FACULTY OF SCIENCES

SYLLABUS

FOR

M.Sc. MATHEMATICS
(For Colleges)
(Semester: I-IV)

Examinations: 2012-13

GURU NANAK DEV UNIVERSITY
AMRITSAR

M.Sc. MATHEMATICS (SEMESTER SYSTEM) *(For Colleges)*

.

Scheme of Course

M.Sc. (Maths) Semester-I

MATH-551 Real Analysis-I
MATH-552 Complex Analysis
MATH-553 Algebra-I
MATH-554 Mechanics-I
MATH-555 Differential Equations

M.Sc. (Maths) Semester-II

MATH-561 Real Analysis-II
MATH-562 Tensors and Differential Geometry
MATH-563 Algebra-II
MATH-564 Mechanics-II
MATH-565 Differential & Integral Equations

M.Sc. (Maths) Semester –III

MATH-571 Functional Analysis-I
MATH-572 Topology-I

M.Sc. (Maths) Semester-IV

MATH-581 Functional Analysis-II
MATH-582 Topology-II

Optional Papers: In addition to above two compulsory papers in third and fourth semester, student has to be chosen three optional papers in third and fourth semester keeping in view the prerequisites and suitability of the combinations.

MATH-575 Discrete Mathematics-I
MATH-576 Integral Transforms
MATH-577 Statistics-I
MATH-578 Operations Research-I
MATH-579 Advanced Numerical Analysis
MATH-585 Discrete Mathematics-II
MATH-586 Number Theory
MATH-587 Statistics-II
MATH-588 Operations Research-II
MATH-589 Computer Programming with C

Note:

(i) Student can not opt Discrete Mathematics-II, Statistics-II and Operations Research-II if he/she has not opted Discrete Mathematics-I, Statistics-I and Operations Research-I respectively in the previous semester.
(ii) Discrete Mathematics-I and Discrete Mathematics-II, Statistics-I and Statistics-II, and Operations Research-I and Operations Research-II can not be opted simultaneously by a student in one semester.
(iii) Non-Programmable Scientific Calculators are allowed in Papers MATH-577, MATH-578, MATH -579, MATH -587 and MATH-588.

Note: In addition to Note (i), (ii) and (iii) above, given in the scheme of course, it is clarified that students can opt any of these papers (MATH-576, MATH-579, MATH-586 and MATH-589) in Semester-III and IV, subject to the condition that paper opted in Semester-III, can not be opted in Semester-IV.

M.Sc. MATHEMATICS (SEMESTER-I) *(For Colleges)*

REAL ANALYSIS-1

MATH-551

Time: 3Hrs **Max. Marks: 100**
Contact Hours: 6 Hrs/Week

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Set Theory: Finite, countable and uncountable sets. Metric spaces: Definition and examples, open sets, closed sets, compact sets, elementary properties of compact sets, k- cells, compactness of k- cells, Compact subsets of Euclidean space R^k.

Unit-II

Perfect sets, The Cantor set, Separated sets, connected sets in a metric space, Connected subsets of real line, Components, Functions of Bounded Variation.

Unit-III

Sequences in Metric Spaces: Convergent sequences (in Metric Spaces), subsequences, Cauchy sequences, Complete metric spaces, Cantor's Intersection Theorem, Baire's theorem, Banach contraction principle.

Unit-IV

Continuity: Limits of functions (in metric spaces) Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform Continuity.

Unit-V

The Riemann Stieltje's Integral: Definition and existence of Riemann Stieltje's integral, Properties of integral. Integration and Differentiation. Fundamental Theorem of Calculus, Ist and 2nd Mean Value Theorems of Riemann Stieltje's integral.

Books Recommended :

1. Walter Rudin : Principles of Mathematical Analysis (3rd Edition) McGraw-Hill Ltd Ch.2, Ch.3, (3.1-3.12), Ch.4, Ch.6, (6.1-6.22)
2. Simmons, G.F. : Introduction to Topology and Modern Analysis, McGraw-Hill Ltd(App.1) pp337-338, Ch.2(9-13)
3. Shanti Narayan : A course of Mathematical Analysis.
4. Apostol, T.M. : Mathematical Analysis 2nd Edition 7.18(Th.7.30&7.31)
5. Malik, S.C. : Mathematical Analysis, Wiley Eastern Ltd.

M.Sc. MATHEMATICS (SEMESTER-I) *(For Colleges)*

COMPLEX ANALYSIS

MATH- 552

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit–I

Functions of complex variables, continuity and differentiability. Analytic functions, Conjugate function, Harmonic function. Cauchy Riemann equations (Cartesian and Polar form). Construction of analytic functions.

Unit-II

Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form. Cauchy's inequality. Poisson's integral formula, Morera's theorem. Liouville's theorem.

Unit-III

Conformal transformations. Bilinear transformations. Critical points, fixed points, cross-ratio. Problems on cross-ratio and bilinear transformation, Analytic Continuation, Natural Boundary, Schwartz Reflection Principle.

Unit–IV

Power Seires, Taylor's theorem, Laurent's theorem. Maximum Modulus Principle. Schwarz's lemma. Theorem on poles and zeros of meromorphic functions. Argument principle. Fundamental theorem of Algebra and Rouche's theorem.

