FACULTY OF SCIENCE
Mohanlal Sukhadia University, Udaipur
M.Sc. Mathematics (CBCS) Programme
(valid from session 2015-16 on wards)

1. Duration of the Course

The Master of Science Mathematics programme will be of four semesters duration under Choice based Credit system which will be conducted in two years. Each semester will be of approximately 5 months (minimum 90 working days in a semester) duration.

2. Eligibility:

Candidates seeking admission to the first semester of M.Sc.(Mathematis) must have a Bachelors degree with Mathematics as one of the optional subjects or as a honours subject (10+2+3 scheme) with minimum 48% marks from a UGC recognized University

3. Admissions:

Admissions to the first semester of M.Sc.(Mathematics) will be made as per admission rules for M.Sc.(CBCS)

4. Medium of Instruction

The medium of instruction and examination shall be English.

5. No. of Seats

Total number of normal fee seats: As per information bulletin

6. Curriculum

6.1 M.Sc.(Mathematics) programme has a two year , four semester prescribed course structure which in general terms is known as curriculum. It prescribes courses to be studied in each semester as given below

6.2 M.Sc.(Mathematics) programme shall have a curriculum and course contents (syllabi) for the courses recommended by the committee courses in Botany and approved by the academic council of the university.

6.3 The programme shall follow Choice Based Credit System(CBCS) and will be governed by the Common Rules and Regulations of Masters programme under CBCS approved by the Academic Council of the University

7. **Courses of Study and Examination (2015-16)**

M.A. /M.Sc. MATHEMATICS (CBCS) 2015-16

Course Code PSSSCCXX	Title of the Course
M1 MAT 01-CT01	Algebra-I
M1 MAT 02-CT02	Real Analysis
M1 MAT 03-CT03	Differentional Equations & Calculus of Variation
M1 MAT 04-CT04	Mechanics-I
M1 MAT 05-CT05	Differential Geometry-I
M2 MAT 01-CT06	Algebra-II
M2 MAT 02-CT07	Complex Analysis
M2 MAT 03-CT08	Special Functions
M2 MAT 04-CT09	Mechanics-II
M2 MAT 05-CT10	Differential Geometry-II
M3 MAT 01-CT11	Topology
M3 MAT 02-CT12	Tenser Analysis
M4 MAT 01-CT 13	Functional Analysis
M4 MAT 02-CT 14	Relativity and Cosmology

Discipline Specific Elective Course (DSE) for Semester III & IV

Note: Students are to opt any three DSE courses among the following with the permission of the Head of the Department.

Course Code PSSSCCXX	Title of the Course
M3 MAT01–DSE 01	Numerical Analysis-I
M3 MAT02–DSEP 02	*Computer Programming in-C
M3 MAT03–DSE 03	Discrete Mathematics-I
M3 MAT04–DSE 04	Optimization Techniques-I
M3 MAT05 –DSE 05	Mathematical Theory of Statistics-I
M3 MAT06–DSE 06	Viscous Fluid Dynamics-I
M3 MAT07–DSE 07	Integral Equations
M3 MAT08–DSE 08	Astronomy-I
M3 MAT09–DSE 09	Number Theory-I
M4 MAT01 –DSE 01	Numerical Analysis-II
M4 MAT02 –DSEP 02	**Computer Programming of Numerical Methods
M4 MAT03 –DSE 03	Discrete Mathematics-II

M4 MAT04 –DSE 04	Optimization Techniques-II
M4 MAT05 –DSE 05	Mathematical Theory of Statistics-II
M4 MAT06 –DSE 06	Viscous Fluid Dynamics-II
M4 MAT07 –DSE 07	Integral Transforms
M4 MAT08 –DSE 08	Astronomy-II
M4 MAT09 –DSE 09	Number Theory-II

* (i) This paper cannot be opted by the students having computer science as an optional paper in their U.G. Course.
(ii) This paper can be opted by maximum of 25 students on the basis of merit of previous semesters.

** This paper can be opted by maximum of 25 students on the basis of merit of previous semesters.

List of Skill Courses (SC)

Course no.	Course Code PSSSCCXX	Title of the Course
I	M2 MAT 06-SC01	Mathematical and Analytical Skill (For Biological Sciences)
II	M2 MAT 06-SC02	Official Statistics-I
III	M4 MAT -SC 01	Basic Statistical Techniques
IV	M4 MAT -SC 02	Official Statistics-II

Prerequisites to opt the DSE courses for semester IV are as follows:

For	M4 MAT01 –DSE 01	is M3 MAT01–DSE 01
For	M4 MAT02 –DSE 02	is M3 MAT02–DSE 02
For	M4 MAT03 –DSE 03	is M3 MAT03–DSE 03
For	M4 MAT04 –DSE 04	is M3 MAT04–DSE 04
For	M4 MAT05 –DSE 05	is M3 MAT05–DSE 05
For	M4 MAT06 –DSE 06	is M3 MAT06–DSE 06
For	M4 MAT07 –DSE 07	is M3 MAT07–DSE 07
For	M4 MAT08 –DSE 08	is M3 MAT08–DSE 08
For	M4 MAT09 –DSE 09	is M3 MAT09–DSE 09

M.A. /M.Sc. MATHEMATICS (CBCS) 2015-16

Semester- I

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M1 MAT 01-CT01	Core Course- 01 Algebra-I	4-1-0	5	80	20	100
II	M1 MAT 02-CT02	Core Course- 02 Real Analysis	4-1-0	5	80	20	100
III	M1 MAT 03-CT03	Core Course- 03 Differentional Equations & Calculus of Variation	4-1-0	5	80	20	100
IV	M1 MAT 04-CT04	Core Course- 04 Mechanics-I	4-1-0	5	80	20	100
V	M1 MAT 05-CT05	Core Course- 05 Differential Geometry-I	3-1-0	4	80	20	100

Semester- II

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M2 MAT 01-CT06	Core Course- 06 Algebra-II	4-1-0	5	80	20	100
II	M2 MAT 02-CT07	Core Course- 07 Complex Analysis	4-1-0	5	80	20	100
III	M2 MAT 03-CT08	Core Course- 08 Special Functions	3-1-0	4	80	20	100
IV	M2 MAT 04-CT09	Core Course- 09 Mechanics-II	4-1-0	5	80	20	100
V	M2 MAT 05-CT10	Core Course- 10 Differential Geometry-II	3-1-0	5	80	20	100
VI	M2 MAT 06-SC01	Skill Course- 01	2-0-0	2	80	20	100

Skill Course (SC) for Semester II

Note: Students can opt one SC courses with the permission of the Head of the Department.

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	

	1	2		3	4	5	6
I	M2 MAT 06-SC 01	Skill Course Elective 01 Mathematical and Analytical Skill (For Biological Sciences)	2-0-0	2	80	20	100
II	M2 MAT 06-SC 02	Skill Course Elective - 02 Official Statistics-I	2-0-0	2	80	20	100

Semester- III

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M3 MAT 01-CT11	Core Course- 11 Topology	3-1-0	4	80	20	100
II	M3 MAT 02-CT12	Core Course- 12 Tenser Analysis	4-1-0	5	80	20	100
III	M3 MAT 0X–DSE 0X	DSE – 0 X	-	5	80	20	100
IV	M3 MAT 0X–DSE 0X	DSE - 0 X	-	5	80	20	100
V	M3 MAT 0X–DSE 0X	DSE - 0 X	-	5	80	20	100

Discipline Specific Elective Course (DSE) for Semester III

Note: Students are to opt any three DSE courses among the following with the permission of the Head of the Department.

