Scheme & Syllabi for M.Sc.(Mathematics)

Through Distance Education

w.e.f. 2019-20

Paper Code	Nomenclature	External Marks	Internal Marks	Total Marks
Semester I				
MAL 511	Algebra	70	30	100
MAL 512	Real Analysis	70	30	100
MAL 513	Mechanics	70	30	100
MAL 514	Ordinary Differential Equations-I	70	30	100
MAL 515	Complex Analysis-I	70	30	100
MAL 516	Programming with Fortran (Theory)	70	30	100
Semester II				
MAL 521	Abstract Algebra	70	30	100
MAL 522	Measure & Integration Theory	70	30	100
MAL 523	Methods of Applied Mathematics	70	30	100
MAL 524	Ordinary Differential Equations-II	70	30	100
MAL 525	Complex Analysis-II	70	30	100
MAL 526	Advance Numerical Methods	70	30	100
Semester III				
MAL 631	Topology	70	30	100
MAL 632	Partial Differential Equations	70	30	100
MAL 633	Mechanics of Solids-I	70	30	100
MAL 636	Fluid Mechanics	70	30	100
MAL 637	Advanced Discrete Mathematics	70	30	100
MAP 634	Computing Lab-II(Practical)	70	30	100
Semester IV				
MAL 641	Functional Analysis	70	30	100
MAL 642	Differential Geometry	70	30	100
MAL 643	Mechanics of Solids-II	70	30	100
MAL 644	Integral Equations	70	30	100
MAL 645	Advanced Fluid Mechanics	70	30	100
MAP 648	Computing Lab-III (Practical)	70	30	100

Note:-

1. In external major exam there will be nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

2. 30 % of the maximum marks in each paper are allocated for internal assessment based on two assignments (handwritten) each of 10 marks and 10 marks in written exam during PCP. (For more details see Prospectus)

M.Sc. (Mathematics) 1ST Semester

MAL- 511 Algebra | **Marks for Major Test (External) : 70**

Marks for Internal Assesment : 30

Time : 3 Hours | **Total :100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize students with some properties of groups and fields which have many applications in Coding Theory.

Unit - I

Zassenhaus's lemma, Normal and Subnormal series. Scheiers Theorem, Composition Series. Jordan-Holder theorem. Commutators and their properties. Three subgroup lemma of P.Hall.

Unit - II

Central series. Nilpotent groups. Upper and lower central series and their properties. Invariant (normal) and chief series. Solvable groups. Derived series. Field theory. Prime fields.

Unit - III

Extension fields. Algebraic and transcendental extensions. Algebraically closed field. Conjugate elements. Normal extensions. Separable and inseparable extensions. Perfect fields. Construction with ruler and campass. Finite fields

Unit - IV

Roots of unity. Cyclotomic Polynomial in ϕ_n (x). Primitive elements. Automorphisms of extensions. Galois extension. Fundamental theorem of Galois theory. Solutions of polynomial equations by radicals. Insolvability of the general equation of degree 5 by radicals.

Suggested Readings

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 (2nd Edition), Cambridge University Press, Indian Edition, 1997.

3. I.D.Macdonald, Theory of Groups.

4. M.Artin, Algebra, Prentice-Hall of India, 1991.

I.S.Luther and I.B.S.Passi, Algebra, Vol. I-Groups, Vol.lI-Rings, Narosa Publishing House (Vol. I-1996, Vol. II-1999).

MAL-512: REAL ANALYSIS **Marks for Major Test (External): 70**

Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To acquaint the students with the topics of Riemann-Stieltjes integral, sequence and series of functions, power series, functions of several variables and with the basic concepts of measurability of sets.

Unit – I

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

Unit - II

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 Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem, Power series, uniqueness theorem for power series, Abel's theorems.

Unit - III

Functions of several variables, linear transformations, derivatives in an open subset of R^{η}, chain rule, partial derivatives, interchange of the order of differentiation, derivatives of higher orders, Taylor's theorem, Inverse function theorem, Implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method.

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.

Suggested Readings

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. R.R. Goldberg, Methods of Real Analysis, John Wiley and Sons, Inc., New York, 1976.
4. P.K.Jain and V.P.Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986 (Reprint 2000).
5. H.L.Royden, Real Analysis, Macmillan Pub. Co. Inc. 4th Edition, New York, 1993.