Unit-V

Zeros, Singularities, Residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma. Integration round Unit circle. Evaluation of integrals of the type of $\int_{-\infty}^{\infty} f(x)dx$ and integration involving many valued functions.

BOOKS RECOMMENDED:

1. Copson, E.T.: Theory of functions of complex variables.
2. Ahlfors, D. V.: Complex analysis.
4. Kasana, H.S. : Complex variables theory and applications.
5. Conway, J.B.: Functions of one complex variable
6. Shanti Narayan : Functions of Complex Variables.

M.Sc. MATHEMATICS (SEMESTER-I) *(For Colleges)*

ALGEBRA-I

MATH-553

Time: 3Hrs **Max. Marks: 100**
Contact Hours: 6 Hrs/Week

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Groups: Definition & examples, Subgroups, Normal subgroups and Quotient Groups, Lagrange's Theorem.

Unit-II

Generating sets, Cyclic Groups. The Commutator subgroups, Homomorphism, Isomorphism Theorems, Automorphisms,

Unit-III

Permutation groups, the alternating groups, Simplicity of A_n, n 5, Cayley's theorem. Direct Products: External and Internal. Fundamental theorem of finitely generated Abelian groups (Statement only) and applications, Structure of finite Abelian groups.

Unit-IV

Conjugate elements, class equation with applications, Cauchy's Theorem, Sylow's Theorems and their simple applications, Solvable Groups, Composition Series, and Jordan Holder Theorem.

Unit-V

Rings, Subrings, Ideals, Factor Rings, Homomorphism, Integral Domains. Maximal and prime ideals. The field of Quotients of an integral domain.

BOOKS RECOMMENDED:

1. Herstein, I.N. : Topics in Algebra, Willey Eastern 1975.
2. Dummit, D.S. & Foote. : Abstract-Algebra, John-Wiley & Sons, Students Edition-1999
3. Fraleigh, J. B. : An Introduction to Abstract Algebra.
4. Bhattacharya, P.B.,Jain, S.K. & Nagpaul, S.R. : Basic Abstract Algebra, Cambridge University Press, 1997.
5. Surjit Singh : Modern Algebra.

MECHANICS –I

MATH-554

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week
Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Velocity and acceleration of a particle along a curve, Radial & Transverse components (plane motion). Relative velocity and acceleration. Kinematics of a rigid body rotating about a fixed point. Vector angular velocity, General motion of a rigid body, General rigid body motion as a screw motion. Composition of angular velocities. Moving axes. Instantaneous axis of rotation and instantaneous centre of rotation.

Unit-II

Newton's laws of motion, work, energy and power. Conservative forces, potential energy. Impulsive forces, Rectilinear particle motion:-
(i) Uniform accelerated motion (ii) Resisted motion (iii) Simple harmonic motion (iv)Damped and forced vibrations.

Unit-III

Projectile motion under gravity, constrained particle motion, angular momentum of a particle. The cycloid and its dynamical properties.

Unit-IV

Motion of a particle under a central force, Use of reciprocal polar coordinates, pedal- co-ordinates and equations. Kepler's laws of planetary motion and Newton's Law of gravitation. Disturbed orbits, elliptic harmonic motion (scope and standard of syllabus is the same as given by Chorlton).

Unit-V

Moments and products of Inertia, Theorems of parallel and perpendicular axes, angular motion of a rigid body about a fixed point and about fixed axes. Principal axes, Kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid, equimomental systems, coplanar distribution.

BOOKS RECOMMENDED:

1. Chorlton, F : Text Book of Dynamics
2. Loney, S.L. : Dynamics of rigid body
3. Rutherford, D.E. : Classical Mechanics.

M.Sc. MATHEMATICS (SEMESTER-I) *(For Colleges)*

DIFFERENTIAL EQUATIONS

MATH-555

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week
Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Existence and uniqueness theorem for solution of the equation $\frac{dy}{dx} = f(x, y)$, The method of successive approximation, general properties of solution of linear differential equation of order n, adjoint and self-adjoint equations.

Unit-II

Laplace Transform: Definition, existence, and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace transform solution of linear differential equations and simultaneous linear differential equations with constant coefficients, Complex Inversion formula.

Unit-III

Fourier Transform: Definition, existence, and basic properties, Convolution theorem, Fourier transform of derivatives and Integrals, Fourier sine and cosine transform, Inverse Fourier transform, solution of linear ordinary differential equations, Complex Inversion formula.

Unit-IV

Special Functions: Solution, Generating function, recurrence relations and othogonality of Legendre polynomial, Bessel functions, Hermite and Laguerre polynomials.

Unit-V

Total differential equations. Simultaneous differential equations, orthogonal trajectories, Sturm Liouville's boundary value problems. Sturm comparison and Separation theorems, Orthogonality solution.

BOOKS RECOMMENDED:

1. Rainvile: Special Functions.
2. Piaggio: Differential equations.
3. Ross, S.L.: Differential equations.
4. Watson, G.N.: A treaties on the theory of Bessel functions.
5. Coddington, E.A.: Introduction to Ordinary Differential Equations.