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M3 MAT01–DSE 01	DSE- 01 Numerical Analysis-I	4-1-0	5	80	20	100
II	M3 MAT02–DSEP 02	DSE – 02 * Computer Programming in-C	2-0-3	5	80	20	100
III	M3 MAT03–DSE 03	DSE - 03 Discrete Mathematics-I	4-1-0	5	80	20	100
IV	M3 MAT04–DSE 04	DSE - 04 Optimization Techniques-I	4-1-0	5	80	20	100
V	M3 MAT05 –DSE 05	DSE - 05 Mathematical Theory of Statistics-I	4-1-0	5	80	20	100
VI	M3 MAT06–DSE 06	DSE - 06 Viscous Fluid Dynamics-I	4-1-0	5	80	20	100
VII	M3 MAT07–DSE 07	DSE - 07 Integral Equations	4-1-0	5	80	20	100
VIII	M3 MAT08–DSE 08	DSE - 08 Astronomy-I	4-1-0	5	80	20	100
IX	M3 MAT09–DSE 09	DSE - 09 Number Theory-I	4-1-0	5	80	20	100

* (i) This paper cannot be opted by the students having computer science as an optional paper in their U.G. Course.
(ii) This paper can be opted by maximum of 25 students on the basis of merit of previous

semesters.

Semester- IV

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M4 MAT 01-CT 13	Core Course- 13 Functional Analysis	3-1-0	4	80	20	100
II	M4 MAT 02-CT 14	Core Course- 14 Relativity and Cosmology-II	4-1-0	5	80	20	100
III	M4 MAT 0 X –DSE 0X	DSE - 0 X		5	80	20	100
IV	M4 MAT 0 X –DSE 0X	DSE - 0 X		5	80	20	100
V	M4 MAT 0 X –DSE 0X	DSE - 0 X		5	80	20	100
VI	M4 MAT -SC 02	Skill Course- 02	2-0-0	2	80	20	100

Discipline Specific Elective Course (DSE) for Semester IV

Note: Students are to opt any three DSE courses among the following with the permission of the Head of the Department.

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M4 MAT01 –DSE 01	DSE- 01 Numerical Analysis-II	4-1-0	5	80	20	100
II	M4 MAT02 –DSEP 02	DSE – 02 * Computer Programming of Numerical Methods	2-0-3	5	80	20	100
III	M4 MAT03 –DSE 03	DSE - 03 Discrete Mathematics-II	4-1-0	5	80	20	100
IV	M4 MAT04 –DSE 04	DSE - 04 Optimization Techniques-II	4-1-0	5	80	20	100
V	M4 MAT05 –DSE 05	DSE - 05 Mathematical Theory of Statistics-II	4-1-0	5	80	20	100
VI	M4 MAT06 –DSE 06	DSE - 06 Viscous Fluid Dynamics-II	4-1-0	5	80	20	100
VII	M4 MAT07 –DSE 07	DSE - 07 Integral Transforms	4-1-0	5	80	20	100
VIII	M4 MAT08 –DSE 08	DSE - 08 Astronomy-II	4-1-0	5	80	20	100
IX	M4 MAT09 –DSE 09	DSE - 09 Number Theory-II	4-1-0	5	80	20	100

* This paper can be opted by maximum of 25 students on the basis of merit of previous semesters.

Prerequisites to opt the DSE courses for semester IV are as follows:

For	M4 MAT01 –DSE 01	is	M3 MAT01–DSE 01
For	M4 MAT02 –DSE 02	is	M3 MAT02–DSE 02
For	M4 MAT03 –DSE 03	is	M3 MAT03–DSE 03
For	M4 MAT04 –DSE 04	is	M3 MAT04–DSE 04
For	M4 MAT05 –DSE 05	is	M3 MAT05–DSE 05
For	M4 MAT06 –DSE 06	is	M3 MAT06–DSE 06
For	M4 MAT07 –DSE 07	is	M3 MAT07–DSE 07
For	M4 MAT08 –DSE 08	is	M3 MAT08–DSE 08
For	M4 MAT09 –DSE 09	is	M3 MAT09–DSE 09

Skill Course (SC) for Semester IV

Note: Students can opt one SC courses with the permission of the Head of the Department.

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M4 MAT -SC 01	Skill Course Elective 01 Basic Statistical Techniques	2-0-0	2	80	20	100
II	M4 MAT -SC 02	Skill Course Elective - 02 Official Statistics-II	2-0-0	2	80	20	100

M. A. / M. Sc. MATHEMATICS (Semester I)

M1 MAT 01-CT01
ALGEBRA-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

External and Internal direct product of two and finite number of subgroups; Commutator subgroup; Cauchy's theorem for finite abelian and non abelian groups.

UNIT II

Sylow's three theorem and their easy applications, Subnormal and Composition series, Zassenhaus lemma and Jordan Holder theorem.

UNIT III

Solvable groups and their properties, Nilpotent groups, Fundamental theorem for finite abelian groups.

UNIT IV

Annihilators of subspace and its dimension in finite dimensional vector space, Invariant, Projection, adjoins.

UNIT V

Singular and nonsingular linear transformation, quadratic forms and Diagonalization.

Books recommended:

1. Surjeet Singh and Quazi Zameeruddin : Modern Algebra.
2. Herstein, I.N. : Topics in algebra.
3. Agrawal, R.S. : Algebra.
4. Jacobson, N. : Basic Algebra Vol. I, II.
5. Lang, S. : Algebra IIIrd Edition.
6. Bhattacharya, P.B., Jain, S.K. and Etc. : Basic Abstract Algebra (IInd Edition).

M. A. / M. Sc. MATHEMATICS (Semester I)

M1 MAT 02-CT02

REAL ANALYSIS

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Measure Theory: Length of an interval, outer measure of a subset of R, Labesgue outer measure of a subset of R, Existence, non-negativity and monotonicity of Lebesgue outer measure, Translation Invariance of outer measure, Countable sub-additivity of Lebesgue outer measure, the relation between outer measure and length of an interval.

UNIT II

Lebesgue outer Measure: σ- algebra, Definition of measures with equations, signed measure, measurable space, measurable sets (Lebesgure), Complement, Lebesgue measure, union intersection and difference of measurable sets, Denumerable union and intersection of measurable sets, countable additivity of measure, counting measurem Haar measure, Borel measure, Measures of infinite union of measure sets (intersection), convergence in measure, F_σ and G_σ sets, the measure of the intersection of a decreasing sequence of measure sets.

UNIT III

Measurable functions; Different equivalent definition of a measurable function; almost every where Scalar multiple constant function, modules f/g, inverse image of a mean function, sum, difference and product of measurable functions of measurable function. Measurability of a continuous function and measurability of a continuous image of measurable function. Supremum, infimum, limit superior, limit inferior and limit of a sequence of measurable functions. Convergence pointwise and convergence in measures of a sequence of measurable functions.

UNIT IV

Convergence of sequence of Measurable function: Convergence pointwise, uniform Convergence, Convergence almost every where (a.e.), Convergence in measure of a sequence of measurable functions, characteristic function of a set, simple function, step function, pointwise Convergence, theorem of measure functions.

UNIT V

Lebesgue Integral; Characteristic function of a set; Simple functions, Lebesgue integral of a simple function; Lebesgue integral of a bounded measurable function; Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a non-negative function; Lebesgue integral of a measurable function; Properties of Lebesgue integral. Convergence Theorems and Lebesgue integral; the bounded convergence theorem; Fatou's Lemma: Monotone convergence theorem; Lebesgue convergence theorem.

