•	Field of quotients							CO2
Unit 3	**Vector Spaces, Basis and Dimension**							
•	Vector spaces, subspaces, algebra of subspaces							CO3
•	quotient spaces, linear combination of vectors							CO3
•	linear span, linear independence, basis and dimension							CO3
•	Dimension of subspaces							CO3
Unit 4	**Linear Transformation**							
•	Linear transformations, null space, range space							CO4
•	rank and nullity of a linear transformation							CO4

●	matrix representation of a linear transformation	CO4
●	algebra of linear transformations	CO4
Text Books	● Joseph A. Gallian, Contemporary Abstract Algebra, (9th Edition), Narosa Publishing House, 2019. ● Vivek Sahai and Vikas Bist, Linear Algebra, (2nd Edition), Narosa 2013.	
Reference Books	● Bhattacharya, P.B., S.K.Jain, and S.R.Nagpal. Basic Abstract Algebra, 2nd edition. U.K: Cambridge University Press, 2004. ● Hoffman, Kenneth, and Ray Alden Kunze. Linear Algebra, 2nd edition. Prentice-Hall of India Pvt. Ltd., 1971. ● Fraleigh, John B. A First Course in Abstract Algebra, 8th edition. Pearson, 2022. ● Artin, M. Abstract Algebra, 2nd Ed., Pearson, 2011. ● Lang, S. Introduction to Linear Algebra, 2nd Ed., Springer, 2005. ● Strang, Gilbert. Linear Algebra and its Applications, Thomson, 2007.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT314							
Course Title	Mechanics							
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand the concepts of equilibrium in case of number of coplanar concurrent forces and basic notions of parallel forces. **CO2**: Understand basic concepts of Moment and couple. **CO3**: Understand the applications of Newton laws of motion and basic concepts of SHM **CO4**: Understand the fundamental concepts related to curvilinear motion and principles of work and energy.							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Moment and Couple**							
•	Composition and Resolution of forces- parallelogram law, resolved part of a force,							CO1
•	$\lambda - \mu$ theorem, Lami's Theorem, Parallel forces.							CO1
•	Moments- definition, sign conventions, geometrical representation, Varginon Theorem, moment about a line							CO1
•	Couples- definition, moment of a couple, equilibrium of two couples, resultant of a force and a couple							CO1
Unit 2	**Friction**							
•	Equilibrium of a rigid body acted on by three coplanar forces, $m - n$ theorem							CO2
•	General conditions of equilibrium of a body acted upon by coplanar forces							CO2
•	Friction- definition and nature of friction, types and laws of friction, angle of friction							CO2
•	coefficient of friction, and equilibrium of a particle on a rough inclined plane.							CO2
Unit 3	**Newton's laws of motion and their applications**							

•	Motion in a straight line with constant acceleration, Vertical motion under gravity, velocity-time curve	CO3
•	Relative motion, Motion under variable acceleration	CO3
•	Motion of two particles connected by a string passing over a smooth pulley: two particles hanging freely, one particle being placed on a smooth table and the other hanging freely.	CO3
•	Simple harmonic motion	CO3
Unit 4	**Projectile motion and Curvilinear Motion**	
•	Projectile motion in a vertical plane under gravity - equation of trajectory, range, time of flight, greatest height achieved and related problems; Projectile on an inclined plane	CO4
•	Work, Power and energy, principle of conservation of energy.	CO4
•	Angular velocity and angular acceleration, Centripetal and centrifugal forces, Central force motion- areal velocity and angular momentum	CO4
•	Curvilinear motion of particle- expressions of velocity and acceleration in tangential and normal components	CO4
Text Books	• **N. H. Dubey,** Engineering Mechanics: Statics and Dynamics, Tata McGraw-Hill, 2013 • M.Ray , A Text Book on Dynamics, S. Chand and Company- 1989	
Reference Books	• S.L. Loney, **The elements of statics and dynamics**, 5th edition, Cambridge University Press, 1947. • Nelson E.W., Best C.L. and Mclean W.G., Schaum's outline of theory and problems of engineering mechanics-statics and dynamics, 5th edition, Mc Graw Hill Book Company, New Delhi, 1997.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT401						
Course Title	Abstract Algebra						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Learn the applications of Sylow Theorems and different tests to check simplicity of groups. **CO2:** Characterize all finite and finitely generated abelian groups. **CO3:** Understand the subnormal and normal series for the solvable groups. **CO4:** Understand different types of ideals and connection between ideal of a ring and matrix ring over it.						
Examination Mode	Theory						
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Sylow Theorems and Simple Groups**							
•	Review of Sylow Theorems							CO1
•	groups of order p^2, pq							CO1
•	Applications of Sylow Theorems, Simple groups and examples							CO1
•	Simplicity of $A_n (n \geq 5)$, Simplicity tests							CO1
Unit 2	**Characterization of Finitely Generated Abelian Groups**							
•	Finite Abelian Groups.							CO2
•	Invariants of Finite Abelian Groups							CO2
•	Fundamental Theorem on Finitely generated Abelian Groups.							CO2
Unit 3	**Subnormal, normal and composition series**							
•	Normal and Subnormal Series.							CO3
•	Derived Series.							CO3
•	Composition Series.							CO3
•	Solvable Groups and Nilpotent groups.							CO3
Unit 4	**Connect the fundamental concepts of rings, subrings and ideals**							
•	Algebra of Ideals.							CO4
•	Maximal and prime ideals, Ideals in quotient rings.							CO4
•	Field of Quotient of Integral domain.							CO4
•	Relation between one sided/two sided ideals of ring R and ring $M_n(R)$.							CO4