MAL-513: MECHANICS | **Marks for Major Test (External): 70**
Internal Assessment:30

Time: 3 Hours | **Total Marks:100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize students with the basic concepts of moment of inertia; representation of the equations of motion for mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.

Unit - I

Moments and products of Inertia, Theorems of parallel and perpendicular axes, principal axes, The momental ellipsoid, Equimomental systems, Coplanar distributions. Generalized cooordinates. 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 Integral invariant. Whittaker's equations. Jacobi's equations. Hamilton-Jacobi equation. Jacobi 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.

Suggested Readings

1. F.Chorlton, A Text Book of Dynamics, CBS Publishers & Dist., New Delhi.
2. F.Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow.
3. A.S. Ramsey, Newtonian Gravitation, The English Language Book Society and the Cambridge University Press.
4. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press.

MAL-514: ORDINARY DIFFERENTIAL EQUATIONS-I

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To acquaint the students with existence and uniqueness of solutions of initial value problems, continuation of solutions, differential inequalities and with Sturm-Liouville boundary value problems.

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

Approximate methods of solving first-order equations: Power Series Methods, Numerical Methods. Continuation of solutions, Maximum interval of existence, Extension theorem, Dependence of solutions on initial conditions and function. Matrix method for homogeneous first order systems, nth order equation (Relevant topics from the books by Coddington & Levinson, and by Ross).

Unit - III

Total differential equations: Condition of integrability, Methods of Solution. Gronwall's differential inequality,Ccomparison theorems involving differential inequalities.

Unit – IV

Zeros of solutions, Sturms separation and comparison theorems. Oscillatory and nonoscillatory equations, Riccati's equation and its solution, Pruffer transformation, Lagrange's identity and Green's formula for second-order equation, Sturm-Liouville boundary-value problems, properties of eigen values and eigen functions. (Relevant topics from the books by Birkhoff & Rota, and by Ross).

Suggested Readings

1. E.A. Coddington and N. Levinson. Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.
2. G. Birkhoff and Rota, G.C. Ordinary Differential Equations, John Wiley and sons inc., NY, 1978.
3. S.L. Ross. Differential Equations, John Wiley and sons inc., NY, 1984.
4. Boyce, W.E. and Diprima, R.c. 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).

MAL-515: COMPLEX ANALYSIS-I **Marks for Major Test (External): 70**

Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize with the analytic and meromorphic functions and their applications.

Unit - I

Cauchy Riemann Equations, Analytic functions, Reflection principle, Complex Integration, Antiderivatives, Cauchy-Goursat Theorem, Simply and Multiply connected domains, Cauchy's Integral formula, Higher Order derivatives,

Unit - II

Morera's theorem, Cauchy's inequality, Liouville's theorem, The fundamental theorem of Algebra, Maximum Modulus Principle, Schwarz lemma, Poisson's formula, Taylor's Series, Laurent's Series.

Unit - III

Isolated Singularities, Meromorphic functions, Argument principle, Rouche's theorem, Residues, Cauchy's residue theorem, Evaluation of Integrals, Mittag Leffler's expansion theorem.

Unit - IV

Branches of many valued functions with special reference to arg z, Log z, z^a. Bilinear transformations, their properties and classification, definition and examples of conformal mapping.

Suggested Readings

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.ChurchilI, Complex Variables and Applications, McGraw HilI, 1996.

MAL-516: PROGRAMMING WITH FORTRAN (THEORY)

Marks for Major Test (External): 70
Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with the basics of computer and programming concepts of scientific language Fortran 90/95.

Unit - I

Computer Fundamentals: Computer Components, characteristics & classification of computers, hardware & software, peripheral devices. Algorithm Development: Techniques of problem solving, Flowchart.

Unit - II

Programming in Fortran 90/95: Numerical constants and variables, arithmetic expressions; implicit declaration, named constants, input/output; List directed input/output statements, Format specifications

Unit - III

Logical expressions and control flow; conditional flow; IF structure, Block DO loop Counted controlled Loops, arrays; strings; array arguments.

Unit - IV

Functions; subroutines; Derived types Processing files, Sequential file, Direct Access file; Pointers.