Books Recommended:

1. Pal R. Halmos : Measure Theory, (D.Van Nostrand Company, INC), 6th Edition, Univ. of Chikago.
2. Murray R. Spiegel : Theory and Problems of Real Variables (Schaum's Outline series, McGraw-Hill Book)
3. P.K. Jain & V.P. Gupta : Measure and Integration (New age International Publishers)
4. M.E. Munroe : Introduction to Measure and Integration (Deptt. Of Mathematics, Univ. of Illinoi's
5. G.D. Barra : Measure and Integration (New age International Publishers)

M. A. / M. Sc. MATHEMATICS (Semester I)

M1 MAT 03-CT03

DIFFERENTIONAL EQUATIONS & CALCULUS OF VARIATION

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Partial differential equation: Lipschitz condition and question based on it. Existence and Uniqueness theorem and Existence and uniqueness solutions of I.V.P. $\frac{dy}{dx} = f(x,y)$, $y(x_o) = y_0$ Solution of second order partial differential equations through Mange's method.

UNIT II

Canonical forms and reduction of second order Semilinar partial differential equations to canonical forms. Classification of second order partial differential equations having more than two independent variables. Cauchy's problem.

UNIT III

Boundary value problems of second order ordinary differential equations. Orthogonality, Strum-Liouville B.V.P. Lagrange's Identity. Relevent theorems and properties based on eigen values and eigen functions. Expansion of function in terms of eigen functions. Periodic Strum problem.

UNIT IV

Solution of second order P.D. equations by the method of separation of variables.

Green's function and its construction and solution of second order Homogonous B.V.P's through Green's function. Dirac delta function and its important properties.

UNIT V

Calculus of variations: Functionals, Euler- Largrauge differential equation for externals and it's alternative forms. Variational problems involving several dependent variables, several in dependent variables and higher order derivatives. Isoperimetric Problems.

Solution of variational problems using Ritz method.

Books recommended:

1. Sneddon, I.N. : Element of Practical differential equation.
2. Forsyth, A.R. : A Treatise of Differential equations.
3. Gupta, A.S. : Calculus of variations with Applications.
4. Bansal, J.L. : Differential equations Vol. II.
5. Gelfand, I.M. and Fomin, S.V. : Calculus of variations.

M. A. / M. Sc. MATHEMATICS (Semester I)

M1 MAT 04-CT04

MECHANICS-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Hydrodynamics: Lagrange's and Euler's, Methods; Acceleration, Equation of Continuity, Boundary surface, Stream lines, velocity potential.

UNIT II

Euler's dynamical Equations, Bernoulli's Theorem, Lagrange's Equations under conservative forces, the motion once irrotational is always irrotational.

UNIT III

Central Orbit, Kapler's Law of Planetary motion.

UNIT IV

Michelson-Morley experiment, Lorentz-Fitgerald contraction, postulates of special theory of Relativity, Lorentz transformations.

UNIT V

Mass-Energy formula, transformation formulas for momentum and energy. Minkowski's 4-dimensional continuum space, Space like and time like intervals, Relativistic Hamiltonian and Lagrangian.

Books Recommended:

1. Ramsay, A.S. : A Text book of Hydrodynamics.
2. Ray, M. : Hydrodynamics.

3. Gaur, Mathur & Goyal : Hydrodynamics.
4. Ray, M. : Dynamics of a particle.
5. Roy & Bali : Theory of Relativity.

M. A. / M. Sc. MATHEMATICS (Semester I)

M1 MAT 05-CT05

DIFFERENTIAL GEOMETRY-I

L-T-P	3-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

The Axes of Plane Sections: Circular sections, Axes of central sections of a central conicoid, Axes of non central section of a central conicoid.

UNIT II

Axes of any section of a central conicoid, Circular sections. Generating Lines: Introduction, properties of generating line, intersection of generators of hyperboloid of one sheet, generators through any point of hyperboloid, direction cosines of generating line, The section of a surface by a tangent plane.

UNIT III

Systems of generators of a central hyperboloid, Locus of the points of intersection of perpendicular, generators, The projection of generators, Generators' of the hyperbolic paraboloid.

UNIT IV

Confocal Conicoids: The three confocals through a point,- Elliptic coordinates, confocal touching a given plane, confocal touching a given line, The parameter of the confocals through a point on a central conicoid, The normals. The self polar tetrahedron, The axes of an enveloping cone.

UNIT V

Conoids; Equation to a conoid, surface in general, The degree of a surface, tangents and tangent planes, The inflexional tangents; the equations $\zeta=f(\xi,\eta)$. The indicatrix and representation by parameters.

Books recommended:

1. Robert, L., Bell, J.T. : Coordinate Geometry of the three dimensions.
2. Bansal &Sharma : Differential Geometry.
3. N. Saran & R. S. Gupta : Analytical Geometry of Three Dimension.

M. A. / M. Sc. MATHEMATICS (Semester II)

M2 MAT 01-CT06

ALGEBRA-II

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Prime fields of characteristic zero and of prime number, Polynomial rings, Factorization theory in Integral domain, Prime and irreducible elements, Greatest common divisor and least common multiple, Euclidean domain, Principle ideal domain and Unique Factorization domain and their related theorems, Product of ideals and nilpotent ideals.

UNIT II

Definition and examples of Modules, sub module, Sub module generated by a set, Sum and direct sum of two sub modules, Quotient Modules, R-Homomorphism, Kernel, Fundamental, Theorems of Homorphism and isomorphism. Three isomorphism theorems in modules.

UNIT III

Simple, free, cyclic and Finitely generated modules, Fundamental theorem on finitely generated modules over Euclidean rings, Noetherian and Artinian modules, maximal element and theorems based on it's.

UNIT IV

Field extension: finite and infinite, examples, Algebraic and transcendental extensions, Splitting field Separable and inseparable extensions, Normal Extensions, Perfect fields, Finite fields, primitive elements.

UNIT V

Automorphisms, Galois Theory of field extensions and its fundamental theorem, Solution of polynomial equations by radicals, Abel's theorem.

Books recommended:

1. Surjeet Singh and Quazi Zameeruddin : Modern Algebra
2. I.N.Herstein : Topics in algebra
3. R.S.Agrawal : Algebra
4. N. Jacobson : Basic Algebra Vol. I, II
5. S. Lang : Algebra IIIrd Edition
6. P.B. Bhattacharya S.K. Jain and Etc. : Basic Abstract Algebra (IInd Edition)

M. A. / M. Sc. MATHEMATICS (Semester II)

M2 MAT 02-CT07

COMPLEX ANALYSIS

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Complex numbers, Algebra of complex functions, differentiability of complex function, Analytic functions, Cauchy-Riemann equations, Harmonic functions, Power series, radius of convergence , circle of convergence.

UNIT II

Conformal transformation, Linear & Bilinear transformations, fixed points, cross ratio, inverse points, critical points Exponential, Trigonometric transformations.

UNIT III

Complex integration : Riemann definition of integration, complex integral as the sum of line integrals, Cauchy's fundamental theorem, extension of Cauchy's theorem to multi-connected region, Cauchy's integral formula, Cauchy's integral formula for multi-connected region, Cauchy's integral formula for higher order derivatives.

UNIT IV

Morera's theorem, Liouville's theorem , Maximum Modulus theorem, Poisson's integral formula, Development of Analytic function as power series : Taylor's Series, Laurent's Series.

UNIT V

Singularities and Zeroes of an Analytic function, residues, Cauchy's theorem of residues and Evaluation of definite integrals.

Books Recommended :

1. E.G.Phillips : Functions of a complex variable.
2. E.T.Copson : An introduction to the Theory of functions of a Complex variable.
3. Zill Shanahan : A First Course in Complex Analysis with Application
4. T. Pati : Functions of a Complex Variable

M2 MAT 03-CT08

SPECIAL FUNCTIONS

L-T-P	3-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Series solutions and Hypergeometric equations: Singularities in second order ordinary differential equations with constant coefficients and variable coefficients, radius of convergence. Series solutions of second order homogeneous ordinary differential equations. Frobenius method. Hypergeometric Series. Hypergeometric functions. Confluent Hypergeometric function and solution of confluent Hypergeometric equation.