Text Books	• Shahi V., and V. Bist, Algebra, 4th Edition. Alpha Science International Ltd, Delhi: 2018. • Bhattacharya, P. B., S. K. Jain, and S. R. Nagpaul, Basic Abstract Algebra, 2nd Edition. U.K.: Cambridge University Press, 2004. • Dummit, David. S., and Richard M. Foote, Abstract Algebra, 3rd Edition. New Delhi: Wiley, 2011.	
Reference Books	• Herstein, I. N. Topics in Algebra, 2nd Edition. Vikas Publishing House, New Delhi: 2006. • Singh, Surjeet, and Q. Zameeruddin, Modern Algebra, 8th Edition. New Delhi: Vikas Publishing House, 2006. • Malik D. S., J. N. Mordeson and M. K. Sen. Fundamentals of Abstract Algebra, McGraw-Hill, New York: 1997. • Luthar I. S. and I. B. S. Passi, Algebra Vol. 2, Narosa Publishing House, New Delhi: 1999.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT402						
Course Title	Mathematical Statistics						
Course Outcomes	On the completion of the course the student will be able to **CO1**: Learn Probability distributions. **CO2**: Learn Sampling Theory and Hypothesis testing. **CO3**: Learn Hypothesis Testing. **CO4**: Learn Large Sample tests.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Probability distributions for discrete and continuous**							
•	Discrete probability distributions: Geometric and Negative Binomial distributions and their properties							C01
•	Continuous probability distributions: Uniform, normal, beta distribution of first and second kind, gamma.							C01
•	Uniform, normal, beta distribution of second kind.							C01
•	Exponential distributions and their properties.							C01
Unit 2	**Sampling Theory and distribution**							
•	Types of Sampling- Simple, Stratified, Systematic							C02
•	Errors in sampling, Parameter and Statistics.							C02
•	Exact Sampling Distributions: Chi-square distribution, Student's-t distribution							C02
•	Snedecor's F- distribution, Fisher's – Z distribution.							C02
Unit 3	**Hypothesis Testing**							
•	Tests of significance for small samples, Null and Alternative hypothesis, Critical region and level of significance							C03
•	Most powerful and uniformly most powerful tests, likelihood ratio tests.							C03
•	Tests of significance based on t, Chi square test of goodness of fit							C03
•	Tests of significance Z and F distributions							C03
Unit 4	**Large sample tests**							
•	Large Sample tests, Sampling of attributes							C04