Suggest Readings

1. V. Rajaraman : Computer Programming in FORTRAN 90 and 95, Printice-Hall of India Pvt. Ltd., New Delhi.
2. J.F. Kerrigan : Migrating to FORTRAN 90, Orielly Associates, CA, USA.
3. M. Metcalf and J. Reid : FORTRAN 90/95 Explained, OUP, oxford, UK.

M.Sc. (Mathematics) 2ND Semester
MAL-521: ABSTRACT ALGEBRA **Marks for Major Test (External): 70**
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize students with some properties of rings and modules.

Unit - I

Canonical Forms-Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent transformation.

Unit - II

The primary decomposition theorem. Jordan blocks and Jordan forms. Rational canonical form. Generalized Jordan form over any field.

Unit - III

Cyclic modules. Free modules. Simple modules. Semi-simple modules. Schur's Lemma. Noetherian and Artinian modules and rings Hilbert basis theorem.

Unit - IV

Wedderburn-Artin theorem. Uniform modules, primary modules, and Noether-Lasker theorem. Smith normal form over a principal ideal domain and rank. Fundamental structure theorem for finitely generated abelian groups and its application to finitely generated Abelian groups.

Suggested Readings

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 (2nd 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).

MAL-522: MEASURE AND INTEGRATION THEORY

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To acquaint the students with the topics of measurable functions, Lebesgue integral, Differentiation of monotonic functions and L^p spaces.

Unit - 1

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, Egoroffs theorem, Lusin's theorem, Convergence in measure and F. Riesz theorem for convergence in measure, Almost uniform convergence.

Unit - II

Shortcomings of Riemann Integral. Lebesque 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, Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.

Unit - III

Vitali's covering Lemma, Differentiation of monotonic functions, 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.

Unit-IV

L^p spaces, Convex functions, Jensen's inequalities, The Holder and Minkowski inequalities, Convergence and Completeness of L^p space, Riesz-Fisher Theorem, Bounded linear functional on L^p space, Riesz representation theorem.

Suggested Readings

1. G. De Barra, Measure Theory and Integration, Weiley Eastern Limited, 1981.
2. P.K.Jain and V.P.Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986 (Reprint 2000).
3. H.L.Royden, Real Analysis, Macmillan Pub. Co. Inc. 4th Edition, New York, 1993.
4. R. G. Bartle, The elements of Integration and Lebesgue Measure, John Wiley and Sons, 1995
5. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International student edition.

MAL-523: METHODS OF APPLIED MATHEMATICS

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with basics of Fourier Transforms and its applications, Curvilinear Co-ordinates, probability distributions, multiple correlation and sampling distributions.

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, Change of Co-ordinates, Cartesian, Cylindrical and spherical co-ordinates, expressions for velocity and accelerations, ds, dv and ds^2 in orthogonal co-ordinates, Areas, Volumes & surface areas in Cartesian, Cylindrical & spherical co-ordinates in a few simple cases, Grad, div, Curl, Laplacian in orthogonal Co-ordinates, Contravariant and Co-variant components of a vector, Metric coefficients & the volume element.

Unit - III

Sample spaces, random variables, Mathematical expectation and moments, Binomial, Poisson, Geometric, Uniform and Exponential distributions.

Unit - IV

Normal & Gamma distributions. Multiple Regression, Partial and Multiple Correlation, t, F and Chi-square distributions, weak law of large numbers and Central Limit Theorem.

Suggested Readings

1. Sneddon, I. N., The Use of Integral Transforms.
2. Schaum's Series, Vector Analysis.
3. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics

MAL-524: ORDINARY DIFFERENTIAL EQUATIONS-II

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with linear systems, adjoint systems, non-linear systems and with some motivating problems of calculus of variation.

Unit - I

Linear systems, fundamental set and fundamental matrix of a homogeneous system, Wronskian of a system. Abel - Liouville formula, Adjoint systems, Reduction of the order of a homogeneous system.

Unit - II

Systems with constant coefficients, Method of variation of constants for a non-homogeneous system, Periodic solutions, Floquet theory for periodic systems, Linear differential equations of order n, Lagrange's identity, Green's formula (Relevant topics from the book by Coddington and Levinson and by S.L.Ross).