UNIT II

Legendre's polynomial Functions: Legendre's differential equation and associated Legendre's differential equations.

UNIT III

Simple properties of Legendre's functions of first and second kind and the associated Legendre's function of integral order.

UNIT IV

Bessel functions, Generating function, Integral formula, Recurrence relations; addition formula and other properties of Bessel functions.

UNIT V

Classical Orthogonal Polynomials, Generating functions and other properties, associated with the Laguerre, Legendre and Hermite Polynomials.

Books recommended:

1. Rainville, E.D. : Special Functions.
2. Sneddon, I.N. : Special Functions.
3. S.P. Goyal : Special Functions.
4. Bansal, J.L. : Differential Equations Vol. II

M2 MAT 04-CT09

MECHANICS-II

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Rigid Dynamics: Moments and products of inertia, Principal axes theorem, Parallel axes, Momental ellipsoid.

UNIT II

D'Alembert's principle and the equation of motion. Motion about fixed axes.

UNIT III

Motion in two dimensions under finite forces including sliding and rolling friction, Impulsive motion in two dimensions.

UNIT IV

Principles conservation of momentum and energy.

UNIT V

Lagrange's equations in generalized coordinates under finite and impulsive forces.

Books Recommended:

1. S.L.Loney : Dynamics
2. A.S.Ramsay : Dynamics
3. Bansal, Sharma & Goyal : Dynamics of a Rigid Body
4. Ray & Sharma : A Text Book of dynamics of a Rigid Body

M. A. / M. Sc. MATHEMATICS (Semester II)

M2 MAT 05-CT10

DIFFERENTIAL GEOMETRY-II

L-T-P	3-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Curves in space, Equation to a curve, The tangent and its direction cosines, The normal plane-, contact of a curve and surface, Oscilating plane, Principal normal and binormal curvature, torsion, spherical indicatrices, frenet's formulae, signs of the curvature and torsion.

UNIT II

Formula for direction cosines of the principal normal and binormal , radius of torsion the relation $\sigma = + \eta \tan \alpha$ Circle of curvature, The osculating sphere and coordinates in terms of the arc.

Envelopes: Envelopes of a system of surfaces with one parameter and its relation with characteristic, The edge of regression and its relation with characteristic, Envelope of a system of surfaces with two parameters and its relation with characteristic.

UNIT III

Skew and developable surface, Tangent plane to a ruled surface, Generators of developable surface, envelope of a plane with one parameter: criterion for $\zeta = f(\xi,\eta)$ to represent a developable surface and properties of a generator of a skew surface, Curvature of surfaces, Curvature of normal sections through elliptic and hyperbolic points, Umblics.

UNIT IV

Curvature of an oblique section, radius of curvature of a given section through any point of a surface, Principal radii at a point of an ellipsoid, Lines of curvature of an ellipsoid, Lines of curvature on a developable surface, Normals to a surface at points of a line of a curvature, Lines of curvature on a surface of revolution.

UNIT V

Principal radii and lines of curvature through a point of the surface, determination of umblics, Curvature at points of a generator of a skew surface, The measure of curvature at a point and expressions for the measure of curvature, Curvilinear coordinates, Linear element principal radii and lines of curvature.

Books recommended:

1.	L. Robert, J-T.Bell	:	Coordinate Geometry of the three dimensions.
2.	Bansal & Sharma	:	Differential Geometry.
3.	Raj Bali	:	Advanced Tensor Analysis.
4.	N. Saran & R. S. Gupta	:	Analytical Geometry of Three Dimension.
5.	Raj Bali	:	Advance Differential Geometry

M. A. / M. Sc. MATHEMATICS (Semester III)

Note- There will be five papers in all.

M3 MAT 01-CT11

TOPOLOGY

L-T-P	3-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Metric Space: Definition, Examples and properties of a metric space.

Open and closed sphere (ball or neighbourhood), open sets, closed sets and the related results, limit point, continuous mappings, Convergence of a sequence, Cauchy Sequence, Uniform and Pointwise convergence, Complete metric space, compact spaces and compact sets, Baire's category theorem.

UNIT II

Topological Spaces: Definition of Topology, T-open sets, weaker and stronger topology, open sets and closed sets, closure of a set, limit point of a set, derived set, Interior of a set, Boundary of set, Intersection of topological spaces, Kuratowski-space, Kuratowski theorem. Base, sub base, open bases, open sub bases, first countable space, second countable space, separable space, continuous functions in topological spaces, sequentially topological spaces.

UNIT III

Separation Axioms: T_o , T_1 , T_2- space, separation axioms, normal spaces, Regular spaces, completely regular space, tychonoff space, Housdorff space.

Compactness: Cover, open cover, finite sub cover, compact sets, Lindelof space, Locally compact, sequentially compact, Bolzano Weirstrass property and sequentially compactness, compactness for metric spaces, Lindelof theorem, Product spaces.

UNIT IV

Connectedness: Connectedness and continuity, components of a space, product of connected topologic al spaces, Locally connected Spaces.

UNIT V

Approximation: The Weirstrass approximation theorem, function algebra, C(X, R) and C (X, C), the real Stone-Weirstrass theorem, The Complex Stone-Weirstrass theorem.

Books recommended:

1. George F. Simmons : Introduction to Topology and modern analysis, McGraw Hill Book Co.
2. S.I. Hu : Elements of Real Analysis.
3. H.L. Royden : Real analysis.
4. W.J. Thron : Topological structure.
5. J. Kelley : General Topology.

6. Malik S.C. & Arora, Savita : Mathematical Analysis (Third Revised Edition)

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 02-CT12

TENSER ANALYSIS

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Tensors; Transformation of coordinates, Contravariant and covariant vectors, second order tensors, Higher order tensors. Addition, subtraction and multiplication of tensors, Contraction, Quotient Law, symmetric and skew symmetric tensors: Conjugate symmetric tensors of the second order, Fundamental tensor, Associated tensors.

UNIT II

Christoffel symbols, Transformation law of Christoffel symbols, Covariant differentiation of vectors and tensors.

UNIT III

Geodesics, Null Geodesics, Tensor form of gradient, divergence, Laplacian and curl, Intrinsic derivative, Riemannian and Normal Coordinates, Gaussian Coordinates, Parallel transport, Geodesics are auto parallel curves, Parallel propagation.

UNIT IV

Riemannian curvature tensor, Symmetric properties of R^i_{ljk}, Covariant curvature tensor R_{hljk}, Number of independent components of R_{hljk} in a V_n, Ricci tensor, Bianchi indentities, Conformal Curvature tensor, Condition for flat space.

UNIT V

Maxwell's equations in empty space, Transformation of vector and scalar potentials, Transformations of electric and magnetic intensities, Lorentz invariance of Maxwell's equations.

Maxwell's equations in Tensor form, Energy momentum tensor for electromagnetic field, Einstein-Maxwell equation in General Relativity.

Books Recommended:

1. P.G.Bergman : Introduction to Theory of Relativity.
2. J.L.Synge : Relativity, The special Theory.

3. B. Spain : Tensor Calculus.
4. J.L. Bansal : Tensor Analysis.
5. Roy & Bali : Theory of Relativity.
6. Raj Bali : Advanced Tensor Analysis.

M. A. / M. Sc. MATHEMATICS (Semester III)

Discipline specific elective (DSE) courses.

Any three of the following papers with the permission of the Head of the Department of Mathematics & Statistics.