M.Sc. MATHEMATICS (SEMESTER-II) *(For Colleges)*

REAL ANALYSIS-II

MATH-561

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week
Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit I

Sequence and Series of functions: Discussion of main problem, Uniform Convergence, Uniform Convergence and Integration, Uniform Convergence and Differentiation, Equicontinuous families of functions, Arzela's Theorem, Weierstrass Approximation theorem.

Unit II

Measure Sets: Outer Measure, Lebesgue Measure, Properties of Measurable Sets, Non Measurable Sets.

Unit III

Measurable Functions: Definition & Properties of Measurable functions, Characteristic functions, Step Functions and Simple Functions, Little wood's three Principles

Unit IV

Lebesgue Integral: Lebesgue Integral of bounded function, Comparison of Riemann and Lebesgue Integral, Integral of a non negative function, General Lebesgue Integral, Convergence in measure.

Unit V

Differentiation and Integration: Differentiation of monotone functions, Differentiation of an integral, Absolute Continuity.

Books Recommended:

1. Walter Rudin :Principles of Mathematical Analysis (3rd edition) McGraw Hill Ltd. Ch. 7 (7.1-7.27)
2. Malik, S.C. :Mathematical Analysis, Wiley Eastern
3. Royden, H.L. :Real Analysis, Macmillan Co. (Ch. 3, 4, 5 excluding section 2, 5)
4. Jain, P.K. and Gupta, V.P. : Lebesgue Measure and Integration.
5. Barra, G De. : Introduction to Measure Theory, Van Nosh and Reinhold Company

M.Sc. MATHEMATICS (SEMESTER-II) *(For Colleges)*

TENSORS AND DIFFERENTIAL GEOMETRY

MATH- 562

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week
Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-1

Notation and summation convention, transformation law for vectors, Kronecker delta, Cartesian tensors, addition, multiplication, contraction and quotient law of tensors. Differentiation of Cartesians tensors, metric tensor, contra-variant, covariant and mixed tensors, Christoffel symbols. Transformation of christoffel symbols and covariant differentiations of a tensor.

Unit – II

Theory of Space Curves: Tangent, principal normal, bi-normal, curvature and torsion. Serret-frenet formulae.Contact between curves and surfaces. Locus of centre of curvature, spherical curvature, Helices.

Unit-III

Spherical indicatrix, Bertrand curves, surfaces, envelopes, edge of regression, developable surfaces, two fundamental forms.

Unit-IV

Curves on a surface, Conjugate Direction, Principle Directions, Lines of Curvature, Principal Curvatures, Asymptotic Lines. Theorem of Beltrami and Enneper, Mainardi- Codazzi equations.

Unit-V

Geodesics, Differential Equation of Geodesic, torsion of Geodesic, Geodesic Curvature, Clairaut's theorem, Gauss- Bonnet theorem, Joachimsthal's theorem, Geodesic Mapping, Tissot's theorem.

Books Recommended:

1. Lass, H.: Vector and Tensor Analysis
2. Shanti Narayan: Tensor Analysis
3. Weather burn, C.E.: Differential Geometry
4. Willmore, T.J.: Introduction to Differential Geometry
5. Bansi Lal. Differential Geometry

M.Sc. MATHEMATICS (SEMESTER-II) *(For Colleges)*

ALGEBRA-II

MATH-563

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week
Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Principal Ideal domains, Euclidean Rings. The ring of Gaussian Integers, Unique Factorization domains, Polynomial Rings, Chain conditions (Definition and examples only).

Unit-II

Extension Fields: Finite, Algebraic, Simple, Separable Extensions, Algebraically Closed fields.

Unit-III

Splitting Fields: Existence & Uniqueness. Finite fields, existence of $GF(p^n)$, Constructive polygons.

Unit-IV

Galois Theory: Normal extension Galois Groups, Symmetric rational functions, Fundamental Theorem, Solvability by radicals.

Unit-V

Modules, Cyclic Modules, simple modules, Free Modules, Fundamental structure theorem for finitely generated modules over a U.F.D. (Statement only).

BOOKS RECOMMENDED:

1. Herstein, I.N. : Topics in Algebra, Willey Eastern 1975.
2. Dummit, D.S. & Foote. : Abstract-Algebra, John-Wiley & Sons, Students Edition-1999
3. Fraleigh, J. B. : An Introduction to Abstract Algebra.
4. Bhattacharya, P.B.,Jain, S.K. & Nagpaul, S.R.. : Basic Abstract Algebra, Cambridge University Press, 1997.
5. Surjit Singh : Modern Algebra.

MECHANICS - II

MATH-564

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

General motion of a rigid body, linear momentum of a system of particles. Angular momentum of a system, use of centroid, moving origins, impulsive forces. Problems in two-dimensional rigid body motion, law of conservation of Angular momentum, illustrating the laws of motion, law of conservation of energy, impulsive motion.

Unit-II

Euler's dynamical equations for the motion of a rigid body about a fixed point, further properties of rigid body motion under no forces. Problems on general three-dimensional rigid body motion.