•	Tests of significance for single proportion and for difference of proportions	C04
•	Sampling of variables	C04
•	Tests of significance for single mean and for difference of means and for difference of standard deviations	C04
Text Books	• Gupta, S. C., and V. K. Kapoor. Fundamentals of Mathematical Statistics. Sultan Chand & Sons: New Delhi, 2020. • Hogg Robert V., Joeseph McKlean, and Allen T Craig. Introduction to Mathematical Statistics. London: Pearson Education Limited, 8th Edition 2019.	
Reference Books	• J.S. Milton and J.C. Arnold, Introduction to Probability and Statistics, Fourth Edition, McGraw Hill 2006. • Lehmann, E. L., & Casella, G. Theory of point estimation (Vol. 31). Springer Science & Business Media, 1998. • Mood, A.M., Graybill, F.A. and Boes, D.C. Introduction to the Theory of Statistics, 3rd Edition, McGraw-Hill series, New York, 1974.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT403							
Course Title	Metric Spaces							
Course Outcomes	On the completion of the course the student will be able to CO1: Learn Basic set topology and Sequences and series and their convergence CO2: Understand the basic concepts of Metric spaces and their completeness CO3: Understand the concepts of continuity in metric spaces. CO4: Theorems on boundedness, Uniform continuity and theorems on various properties of Metric space.							
Examination Mode	Theory							
Assessment Tools		**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Metric Spaces**							
•	Compact sets, Perfect sets							CO1
•	Definition and examples of Metric Spaces							CO1
•	Open and closed sets in Metric Spaces and their properties							CO1
•	Subspaces and their properties							CO1
Unit 2	**Convergence and Completeness**							
•	Interior, Exterior, Frontier and Boundary Points and their properties.							CO2
•	Sequence, Cauchy sequence and Complete Metric Spaces							CO2
•	Cantor intersection theorem							CO2
Unit 3	**Continuity and Uniform Continuity**							
•	Continuity, Sequential Continuity							CO3
•	Uniform continuity							CO3
•	Compactness							CO3
•	Heine Borel theorem							CO3

Unit 4	**Compactness and Connectedness**	
•	Sequential compactness	CO4
•	Finite Intersection Property, totally bounded	CO4
•	Bolzano-Weiertrass property	CO4
•	Connectedness	CO4
Text Books	• Jain, P. K. Jain and Khalil Ahmad. *Metric Spaces,* Alpha Science International, 2nd Revised Edition, 2004. • R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd ed.), John Wiley and Sons, 2002. • Kumaresan, S. *Topology of Metric Spaces*, Narosa Publication, 2nd ed., 2011. • N. L. Carothers, Real Analysis, Cambridge University Press 2000.	
Reference Books	• Copson, E.T. *Metric Spaces,* London: Cambridge University Press, 1988. Print. • Rudin, W. Principles of Mathematical Analysis, McGraw-Hill Publishing Company; 3rd (Third) Edition (January 1, 1976). • T. M. Apostol, Mathematical Analysis (2nd ed. Reprint), Narosa, 2002.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT411						
Course Title	Advanced Linear Algebra						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Learn about linear transformations and its association with matrices. **CO2:** Learn about linear functionals and dual spaces. **CO3:** Learn about Characteristic Values and Characteristic Vectors. **CO4:** Learn about Inner Product Spaces and their Properties.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Dual Spaces**							
•	Linear Functionals							CO1
•	Dual Spaces							CO1
•	Dual Bases							CO1
•	Double Dual							CO1
Unit 2	**Characteristic Values and Vectors**							
•	Characteristic Values and Characteristic Vectors							CO2
•	Characteristic Spaces and Similarity							CO2
•	Diagonalizable							CO2
•	Minimal Polynomials and Equations							CO2
Unit 3	**Canonical Forms**							
•	Diagonal forms, triangular forms							CO3
•	Rational and Jordan canonical Forms.							CO3
•	Eigen spaces and similarity							CO3
Unit 4	**Inner Product Space**							
•	Inner Product Spaces, Norms and Distances							CO4
•	Orthonormal basis, The Gram-Schmidt Orthogonalization, Orthogonal complements							CO4
•	The Adjoint of a Linear operator on an inner product space							CO4
•	Normal and self-Adjoint Operators, Unitary and Normal Operators							CO4
Text Books	• Hoffman, K., and R. Kunze. Linear algebra, 2nd Edition. New Delhi: Prentice Hall, 2015.							