Unit – III

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, Perturbations, Simple critical points, Dependence on a parameter, Liapunov function, Liapunov's method to determine stability for nonlinear 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, Brachistochrone problem, Isoperimetric problem, Geodesic, Fundamental lemma of calculus of variations, Euler's equation for one dependent function and its generalization to 'n' dependent functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints. (Relevant topics from the book by Gelfand and Fomin)

Suggested Readings

1. E.A. Coddington and N. Levinson. Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.
2. G. Birkhoff and Rota, G.C. Ordinary Differential Equations, John Wiley and sons inc., NY, 1978.
3. S.L. Ross. Differential Equations, John Wiley and sons inc., NY, 1984.
4. J.M. Gelfand and Fomin, S.V., Calculus of Variations, Prentice Hall, Englewood, Cliffs, New Jersy, 1963.
5. Boyce, W.E. and Diprima, R.C., 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).

MAL-525: COMPLEX ANALYSIS-II **Marks for Major Test (External): 70**

Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the concepts of analytic continuation, properties of entire functions and conformal mapping.

Unit - I

Analytic Continuation; Spaces of Analytic functions, Hurwitz's theorem, Montel's theorem, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, power series method of analytic continuation. Monodromy theorem and its consequences,

Unit – II

Entire function; Canonical products, Weierstrass' factorisation theorem, Exponent of Convergence, Order of an entire function, Jensen's formula, Borel's theorem. Hadamard's factorization theorem, Hadamard's three circles theorem.

Unit – III

The range of an analytic function. Bloch's theorem. The Little Picard theorem. Schottky's theorem. Montel Caratheodory and the Great picard theorem.

Unit - IV

Conformal mapping; Riemann mapping theorem, Harmonic function on a disk, Dirichlet problem. Green's function. Harnack's inequality and theorem, Univalent functions. Bieberbach's conjecture (Statement only) and the 1/4 theorem.
Meromorphic Function; Gamma function and its properties, Riemann Zeta function, Riemann's functional equation. Runge's theorem, Poisson-Jensen formula.

Suggested Readings

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, McGraw Hill, 1996.

MAL-526: Advanced Numerical Methods

Marks for Major Test (Theory) : 70
Marks (Internal Assessment) : 30
Total Marks: 100

Time : 3 ours

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Unit-I

Interpolation and Approximation

Interpolation: Introduction of Gauss' Central Difference Formulae, Stirling's Formula, Bessel's Formula without proof, Everett's Formula, Relation between Bessel's and Everett's Formulae. Hermite's Interpolation Formula, Divided Differences and Their Properties, Newton's General Interpolation Formula, Interpolation by Iteration, Inverse Interpolation, Double Interpolation.

Approximation: Norms of functions – Best Approximations: Least squares polynomial approximation– Approximation with Chebyshev polynomials – Piecewise Linear & Cubic Spline approximation.

Unit-II

Numerical Differentiation and Integration

Numerical Differentiation: Errors in Numerical Differentiation, Cubic Splines Method, Differentiation Formulae with Function Values, Maximum and Minimum Values of a Tabulated Function.

Numerical Integration: Boole's and Weddle's rules, use of Cubic splines, Romberg integration, Newton-Cotes integration formula, Euler-Maclaurin formula, Adaptive Quadrature method. Gaussian integration, Numerical evaluation of Singular integrals, Numerical evaluation of double and triple integrals with constant and variable limits and its application, Solution of integral equations.

Unit-III

Iterative Methods for Linear and Nonlinear System

Iterative Method for System of Linear Equations: General iterative method. Jacobi and Gauss-Seidel method. Relaxation method. Necessary and sufficient conditions for convergence. Speed of convergence. S.O.R. and S.U.R. methods. Determination of eigenvalue by iterative methods. Ill conditioned system. Solution of tridiagonal system,

Iterative Method for System of Non-linear Equations: Complex root of non-linear equation, solution of simultaneous non-linear equations.

Unit-IV

Numerical solution of ordinary differential equations

Initial value problems: Runge Kutta methods of fourth order, Multistep method- The Adams-Moulton method, stability, Convergence and Truncation error for the above methods. Milne's method, Cubic spline method, Simultaneous and higher order equations,

Boundary Value Problems: Second order finite difference, Shooting method and Cubic spline methods, Numerov's method, Mixed BVPs.

