Scheme and Syllabi of Examination

for

M.Sc. (Mathematics)

Offered by

Department of Mathematics

Bhagat Phool Singh Mahila Vishwavidyalaya

Khanpur Kalan (Sonepat), Haryana-131305

Department of Mathematics
Bhagat Phool Singh Mahila Vishwavidyalaya,
Khanpur Kalan (Sonepat), Haryana-131305
www.bpswomenuniversity.ac.in

SCHEME OF STUDIES & EXAMINATIONS

M.Sc. in Mathematics (Two Year Course)

Semester – I
Effective from Academic Session 2023-2024(With CBCS)

Paper No.	Paper title	Teaching Scheme			Examination Scheme			Duration of Exam.	Credit
		L	T	P	Internal Marks	External Marks	Total		
MAL- 501	Advanced Abstract Algebra–I	4	0	0	20	80	100	3 Hours	4
MAL- 503	Real Analysis	4	0	0	20	80	100	3 Hours	4
MAL- 505	Complex Analysis-I	4	0	0	20	80	100	3 Hours	4
MA L-507	Ordinary Differential Equations-I	4	0	0	20	80	100	3 Hours	4
MAL- 509	Classical Mechanics	4	0	0	20	80	100	3 Hours	4
MAP- 511	Programming in ‘C’ (Lab)	0	0	4	20	80	100	4 Hours	2
MAP- 513	Seminar-I	0	0	2	25	…	25	…	1
Total		**20**	**0**	**6**	**145**	**480**	**625**		**23**

SCHEME OF STUDIES & EXAMINATIONS

M.Sc. in Mathematics (Two Year Course)

Semester – II
Effective from Academic Session 2023-2024(With CBCS)

Paper No.	Paper title	Teaching Scheme			Examination Scheme			Duration of Exam	Credit
		L	T	P	Interna Marks	External Marks	Total		
MAL- 502	Advanced Abstract Algebra-II	4	0	0	20	80	100	3 Hours	4
MAL- 504	Complex Analysis-II	4	0	0	20	80	100	3 Hours	4
MAL -506	Mathematical Statistics	4	0	0	20	80	100	3 Hours	4
MAL -508	Ordinary Differential Equations-II	4	0	0	20	80	100	3 Hours	4
MAL- 510	Methods of Applied Mathematics	4	0	0	20	80	100	3 Hours	4
MAP -512	Programming with FORTRAN(Lab)	0	0	4	20	80	100	4 Hours	2
MAP-514	Seminar-II	0	0	2	25	------	25	-------	1
Total		**20**	**0**	**6**	**145**	**480**	**625**		**23**

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SCHEME OF STUDIES & EXAMINATIONS

M.Sc. in Mathematics (Two Year Course)

Semester – III

Effective from Academic Session 2024-2025(With CBCS)

Paper No.	Paper title	Teaching Scheme			Examination Scheme			Duration of Exam	Credit
		L	T	P	Internal Marks	External Marks	Total		
MAL- 601	Measure &Integration Theory	4	0	0	20	80	100	3 Hours	4
MAL- 603	Topology	4	0	0	20	80	100	3 Hours	4
MAL -605	Mechanics of Solids-I	4	0	0	20	80	100	3 Hours	4
Open Elective(to be chosen from the list of electives provided by the University)/CBCS Paper		4	0	0	20	80	100	3 Hours	4
	Elective-I	4	0	0	20	80	100	3 Hours	4
	Elective-II	4	0	0	20	80	100	3 Hours	4
MAP-615	MATLAB (Lab)	0	0	4	20	80	100	4 Hours	2
MAP-617	Seminar-III	0	0	2	25	--------	25	-------	1
Total		**24**	**0**	**6**	**165**	**560**	**725**		**27**

Electives:
(Students are required to take both the electives from the Group- A)

Group-A
MAL- 607 Analytic Number Theory
MAL- 609 Operations Research
MAL- 611 Fluid Mechanics
MAL- 613 Advanced Discrete Mathematics

Note: Electives can be offered subject to availability of requisite resources/ faculty in the department.

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SCHEME OF STUDIES & EXAMINATIONS

M.Sc. in Mathematics (Two Year Course)

Semester – IV

Effective from Academic Session 2024-2025(With CBCS)

Paper No.	Paper title	Teaching Scheme			Examination Scheme			Duration of Exam	Credit
		L	T	P	Internal Marks	External Marks	Total		
MAL -602	Functional Analysis	4	0	0	20	80	100	3 Hours	4
MAL-604	Integral Equations	4	0	0	20	80	100	3 Hours	4
MAL -606	Mechanics of Solids-II	4	0	0	20	80	100	3 Hours	4
Open Elective(to be chosen from the list of electives provided by the University) CBCS Paper		4	0	0	20	80	100	3 Hours	4
	Elective-III	4	0	0	20	80	100	3 Hours	4
	Elective-IV	4	0	0	20	80	100	3 Hours	4
MAP-616	LATEX(Lab)	0	0	4	20	80	100	4 Hours	2
MAP-618	Seminar-IV	0	0	2	25	-------	25	--------	1
Total		**24**	**0**	**6**	**165**	**560**	**725**		**27**

Electives:
(Students are required to take both the electives from the Group B)

Group B
MAL -608 Algebraic Coding Theory
MAL -610 Differential Geometry
MAL- 612 Advanced Fluid Mechanics
MAL- 614 Partial Differential Equations

Note: Electives can be offered subject to availability of requisite resources/ faculty in the department.

M.Sc. (Mathematics) 1st Semester w.e.f. 2023-2024
MAL - 501: ADVANCED ABSTRACT ALGEBRA-I

L T P	Marks for External Exam : 80
4 0 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time :3Hours

Course outcomes

1. Understand concepts of normal subgroup, quotient group, isomorphism, automorphism, normal series, subnormal series, composition series, solvable group.
2. Understand nilpotent group and their class of nilpotency.
3. Learn about extension of fields, splitting field, prime field and perfect fields.
4. Universlity of Galios group and Galoisex tension.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Zassenhaus's lemma, normal, subnormal series, Scheiers theorem, composition series, Jordan-Holder theorem (Abelian and Non-Abelian groups), Commutators and their properties, Hall-Witt identity, three subgroup lemma of P. Hall.

Unit-II

Nilpotent groups and their class of nilpotency, upper and lower central series and their properties, invariant (normal) and chief series, solvable groups and derived series.

Unit-III

Extension of fields, algebraic and transcendental extensions, splitting fields, normal extensions, prime fields, perfect fields.

Unit-IV

Finite fields, automorphism of extensions, fixed fields, Galois group, Galois extension, Galois fields, Fundamental theorem of Galois Theory.

References:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nag Paul, Basic Abstract Algebra (2^{nd} Edition), Cambridge University Press, Indian Edition, 1997.
3. M. Artin, Algebra, Prentice-Hall of India, 1991.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. I-1996, Vol. II-1999).
5. David S. Dummit and Richard M Foote, Abstract Algebra, Third Edition, John Wiley &Sons, Inc. USA.