Unit-III

Generalised co-ordinates and velocities Virtual work, generalized forces. Lagrange's equations for a holonomic system and their applications to small oscillation. Lagrange's equations for impulsive forces. Kinetic energy as a quadratic function of velocities. Equilibrium configurations for conservative holonomic dynamical systems. Theory of small oscillations of conservative holonomic dynamical systems (Scope and standard of the syllabus is the same as given by Chorlton).

Unit-IV

Linear functional, Extremal. Euler's - Lagrange's equations of single independent and single dependent variable. Brachistochrone problem, Extension of the variational method. Hamilton's Principle, Principle of Least action. Distinctions between Hamilton's Principle and the Principle of Least Action.

Unit-V

Euler's - Lagrange equation of several dependent and several independent variables. Functional involving higher order derivatives. Approximate solution of boundary value problems:- Rayleigh-Ritz Method, Galerkin's method Kanturovich and Treffiz method. Isoperimetric problems. Geodesics.

BOOKS RECOMMENDED:

1. Chorlton, F.: Text Book of Dynamics.
2. Elssgists, L.: Differential equations and the calculus of variations.
3. Gupta: Calculus of Variation with Application. (PHI Learning Pvt. Ltd.)

M.Sc. MATHEMATICS (SEMESTER-II) *(For Colleges)*

DIFFERENTIAL AND INTEGRAL EQUATIONS

MATH-565

Time: 3Hrs **Max. Marks: 100**

Contact Hours: 6 Hrs/Week
Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Partial Differential Equations of First Order **:** origin of first order partial differential equations. Cauchy problem of first order equations. Integral surface through a given curve. Surface orthogonal to given system of surfaces. Non linear p.d.e of first order, Charpit's method and Jacobi's method.

Unit-II

Partial differential equations of the 2^{nd} order. Origin of 2^{nd} order equations. Linear p.d.e. with constant coefficients and their complete solutions. Second order equation with variable coefficient and their classification and reduction to standard form. Solution of linear hyperbolic equation. Non-linear equations of second order, Monge's Method.

Unit-III

Solution of Laplace, wave and diffusion equations by method of separation of variables and Fourier transforms. Green function for Laplace, waves and diffusion equation.

Unit-IV

Volterra Equations **:** Integral equations and algebraic system of linear equations. Volterra equation L_2 Kernels and functions. Volterra equations of first & second kind. Volterra integral equations and linear differential equations.

Unit- V

Fredholm equations, solutions by the method of successive approximations. Neumann's series, Fredholm's equations with Pincherte-Goursat Kernel's, The Fredholm theorem (Scope same in chapters I and II excluding 1.10 to 1.13 and 2.7 of integral equations by F.G. Tricomi's.)

BOOKS RECOMMENDED:

1. Piaggio: Differential equations.

2. Tricomi, F.G.: Integral equation (Ch. I and II)

3. Kanwal R, P: Linear integral equations

4. Sneddon, I.N.: Elements of partial differential equations.

5. Levitt, W.W.: Integral Equations.

6. Mikhlin: Integral Equations

MATH-571 FUNCTIONAL ANALYSIS - I

Time: 3 Hrs. **Max. Marks 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Normed linear spaces, Banach spaces, subspaces, quotient spaces, L^p-spaces: Holder's and Minkowski's Inequalities, Convergence and Completeness, Riesz-Fischer Theorem

Unit-II

Continuous linear transformations, equivalent norms, finite dimensional normed linear spaces and compactness, Riesz Theorem

Unit-III

The conjugate space N*. The Hahn-Banach theorem and its consequences. natural imbedding of N into N**, reflexivity of normed spaces.

Unit-IV

Open mapping theorem, projections on a Banach space, closed graph theorem, uniform boundedness principle, conjugate operators.

Unit-V

Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets, the conjugate space H*.

BOOKS RECOMMENDED:

1. G.F. Simmons: Introduction to Topology and Modern Analysis, Ch. 9 & 10 (Sections 52-55), Mc.Graw-Hill International Book Company, 1963.
2. Royden, H. L.: Real Analysis , Ch 6 (Sections 6.1 -6.3), Macmillan Co. 1988.
3. Erwin Kreyszig: Introduction to Functional Analysis with Applications, John Wiley & Sons, 1978.
4. Balmohan V. Limaye: Functional Analysis, New Age International Limited.
5. P.K.Jain, O.P Ahuja & Khalil Ahmed: Functional Analysis, New Age International (P) Ltd. Publishers, 1995.
6. K. Chanrashekhra Rao: Functional Analysis, Narosa, 2002
7. D. Somasundram: A First Course in Functional Analysis, Narosa, 2006.

MATH-572 TOPOLOGY -I

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit – I

Topological Spaces, Basic concepts, closure, interior, exterior and boundary of a set. Dense sets, Closure operator [Kuratowski function] and Interior operator. Neighbourhoods and neighbourhood system, Coarser and finer topologies. Local bases, bases and sub – bases for a topological space. Convergence of a sequence. First and second countable spaces. Lindel of spaces, Separable spaces.

Unit – II

Sub-spaces, Hereditary properties, Separated sets, Connected sets, Connected and disconnected spaces, Connectedness on real line. Components, Locally connected space. Totally disconnected space.