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 01–DSE 01

NUMERICAL ANALYSIS-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Theory of Iteration: Simple iteration, Rate of Convergence, Acceleration a convergence, method for multiple and complex roots, Convergence of iteration process in the case of several unknowns.

UNIT II

Real and complex roots, solution of transcendental and polynomial equations by using besection method, secant method, Regula-Falsi method, Newton Ruphson method, Chebyshev method and Muller method.

UNIT III

Concept of synthetic division, the Birge – vita, Bairstow and Graeffe's root squaring method. System of Simultaneous equations(Linear): Direct method of determinant, Gauss–Elimination.

UNIT IV

Gauss-Jordan Cholesky, Partition method of Successive approximation, Conjugate Gradient, Gaurs or Jacobi iteration, Gauss-Seidel and Relaxation methods.

UNIT V

Eigen value problems: Basic properties of Eigen values and Eigen vector power methods, Method for finding all Eigen pairs of a matrix, Complex Eigen values.

Books Recommended:

1. Jain, Iyenger and Jain : Numerical Analysis.

2. Jain, M. K. : Numerical solutions of differential equation.
3. Chouhan D.S., Vyas P. & Soni. V. : Studies in Numerical Analysis

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 02 –DSEP 02

COMPUTER PROGRAMMING IN-C

(Practical Oriented)

L-T-P	2-0-3

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Definition and properties of algorithm, flow chart, conversion of flow chart to language, examples of algorithms and flow charts, introduction to program design, errors, syntax error, logical error, runtime error.

UNIT II

Character set of C, constants and variables in C, arithmetic expressions in C, assignment and multiple assignment and mode of statements in C, built in functions and libraries in C, input and output statements in C, data types, structure of C program, elementary programs in C

UNIT III

Logical if statements in C: if- else, nested if, switch, break, continue, GOTO statements in C
For , while and do-while loops in C, nested loops

UNIT IV

Functions : Defining and accessing a function, passing arguments to a function, specifying arguments data types, function prototypes, Scope rules of functions, call by value, call by reference

UNIT V

Array : introduction of array, Classification of arrays, functions with arrays, Pointers in C, pointers and arrays, File input/output: create, open, write, delete, close.

Books Recommended:

1. Introduction Information Technology : Satish jain, BPB Publication, New Delhi.
2. Fundamentals of computers : P. K. Sinha
3. The C-Programming Language : B.W. Kernyharn & D.M. Ritche - PHI Ltd.
4. Computer Programming in C : Y Kanetkar-B.P.B. Publication, New Delhi.
5. Programming In ANSI C : E Balagurusamy.

Note: Two theory lectures per week are required for this paper.

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 03 –DSE 03

DISCRETE MATHEMATICS-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Formal logic– Statement, Symbolic Representation and Tautologies, Quantifiers, Predicate validity, Propositional logic. Semi groups and monoids, Relations and ordering. Functions definitions and examples of semi groups and monoids (including those pertaining to concatenation operation).

UNIT II

Homomorphism of semi groups and monoids. Quotient subgroups, sub semigroups and sub monoids. Direct products. Basic Homomorphism theorem.

UNIT III

Lattices: - Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. Sub lattices, direct products and Homomorphism complete, Complemented and distributive lattices.

UNIT IV

Boolean Algebras:- Boolean Algebras as lattices. Various Boolean identities. The switching Algebras examples. Sub Algebras. Direct products and Homeomorphisms, Join- irreducible elements, Atoms and minterms.

UNIT V

Boolean forms and their equivalence. Minterms, Boolean forms. Minimization of Boolean functions. Application of Boolean Algebras to switching theory (OR and not gates).The Karnaugh map method.

Books recommended:

1. J.P. Tremblay & R. Manohar : Discrete Mathematical structure with applications to computer science.
2. J.L. Gerstling : Mathematical Structures for Computer Science, (3^{rd} edition).
3. N. Arsing Deo : Graph theory with applications to Engineering and Computer Science.
4. K.D. Joshi : Foundation of Discrete Mathematics.
5. S. Wiitala : Discrete mathematics – A Unified Approach.
6. C. L. Liu : Elements of Discrete Mathematics.
7. Gokhroo & Gokhroo : Advanced Discrete Mathematics(Navkar Publications)

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 04 –DSE 04

OPTIMIZATION TECHNIQUES-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Dual simplex method, Bounded value algorithm, Parametric linear Programming.

UNIT II

Sensitivity Analysis: (i) Changes in the coefficients of the objective function, (ii) Changes in the components of vector b, (iii) Changes on the component (a_{ij}) of the matrix A.

UNIT III

Addition of the new variable, Addition of a new constraint. Deletion of a variable, Deletion of constraint.

UNIT IV

Integer programming: Importance of interger programming problems, Gomory's cutting plane methods, δ Fractional cut and λ-cut, Branch and bound method.

UNIT V

Project Management by PERT and CPM, cost time, trade off, Resource leveling.

Books Recommended:

1. Kanti swaroop, Mak-Mohan, P.K. Gupta. : Operation Research
2. Hamdy A. Taha : Operation Research
3. S.D. Sharma : Operation Research
4. S.I. Gass : Linear-Programming
5. K.V. Mittal : Optimization Methods in Operations Research and systems analysis

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 05–DSE 05
MATHEMATICAL THEORY OF STATISTICS-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Elements of theory of probability; sample space, various definitions of probability, addition and multiplication laws of probability, conditional probability and statistical independence of events. Baye's theorem and its applications.

UNIT II

Mathematical expectations, conditional expectations, Moments and cumulates. Moments generating and characteristic functions. Inversion theorem, Chebyshev's inequality, Central limit theorem for i.i.d. random variables.

UNIT III

Binomial, Negative -binomial, Poisson and Hyper geometric distributions.

UNIT IV

Rectangular, Normal, Cauchy, Gamma and Beta distributions Elementary idea of Exponential and Laplace distributions.

UNIT V

Curve fitting and principle of least squares, Scatter diagram, linear regression and correlation.

Note: Candidates who have offered Mathematical Statistics / Statistics / Applied Statistics as an optional subject in their B.A. /B.Sc. examination will not be permitted to offer this course.

Books recommended:

1. Gupta and Kapoor : Fundamentals of Mathematical Statistics.
2. Kapur and Sexena : Mathematical Statistics.
3. Goon and Others : Outline of Statistical Theory, Vol. I, II.

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 06 –DSE 06

VISCOUS FLUID DYNAMICS-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Viscosity, Analysis of stress, Relation between stress and rate of strain, Navier-stokes equations and equation of energy in cartesian system of coordinates.

UNIT II

vorticity and circulation. Reynolds law of similarity, Physical importance of non-dimentional parameters, Reynolds number Froude numbers, Mach number, Prandtl number, Eckert number.

UNIT III

Some exact solutions of Navier-stokes equations-steady, motion between parallel plates, Hagen poiseuille flow a circular pipe, flow between coaxial circular pipes, flow between two concentric rotating cylinders.

UNIT IV

Pulsatile flow between parallel surfaces, flow in convergent and divergent channels (Jaffery-Hamel flow), flow in the vicinity of stagnation point.

UNIT V

Unsteady motion of a plate. Theory of very slow motion of a sphere in viscous fluid Osceen's improvement of stoke's theory.

Book& Recommended:

1. G. Schfichting : Boundary Layer Theory.
2. S.I. Pai : Viscous Flow Theory, Vol.I, Laminar flow.
3. J.L. Bansal : Viscous Fluid Dynamics.
4. M. D. Raisinghania : Fluid Dynamics.
5. Shanti Swarup : Fluid Dynamics.

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 07–DSE 07

INTEGRAL EQUATIONS

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Linear Integral equations: Definition and classification, Conversion of initial and boundary value problem to an integral equation, Eigen values and Eigen functions.