M.Sc. (Mathematics) 1st Semester w.e.f. 2023-2024
MAL -503: REAL ANALYSIS

L T P	Marks for External Exam : 80
4 0 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Understand the convergence of sequences, series of functions and the proof of related theorems.
2. Understand differentiability and continuity of functions of several variables and apply the knowledge to prove inverse function theorem and implicit function theorem.
3. Understand Riemann Stieltjes integral, its properties and rectifiable curves.
4. Know about Lebesgue measure, outer measure and its properties.

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Unit -I

Sequences and series of functions, point-wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and differentiation. Weierstrass approximation theorem, power series, uniqueness theorem for power series, Abel's theorem.

Unit-II

Functions of several variables, linear transformations, derivatives in an open subset inR_n, chainrule, partial derivatives, interchange of the order of differentiation, derivatives of higher orders, Explicit and Implicit function theorem, Taylor's theorem, Jacobian, extreme problems with constraints, Lagranges multiplier method.

Unit - III

Definition and existence of Riemann-Stieltjes integral, properties of the integral, integration and differentiation, Fundamental theorem of Calculus, integration of vector-valued functions, rectifiable curves.

Unit - IV

Set functions, intuitive idea of measure, elementary properties of measure, measurable sets and their fundamental properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets, equivalent formulation of measurable sets in terms of open, closed F_σ and G_δ sets, non measurable sets.

References:

1. W.Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International Student edition.
2. T.M.Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
3. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited, New Delhi, 1986 (Reprint 2000).
4. H.L. Royden, Real Analysis, Macmillan Pub. Cop. Inc. 4th Edition, New York, 1993.

M.Sc. (Mathematics) 1st Semester w.e.f. 2023-2024
MAL - 505: COMPLEX ANALYSIS-I

L T P	Marks for External Exam : 80
4 0 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Understand the concepts of analytic functions, Cauchy Riemann equations and harmonic function.
2. Solve the complex integrals of various kinds through the applications of relevant theorems, formulae and power series expansions.
3. Learn about Jacobian transformation, conformal transformation, Bilinear transformation and its properties.
4. Concept of Taylor's Series, Laurent's Series and residues.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -I

Cauchy Riemann equations, necessary and sufficient conditions for a function to be analytic, polar form of Cauchy Riemann equations, harmonic function, construction of analytic function, power series, radius of convergence of power series, sum function of power series, Cauchy Hadamard theorem.

Unit –II

Complex Integration, Cauchy-Goursat Theorem, simply and multiply connected domains, Cauchy's Integral formula, Cauchy's Integral formula for higher Order derivatives, Morera's theorem, Cauchy's inequality, Liouville's theorem, Fundamental theorem of Algebra, maximum and minimum Modulus Principle, Schwarz Lemma, Poisson's integral formula.

Unit - III

Transformation, Jacobian Transformation, Conformal Transformation, Some general transformations, Bilinear transformations and their properties and classification.

Unit -IV

Taylor's Series, Laurent's Series, singularities, meromorphic functions, Argument principle, Rouche's theorem, calculus of residues, Cauchy's residue theorem, Mittag Leffler's expansion theorem.

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International Student-Edition, Narosa Publishing House, 1980.
3. L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.
4. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
6. J.W. Brown and R.V. Churchill, Complex Variables and Applications, MC Graw Hi**ll.**

M.Sc. (Mathematics) 1st Semester w.e.f. 2023-2024

MAL- 507: ORDINARY DIFFERENTIAL EQUATIONS-I

L T P	Marks for External Exam : 80
4 0 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Understand system of differential equations and its existence theory, dependence of solution of an IVP on initial parameters, extremal solutions. Cauchy Peano Existence and uniqueness theorem.
2. Learn about the concept of integrability of total differential equation, Riccati's equation and Pruffer transformation.
3. Understand the Sturm-Liouville bounded value problems, its separation and comparison theorems. Apply separation variable method for heat ,wave and laplace equation.
4. Apply methods of reduction of order and variation of parameters to solve linear differential equations, solve higher order linear differential equations with constant coefficients.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Initial-value problem and the equivalent integral equation, ε-approximate solution, Cauchy-Euler construction of an ε-approximate solution, Equicontinuous family of functions, Ascoli-Arzela theorem, Cauchy-Peano existence theorem.

Uniqueness of solutions, Lipschitz condition, Picard-Lindelof theorem for local existence and uniqueness of solutions, solution of initial-value problems by Picard method.

Unit-II

Total differential Equations: condition of integrability, methods of solution, Gronwall's differential inequality, comparison theorems involving differential inequalities, zeros of solutions, Riccati's Equation, Pruffer transformation, Lagrange's identity and Green's Formula for second-order equation.

Unit-III

Sturms separation and comparison theorems, Sturm-Liouville boundary-value problems, properties of eigen values and eigen functions, separation variable method for heat and wave equation (one dimensional) and Laplace equation in (two dimensional) in Cartesian system.

Unit-IV

Introduction solution of linear differential equation of second order, complete solution in terms of known integral, Removal of the first order derivative, transformation of the equation by changing the independent variable, method of variation of parameters and method of operational factors.

References:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.
2. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley and Sons Inc. N Y, 1978.
3. S.L. Ross, Differential Equations, John Wiley and Sons Inc., NY, 1984.
4. W.E. Boyce and R.C. Diprima, Elementary Differential Equations and Boundary Value Problems, John Wiley and sons Inc., NY, 1986.
5. Philip Hartman, Ordinary Differential Equations, John Wiley & Sons, NY 1964.

M.Sc. (Mathematics) 1st Semester w.e.f. 2023-2024
MAL -509: CLASSICAL MECHANICS

L T P	Marks for External Exam : 80
400 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Be familiar with the concept of momental ellipsoid, equimomental system and general motion of a rigid body.
2. Understand ideal constraints, general equation of dynamics and Langrange's equation for potential forces.
3. Describe Hamiltonian function, Poincare carton integral invariants and Principle of least action.
4. Learn about Gravitation and Equipotential surfaces.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Moments and products of Inertia, theorems of parallel and perpendicular axes, principal axes, the momental ellipsoid, equimomental systems, coplanar distributions, generalized coordinates, holonomic and non-holonomic systems, Scleronomic and Rheonomic systems, Lagrange's equations for a holonomic system.

Unit-II

Lagrange's equations for a conservative and impulsive forces, kinetic energy as quadratic function of velocities, generalized potential, energy equation for conservative fields.
Hamilton's variables, Donkin's theorem, Hamilton canonical equations, cyclic coordinates, Routh's equations, Poisson's Bracket, Poisson's Identity, Jacobi-Poisson Theorem.

Unit -III

Hamilton's Principle, Principle of least action, Poincare Cartan's Integral invariant, Whittaker's equations. Jacobi's equations, Hamilton-Jacobi equation, Jacobi's theorem, method of separation of variables, Lagrange Brackets, condition of canonical character of a transformation in terms of Lagrange brackets and Poisson brackets, invariance of Lagrange brackets and Poisson brackets under canonical transformations.