Unit – III

Continuous functions, Restriction and extension of a mapping. Sequential continuity at point. Invariants under a continuous mapping. Open and closed mappings. Homeomorphism and embedding. Topological properties.

Unit – IV

Product of two spaces, The product of *n* spaces. Base for a finite product topology. General product spaces. Sub-base and base for product topology. Productive properties. Quotient spaces.

Unit – V

Separation Axioms: T_0, T_1, T_2 – spaces. Regular spaces, T_3 – spaces, Normal spaces, T_4 – space. Tychonoff lemma, Urysohn lemma, Tietze extension theorem.

BOOKS RECOMMENDED:

1. T.O. Moore : Elementary general Topology (Chapters 2–8).
2. J.L. Kelley : General Topology (Chapters 1–5).
3. J.R. Munkres : Topology.
4. G.F. Simmons : Introduction to Topology and Modern Analysis.
5. S.W. Davis : Topology, McGraw Hill 2005.

MATH-581 FUNCTIONAL ANALYSIS – II

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Strong and weak convergence in finite and infinite dimensional normed linear spaces. Weak convergences in Hilbert spaces, weakly compact set in Hilbert spaces.

Unit- II

The adjoint of an operator, self adjoint operators, normal operators, Unitary operators, projections on a Hilbert space.

Unit-III

Finite dimensional spectral Theory.: Eigen- values and Eigen vectors, Spectrum of a bounded linear operator, spectrum of self-adjoint, positive and Unitry operators. Spectral Theorem for normal operators.

Unit-IV

Compact Linear Operator on normed spaces, properties of compact linear operators, spectral properties of compact linear operators.

Unit-V

Banach algebras: definitions and simple examples. Regular and singular elements. Topological divisors of zero, Spectrum of an element of Banach Algebra, formula for spectral radius.

BOOKS RECOMMENDED:

1.	Simmons, G.F.:	Introduction to Topology and Modern Analysis Ch. X (Sections 56-59), Ch. XI (Sections 61-62) , Ch. 12 (Sections 64-68), Mc Graw- Hill (1963)International Book Company.
2.	Erwin Kreyszig:	Introduction to Functional Analysis with Applications, Ch 8, Sections 8.1-8.3, John Wiley & Sons(1978).
3.	Limaye, Balmohan V.:	Functional Analysis, New Age International Limited., 1996.
4.	Jain, P.K., Ahuja, O.P & : Khalil Ahmed	Functional Analysis, New Age International (P) Ltd. Publishers, 1995.
5.	Chandrasekhra Rao, K.:	Functional Analysis, Narosa, 2002.
6	Somasundram, D.:	A First Course in Functional Analysis, Narosa, 2006.

MATH-582 TOPOLOGY-II

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit – I

Higher Separation Axioms: Completely regular spaces. Tychonoff spaces, Completely normal space, T_5 – spaces. Metric spaces as Hausdorff regular, normal and completely normal space. Product of metric spaces.

Unit – II

Compact spaces, Compact sets, Subsets of compact space. Finite intersection property. Compactness of subsets of real line. Relation of compact spaces with Hausdorff spaces, Regular spaces and normal spaces.

Unit – III

Sequentially compact spaces, Bolzano Weierstrass property. Countably compact spaces. Locally compact spaces. Compactness in terms of base element and sub – base elements. Tychonoff theorem. One point compactification.

Unit – IV

The Stone-Čech compactification, Evaluation mappings, Separate point family, Separate point and closed set family. Embedding lemma, Tychonoff cube, Embedding theorem, Metrization. Urysohn metrization theorem.

Unit – V

Directed sets and nets. Convergence of a net in a space, Clustering of a net, nets and continuity, Nets in product spaces, Ultra nets. Compactness in term of nets, Topologies determined by nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultra-filters and compactness.

BOOKS RECOMMENDED:

1. T.O. Moore : Elementary general topology (Chapter 2 to 8).
2. J.L. Kelley : General Topology (Chapter 1to 5).
3. J.R. Munkres : Topology.
4. G.F. Simmons : Introduction to Topology and Modern Analysis.
5. S.W. Davis : Topology, McGraw Hill 2005.

M.Sc. MATHEMATICS (SEMESTER – III & IV) *(For Colleges)*

(OPTIONAL PAPERS)

MATH-575 DISCRETE MATHEMATICS-I

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Relations and Functions : Binary relations, equivalence relations and partitions, partial order relations, inclusion and exclusion principle, Hasse diagram, Pigeon hole principle.

Unit-II

Mathematical Logic : Basic logical operations, conditional and biconditional statements, tautologics, contradiction, quantifiers, prepositional calculus.

Unit-III

Semi Groups and Monoids : Definition and examples of semi groups and monoids, Homomorphism of semigroups and monoids, Congruence relations and quotient subgroups.

Unit-IV

Grammar and Languages: Phrase structure grammars, rewriting rules, derivation sentential forms, language generated by grammar, regular, context free and context sensitive grammar and languages.

Unit-V

Recurrence Relations and Generating Functions: Polynomial expressions, telescopic form, recursion theorem, closed form expression, generating function, solution of recurrence relation using generating function.