Reference Books	● Lipschutz, S., and M. Lipson. Linear Algebra, 3rd Edition. New Delhi: Tata McGraw Hill, 2017. ● Axler, S. Linear Algebra Done Right, 2nd Edition. New York: Springer Verlag, 2004. ● Lang, S. Undergraduate Texts in Mathematics, 3rd Edition. New York: Springer-Verlag, 2004. ● Singh, S. Linear Algebra. New Delhi: Vikas Publishing, 2009.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT405						
Course Title	Complex Analysis						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Learn about functions of complex variables and their Analyticity. **CO2:** Learn about Complex Integration. **CO3:** Learn about zeros and singularities of complex functions. **CO4:** Learn to calculate improper integrals.						
Examination Mode	Theory						
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Functions of Complex Variables**							
•	Complex plane, Riemann sphere,							CO1
•	Function of complex variables, Continuity and Differentiability, Analytic functions							CO1
•	Conjugate function, Harmonic function, Cauchy Riemann equations (Cartesian and Polar form).							CO1
•	Construction of analytic functions. Elementary Functions of Complex Variables							CO1
Unit 2	**Complex Integration**							
•	Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form.							CO2
•	Cauchy's inequality, Morera's theorem, Liouville's theorem							CO2
•	Fundamental theorem of Algebra, Maximum modulus Principle.							CO2
•	Power series, Taylor's theorem, Laurent's theorem.							CO2
Unit 3	**Zeros and Singularities**							
•	Singularities, Residues, Cauchy's Residue theorem, Residue at infinity							CO3
•	Classification of Isolated singularity, Residues at Poles							CO3
•	Zeros of Analytic functions, Zeros and Poles.							CO3
•	Argument principle and Rouche's theorem.							CO3
Unit 4	**Improper Integrals and Bilinear forms**							
•	Evaluation of Improper Integrals. Jordan's Lemma. An indentation around a Branch point							CO4
•	Definite integrals involving Sine and Cosine.							CO4

•	Elementary transformations, conformal transformation, Mobius transformation, Stereographic projection	CO4
•	Critical points, fixed points, Cross ratio problems.	CO4
Text Books	• Ponnusamy, S. Foundation of Complex Analysis, 2nd Edition. New Delhi: Narosa Publishing House Pvt. Ltd, 2011.	
Reference Books	• Churchill, R. V. and J. W. Brown. Complex Variables and Applications. New Delhi: Tata McGraw Hill International, 9th Edition, 2013. • Copson, E. T. Theory of functions of complex variables. U.K.: Oxford University Press, 1970. • Ahlfors, L. V. Complex Analysis 2nd Edition. New Delhi: McGraw Hill, 1966. • Conway, J. B. Functions of one complex variable. New York: Springer Verlang, 1995. • Zill, D. G. and P. D. Shanahan. A First Course in Complex Analysis with Applications, 3rd Edition. Massachusetts: Jones and Bartlett Publishers, 2013.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT404						
Course Title	Number Theory						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Learn Division Algorithm, Congruences and reduced residue system. **CO2:** Learn Chinese Remainder theorem, Euler's theorem and Arithmetic functions. **CO3:** Learn Quadratic residues and Quadratic reciprocity law. **CO4:** Learn Diophantine Linear Equations and Continued fractions.						
Examination Mode	Theory						
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Division Algorithm, Congruences and Reduced residue system.**							CO1
•	Divisibility of Integers, Greatest common divisor							CO1
•	Euclidean algorithm. The Fundamental theorem of Arithmetic							CO1
•	Congruences and problems based on it							CO1
•	Residue classes and reduced residue classes.							CO1
Unit 2	**Chinese Remainder theorem, Euler's theorem and Arithmetic functions**							CO2
•	Chinese remainder theorem and problems based on it							CO2
•	Fermat's little theorem, Wilson's theorem, Euler's theorem.							CO2
•	Arithmetic functions σ(n), d(n)							CO2
•	Arithmetic functions τ(n), μ(n)							CO2
Unit 3	**Quadratic residues and Quadratic reciprocity law**							CO3
•	Quadratic residues, Legendre symbol							CO3
•	Euler's criterion, Gauss's lemma							CO3
•	Quadratic reciprocity law							CO3
•	Jacobi symbol. Perfect numbers							CO3
Unit 4	**Diophantine linear and non-linear equations, Sum of two squares**							CO4
•	Diophantine linear equations $ax + by = c$							CO4
•	Diophantine non-linear equations $x^2 + y^2 = z^2$							CO4
•	Diophantine non-linear equations $x^4 + y^4 = z^4$							CO4
•	Representation of an integer as a sum of two squares							CO4