Suggested Readings:

1. C.F. Gerald and P.O. Wheatley : Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), Sixth Edition.
2. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Edn., AMS (2002).
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).
4. John H Mathews, Numerical Methods for Mathematics, Science and Engineering, Prentice Hall of India (1994).
5. K. E. Atkinson, Introduction to Numerical Analysis, 2nd Edn., John Wiley (1989).
6. M.K. Jain: Numerical Solution of Differential Equations, 4^{th} Edition, New Age (2018).

M.Sc. (Mathematics) 3rd Semester

MAL-631: TOPOLOGY **Marks for Major Test (External): 70**

Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with basics of a topological space, compactness, connectedness, separation axioms and product spaces..

Unit - I

Definition and examples of topological spaces. Closed sets. Closure. Dense subsets. Neighbourhoods. Interior, exterior and boundary points of a set. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology. Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighbourhood Systems. Continuous functions and homeomorphism.

Unit - II

Compactness. Continuous functions and compact sets. Basic properties of compactness. Compactness and finite intersection property. Sequentially and countably compact sets. Local compactness and one point compactification. Compactness in metric spaces. Equivalence of compactness, countable compactness and sequential compactness in metric spaces.

Unit - III

Connected spaces. Connectedness on the real line. Components. Locally connected spaces. First and Second Countable spaces. Lindelof 's theorem. Separable spaces. Second Countability and Separability. Separation axioms. T_0, T_1, and T_2 spaces. Their characterization and basic properties.

Unit - IV

Regular and normal spaces. Urysohn's Lemma. T_3 and T_4 spaces. Complete regularity and Complete normality. $T_{3/½}$ and T_5 spaces. Product topological spaces, Projection mapping. Tychonoff product topology in terms of standard sub-base and its characterizations.

Suggested Readings

1. W.J.Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.
2. J.L.Kelley, General Topology, Van Nostrand, Reinhold 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 Book Company, 1963.
5. J.Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.).
6. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.

MAL-632: PARTIAL DIFFERENTIAL EQUATIONS

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with linear and non-linear partial differential equations in R^n and various methods to obtain the solution of partial differential equations.

Unit - I

Solution of Partial Differential Equations Transport Equation-Initial value Problem. Non-homogeneous Equation. Laplace's Equation-Fundamental Solution, Mean Value Formulas, Properties of Harmonic Functions, Green's Function, Energy Methods.

Unit – II

Wave Equation-Solution by Spherical Means, Non-homogeneous Equations, Energy Methods. Poisson’s formula, Kirchoff’s formula, D. Alembert’s formula, Uniqueness of Solution Domain of Dependence of Solution.

Unit – III

Heat Equation-Fundamental Solution, Solution of initial value problem, Non Homogeneous Equation, Mean Value Formula.

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 (Plane and Travelling Waves, Solitons, Similarity under Scaling), Fourier and Laplace Transform, Hopf-Cole Transofrm, Hodograph and Legendre Transforms, Potential Functions.

Suggested Readings

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19. AMS, 1998.
2. Sneddon I. N., Elements of Partial Differential Equations, McGraw Hill International

MAL-633: MECHANICS OF SOLIDS-I

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize students with basics of Cartesian Tensor, theory of elasticity including strain/displacement relations, equilibrium and constitutive equations, Hooke's law to develop stress-strain relationships for different types of materials, basic properties of materials to solve problems related to isotropic elasticity.

Unit - I

Cartesian Tensor: Coordinate transformation, Cartesian Tensor of different order, Sum or difference and product of two tensors. Contraction theorem, Quotient law, Symmetric & Skewsymmetric 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 - II

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.

Analysis of Stress: Stress tensor. Equations of equilibrium. Transformation of coordinates.

Unit - III

Stress quadric of Cauchy. Principal stress and invariants. Maximum normal and shear stresses.Equations of Elasticity: Generalised Hooke's law. Homogeneous isotropic media.

Unit - IV

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.

Suggested Readings

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.
4. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
5. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi.

MAL-636: FLUID MECHANICS

Marks for Major Test (External): 70
Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: The objective of this paper is to make the students familiar with the flow properties of ideal fluid.

Unit - I

Kinematics of fluid: Lagrangian and Eulerian approach, Stream lines, Path lines, Streak lines, Velocity potential, Irrotational and rotational motions. Vortex lines, Equation of Continuity. Euler's equation of motion, Bernoulli's theorem, Kelvin circulation theorem, Vorticity equation.

Unit - II

Energy equation for an incompressible flow. 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.