BOOKS RECOMMENDED:

1. Trambley, J.P. and Manohar,R : Discrete Mathematical Structure with Applications to computer science
2. Liu, C.L. : Elements of Discrete Mathematics
3. Alan Doer : Applied Discrete Structure for Computer Science

(OPTIONAL PAPERS)

MATH-576 INTEGRAL TRANSFORMS

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Finite Fourier Transforms : Finite Fourier sine, cosine transforms, inversion formula for sine & cosine transforms, multiple finite Fourier transforms, problems related to finite Fourier transforms, Applications of Fourier transforms in initial and boundary value problems.

Unit-II

Application of Laplace Transforms in Initial and Boundary Value Problems: Heat conduction equation, wave equation, Laplace equation and problems based on above equations.

Unit-III

Hankel Transforms: Hankel transforms, inversion formula for the Hankel transform, infinite Hankel transform, Hankel transform of the derivative of a function, Parseval's theorem.

Unit-IV

The finite Hankel transforms, Applications of Hankel transform in boundary value problems.

Unit-V

Z- Transform, Convergence, properties of Z-Transform, convolution theorem, Inverse Z-transforms, Applications to Difference equations.

BOOKS RECOMMENDED:

1. Sheddon : The Uses of Integral Transforms
2. Churchill, R.V. : Operational Mathematics
[Chapters I, II, III (28-36), IV (40-49), VI (65-68, 70), VII, XI (119-124,129), XII, XIII (138-144), XIV (148-150,152)]

M.Sc. MATHEMATICS (SEMESTER – III & IV) *(For Colleges)*

(OPTIONAL PAPERS)

MATH-577 STATISTICS-I

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Measures of central tendency and dispersion, moments, Measures of skew ness and kurtosis, Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Bayes theorem.

Unit-II

Random variable, probability mass function, probability density function, cumulative distribution function, Two and higher dimensional random variables, joint distribution, marginal and conditional distributions, Stochastic independence, function of random variables and their probability density functions.

Unit-III

Mathematical expectations and moments, moment generating function and its properties, Chebyshev's inequality and its application, Stochastic convergence, central limit (Laplace theorem Linder berg, Levy's Theorem).

Unit-IV

Discrete Probability Distributions: Uniform hyper geometric, Binomial, Poisson, Geometric, Hyper geometric, Multinomial. Continuous probability distributions: Uniform, Exponential, Gamma, Beta, Normal distributions.

Unit-V

Least square principle, correlation and linear regression analysis for bi-variate data, partial and multiple correlation coefficients, correlation ratio, association of attributes.

Books Recommended:

1. Hogg, R.V., Mckean, J.W. and Craig, A.T.: Introduction to Mathematical Statistics.
2. Gupta, S.C. and Kapoor, V.K. : Fundamentals of Mathematical Statistics.
3. Mukhopadhyay, P : Mathematical Statistics.
4. Goon,A.M.,Gupta, M.K. & Dasgupta B. : An Outline of Statistical Theory Vol.-I.

(OPTIONAL PAPERS)

MATH-578 OPERATIONS RESEARCH-I

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

The linear programming problem, properties of a solution to the linear programming problem, generating extreme point solution, simplex computational procedure, development of minimum feasible solution, the artificial basis techniques, a first feasible solution using slack variables, two phase and Big-M method with artificial variables.

Unit-II

General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, Duality theorems, complementary slackness theorem, duality and simplex method, economic interpretation of duality, dual simplex method.

Unit-III

General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, LP formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm (MODI method), time- minimization transportation problem.

Unit-IV

Mathematical formulation of assignment problem, assignment method, typical assignment problem, the traveling salesman problem. Game Theory: Two-person zero-sum games, maximin-minimax principle, games without saddle points(Mixed strategies), graphical solution of $2\times n$ and $m\times 2$ games, dominance property, arithmetic method of $n\times n$ games, general solution of $m\times n$ rectangular games.

Unit-V

Integer Programming: Gomory's all I.P.P. method, constructions of Gomory's constraints, Fractional cut method-all integer and mixed integer, Branch-and-Bound method, applications of integer programming. Dynamic Programming: The recursive equation approach, characteristics of dynamic programming, dynamic programming algorithm, solution of-Discrete D.P.P. , some applications, solution of L.P.P. by Dynamic Programming.

BOOKS RECOMMENDED:

1. Gass, S. L. : Linear Programming
2. Handley, G. : Mathematical Programming
3. Kambo, N. S. : Mathematical Programming
4. Panneerselvam, R. : Operations Research
5. Taha, H.A. : Operations Research
6. Kanti Sawrup, Gupta, P.K. and Manmohan : Operations Research

(OPTIONAL PAPERS)

MATH-579 ADVANCED NUMERICAL ANALYSIS

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Interpolation with cubic splines, End Conditions, Minimizing Property, Error Analysis, Numerical Calculation of Fourier Integrals, The cubic splines method, orthogonalization process, least square solution of B-splines, The Cox-de-Boor recurrence formula, Chebyshev polynomials.