Text Books	● Burton, D.M. Elementary Number Theory, 7th Edition. New Delhi: Tata McGraw-Hill 2017. ● Apostal, T.N. Introduction to Analytic Number Theory. Springer Verlag 1998.	
Reference Books	● Niven, I., S. Zuckeman, and H. L. Montgomery. Introduction to Number Theory. Wiley Eastern 1991. ● Hardy, G.H. and E.M. Wright. An Introduction to the Theory of Number. U.K: Oxford Univ. 2008	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT412							
Course Title	Riemann Stieltjes Integration and Functions of Several Variables							
Course Outcomes	On the completion of the course the student will be able to **CO1:** Review of Riemann Integration, Introduction to Riemann Stieltjes Integration. **CO2:** Understand Properties of the Riemann-Stieltjes integral and its applications. **CO3:** Understand Uniform convergence & Equicontinuous families of functions. **CO4:** Understand Functions of several variables and its differentiation.							
Examination Mode	Theory							
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Introduction to Riemann Stieltjes Integration**							
•	Review of Riemann Integration							CO1
•	Introduction to Riemann Stieltjes Integration							CO1
•	Definition and existence of the Riemann-Stieltjes integral							CO1
Unit 2	**Properties of Riemann Stieltjes Integration**							
•	integration of vector-valued functions							CO2
•	Sequences and series of functions							CO2
•	Problem of interchange of limit processes for sequences of functions							CO2
•	Uniform convergence							CO2
Unit 3	**Sequences and series of functions**							
•	Uniform convergence and continuity							CO3
•	Uniform convergence and integration, Uniform convergence and differentiation							CO3
•	Equicontinuous families of functions							CO3
•	Stone Weierstrass Theorem							CO3
Unit 4	**Functions of several variables**							
•	Linear Transformations, Differentiation							CO4
•	The contraction principle							CO4

•	The Inverse function theorem	CO4
•	The implicit function theorem	CO4
Text Books	• Rudin, W. *Principles of Mathematical Analysis, 3rd Edition*. New Delhi: McGraw-Hill Inc., 2017. • Royden, H. L., and P. M. Fitzpatrick. *Real Analysis, 4th Edition.* New Delhi: Pearson, 2010.	
Reference Books	• Apostol, Tom. *Mathematical Analysis –A modern approach to Advanced Calculus*. New Delhi: Narosa Publishing House, 2nd Edition1974. • Bartle R. G. and Sherbert D. R., Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT413							
Course Title	Differential geometry							
Course Outcomes	On the completion of the course the student will be able to **CO1**: Understand differential geometry of plane curves and space curves **CO2**: Understand the orientability of surfaces **CO3**: Understand geometrical interpretation of fundamental forms and principal curvature **CO4**: Understand geodesic curves and related notions							
Examination Mode	Theory							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/ PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Plane and Space Curves**							
•	Vectors in the Euclidean space, Review of the basics of vector calculus, Level Curves vs Parametrized Curves, Arc length Reparameterization							CO1
•	Plane Curves: curvature, osculating circles, Fundamental theorem of plane curves							CO1
•	Space Curves: curvature, torsion and the Frenet frame,							CO1
•	Fundamental theorem of space curves.							CO1
Unit 2	**Surface in 3D**							
•	Surfaces in three dimensions: Surface, Smooth Surfaces.							CO2
•	Tangents, Normals and Orientability.							CO2
•	Quadric Surfaces							CO2
•	Triply Orthogonal Systems							CO2
Unit 3	**Fundamental Forms**							
•	The First Fundamental Form: Lengths of Curves on Surfaces, Isometries of Surfaces. Conformal mappings of Surfaces, Surface Area.							CO3
•	The Second Fundamental Form. The curvature of Curves on a Surface							CO3
•	The Normal and Principal Curvature							CO3
•	Geometrical interpretation of Principal Curvature.							CO3
Unit 4	**Geodesics and their properties**							

●	Geodesics and their properties	
●	The Gaussian and Mean Curvatures, The Pseudosphere	CO4
●	Flat Surfaces. Surfaces of constant Mean Curvature.	CO4
●	Gaussian Curvature of compact Surfaces.	CO4
●	The Gauss Map. Geodesic Equations.	CO4
Text Books	● Pressley, Andrew. Elementary Differential Geometry. Springer, 2nd ed. 2010. ● Prakash, N. Differential Geometry: An Integrated Approach. US: McGraw-Hill Inc, 1982.	
Reference Books	● Willmore, T. J. Introduction to Differential Geometry. Oxford University Press India, 2012. ● Weatherburn, C. E. Differential Geometry of Three Dimensions. Vol 1, Nabu Press, 2016. ● Berger, M. A Panoramic View of Riemannian geometry. Springer, 2007. ● R. S. Millman and G.D. Parker, Elements of Differential Geometry (Prentice-Hall, New Jersey, 1977). ● M. M. Lipschutz, Schaum's Outline of Differential Geometry (McGraw Hill, 1969).	