Unit -IV

Gravitation: Attraction and potential of rod, disc, spherical shells and sphere, Laplace and Poisson equations, work done by self-attracting systems, distributions for a given potential, equipotential surfaces, surface and solid harmonics, surface density in terms of surface harmonics.

References:

1. F. Chorlton, A Text Book of Dynamics, CBS Publishers & Dist., New Delhi.
2. F.Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow,1975.
3. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press,1999.

M.Sc. (Mathematics) 1st Semester w.e.f. 2023-2024
MAP- 511: PROGRAMMING IN 'C'

L T P	Marks for External Exam : 80
0 0 4(02 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Implement selective structures and repetitive structure in C programs using different control statements.
2. To emphasize on the importance of use of pointers for efficient C programming.
3. Use structure and union in a C program for handling multivariate data.

List of Programs using C:

1. Program to generate prime numbers upto a given number.
2. Program to find factorial using recursion.
3. Program to find fibonacci terms without recursion.
4. Program to generate table of a number.
5. Program to find roots of a quadratic equation.
6. Program to generate fibonacci series with recursion.
7. Program to find factorial without recursion.
8. Program to find S= $\sum_{n=1}^{10} 1/(n-7)$, n!=7.
9. Program to find element from a given array.
10. Program to find transpose of a matrix.
11. Program to swap two numbers using pointers.
12. Program to arrange a string in alphabetical order.
13. Program to convert decimal number into octal and hexadecimal.
14. Program to find matrix multiplication.
15. Program to find arithmetic mean, variance, S.D.
16. Program to check whether a number is prime or not.
17. Program to print sum of digits.
18. Program to reverse a given number.

M.Sc. (Mathematics) 2nd Semester w.e.f. 2023-2024
MAL - 502: ADVANCED ABSTRACT ALGEBRA-II

L	T	P		Marks for External Exam	: 80
4	0	0 (4 Credits)		Marks for Internal Exam	: 20
				Total	: 100
				Time	: 3 Hours

Course outcomes

1. Understand the concept of module and sub-module , cyclic modules, simple module and free modules.
2. Learn about Noetherian and Artinian modules.
3. Have a deep knowledge of Canonical forms : Nilpotent transformation, index of nilpotency and invariants of a nilpotent transformation.
4. Learn about Primary Decomposition theorem, Jordan form, rational canonical form and elementary divisors.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -1

Opposite rings, modules and submodules, Cyclic modules, simple modules, Schur's Lemma. free modules, Fundamental structure theorem for finitely generated abelian groups and its application to finitely generated abelian groups.

Unit-2

Noetherian and Artinian modules and rings , Hilbert basis theorem, homomorphism (R,R,).

Unit -3

Canonical Forms: similarity of linear transformations, invariant subspaces, reduction to triangular forms, nilpotent transformations, index of nilpotency, cyclic subspace with respect to nilpotent transformation, invariants of a nilpotent transformation.

Unit-4

The primary decomposition theorem, Jordan blocks and Jordan forms, rational canonical form, generalized Jordan form over any field, elementary divisors of a transformation.

References:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nag Paul, Basic Abstract Algebra (2^{nd} Edition), Cambridge University Press, Indian Edition, 1997.
3. P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
4. N. Jacobson, Basic Algebra, Vols. I & II, W.H. Freeman, 1980.
5. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House, Vol. I-1996, Vol. II-1999.

M.Sc. (Mathematics) 2nd Semester w.e.f. 2023-2024
MAL – 504: Complex Analysis-II

L T P
400 (4 Credits)

Marks for External Exam : 80
Marks for Internal Exam : 20
Total : 100
Time : 3 Hours

Course outcomes

1. Learn about spaces of analytic functions , Riemann mapping theorem, Gamma functions and its properties.
2. Demonstrate the idea of Harnack Inequality, Dirichlet region, Green function and its properties.
3. Understand the concept of entire function, their factorization, order and exponent of convergence.
4. Know how big the range of an entire function, proof of Picard and related theorems.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -1

Spaces of analytic functions, Hurwitz's theorem, Montel's theorem, Riemann mapping theorem, Weierstrass factorization theorem, Gamma function and its properties, Riemann Zeta function, Riemann's functional equation. Runge's theorem.

Unit -I1

Analytic continuation, uniqueness of direct analytic continuation, uniqueness of analytic continuation along a curve, power series method of analytic continuation, Monodromy theorem and its consequences, harmonic function on a disk, Harnack's inequality and theorem, Dirichlet problem, Green's functions.

Unit -III

Canoncial products, Jensen's formula, Poisson-Jensen formula, Hadamard's three circles theorem, order of an entire function, exponent of convergence, Borel's theorem, Hadamard's factorization theorem.

Unit- IV

The range of an analytic function, Bloch's theorem, the little Picard theorem, Schottky's theorem, Montel Caratheodory and the Great Picard theorem. univalent functions, Bieberbach's conjecture (Statement only) and the "¼ theorem" (Statement only).

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International Student-Edition, Narosa Publishing House, 1980.
3. L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.
4. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
6. J.W. Brown and R.V. Churchill, Complex variable and Applications, McGraw Hill.

M.Sc. (Mathematics) 2nd Semester w.e.f. 2023-2024
MAL - 506: MATHEMATICAL STATISTICS

L	T	P		Marks for External Exam	: 80
4	0	0 (4 Credits)		Marks for Internal Exam	: 20
				Total	: 100
				Time	: 3 Hours

Course outcomes

1. Understand probability, random variables , distribution functions, mathematical expectation, moments, moment generating function and characteristic function.
2. Learn detailed theory of probability distributions : Binomial, Poisson, Geometric, Uniform and Exponential .
3. Learn theory of Normal , Gamma, T, F and Chi- square distribution.
4. Understand the concept of correlation and regression.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -I

Sample spaces, random variables, distribution and density distribution function, marginal and conditional distribution, mathematical expectation, moments, moment generating function, cumulants, cumulants generating function, characteristic function,

Unit-II

Probability distributions: Binomial, Poisson, Geometric, Uniform and Exponential distributions.(Detailed Theory)

Unit -III

Normal distribution, Gamma distribution, T, F and Chi-square distribution as sampling distributions, Weak law of large numbers, Central limit theorem.

Unit –IV

Correlation: Karl Pearson coefficient of correlation, rank correlation, partial and multiple correlation and their coefficients, Yules notations.

Regression: lines of regression, regression curves, regression coefficients and its properties, angle between two lines of regression, plane of regression

References:

1. R.V.Hogg & A.T.Craig: Introduction to Mathematical Statistics, Amerind Pub. Co. Pvt. Ltd. New Delhi,1972
2. S.C. Gupta and V.K Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons, Educational Pub., New Delhi
3. Schaum series outlines, Mathematical Statistics.