Unit-II

Finite difference approximations to partial derivatives, Solution of Laplace Equations by iteration method, Jacobi's Method, Gauss Siedel method, SOR method, ADI Method, Parabolic Partial differential equations: An explicit method, Crank Nicolson Implicit method, derivative boundary conditions, Solution of Hyperbolic Equations.

Unit -III

Finite Element Method: Shooting method, Rayleigh Ritz method, the collocation and Galerkin's method, finite element methods for ODE's and finite element for one dimensional & two dimensional Columns, Finite element method for Elliptic, Parabolic and Hyperbolic partial differential equations.

Unit-IV

Introduction to simulation, need of simulation, random number generation, Congruential generators, Buffen's needle problem, approximate value of π.Random Variates Generation: Inverse transform method, composition method, acceptance rejection method, generating random variates from continuous and discrete distribution. Generation of random from multinomial distribution.

Unit-V

Monte Carlo integration & variance reduction techniques: Hit or Miss method, Sample mean method, Importance sampling. Corrected sampling control variates, stratified sampling, Antithetic variates, partition of region.

(OPTIONAL PAPERS)

BOOKS RECOMMENDED:

1. Sastry,S.S.: Introductory methods of Numerical Analysis (3^{rd} edition).
2. Smith, G.D.: Numerical solution of partial differential equations, Finite difference methods, (3^{rd} edition).
3. Gerald, C.F.: Applied Numerical Analysis (7^{th} edition).
4. Scarborough: Numerical Mathematical Analysis (6^{th} edition).
5. R.Y.Rubinstein: Simulation and Monte Carlo method. John Wiley.
6. Narsingh Deo: System Simulation with Digital Computer, Prentice Hall of India.

M.Sc. MATHEMATICS (SEMESTER – III & IV) *(For Colleges)*

(OPTIONAL PAPERS)

MATH-585 DISCRETE MATHEMATICS-II

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Lattices: Lattices as partially ordered sets, properties, lattices as algebraic systems, sublattices, direct products, Homomorphism, some special lattices (complete, complemented, distributive lattices).

Unit-II

Boolean Algebra: Boolean algebra as lattices, Boolean identities, sub-algebra, direct product, Homomorphism, join-irreducible elements, atoms and minterms, Boolean forms and their equivalence, sum of product & product of sum canonical forms, application of Boolean algebra in switching circuits.

Unit-III

Graph Theory: Definition, undirected graphs, paths, circuits, cycles, subgraphs, induced subgraphs, degree of vertex, connectivity, planner graph, complete, bipartite complete graph, matrix representation of graph, adjacency and incident matrix for graph.

Unit-IV

Euler's theorem on the existence of Eulerian paths and circuits, directed graphs, in-degree and out-degree of a weighted graphs, cut set, fundamental cut sets and cycles.

UNIT-V

Trees: Rooted tree, directed trees, search tree, tree traversals, spanning trees, minimal spanning trees, Kruskal's algorithm, colouring of the graph, four-colour problem, chromatic polynomials.

BOOKS RECOMMENDED :

1. Trambley,J.P. and Manohar,R : Discrete mathematical structure with applications to computer science
2. Liu C.L. : Elements of Discrete Mathematics
3. Alan Doer : Applied discrete structure for computer science
4. Deo, N. : Graph theory with applications to engineering and computer sciences

M.Sc. MATHEMATICS (SEMESTER – III & IV) *(For Colleges)*

(OPTIONAL PAPERS)

MATH-586 NUMBER THEORY

Time: 3 Hrs. **Max. Marks 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Simultaneous Linear Congruences, Chinese Remainder theorem with applications, Wolsten-Holme's theorem, Lagrange's proof of Wilson theorem, Fermat numbers, The order of an integer modulo n. Primitive roots, Existence and number of primitive roots.

Unit-II

Indices and their applications, Quadratic residues , Euler's criterion, Product of quadratic residues and quadratic non-residues, The Legendre symbol and its properties, Gauss's Lemma, Quadratic reciprocity law, Jacobian symbol and its properties..

Unit-III

Arithmetic functions $\tau(n), c(n), c_k(n), \mu(n)$, Perfect numbers, Mobius inversion formula, Diophantine equation $x^2 + y^2 = z^2$ and its applications to $x^n + y^n = z^n$ when $n = 4$.

Unit-IV

Criterion for an integer to be expressible as sum of two squares and sum of four squares, Farey series, Farey dissection of a circle and its applications to approximations of irrationals by rationals.

Unit-V

Finite and Infinite simple continued fractions, periodic and purely periodic continued fractions, Lagrange's Theorem on periodic continued fractions. Applications to Pell's equation. The fundamental solution of Pell's equation.

BOOKS RECOMMENDED:

1. Hardy and Wright : Theory of Numbers.
2. Niven and Zuckerman : An introduction to number theory.
3. Burton, David M. : Elementary Number Theory, McGraw Hill 2002.

M.Sc. MATHEMATICS (SEMESTER – III & IV) *(For Colleges)*

(OPTIONAL PAPERS)

MATH-587 STATISTICS-II

Time: 3 Hrs **Max. Marks: 100**
CONTACT HOURS: 6 HRS./WEEK **Theory: 70**
Practical: 30

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books. Non programmable calculator is allowed.
The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Sampling Distributions: Chi-square, t and F-distributions with their properties, distribution of sample mean and variance, distribution of order statistics and sample range from continuous populations.