UNIT II

Solution of fredholm integral equations of second kind with seperable kernels. Reduction to a system of Algebraic equations.

UNIT III

Solution of Fredholm and Voltera integral equations of second kind by method successive substitution and successive approximations. Resolvenlt Kernal and its applications.

UNIT IV

Condition of uniform convergence and uniqueness of series solutions. Integral Equation with symmetric kernels: Complex Hilbert space, Orthogonal system of functions. Fundamental Properties of Eigen values and Eigen functions for symmetric Kernels, Expansion in Eigen-functions and Bilinear form.

UNIT V

Hilbert–Schmidt theorem, Solution of Fredholm integral equations of second kind with symmetric Kernels. Classical–Fredholm theory, Fredholm theorems, Solution of volterra integral equations with convolution type Kernels and Librated Kernels.

Books Recommended:

1. Ranville, E.D. : Laplace and Fourier Transforms.
2. Sneddon, I.N. : The use of Integral Transforms.
3. Ze manian, A.H. : Generalized Integral transforms.
4. Lowit : Linear Integral equations.

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 08–DSE 08

ASTRONOMY-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Spherical Trigonometry- Great and small circular spherical triangles and their properties, various spherical trigonometrically formula-Cosine, sine, supplemental cosine, sine cosine, contingent, half of an angle and side Napier's analogies.

UNIT II

Delambe's analogies, their identities formulae for, right angled triangles and their solutions.

UNIT III

Celestial sphere, diurnal motion, Hour angle rising and setting of stars motion of sun, Zenith distance and Azimuth, Twilight.

UNIT IV

Refraction: Laws, effect of refraction on sun rise and sun set, Simpson's Hypothesis, effect of refraction in right ascension and declination etc. Time: Equation of time, seasons and their lengths, precession and Nutation and their effects on right ascension and declination, planetary precession double stars.

UNIT V

Aberration and its effect of longitude, latitude, right ascension and declination, position of apex, diurnal aberration and its effect in declination, right ascension and hour angle.

Books Recommended:

1. Astronomy by Gorakh Prasad.
2. Astronomy by Smart.

M. A. / M. Sc. MATHEMATICS (Semester III)

M3 MAT 09–DSE 09

NUMBER THEORY-I

L-T-P	4-1-0

TIME: 3 hours

External Assessment 80
Internal Assessment 20

UNIT I

Divisibility: Gcd and Lcm of two or more integers, Euclidean, algorithm, the linear diophantine equation $ax + by = c$. Prime Numbers, composite numbers, infinitude of primes, fundamental theorem of arithmetic.

UNIT II

Congruences: Basic properties, divisibility tests, linear Congruences. Application of Congruences: Fermat's little theorem, Euler's generalization, Wilsons's theorem Chinese remainder theorem.

UNIT III

Number Theoretic functions: T.J, and, Multiplicative functions, Mobius inversion formula, the greatest integer function. Primitive Roots and Indices, Primitive roots, characterization of natural numbers having primitive roots, theory of indices, solution of certain congruence, through indices.

UNIT IV

Quadratic Residues: Quadratic residues and quadratic non residues of an integer in general and of a prime in particular, Gauss Lemma and its applications, the quadratic reciprocity law.

UNIT V

Special Numbers: Fibonacci numbers, Fermat's numbers, Perfect numbers. Diophantine Equations: Representation of integers as sums of 2, 3 and 4 squares.

Books Recommended:

1. Donald M. Burton : Elementary Number Theory, Allyn and Bacon Inc.
2. Niven & H.S. Zuckerman : An Introduction to the Theory of Numbers, Willey eastern India Ltd.
3. Lang, S. : Algebraic Number theory, GTM Vol. 110, Springer-Verlag 194.

M. A. / M. Sc. MATHEMATICS (Semester IV)

Note- There will be five papers in all.

M4 MAT 01-CT 13

FUNCTIONAL ANALYSIS

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Normed linear spaces; Banach spaces, Riesz Lemma, Quotient space of normed liner space and its completeness and examples Continuous linear transformations.

UNIT II

Hahn-Banach theorem; the natural embedding of a normed linear space into its second conjugate, the open mapping theorem; the closed graph theorem, the uniform boundedness theorem.

UNIT III

Inner product spaces, Hillbert spaces; Schwartz's inequality: Bessel's inequality, orthogonality, Parallelogram law, Polarization identity with examples, Pythagoras theorem, orthonormal sets.

UNIT IV

Orthonormal basis and Parseval's identity, Complete Orthonormal sets, Gram Schmidt Orthogonalization process with examples, conjugate space.

UNIT V

Riesz representation theorem, Adjoint of an operator, self adjoint operator, Normal operator, unitary operator, Matrix representation of a linear operator.

Books recommended:

1. George F. Simmons : Introduction to Topology and modern analysis, McGraw Hill Book Co.
2. S.I.Hu : Elements of Real Analysis.
3. H.L. Royden : Real analysis.
4. W.J. Thron : Topological structure.
5. J. Kelley : General Topology.

M4 MAT 02-CT 14

RELATIVITY AND COSMOLOGY

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Principle of covariance, principle of equivalence, Mach- Principle, geodesic postulates, Newton's Potential, Newtonian approximation of relativistic equation of motion. Einstein field equations with derivation and its Newtonian approximation.

UNIT II

Clock paradox, Schwarzchild exterior solution for empty space, singularities and related problems, isotopic form of Schwazchild line element, energy momentum tensor and its expression for perfect fluid.

UNIT III

Planetary orbit, Three crucial tests, Advance of Perihelion of planets, Gravitational Deflection of light ray, Shift in the spectral lines. Radar echo delay. Analogous to Kepler's law, Schwarzchild interior solution.

UNIT IV

Principals of Cosmology, Static cosmological models. Einstein and De-Sitter Universes, their derivations, properties and comparison with the actual universe and some related problems.

UNIT V

Non static cosmological models. Hubble's law, Weyl's postulate. Derivation of Robertson-Walker Metric, Geometrical features of R-W metric. Surface brightness, source counts, Red shift. Particle and event Horizons, Expressions for FRW model upto non zero pressure. .

Books Recommended:

1. P.G. Bergman : Introduction to Theory of Relativity.
2. J.L. Synge : Relativity, the General Theory.
3. J.V. Narlikar : Lecture on general Relativity.
4. Roy & Bali : Theory of Relativity.
5. B.F. Shutz : A first course in General Relativity.

M. A. / M. Sc. MATHEMATICS (Semester IV)

Discipline specific elective (DSE) courses.

Any three of the following papers with the permission of the Head of the Department of Mathematics & Statistics.

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 01–DSE 01

NUMERICAL ANALYSIS-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Curve fitting and Function Approximations: Least square principle, fitting a straight line, exponential functions, parabola and polynomial of n^{th} degree, Approximation of functions by Chebyshev Polynomials.

UNIT II

Numerical Solutions of ordinary differential equations using Taylor series method, Picard's method, Euler's method, modified Euler's method.

UNIT III

Solutions by Runge-Kutta method up to fourth order, solutions by multi step method: Milne's method, Adams Moulton's method, Stability Analysis of Single and Multi step methods.

UNIT IV

Difference method for solving linear boundary value problem of ODE's: Finite difference method and shooting method, Numerical integration by Trapezoidal, Simpson's and Gauss Quadrature rule.