Unit - III

Stream functions, Stokes stream functions, Sources, Sinks and doublets, Images in a rigid impermeable infinite plane and in impermeable spherical surfaces Conformal mapping, Milne-Thomson Circle theorem, Blasius theorem.

Unit - IV

Two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid, Vortex motion and its elementary properties, Kelvin's proof of permanence, motion due to rectilinear vortices.

Suggested Readings

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 & Sons.

MAL-637: ADVANCED DISCRETE MATHEMATICS

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To study some important results of discrete mathematics with their applications.

Unit - I

Formal Logic - Statements, Symbolic, Representation and Tautologies, Quantifiers, Proposition Logic. Lattices - Lattices as partially ordered sets, Their properties, Lattices as Algebraic systems, Some special Lattices, e.g., complete, complemented and Distributive Lattices. Sets Some Special Lattices e.g., Bounded, Complemented & Distributive Lattices.

Unit - II

Boolean Algebra - Boolean Algebra as Lattices, Various Boolean Identities, The Switching Algebra example, Join - irreducible elements, Atoms and Minterms, Boolean Forms and Their Equivalence, Minterm Boolean Forms, Sum of Products canonical Forms, Minimization of Boolean Functions, Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates).

Unit - III

Graph Theory - Definition of Graphs, Paths, Circuits, Cycles and Subgraphs, Induced Subgraphs, Degree of a vertex, Connectivity, Planar Graphs and their properties, Euler's Formula for Connected Planar Graph, Complete and Complete Bipartite Graphs,

Unit - IV

Trees, Spanning Trees, Minimal Spanning Trees, Matrix Representation of Graphs, Euler's theorem on the Existence of Eulerian Paths and circuits, Directed Graphs, Indegree and outdegree of a vertex, Weighted undirected Graphs, Strong Connectivity and Warshall's Algorithm, Directed Trees, Search Trees, Tree Traversals.

Suggested Readings

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Book Co., 1997.
2. Seymour Lepschutz, Finite Mathematics (International edition 1983), McGraw-Hili Book Company, New York.
3. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hili Book Co.
4. N.Deo, Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India.

MAP634: COMPUTING LAB-2 **Marks for Major Test (External): 70**
1.5 Credits (0-0-3) **Internal Assessment: 30**
Total Marks: 100

Objectives: The objective of the course is to familiarize the students with the working of the MATLAB softwares:

Introduction of Starting MATLAB, Creating Arrays, Mathematical operations with Arrays, creating M. files, script-files and functions and files and managing data, Two-dimensional plots, Programming in MATLAB, User-defined functions and function files, Polynomials, Applications in numerical analysis, Symbolic Math.

Suggested Readings

1. Amos Gilat, MATLAB: An Introduction with Applications, John Wiley & Sons.
2. Brian R. Hunt, Ronald Lipsman and Jonathan M. Rosenberg, A Guide to Matlab, Cambridge University Press.

M.Sc. (Mathematics) 4TH Semester
MAL641: FUNCTIONAL ANALYSIS

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objective: To familiarize the students with the topics of Normed linear spaces, Conjugate spaces, Equivalent norms and Inner product spaces.

Unit - 1

Normed linear spaces, metric on normed linear spaces, Holder's and Minkowski's inequality, completeness of quotient spaces of normed linear spaces. Completeness of l_P, L^P, R^η, C^η and C[a, b]. Bounded linear transformation. Equivalent formulation of continuity. Spaces of bounded linear transformation. Continuous linear functional, conjugate spaces.

Unit - 1I

Hahn Banach extension theorem (Real and Complex form), Riesz Representation theorem for bounded linear functionals on L^P and C[a, b]. Second Conjugate spaces, Reflexive spaces, uniform boundedness principle and its consequence, open mapping theorem and its application, projections, closed graph theorem.

Unit - III

Equivalent norms, weak and strong convergence, their equivalence in finite dimensional spaces. 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.

Unit - IV

Inner product spaces, Hilbert spaces, Schwarz's inequality, Hilbert space as normed linear space, convex sets in Hilbert spaces. Projection theorem, orthonormal sets, Bessel's inequality, Parseval's identity, Conjugate of a Hilbert space.