M.Sc. (Mathematics) 2nd Semester w.e.f. 2023-2024

MAL - 508: ORDINARY DIFFERENTIAL EQUATIONS-II

L T P	Marks for External Exam : 80
4 0 0(4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Learn about system of linear differential equations of first order and its preliminary concepts, homogeneous and non-homogeneous linear systems, existence and uniqueness theory, fundamental matrix, theory of adjoint systems, linear systems with constant coefficients and with periodic coefficients.
2. Have deep understanding of theory of non-linear differential equations, classification of critical points- Rotation points, Nodes, Saddle points. Also stability and unstability of critical points.
3. Learn about Liapunov function, Bendixson non-existence theorem, statement of Poincare-Bendixson theorem, index of a critical point.
4. To be familiar with problems of calculus of variations.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -I

Linear systems, fundamental set and fundamental matrix of a homogeneous system, Wronskian of a system, method of variation of constants for a non-homogeneous system, reduction of the order of a homogeneous system, systems with constant coefficients, adjoint systems, periodic solutions, Floquet theory for periodic systems (Relevant topics from the book by Coddington and Levinson).

Unit -II

Nonlinear differential equations, plane autonomous systems and their critical points, classification of critical points-rotation points, foci, nodes, saddle points, stability, asymptotical stability and unstability of critical points, almost linear systems, Simple Critical points, dependence on a parameter.

Unit -III

Liapunov function, Liapunov’s method to determine stability for non-linear systems, limit cycles, Bendixson non-existence theorem, statement of Poincare-Bendixson theorem, index of a critical point (Relevant topics from the books of Birkhoff& Rota, and by Ross).

Unit -IV

Motivating problems of calculus of variations, shortest distance, minimum surface of revolution, Brachistocrone problem, isoperimetric problem, geodesics, Fundamental lemma of calculus of variations, Euler’s equation for one dependent function and generalization to n dependent functions and to higher order derivatives, conditional extremum under geometric constraints and under integral constraints(Relevant topics from the book Gelfand and Fomin).

References

1. E.A.Coodington and N. Levinson. Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.
2. G.Birkhoff and G.C.Rota, Ordinary Differential Equations, John Wiley and Sons , NY, 1978.
3. S.L. Ross. Differential Equations, John Wiley and Sons inc., NY, 1984.
4. J M Gelfand and Fomin ,S V ,Calculation of variations, Prentice hall, new Delhi,1963.
5. W.E. Boyce and R.C. Diprima, Elementary Differential Equations and Boundary Value Problems, John Wiley and Sons Inc., NY, 1986.
6. Philip Hartman, Ordinary Differential Equations, John Wiley & Sons, NY,1964.

M.Sc. (Mathematics) 2nd Semester w.e.f. 2023-2024
MAL -510: METHODS OF APPLIED MATHEMATICS

L T P	Marks for External Exam : 80
4 0 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Understand the concept of Fourier series, Fourier integral and Fourier transform.
2. Learn about curvilinear coordinates: co-ordinate transformation, orthogonal co-ordinates, cylindrical and spherical co-ordinates.
3. Knowledge of Mellin and Hankel transformation.
4. Asymptotic approximation: order notation, defination of asymptotic sequence, expansions and series.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -I

Fourier Transforms: Definition and properties, Fourier transform of some elementary functions, convolution theorem, application of Fourier transforms to solve ordinary & partial differential equations.

Unit -II

Curvilinear co-ordinates: Co-ordinate transformation, orthogonal co-ordinates, Grad, Div, Curl, Laplacian in orthogonal co-ordinates, cylindrical and spherical co-ordinates, expressions for velocity and accelerations, ds, dv and ds^2 in orthogonal co-ordinates, areas, volumes and surface areas in cartesian, cylindrical & spherical co-ordinates, contravariant and co-variant components of a vector, metric coefficients & volume elements.

Unit -III

Mellin Transforms: Elementary properties, Mellin Transforms of derivatives and integrals, Inversion and Convolution theorem, solution of some integral equation, Hankel Transforms: Elementary properties, Inversion theorem, Hankel Transforms of derivatives and some elementary function, relation between Fourier and Hankel transform, asymptotic methods-introduction, asymptotic analysis of sums.

Unit-IV

Asymptotic approximation: Order notation, defination of asymptotic sequence, expansions and series, integration by parts and Watson Lemma, Laplace Method of steepest decent with examples.

References:

1. I.N Sneddon., The Use of Integral Transforms, McGraw Hill, 1972.
2. Murray and R.Spiegel, Vector Analysis, Schaum’s Series.

M.Sc. (Mathematics) 2nd Semester w.e.f. 2023-2024
MAL-512: PROGRAMMING WITH FORTRAN (Lab)

L	T	P		
0	0	4(02 Credits)	Marks for External Exam	: 80
			Marks for Internal Exam	: 20
			Total	: 100
			Time	: 3 Hours

Course outcomes

1. Implement selective structures and repetitive structure in programs using different control statements.
2. Using FORTRAN find solution of ODE and simultaneous linear algebraic equations.
3. Program to find transpose of a matrix and matrix multiplication.
4. Program using numerical methods .

List of programs using FORTRAN:

1. Program using logical if and block if statements.
2. Program using arithmetic if and nested logical if statement .
3. Program to find maximum, minimum and range of given set of numbers.
4. Program to find out the roots of quadratic equation.
5. Program to find average, S.D. of given numbers.
6. Program to sort marks of N students in ascending order.
7. Program to generate natural (even/odd) numbers between given limits.
8. Program to compute product of two matrices.
9. Program to solve numerical integration by trapezoidal rule.
10. Program to solve numerical integration by simpson's rule.
11. Program using least square curve fitting method.
12. Program to solve differential equations using numerical differentiation.
13. Program to calculate simple interest .
14. Program using statement function and subprograms.
15. Program to generate table of any number.
16. Program to solve simultaneous equations using Gauss elimination method.
17. Program to solve simultaneous equations using Gauss-Jordan Method.
18. Program to solve differentiation by Lagrange's interpolation.
19. Program to generate Fibonacci series.
20. Program to find factorial of a number.

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025

MAL -601: MEASURE AND INTEGRATION THEORY

L T P	Marks for External Exam : 80
40 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Know about Lebesgue measurable functions, their properties and apply the knowledge to prove Egoroff's theorem, Lusin's theorem and F. Riesz theorem.
2. Understand the requirement and the concept of the Lebesgue integral along its properties.
3. Proof of theorems: Monotone convergence theorem, Lebesgue convergences theorem.
4. To be familiar with the function of bounded variation and absolutely continuous function.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit – I

Measurable functions and their equivalent formulations, properties of measurable functions, approximation of measurable functions by sequences of simple functions, measurable functions as nearly continuous functions, Egoroff's theorem, Lusin's theorem, convergence in measure and F. Riesz theorem for convergence in measure, almost uniform convergence.

Unit – II

Shortcomings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties, Lebesgue integral as a generalization of Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions.

Unit – III

Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergences theorem. Vitali's covering Lemma, Differentiation of monotonic functions.

Unit – IV

Functions of bounded variation and its representation as difference of monotonic functions, differentiation of indefinite integral, Fundamental Theorem of Calculus, absolutely continuous functions and their properties.