UNIT V

Finite Difference scheme for non-linear boundary value problems of the type $y' = f(x, y)$, $y'' = (x, y, y')$ and $y''' = f(x, y, y', y'')$, $y^{iv} = f(x, y, y', y'' y''')$

Books Recommended:

1. Jain, Iyenger and Jain : Numerical Analysis.
2. Jain, M. K. : Numerical solutions of differential equation.

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 02–DSEP 02

COMPUTER PROGRAMMING OF NUMERICAL METHODS

(Practical Oriented)

L-T-P	2-0-3

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Algorithm, Flowchart and Computer Programming in C on: Arithmetic operations with normalized floating point numbers, Number system conversions

UNIT II

Algorithm, Flowchart and Computer Programming in C for numerical solution of algebraic and transcendental equations: bisection, false position, Newton-Raphson, secant method

UNIT III

Algorithm, Flowchart and Computer Programming in C for numerical solution of simultaneous linear equation: Gauss Elimination method, Gauss-Seidel method

UNIT IV

Algorithm, Flowchart and Computer Programming in C for Differentiation & Integration: Simpson's rule, Trapezoidal rule, Gaussian Quadrature formula.

UNIT V

Algorithm, Flowchart and Computer Programming in C for Numerical Solutions of differential equations: Eulers method, Taylor's series 4^{th} order method, Runge Kutta 4^{th} order method, Predictor-corrector method

Books Recommended:

1. The C-Programming Language: B.W. Kernyharn & D.M. Ritche - PHI Ltd.
2. Computer Programming in C : Y Kanetkar-B.P.B. Publication, New Delhi.
3. Programming in ANSI C: E Balagurusamy.
4. Computer oriented Numerical Methods: V. Rajaraman PHI Ltd.

Note: Two theory lectures per week are required for this paper and at least two programs from each unit must be practiced in computer laboratory

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 03–DSE 03

DISCRETE MATHEMATICS-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Graph theory: Definition of (Undirected) graphs, Paths, Circuits, Cycles and Sub graphs. Induced Subgrapha..., Degree of vertex. Connectivity. Planer graphs and their properties.

UNIT II

Trees. Euler's formula for connected planar graphs Complete and Complete Bipartite graphs. Non Planar graph, Kuratowsk's theorem (Statement only). Spanning trees. Cut sets, Fundamental cut–sets, and Cycles. Minimal spanning trees and Kruskal's Algorithm.

UNIT III

Euler's theorem on the existence of eulerian paths and circuits. Directed graphs. In degree and out degree of a vertex. Weighted undirected graphs, Dijkstra's Algorithm. Strong connectivity . Directed trees. Search trees. Tree traversals.

UNIT IV

Introductory computability Theory – Finite state machines and their Transition Table Diagrams. Equivalence of finite state machines. Reduced machines. Homomorphism. Finite Automata. Acceptors. Non- deterministic Finite Automata.

UNIT V

Phrase structure Grammar. Rewriting Rules. Derivations, Sentential forms. Language generated by a Grammar. Regular context – free, and context sensitive Grammars and Languages. Regular sets, Regular expressions and pumping Lemna, Kleene's Theorem stamens.

Books recommended:

1. J.P. Tremblay & R. Manohar : Discrete Mathematical structure with applications to computer science.
2. J.L. Gerstling : Mathematical Structures for Computer Science, (3^{rd} edition).
3. N. Arsing Deo : Graph theory with applications to Engineering and Computer Science.
4. K.D. Joshi : Foundation of Discrete Mathematics
5. S. Wiitala : Discrete mathematics – A Unified Approach
6. C. L. Liu : Elements of Discrete Mathematics.
7. Gokhroo & Gokhroo : Advanced Discrete Mathematics(Navkar Publications)

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 04–DSE 04

OPTIMIZATION TECHNIQUES-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Classical Optimization Techniques: Unconstrained problems of Maxima-Minima global maximum, Local maxima mothod of Lagrange's Multipliers for constrained with equality constraints.

UNIT II

Constraints in the form of inequalities: Kuhn Tuker Theorem Kuhn-Tuker necessary and sufficient conditions, saddle point.

UNIT III

Quadratic programming problem: Wolfe's algorithms and Beale's algorithm, Fractonal Programming problem.

UNIT IV

Dynamic Programming Problem: Bellman's principle of optimality, multiple stage decision problems, characteristics of DPP. Solution of finite number of stages problems by DPP.

UNIT V

Network flow problems: Maximal flow, minimal flow, shortest route problem.

Books Recommended:

1. Kanti swaroop, Mak-Mohan, P.K. Gupta. : Operation Research.
2. Hamdy A Taha : Operation Research.
3. S.D. Sharrna : Operation Research.
4. S.I. Gass : Linear-Programming.
5. K.V. Mittal : Optimization Methods in Operations Research and systems analysis.
6. J.K. Sharma : Operation Research

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 05–DSE 05

MATHEMATICAL THEORY OF STATISTICS-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Chi-square and t sampling distribution with derivations, properties and applications.

UNIT II

F sampling distribution with derivations, properties and applications. Large sample theory and applications. Determination of sample size.

UNIT III

Elements of theory of estimation: Point estimation, criterion of good estimators for one parameter; Consistency, Efficiency, sufficiency and unbiasedness.

UNIT IV

Method of maximum likelihood estimation properties of maximum likelihood estimators (without proof). M.L.E. for Binomial, Poisson and Normal populations. Interval estimation for mean and variance in case of Normal population.

UNIT V

Elements of testing of hypothesis: Two kinds of error in testing of hypothesis. Critical region, Neyman-Pearson Lemma and determination of BCR in Neyman sense for testing simple v/s simple hypothesis in uniform and normal populations.

Note: Candidates who have offered Mathematical Statistics / Statistics / Applied Statistics as an optional subject in their B.A. /B.Sc. examination will not be permitted to offer this course.

Books recommended:

1. Gupta and Kapoor : Fundamentals of Mathematical Statistics.
2. Kapur and Saxena : Mathematical Statistics.
3. Goon and Others : Outline of Statistical Theory, Vol. I, II.

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 06–DSE 06

VISCOUS FLUID DYNAMICS-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Boundary layer Theory: Boundary layer equations for two dimensional flows over a plane wall. Boundary layer on a flat plate (Blasius, Topper solution). Characteristic boundary layer parameters. Similar solutions of the boundary layer equations. Exact solutions of the steady state boundary layer equation in two dimensional motion, Boundary layer along a flat plate.

UNIT II

Flow past a wedge, Flow past a convergent channel. Boundary layer separation. Blasius series solution, Gortler, new series method. Prandtl-mises transformation, Axial symmetrical and three dimensional boundary layer: - Boundary layer on a Yawed cylinder.

UNIT I

Approximate methods for the solution of the boundary layer equations Karman momentum integral equation, Karman-Pohlhousen method. Energy integral equations. Walz-Thwaites method based on energy integral equation.

UNIT IV

Thermal Boundary Layer in Two Dimension Flow. Thermal boundary layer equation for a plane wall. Forced convection in a laminar boundary layer on a flat plate (i) Crocco's first integral (ii) Reynolds's analogy (iii) Crocco's second integral for Pr =1.

UNIT V

Free convection from a heated vertical plate: Thermal energy integral equation. Approximate solution of the Pohlhousen's problem of free convection from a heated vertical plate.

Book& Recommended:

1. G. Schfichting : Boundary Layer Theory.
2. S.I. Pai : Viscous Flow Theory, Vol.I, Laminar flow.
3. J.L. Bansal : Viscous Fluid Dynamics.
4. M. D. Raisinghania : Fluid Dynamics.
5. Shanti Swarup : Fluid Dynamics.

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 07–DSE 07

INTEGRAL TRANSFORMS

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Laplace transform: Definition and its properties. Rules of manipulations, Laplace theorems of derivatives and integrals, Properties of inverse laplace transtorms, Convolution theorem, Complex inversion formulas.

UNIT II

Applications of Laplace transform to the solutions of ordinary differential equations with constant and variable coefficients and simple boundary value problems.