Suggested Readings

1. H.L.Royden, Real Analysis Macmillian Publishing Co., Inc, New York 4th Edition 1993.
2. E.Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
3. A.E. Taylor, Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
4. K. Yosida, Functional Analysis, 3rd edition Springer Verlag, New York, 1971.
5. Walter Rudin, Functional Analysis, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1973.

MAL-642: DIFFERENTIAL GEOMETRY

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To apply the concepts and techniques of differential geometry of curves and surfaces; understand the curvature and torsion of a space curve and how to analyze and solve problems, First and Second fundamental forms of a surface; compute the mean and Gauss curvature of a surface; find geodesics on a given surface and its torsion.

Unit - I

Curves with torsion: Tangent, Principal Normal, Curvature, Binormal, Torsion, Serret Frenet formulae (Relevant sections of Weatherburn's book).

Unit - II

Locus of centre of Curvature, Locus of centre of Spherical Curvature, Surfaces, Tangent plane, Normal, Envelope, Characteristics, Edge of regression (Relevant sections of Weather burn's book).

Unit - III

Curvilinear Co-ordinates, First order magnitudes, Directions on a surface, The Normal, Second order magnitudes, Derivative of unit normal (Relevant sections of Weatherburn's book).

Unit - IV

Principal directions and curvatures, First and Second curvatures, Geodesic property, Equations of geodesics, Surface of revolution, Torsion of a geodesic (Relevant sections of Weatherburn's book).

Suggested Readings

1. C.E., Weatherburn, Differential Geometry of Three Dimensions
2. M. Lipschultz, Differential Geometry, Schaum Outlines

MAL-643: MECHANICS OF SOLIDS-II

Marks for Major Test (External): 70
Internal Assessment: 30

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with Two-dimensional elastostistic, problems, fundamentals of Viscoelasticity, Torsion of cylindrical bars, propagation of waves in an elastic solids and variational methods used in deformation of elastic materials.

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 and elastic membrane. Solution of Euler's equation by Ritz, Galerkin and Kantorovich methods.

Suggested Readings

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 Verlag.
5. Martin H. Sadd., Elasticity Theory, Applications and Numerics AP (Elsevier).

MAL-644: INTEGRAL EQUATIONS

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: To familiarize the students with the concepts of integral equations and various methods for the solutions of different type of integral equations.

Unit – I

Definition 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. 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

Unit - IV

Singular Integral Equations - Inversion formula for singular integral equation with kernel of type (h(s) - h(t) - a, 0< a <1). 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.

Suggested Readings

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 - Methods of Applied Mathematics

MAL-645: ADVANCED FLUID MECHANICS

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks 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.

Objectives: The objectives of this paper is to make familiar with the flow properties of real fluids and their applications in science and technology.

Unit – I

Stress components in a real fluid, Relations between rectangular components of stress, Connection between stresses and gradients of velocity. Viscous fluid, 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.

Unit – II

Flow through tubes of uniform cross section in the form of circle, annulus, ellipse and equilateral triangle under constant pressure gradient. Unsteady flow over a flat plate. Dynamical similarity: Buckingham π-theorem. Reynolds number, Wever Number, Mach Number, Froude Number, Eckert Number, Application of pi- theorem to viscous and compressible fluid flow.

Unit – III

Boundry Layer Flow: Prandtl's boundary layer approximation, boundary layer thickness, displacement thickness, momentum thickness; boundary layer equations in two-dimensions, Blasius solution, Karman integral equations. Separation of boundary layer.

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.

Suggested Readings

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.

MAL-648: COMPUTING LAB-III

Marks for Major Test (External): 70
Internal Assessment: 30
Time: 3 Hours **Total Marks: 100**

Objectives: The objective of the course is to familiarize the students with the working of the LATEX software:

Overview, Special Characters, Text, Making Tables, Bibliography with Bibtex, Math Mode, Equations and arrays, Specific operators of Mathematics and structure formations – Derivatives, Integrals, del operator, product and sum operator. Making special parts, Format for technical writing – Article, Report. Cover page, Abstract, other front matter, Back matter, graphics, Importing pictures.

Suggested Readings

1. Harvey J. Greenberg, A Simplified Introduction to Latex.
2. Latex Companion, 2nd Edition, Frank Mittelbach, Michel Goossem, Johannes Braams, David Carlisle, Chris Rowley.
3. Guide to Latex, Helmut Kopka and Patrick W. Daly.