References:

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International Student edition.
2. T.M.Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
3. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986 (Reprint 2000)
4. H.L. Royden, Real Analysis, Macmillan Pub. Co. Inc. 4th Edition, New York, 1993.
5. Walter Rudin, Real and Complex Analysis, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1966.

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025

MAL - 603: TOPOLOGY

L T P	Marks for External Exam	: 80
4 0 0(4 Credits)	Marks for Internal Exam	: 20
	Total	: 100
	Time	: 3 Hours

Course outcomes

1. Know about topological spaces, understand neighbourhood system of a point and its properties, interior, closure, boundary, limit points of subsets and base and subbase of topological spaces; apply the knowledge to solve relevant exercises.
2. Understand about continuity and connectedness.
3. Learn about first and second countable spaces, separable, separation axioms and their properties.
4. Know about compactness in topological spaces and apply the knowledge to prove specified theorems.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Definition and examples of topological spaces, neighborhoods, interior point and interior of a set , closed set as a complement of an open set , adherent point and limit point of a set, closure of a set, derived set, properties of closure operator, boundary of a set , dense subsets, interior, exterior and boundary operators.

Base for a topology, neighbourhood system of a point and its properties, base for neighbourhood system, relative(Induced) topology, alternative methods of defining a topology in terms of neighbourhood system and intersection and union of topologies on a set.

Unit-II

Continuous functions, open and closed functions, homeomorphism, connectedness and its characterization, connected subsets and their properties, continuity and connectedness, connectedness spaces, components, locally connected spaces.

Unit- III

First and second countable spaces, separable spaces, separation axioms, T_0, T_1 and T_2 spaces their characterization and basic properties, regular and normal spaces, T_3 and T_4 spaces, complete regularity and complete normality, $T_{3½}$and T_5 spaces.

Unit - IV

Compact spaces and subsets, Compactness in terms of finite intersection property, Continuity and compact sets, Basic properties of compactness, Closedness of compact subset and a continuous map from a compact space into a Hausdorff space and its consequence.

References:

1. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.
2. J.L. Kelley, General Topology, Van Nostrand, Reinholkd Co., New York, 1995.
3. James R Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
4. George F. Simmons, Introduction to Topology and Modem Analysis, McGraw-Hill,
5. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall Of India Pvt. Lt.).

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025
MAL-605: MECHANICS OF SOLIDS-I

L	T	P		Marks of External Exam	: 80
4	0	0 (4 Credits)		Marks for Internal Exam	: 20
				Total	: 100
				Time	: 3 Hours

Course outcomes

1. Understand the concept of tensors as a generalized form of directional entities and to explore their properties through the operations of algebra and calculus. Be familiar with affine transformation and infinitesimal deformation.
2. Analyse the basic properties of strain component, their transformations and Saint-Venant' s equations of Compatibility.
3. Analyse the basic properties of stress component and their transformations.
4. Demonstrate generalized Hooke's Law for 3-D elastic solid which provide the linear relationship between stress and strain components.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -1

Cartesian Tensor: Coordinate transformation, cartesian tensor of different order, sum or difference and product of two tensors, contraction theorem, quotient law, symmetric & skew-symmetric tensors, Kronecker tensor, alternate tensor and relation between them, scalar invariant of second order tensor, eigen values & vectors of a symmetric second order tensor, gradient, divergence & curl of a tensor field.

Unit -I1

Analysis of Strain: Affine transformations, infinitesimal affine deformation, geometrical interpretation of the components of strain, strain quadric of Cauchy, principal strains and invariants, general infinitesimal deformation, Saint- Venant' s equations of compatibility.

Unit-III

Analysis of Stress: Stress tensor, equations of equilibrium, transformation of coordinates, stress quadric of Cauchy, principal stress and invariants, maximum normal and shear stresses.

Unit- IV

Equations of Elasticity: Generalized Hooke's law, homogeneous isotropic media, elastic moduli for isotropic media, equilibrium and dynamic equations for an isotropic elastic solid. strain energy function and its connection with Hooke's law, BeItrami-MicheIl compatibility equations, Saint- Venant' s principle.

Reference:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Shanti Narayan, Text Book of Cartesian Tensors, S. Chand & Co., 1950.
3. S. Timoshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York, 1970.

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025
MAL -607: ANALYTIC NUMBER THEORY (elective)

L T P	Marks of External Exam: 80
4 0 0 (4 Credits)	Marks of Internal Exam: 20
	Total Marks :100
	Time:3 Hours

Course outcomes

1. Knowabouttheclassicalresultsrelatedtoprimenumbersandgetfamiliarwith the irrationality of **e** and**π**.
2. Learn about Riemann Zeta function and its convergence.
3. To be familiar with Euler's Summation formula and average order of arithmetical function.
4. To be familiar with Chebyshev's functions, Shapiro's Tauberian theorem and its applications.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

UNIT-I

Primes in certain arithmetical progressions, Fermat numbers and Mersenne numbers, approximation of irrational numbers by rationals, Hurwitz's theorem, irrationality of e and π. system of linear congruences, Chinese Remainder Theorem, Quadratic residues and non-residues, Legendre's Symbol, Gauss Lemma and its applications, Quadratic Law of Reciprocity, Jacobi's Symbol.

UNIT-II

Riemann Zeta Function $\xi(s)$ and its convergence, application in prime numbers, $\xi(s)$ as Euler's product, evaluation of $\xi(2)$ and $\xi(2k)$, Dirichlet series with simple properties, Dirichlet series as analytic function and its derivative, Eulers products, introduction to modular forms.

UNIT-III

Euler's summation formula and some elementary asymptotic formula, average order of the arithmetical functions $d(n)$, $\sigma_\alpha(n)$, $\phi(n)$, $\mu(n)$ and $\Lambda(n)$, partial sums of a Dirichlet product and their application to $\mu(n)$ and $\Lambda(n)$.

UNIT-IV

Chebyshev's functions $\Psi(x)$ and $\nu(x)$ and relation between $\nu(x)$ and $\pi(x)$, Shapiro's Tauberian theorem and its applications, partial sums of the Mobius function, Selberg's asymptotic formula.

References:

1. T.M. Apostol. Introduction to Analytic number theory (Narosa Publishing House 1980).
2. T.M. Apostol. Modular functions and Dirichlet series in Number Theory (Springer-Verlag 1976).
3. J.P. Serre. A Course in Arithmetic G.T.M. Vol.7 (Springer Verlag 1973).

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025
MAL -609: OPERATIONS RESEARCH (elective)

L T P
4 0 0 (4 Credits)

Marks of External Exam: 80
Marks of Internal Exam: 20
Total Marks : 100
Time : 3 Hours

Course outcomes

1. Identify and develop operations research , its origin, defination, scope and linear programming.
2. Solve various linear programming transportation, assignment, queuing, inventory and game problems related to real life.
3. Learn about the concept of Stochastic processes and Queuing model.
4. To be familiar with Inventary control models and Game theory.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit – I

Operations Research: Origin, defination and scope.
Linear programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big-M and two-phase methods, degeneracy, duality in linear programming.

Unit – II

Transportation Problems: Basic feasible solutions, optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems, transhipment problem.
Assignment problems: Hungarian method, unbalanced problem, case of maximization, travelling sellsman and crew assignments problems.