UNIT III

Fourier Transform: Definition and properties of fourier sine and cosine and complex transforms, Convolution theorem, Inversion theorems and Fouries transform of derivations.

UNIT IV

Applications of Fourier transforms to the solutions of partial differential equations. Mellin Transform: Definition and elementary properties, Mellin transforms of derivations and integrals Inversion theorem and convolution theorem.

UNIT V

Infinite Hankel transform: Definition and Elementary Properties, Hankel transform of derivations, Inversion theorem and parseval theorem. Application to the Solution of simple boundary value problems.

Books Recommended:

1. Ranville, E.D. : Laplace and Fourier Transforms.
2. Sneddon, I.N. : The use of Integral Transforms.
3. Ze manian, A.H. : Generalized Integral transforms.
4. Lowit : Linear Integral equations.
5. Goyal,. S.P. & Goyal,. A. K. : Integral Transforms.

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 08–DSE 08

ASTRONOMY-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Parallax: shape of each, geocentric parallax, distance of Moon, Parallax in declination and Hour angle and geocentric parallax in zenith dist. azimuth, right ascension and declination annual parallax in longitude, and latitude, Parallactic angle and stellar parallax in right ascension and declination.

UNIT II

The meridian circle: the three errors, Besell's formula, correction for level and collimation error, total correction to the observed time of transit.

UNIT III

Kepler's Laws and planetary motion: Various definitions and laws, relation in elliptic motion, anomaly V in terms of eccentric anomaly, true anomaly V in terms of mean anomaly M, Euler's theorem.

UNIT IV

Planetary phenomena: Sydereal period and synodic period and their relation, elongation phases of moon, brightness, maximum brightness. Eclipses: Eclipses of moon angular radius of earth's shadow, duration of eclipses, the ecliptic limits, eclipses of sun and their Limits, frequency of eclipse, the metonic cycle.

UNIT V

Proper motions of stars and their relation, tangential velocity and parallax, radial velocity at different epochs, the solar motion and parallactic motion, determination of solar apex form proper motions.

Books Recommended:

1. Gorakh Prasad : Astronomy
2. Smart : Astronomy

M. A. / M. Sc. MATHEMATICS (Semester IV)

M4 MAT 09–DSE 08

NUMBER THEORY-II

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Continued Fractions: Finite and infinite continued fraction convergent of a given continued fraction and their properties.

UNIT II

Uniqueness of a continued fraction Periodic continued fraction, Pell's equation in general, characterization of solutions of $x-dy = 1$ in terms of its smallest positive solution.

UNIT III

Algebraic number fields and their rings of integers, Calculations for quadratic and cubic cases. Localization , Glois extension.

UNIT IV

Dedikind rings, discrete valuation rings completion, unramified and ramified extensions.

UNIT V

Different discriminates, cyclotomie fields, roots of unity.

Books Recommended:

1. Donald M. Burton : Elementary Number Theory, Allyn and Bacon Inc.
2. Niven & H.S. Zuckerman : An Introduction to the Theory of Numbers, Willey eastern India Ltd.
3. Lang, S. : Algebraic Number theory, GTM Vol. 110, Springer-Verlag 194.

M2 MAT 06-SC 01

Skill Course Elective 01 for II Semester

MATHEMATICAL & ANALYTICAL SKILL (FOR BIOLOGICAL SCIENCES)

L-T-P	2-0-0

Unit I

Real Number system, sets and their types, logic. Matrices and Determinants, concept of inverse of a matrix.

Unit II

Relations, functions and their types, properties of different types of function ex.: linear function, quadratic function, mod function, exponential function, logarithmic function, trigonometrical function etc.

Unit III

Periodic functions, Angles, polar coordinates, conversion of polar coordinates into cartesion and vice-versa, polar graphs, Polynomials. Inverse of logarithmic function, applications, meaning of continous functions.

Unit IV

Differentiation and integrations: Meaning of derivative, growth rate, maxima -minima, Integration as anti-derivative, Simple algebraic integrals.

Unit V

Ording differential equations: Meaning of a differential equation, solution of a differential equation, order and degree of a differential equation. Differntial equation of the type $y^1 = ay$, $y^1 = ay + b$, $y^1 = ay^2 + by + C$, $dy / dx = k (y/ x)$, system of liner differential equations.

M2 MAT 06-SC 02

Skill Course Elective 02

OFFICIAL STATISTICS-I

UNIT I

Introduction to Indian and International Statistical systems. Role, function and activities of Central and State statistical organizations.

UNIT II

Organization of large scale sample surveys. Role of National Sample Survey Organization. General and special data dissemination systems.

UNIT III

Population growth in developed and developing countries.

UNIT IV

evaluation of performance of family welfare programmes, projections of labour force and manpower.

UNIT V

Scope and content of population census of India.

References:

Basic statistics Relating to the Indian Economy (CSO) 1990.

Guide to Official Statistics (CSO), 1999.

Statistical System in India (CSO) 1995).

Principles and Accommodation of National Population Censuses, UNESCO.

Panse, V. G., Estimation of Crop Yields (FAO)

Family Welfare Yearbook. Annual Publication of D/0 Family Welfare.

Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.

M4 MAT -SC 01

Skill Course Elective 01 for IV Semester

BASIC STATISTICAL TECHNIQUES

L-T-P	2-0-0

(For M.Sc. Students not having Statistics as a subject in UG Course)

Unit I

An introduction to Statistics: Data collection and data presentation, frequency distribution, graphical representation, measures of central tendency, dispersion, skewness and kurtosis.

Unit II

Concept of probability, Probability distributions: Binomial, Poisson and Normal distribution (Simple applications only).

Unit III

Introduction to bivariate frequency data and its measurement: covariance, correlation, scatter diagram, Regression analysis: Linear regression, regression coefficient, fitting of regression equation by least square method.

Unit IV

Population, sample, Statistica, standard error, estimation, confidence interval and confidence level, confidence interval estimate of proportion and mean. Hypothesis and its types, errors, level of significance. Test statistics (only Practicals Problems): Student's Chi-square, F and Z-Statistics and their applications in testing of hypothesis.

Unit V

An introduction to Analysis of Variance (ANOVA), its definition, assumptions and uses, One way classification and statistical analysis of the model involved in it (Only Practicals Problems).

Text Books

(1) Hogg, R. V. & Tanis, E. A. (2002): Probability and Statistical Inference Pearson Education, Asia.
(2) Mood, A.M., Graybill, F. A. and Boes D. C. (1999): Introduction to the theory of Statistics, MCGraw Hill, New York.
(3) Arora, P.N. and Malhan, P.K. (2001): Biostatistics, Himalaya Publishing House, New Delhi.
(4) Goon, A.M., Gupta, M.K. and Das Gupta, B. (2006): Basic Statistics, World Publication, Kolkata.
(5) Gupta, S.C.: Fundamental of Statistics.

M4 MAT -SC 01
Skill Course Elective 02

OFFICIAL STATISTICS-II

UNIT I

System of collection of Agricultural statistics.

UNIT II

Crop forecasting and estimation, productivity.

UNIT III

Fragmentation of holdings, support prices, buffer stocks, impact of irrigation projects.

UNIT IV

Statistics related to industries, foreign trade.

UNIT V

Balance of payment, cost of living, inflation, educational and other social statistics.

References:

Basic statistics Relating to the Indian Economy (CSO) 1990.

Guide to Official Statistics (CSO), 1999.

Statistical System in India (CSO) 1995).

Principles and Accommodation of National Population Censuses, UNESCO.

Panse, V. G., Estimation of Crop Yields (FAO)

Family Welfare Yearbook. Annual Publication of D/0 Family Welfare.

Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.