In hours			
L	**T**	**P**	**Credit**
4	0	0	4

Course Code	MAT414						
Course Title	Mathematical Methods						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Understand Functional and its properties, Brachistochrone problem, Geodesics. **CO2:** Understand Variational problems for functionals involving several dependent variables, Approximate solutions of Boundary Value Problem- Rayleigh-Ritz method. **CO3:** Understand Laplace Transforms and its properties and how to use it to solve differential equations. **CO4:** Fourier series and Fourier transforms and its application.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Functional and its properties**							
●	Calculus of Variations and its theorems and derivations.							CO1
●	Brachistochrone Problem							CO1
●	Surface revolution							CO1
●	Geodesics							CO1
Unit 2	**Variational problems**							
●	Variational problems involving several dependent variables							CO2
●	Variational problems involving several independent variables							CO2
●	One end point fixed and other is movable problem							CO2
●	Rayleigh-ritz method.							CO2
Unit 3	**Laplace and inverse Laplace transforms**							
●	Laplace transforms, Laplace transforms of derivatives and integrals							CO3
●	Inverse Laplace transforms							CO3
●	Dirac's delta function, Unit step functions							CO3
●	Convolution theorem and its problems							CO3
Unit 4	**Fourier Series and its application**							
●	Fourier Series, Even and odd functions							CO4
●	Change of interval							CO4

•	Half range Sine and Cosine series	CO4
•	Complex form of a Fourier	CO4
Text Books	• Grewal B.S., Higher Engineering Mathematics, 43rd edition, Khanna Publishers, 2020. • Jain and Iyenger, Higher Engineering Mathematics, 4th edition, Narosa Publication, 2014	
Reference Books	• Elsgolts, L. Differential Equations and the Calculus of Variations. University Press of the Pacific, 2003 • Galfand, I. M. and Fomin, S. V. Calculus of Variation. Dover Publications, 2000.	

In hours			
L	T	P	Credit
4	0	0	4

Course Code	MAT415						
Course Title	Discrete Mathematics						
Course Outcomes	On the completion of the course the student will be able to **CO1:** Learn the fundamentals of logics, truth tables, quantifiers and counting techniques. **CO2:** Learn Pigeonhole principle, solution of recurrence relations and generating functions. **CO3:** Learn graph theory, Handshaking theorem, Planar and Non-planar graph. **CO4:** Learn Boolean Algebra, Logic Gates and Lattice theory.						
Examination Mode	Theory						
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**10**	**5**	**-**	**25**	**-**	**50**	**-**
Syllabus								**CO Mapping**
Unit 1	**Fundamental of logics, truth tables, quantifiers and counting techniques.**							
•	Fundamentals of Logic: Basic connectives and truth tables.							C01
•	Logical equivalence, the laws of logic, rules of inference							C01
•	The use of quantifiers, quantifiers, definitions and proof of theorems.							C01
•	Basic counting techniques.							C01
Unit 2	**Pigeonhole principle, solution of recurrence relations and generating functions.**							
•	The inclusion–exclusion principle, generalizations of the principle.							C02
•	The pigeonhole principle and generalized pigeon hole principle and its problems							C02
•	Solution of recurrence relations							C02
•	Solution of recurrence relations using generating function.							C02
Unit 3	**Graph theory, Handshaking theorem, Planar and Non-planar graph.**							
•	Introduction to Graph Theory: The Handshaking Theorem. Connectivity of Graphs.							C03
•	Isomorphism of Graphs. Homomorphism Graphs.							C03
•	Eulerian and Hamiltonian Graphs.							C03
•	Planar and Non-Planar Graphs. Euler's formula.							C03

Unit 4	**Boolean Algebra, Logic Gates and Lattice theory.**	
●	Boolean algebra, Boolean Function, Switching circuit and Logic Gates	CO4
●	K-map and problems based on it	CO4
●	Lattices and Algebraic Structures	CO4
●	Lattice as algebraic structures, complete lattices	CO4
Text Books	● Joshi, K. D. Foundation of Discrete Mathematics. New Age International Private Limited, 2023. ● Malik, D. S., and M. K. Sen. Discrete Mathematical Structures Theory and Applications. New Delhi: Thomson Cengage Learning, 2004.	
Reference Books	● Rosen, K. H. Discrete Mathematics and its Applications. Delhi: McGraw Hill, 8th edition, 2021. ● Trembley, J. P. and R. P. Manohar. Discrete Mathematical Structures with Applications to Computer Science. New Delhi: McGraw Hall, 1975. ● Liu, C. L. Elements of Discrete Mathematics. Delhi: McGraw Hill, 1986. Grimaldi, R. P. Discrete and Combinatorial Mathematics 5th Edition. New York: Pearson, 1999.	