Unit – III

Concepts of stochastic processes, Poisson process, birth-death process, Queuing models: Basic components of queuing system, steady-state solution of Markovian queuing models with single and multiple servers (M/M/1. M/M/C, M/M/1/K, M/MC/K).

Unit-IV

Inventary control models: Economic order quantity (EOQ) model with uniform demand, EOQ when shortages are allowed, EOQ with uniform replenishment, inventory control with price breaks.
Game theory: Two-person zero sum game, game with saddle points, the role of dominance; algebric, graphical and linear programming methods for solving mixed strategy games.

References:

1. H.A. Taha, Operation Research- An introduction, Printice Hall of India.
2. P.K. Gupta and D.S. Hira. Operations Research, S. Chand and Co.
3. S.D. Sharma, Operation Research, KedarNath Ram Nath Publications.
4. J.K. Sharma, Mathematical model in Operation Research, Tata McGraw Hill.

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025
MAL- 611: FLUID MECHANICS (elective)

L T P	Marks of External Exam : 80
4 0 0 (4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Description of fluid, stream line, path line and streak lines and stream tube.
2. Understand Equation of Motion of sphere, sources, sinks and doublets and flows under different boundary conditions.
3. Irrotational motion in two dimensions, stream functions and complex velocity potentials.
4. Learn about conformal mapping, vortex motion and its elementary properties.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Kinematics of fluid, Lagrangian and Eulerian methods, stream lines, path lines, streak lines, velocity potential, irrotational and rotational motions. vortex lines, equation of continuity, Lagrangian and Eulerian approach, Euler's equation of motion, Bernoulli's theorem, Kelvin circulation theorem, Vorticity equation, energy equation for an incompressible flow.

Unit-II

Boundary conditions, kinetic energy of liquid, axially symmetric flows, motion of a sphere through a liquid at rest at infinity, liquid streaming past a fixed sphere, equation of motion of a sphere, sources, sinks and doublets, images in a rigid impermeable infinite plane and in impermeable spherical surfaces.

Unit-III

Two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid, stream functions, stokes stream functions, complex velocity potential.

Unit- IV

Conformal mapping, Milne-Thomson circle theorem, Blasius theorem, vortex motion and its elementary properties, Kelvin's proof of permanence, motion due to rectilinear vortices.

Reference:

1. W.H. Besaint and A.S. Ramsey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Textbook of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
3. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
4. M.E. O'Neil and F. Choriton, Ideal and Incompressible Fluid Dynamics, John Wiley & Son.

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025

MAL- 613: ADVANCED DISCRETE MATHEMATICS (elective)

L T P	Marks for External exam : 80
4 0 0(4 credits)	Marks for Internal exam : 20
	Total : 100
	Time : 3hours

Course Outcomes:

1. Ability to apply Recurrence relations and generating functions.
2. Understand Hasse diagram, Logics and Lattices.
3. Learn about Boolean Algebra and its basic properties.
4. To be familiar with Graphs and Trees.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit –I

Recurrence relations, explicit formula for a sequence, solution of recurrence relations, homogeneous recurrence relations with constant coefficients, particular solution of a difference equation, recursive functions, generating functions, convolution of numeric functions, solution of recurrence relations by the method of generating function.

Unit – II

The Pigeonhole Principle, partially ordered sets, Hasse diagram, Logics: Basic logical operations, logical equivalence involving Tautologies and Contradictions, conditional propositions, quantifiers, Lattices: Properties of lattices, lattices as algebraic system, lattice isomorphism, bounded, complemented and distributive lattices.

Unit – III

Definitions and basic Properties of Boolean Algebra, Representation Theorem, Boolean expressions, logic gates and circuits, Boolean function, method to find truth table of a Boolean function , Karanugh map, expressing Boolean functions as Boolean polynomials, addition of binary digits, half – adder, full Adder.

Unit – IV

Graphs: Basic concepts and types of graphs, paths and circuits, Eulerian circuits, Hamiltonian Circuits, Matrix Representation of graphs, planar Graphs, Trees: Definition, and characterization of Trees Representation of Algebraic expressions by binary trees, spanning tree of a graph, shortest path problem, Minimal spanning tree, tree Searching.

References:

1.Discrete Mathematics by Koleman, Busby & Rose, Pearson’s Publication
2.Discrete Mathematical Structures by C.L. Liu, Pearson’s Publication
3.Discrete Mathematics by Babu Ram, Pearson’s Education, 2011

M.Sc. (Mathematics) 3rd Semester w.e.f. 2024-2025
MAP - 615: MATLAB

L T P	Marks for External Exam : 80
0 0 4 (02 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Know the basic concept of MATLAB Software.
2. Understand the procedure, algorithm and concepts required in solving specific problems.
3. Solve different types of mathematical problems and draw various types of graphs using MATLAB.
4. Various Programs using Toolbar.

List of programs using MATLAB

1. As a calculator
2. Roots of quadratic equation using command window
3. Numerical solutions of equations (single variable)
4. Coefficient of friction in each test and find average of it
5. Numerical solution of simultaneous linear algebraic equations
6. Numerical solution of ordinary differential equation
7. Numerical Solution of second order ordinary differential equations
8. Create a matrix and find its transpose, inverse and determinant
9. To find eigen value and eigen vector of given matrix.
10. Create a matrix using zeroes, ones, eye and linespace commands and another vector, then replace a particular row or column by the 5th root corresponding to that vector.
11. Using input and disp command
12. Showing vectorized role of fprintf command.
13. Plotting a function and its first three derivatives on same plot/ figure.
14. Hold on and hold off command
15. Plot light intensity vs. distance using label, title, axis text, legand etc. commands.
16. Find the sum of the first n terms of the series $\sum_{k=1}^{n}(-1)^k K/2^k$ using loop. Execute the script file for given n.
17. Using nesting loop and conditional statement.
18. Write a function file for given function then use it.
19. To find subtraction; multiplication & division operation for given two polynomials.
20. To find roots & derivatives of given polynomial.
21. Program on curve fitting
22. Find minimum & maximum value for given function.

Note: Out of the list as above, a student has to perform at least 15 (fifteen) programs in the semester. Five more programs can be done of their own choice.

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL -602: FUNCTIONAL ANALYSIS

L T P	Marks for External Exam	: 80
4 0 0(4 Credits)	Marks for Internal Exam	: 20
	Total	: 100
	Time	: 3 Hours

Course outcomes

1. Understand the concept of bounded linear transformation, equivalent formation of continuity and spaces of bounded linear transformation.
2. Extend a linear functional under suitable conditions; apply the knowledge to prove Hahn Banach Theorem for further application to bounded linear functionals on C[a,b]; know about adjoint of operators; understand reflexivity of a space and demonstrate understanding of the statement and proof of uniform boundedness theorem.
3. Learn the properties of compact operators.
4. Understand totality of orthonormal sets and sequences; represent a bounded linear functional in terms of inner product.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Normed linear spaces, metric on normed linear spaces, Holder's and Minkowski's inequality, completeness of quotient spaces of normed linear spaces, completeness of I_p, L^p, R^n, C^n and C[a,b], bounded linear transformation, equivalent formulation of continuity, spaces of bounded linear transformation, continuous linear functional, conjugate spaces.