Unit-II

Point Estimation: Estimators, Properties of unbiased ness, consistency, sufficiency, efficiency, completeness, uniqueness, methods of estimation

Unit-III

Testing of Hypothesis: Null hypothesis and its test of significance, simple and composite hypothesis, M.P. test, UMP test, Likelihood tests (excluding properties of Likelihood Ratio Tests)

Unit-IV

Applications of Sampling Distributions: Test of mean and variance in the normal distribution, Tests of single proportion and equality of two proportions, Chi-square test, t-test, F-test.

Unit-V

Linear Estimation: Gauss Markoff linear models, BLUE, Gauss Markoff Theorem, estimation with linear restrictions on parameters, residual sum of squares, analysis of variance, analysis of variance for one way and two way classified data with one observation per cell.

BOOKS RECOMMENDED:

1. Hogg R.V., Mckean, J.W. and Craig A.T. : Introduction to Mathematical Statistics
2. Hoel P.G. : Introduction to Mathematical Statistics
3. Gupta S.C. and Kapoor V.K. : Fundamentals of mathematical statistics
4. Mukhopadhyay,P : Mathematical statistics
5. Goon,A.M.,Gupta M.K. & Dasgupta B. : Fundamental of statistic, Vol. I
6. Goon,A.M.,Gupta M.K. & Dasgupta B. : An outline of statistical theory, Vol. I

(OPTIONAL PAPERS)

MATH-588 OPERATIONS RESEARCH-II

Time: 3 Hrs. **Max. Marks: 100**

CONTACT HOURS: 6 HRS./WEEK

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Queueing Theory: Introduction, Queueing System, elements of queueing system, distributions of arrivals, inter arrivals, departure and service times. Classification of queueing models, single service queueing model with infinite capacity (M/M/1): (/FIFO).

Unit-II

Queueing Models: (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process, (M/M/C): (/FIFO), (M/M/C) (N/FIFO), (M/M/R) (KIGD), Power supply model.

Unit-III

Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, economic order quantity (EOQ), Deterministic inventory problems with no shortage and with shortages, EOQ problems with price breaks, Multi item deterministic problems.

Unit-IV

Replacement Problems: Replacement of equipment/Asset that deteriorates gradually, replacement of equipment that fails suddenly, recruitment and promotion problem, equipment renewal problem.

Unit-V

Need of simulation, methodology of simulation. Simulation models, event- type simulation, generation of random numbers, Monto-carlo simulation, simulation of inventory problems, queueing systems, maintenance problem, job sequencing.

BOOKS RECOMMENDED:

1. Handley, G. : Mathematical Programming
2. Kambo, N.S. : Mathematical Programming
3. Panneerselvam, R. : Operations Research
4. Taha, H.A. : Operations Research
5. Kanti Sawrup, Gupta,: Operations Research
   P.K. and Manmohan

M.Sc. MATHEMATICS (SEMESTER – III & IV) *(For Colleges)*

(OPTIONAL PAPERS)

MATH-589 COMPUTER PROGRAMMING WITH C

Time: 3 Hrs **Max. Marks: 100**
CONTACT HOURS: 6 HRS./WEEK **Theory: 70**
Practical: 30

Instructions for the paper setters/examiners:

Note: Question paper must contain at least 35% of the article/theory from the prescribed books.

The question paper will consist of five Units. Each Unit will contain four questions. The candidates are required to attempt two questions from each Unit. Each question carries equal marks.

Unit-I

Programming Basics: Basic Structure of C-program, Constants, variables, Data types. Assignments, console I/o statements, Arithmetical and logical operations, If, If-Else Statements, Nesting, Switch, While, Do While, Continue and Break Statements.

Unit-II

Functions and Arrays: Function definition and declaration, Arguments, Return values and their types, Recursion, Arrays: One and two-dimensional arrays, Initialization, Accessing array elements, Functions with arrays.

Unit-III

Strings and Pointers: String constant and variable, Input/output statements, string handling functions, array of strings, Pointers: Address and pointer variables, declaration and initialization, pointers and arrays, pointers and functions, pointer and character strings.

Unit-IV

Structure, Union and File Handling: Definition, structure initialization and assignment statements, nesting of structure, Array of structures, structure and functions, Union, Union of structure. Defining and opening a file, closing a file, Input/Output operations on files.

Unit-V

C applications to Numerical Methods and statistics (C Programs for solution to linear equations, Non linear equations, Simpson's & Trapezoidal Rule, Numerical methods for ordinary differential equations, Measures of central tendency, Correlation & Regression).

BOOKS RECOMMENDED:

1	Robert Lafore:	Turbo C Programming for IBM.
2	Brain Kernighan & Dennis Ritchi:	The C Programming Language.
3	E Balagurusamy:	Programming in ANSI C
4	Salaria, R.S.:	Computer Oriented Numerical Methods.
5	Yashavant Kanetkar:	Let us C