Unit-II

Fundamental Theorems, Hahn Banach extension theorem (Real and Complex form) Riesz representation theorem for bounded linear functional on L^p and C[a,b] and their consequences, second conjugate spaces, reflexive spaces, uniform boundedness principle and its consequence, open mapping theorem and its application, projections, closed graph theorem equivalent norms.

Unit-III

Compact operators and its relation with continuous operators, compactness of linear transformation on a finite dimensional space, properties of compact operators, compactness of the limit of the sequence of compact operators, fixed point, Banach Contraction Principle and its application to solve matrix equation, differential equations.

Unit-IV

Inner product spaces, Hilbert spaces, Schwarz's inequality, Hilbert space as normed linear space, convex sets in Hilbert spaces, Projection theorem, orthonormal systems and Gram-Schmidt Orthogonalization Process, Bessel's inequality, Parseval's identity, conjugate of a Hilbert space, Riesz representation theorem for continuous functional on a Hilbert space.

References:

1. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
2. A.E. Taylor, Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
3. K. Yosida, Functional Analysis, 3rd edition Springer Verlag, New York, 1971.
4. Walter Rudin, Functional Analysis, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1973.
5. A.H. Siddiqi, Khalil Ahmad, P. Manchanda, Introduction to Functional Analysis with Applications, Anamaya Publishers, New Delhi.

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL -604: INTEGRAL EQUATIONS

L T P	Marks for External Exam :80
4 0 0 (4 Credits)	Marks of Internal Exam :20
	Total Marks :100
	Time :3 Hours

Course outcomes

1. Understand the concept of integral equations to identify different constituents to classify them and to apply the eigen-system method for solving the Fredholm type with separable kernel.
2. Derive procedures to for iterative methods to solve integral equations of both Fredholm and Volterra types without restricting the kernel to be separable and proving specific theorems of Fredholm's theory.
3. Symmetric kernel, Complex Hilbert Space and Hilbert Schmidt Theorem.
4. Understand the concept of Green's function and Modified Green's function.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -I

Definitions of Integral Equations and their classification, relation between integral and differential equations, Fredholm integral equations of second kind with separable kernels, Eigen Values and Eigen functions, reduction to a system of algebraic equations, An approximate method of successive approximations, Iterative scheme, condition of convergence and uniqueness of series solution, Resolvent kernel and its results, Fredholm theorems.

Unit-II

Solution of Volterra's integral equations by iterative scheme: Successive approximation, Resolvent kernel. Integral transform methods: Fourier transform, Laplace transform, Convolution integral, Application to Volterra integral equations with Convolution type kernels, Abel's equations.

Unit-III

Symmetric kernel, Complex Hilbert space, Orthonormal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen function and bilinear form, Hilbert Schmidt theorem, Solution of integral equations with symmetric kernels Singular Integral Equations - Inversion formula for singular integral equation with kernel of type (h(s) - h(t) - a, 0< a <1).

Unit-IV

Dirac Delta Function. Green's function approach to reduce boundary value problems of a self-adjoint differential equation with homogeneous boundary conditions to integral equation forms. Auxiliary problem satisfied by Green's function. Modified Green's function.

Reference:

1. R.P. Kanwal, Linear Integral Equation. Theory and Techniques, Academic Press, New York, 1971.
2. S.G. Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.
3. Abdul J. Jerri, Introduction to Integral Equations with Applications.
4. Hildebrand. F.B - Method of Applied Mathematics

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL 606: MECHANICS OF SOLIDS-II

L T P	Marks for External Exam : 80
4 0 0(4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Two-dimensional problems: Plane stress, Airy stress.
2. Learn about spring & dashpot, Maxwell & Kelvin models, three parameters solid.
3. Understand torsion and waves.
4. Solution of Euler's equation by Ritz, Galerkin and Kantorovich methods.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Two-dimensional Problems: Plane stress, generalized plane stress, airy stress function, general solution of Biharmonic equation, stresses and displacements in terms of complex potentials, the structure of functions of $\phi(z)$ and $\psi(z)$, first and second boundary value problems in plane elasticity, thick-walled tube under external and internal pressures.

Unit-II

Viscoelasticity: Spring & Dashpot, Maxwell & Kelvin Models, Three parameter solid, correspondence principle & its application to the deformation of a viscoelastic. Thick-walled tube in plane strain.

Unit-III

Torsion: Torsion of cylindrical bars, tortional rigidity, torsion and stress functions, lines of shearing stress, simple problems related to circle, ellipse and equilateral triangle.

Waves: Propagation of waves in an isotropic elastic solid medium, waves of dilatation and distortion, plane waves, elastic surface waves such as Rayleigh and Love waves.

Unit-IV

Variational methods - Theorems of minimum potential energy, theorems of minimum complementary energy, Reciprocal theorem of Betti and Rayleigh, Deflection of elastic string, central line of a beam and elastic membrane, solution of Euler's equation by Ritz, Galerkin and Kantorovich methods.

References

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Y.C. Fung, Foundations of Solid Mechanics, Prentice Hall, New Delhi.
3. S. Timoshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York.
4. W. Flugge, Viscoelasticity, Springer VerL.

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL 608: ALGEBRAIC CODING THEORY (elective)

L T P	Marks for External Exam : 80
4 0 0(4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time: 3 Hours

Course outcomes

1. Understand group codes, matrix encoding techniques, polynomial codes and Hamming codes.
2. Have deep understanding of finite fields, BCH codes
3. Learn about linear codes, cyclic codes, self-dual binary cyclic codes and MDS codes.
4. Learn about Hadamard matrices and Hadamard codes.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit – 1

Block codes, minimum distance of a code, decoding principle of maximum likelihood, binary error detecting and error correcting codes, group codes, minimum distance of a group code (m, m+1) parity check, double and triple repetition codes, matrix codes, generator and parity check matrices, dual codes, polynomial codes, exponent of a polynomial over the binary field, binary representation of a number, Hamming codes, minimum distance of a Hamming code. (Chapter 1,2,3 of the book given at Sr. No.1).

Unit – II

Finite fields, construction of finite fields, primitive element of a finite field, irreducibility of polynomials over finite fields, irreducible polynomials over finite fields, primitive polynomials over finite fields, automorphism group of GF (q^n), normal basis of GF (q^n), the number of irreducible polynomials over a finite field, the order of an irreducible polynomial, generator polynomial of a Bose- Chaudhary- Hocqhenghem codes (BCH codes) construction of BCH codes over finite field. (Chapter 4 of the book given at Sr. No. 1 and Section 7.1 to 7.3 of the book given at Sr. No.2)

Unit – III

Linear codes, generator matrices of linear codes, equivalent codes and permutation matrices, relation between generator and parity-check matrix of linear codes over a finite field, dual code of a linear code, self-dual codes, weight distribution of a linear code, weight enumerator of a linear code, Hadamard's transform, McWilliams identity for binary linear codes, Maximum distance separable codes. (MDS codes), examples for MDS codes, characterization of MDS codes in terms of generator and parity check matrices, dual code of a MDS code, Reed Solomon codes. (Chapter 5&9 of the book at Sr. No. 1).

Unit – IV

Hadamard matrices, existence of a Hadamard codes from Hadamard matrices cyclic codes, generator polynomial of a cyclic code, check polynomial of a cyclic code, equivalent code & dual code of a cyclic code, idempotent generator of a cyclic code, Hamming and BCH codes as cyclic codes, Perfect codes, The Gilbert-varsha-move and Plotkin bounds, Self-dual binary cyclic codes. (Chapter 6&11 of the book given at Sr. No.1).

References:

1. L.R. Vermani: Elements of Algebraic coding theory (Chapman and Hall Mathematics)
2. Steven Roman: Coding and information Theory (Springer Verlag)

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL -610: DIFFERENTIAL GEOMETRY (elective)

L T P	Marks for External Exam : 80
4 0 0(4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Can learn about the length and parameterization of curves, curvature and torsion.
2. Knows about Envelopes and edge of regression.
3. Knows the contents and the significance of the Curvilinear coordinates.
4. Understand about Geodesics, its equation and torsion.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Curves with torsion: Tangent, Principal Normal, Curvature, Binormal, Torsion, Serret Frenet formulae, Locus of centre of spherical Curvature.

Unit-II

Envelopes: Surfaces, Tangent plane, Normal Plane, Envelope, Characteristics, Edge of regression.

Unit-III

Curvilinear Co-ordinates: First order magnitude, Directions on a surface, Second order magnitudes, Derivative of unit normal, Principal directions and curvatures.

Unit-IV

Geodesics: Geodesics property, Equations of geodesics, Curvature and Torsion of a geodesics.

References:

1. C.E., Weatherburn, Differential Geometry of Three Dimensions.
2. Differential Geometry by Schaums Series

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL -612: ADVANCED FLUID MECHANICS (elective)

L T P	Marks for External Exam : 80
4 0 0(4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Be familiar with continuum model of fluid flow; classify fluid/flows, rotational and irrotational motion.
2. Deep knowledge about Dynamical similarity.
3. Understand the concept of Boundary layer flow: Prandtl's boundary layer, Boundary layer equations in two-dimensions, Blasius solution.
4. Analyse the wave motion in a gas: speed of sound, equation of motion of a gas, subsonic, sonic and supersonic flows of a gas.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit-I

Stress components in a real fluid, relations between rectangular components of stress, connection between stresses and gradients of velocity, Navier-Stoke's equations of motion, exact solution of Navier-Stoke's equations of motion- Couette flows and generalized Couette flow between two parallel plates, plane poiseuille flow, Hagen poiseuille flow, flow through tubes of uniform cross section in form of circle, annulus, ellipse and equilateral triangle under constant pressure gradient, unsteady flow over a flat plate.

Unit-II

Dynamical similarity: Buckingham π-theorem, Reynolds number, Eckert number, Froude number, application of pi- theorem to viscous and compressible fluid.

Unit-III

Boundary Layer Flow: Prandtl's boundary layer, boundary layer equations in two-dimensions, Blasius solution, boundary layer thickness, displacement thickness, Karman integral equations, separation of boundary layer flows.

Unit-IV

Wave motion in a gas: Speed of sound, equation of motion of a gas, subsonic, sonic and supersonic flows of a gas, isentropic gas flows, flow through a nozzle.

Reference:

1. F. Chorlton, Textbook of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
2. H. Schlichting, Boundary Layer Theory, McGraw Hill Book Company, New York, 1979.
3. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.
4. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAL 614: PARTIAL DIFFERENTIAL EQUATION (elective)

L T P	Marks for External Exam : 80
4 0 0(4 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Apply a range of techniques to find solutions of standard Partial Differential Equations (PDE).
2. Demonstrate capacity to model physical phenomena using PDE's (in particular using the heat and wave equations).
3. Demonstrate accurate and efficient use of methods to solve nonlinear first order PDE's.
4. Apply problem-solving using concepts and techniques from PDE's and Fourier analysis applied to diverse situations in physics, engineering, financial mathematics and in other mathematical contexts.

Note: The examiner is requested to set **nine** questions in all taking two questions from each unit and one **compulsory** question. The compulsory question will consist of four parts and will be distributed over the whole syllabus. The candidate is required to attempt **five** questions selecting one from each unit and the compulsory question.

Unit -I

Solution of Partial Differential Equation. Transport equation-initial value problem, non-homogeneous equation, Laplace equation-fundamental solution, mean value formulas, properties of harmonic functions, green function, energy methods.

Unit -II

Heat equation-fundamental solution, solution of initial value problems, non-homogeneous equations, mean value formula. Wave Equation-solution by spherical means, non-homogeneous equations, energy methods.

Unit -III

Nonlinear first order PDE- complete integrals, envelopes, characteristics, Hamilton Jacobi equations, Hamilton's ODE, Hopf-Lax formula, weak solutions, uniqueness.

Unit -IV

Representation of Solutions: Separation of variables, similarity solutions (Plain & Traveling waves solutions, Similarity under scaling), Fourier & Laplace transform, Hopf-Cole, Hodograph& Legendre transform, potential functions.

References:

1. L.C. Evans, Partial Differential Equations, Graduate studies in mathematics, Volume-19, AMS, 1998.
2. I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill international
3. An Introduction to Partial Differential Equation Yehuda Pinch over and Jacob Rubinstein, CAMBRIDGE University press 2005.

M.Sc. (Mathematics) 4th Semester w.e.f. 2024-2025
MAP – 616: LATEX (Lab)

L T P	Marks for External Exam : 80
0 0 4(02 Credits)	Marks for Internal Exam : 20
	Total : 100
	Time : 3 Hours

Course outcomes

1. Use the preamble of LaTeX file to define document class and layout options.
2. Use nested list and enumerate environments within a document.
3. Use tabular and array environments within LaTeX document.
4. Use BibTeX to maintain bibliographic information and to generate a bibliography for a particular document.

List of programs using LATEX

1. Tabular environment.
2. Create horizontal and vertical lines in table using LATEX commands
3. Multicolumn command.
4. Display role of cline command.
5. Math and math display mode.
6. Mathematical expression using some mathematical operation symbols.
7. Array environment.
8. Nesting array and tabular
9. Equation array and equation array star.
10. Role of no number command.
11. Nesting of array and tabular.
12. Framed equations using fbox command.
13. Signum and Dirichlet function.
14. Role of itemize environment.
15. Enumerate environment nesting of it.
16. Section and subsection.
17. Letter using LATEX.
18. Quote and quotation environments.
19. Role of display style.
20. Program using mbox command.
21. Write some equation using derivative and integral symbols.
22. Verse and Descriptive environment.

Note: Out of the list as above, a student has to perform at least 15 (fifteen) programs in the semester. Five more programs can be done of their own choice.