M.Sc. Mathematics

12MM 411: Advanced Abstract Algebra-I

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Groups : Zassenhaus lemma, Normal and subnormal series, Composition series, Jordan-Holder theorem, Solvable series, Derived series, Solvable groups, Solvability of S_n – the symmetric group of degree n ≥ 2.	18
Unit-2	Nilpotent group: Central series, Nilpotent groups and their properties, Equivalent conditions for a finite group to be nilpotent, Upper and lower central series, Sylow-p sub groups, Sylow theorems with simple applications. Description of group of order p^2 and pq, where p and q are distinct primes(In general survey of groups upto order 15).	25
Unit-3	Field theory, Extension of fields, algebraic and transcendental extensions. Splitting fields, Separable and inseparable extensions, Algebraically closed fields, Perfect fields.	22
Unit-4	Finite fields, Automorphism of extensions, Fixed fields, Galois extensions, Normal extensions and their properties, Fundamental theorem of Galois theory, Insolvability of the general polynomial of degree n ≥ 5 by radicals.	25

Books Recommended :

1. I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
3. P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
4. N. Jacobson, Basic Algebra, Vol. I & II, W.H Freeman, 1980 (also published by Hindustan Publishing Company).
5. S. Lang, Algebra, 3rd editioin, Addison-Wesley, 1993.
6. I.S. Luther and I.B.S.Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. I – 1996, Vol. II –1990).
7. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
8. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.

M.Sc. Mathematics

12MM 412: Real Analysis -I

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Unit	Contents	No. Of Periods
Unit-1	Riemann-Stieltjes integral, its existence and properties, Integration and differentiation, The fundamental theorem of calculus, Integration of vector-valued functions, Rectifiable curves.	16
Unit-2	Set functions, Intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of a set of real numbers, Algebra of measurable sets, Borel set, Equivalent formulation of measurable sets in terms of open, Closed, F and G sets, Non measurable sets.	25
Unit-3	Measurable functions and their equivalent formulations. Properties of measurable functions. Approximation of a measurable function by a sequence of simple functions, Measurable functions as nearly continuous functions, Egoroff's theorem, Lusin's theorem, Convergence in measure and F. Riesz theorem. Almost uniform convergence.	22
Unit-4	Shortcomings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties. Lebesgue integral as a generalization of Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions, Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.	27

Books Recommended : 4

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International Student Edition.
2. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
3. P. K. Jain and V. P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986.
4. G.De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition.

M.Sc. Mathematics

12MM 413 : Topology - I

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Unit	Contents	No. Of Periods
Unit-1	Statements only of (Axiom of choice, Zorn's lemma, Well ordering theorem and Continnum hypothesis). Definition and examples of topological spaces, Neighbourhoods, Interior point and interior of a set , Closed set as a complement of an open set , Adherent point and limit point of a set, Closure of a set, Derived set, Properties of Closure operator, Boundary of a set , Dense subsets, Interior, Exterior and boundary operators. Base and subbase for a topology, Neighbourhood system of a point and its properties, Base for Neighbourhood system. Relative(Induced) topology, Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator. Comparison of topologies on a set, Intersection and union of topologies on a set	27
Unit-2	Continuous functions, Open and closed functions , Homeomorphism. Tychonoff product topology, Projection maps, Characterization of Product topology as smallest topology, Continuity of a function from a space into a product of spaces. Connectedness and its characterization, Connected subsets and their properties, Continuity and connectedness, Connectedness and product spaces, Components, Locally connected spaces, Locally connected and product spaces	25
Unit-3	First countable, second countable and separable spaces, hereditary and topological property, Countability of a collection of disjoint open sets in separable and second 5 countable spaces, Product space as first axiom space, Lindelof theorem. T_0, T_1, T_2 (Hausdorff) separation axioms, their characterization and basic properties.	18
Unit-4	Compact spaces and subsets, Compactness in terms of finite intersection property, Continuity and compact sets, Basic properties of compactness, Closedness of compact subset and a continuous map from a compact space into a Hausdorff and its consequence. Sequentially and countably compact sets, Local compactness, Compactness and product space, Tychonoff product theorem and one point compactification. Quotient topology, Continuity of function with domain- a space having quotient topology, Hausdorffness of quotient space.	20

Books Recommended :

1. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd.
3. J. L. Kelly, General Topology, Affiliated East West Press Pvt. Ltd., New Delhi.
4. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
5. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.

M.Sc. Mathematics

12MM 414 : Integral Equations and Calculus of Variations

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Linear integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series in , Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind.	20
Unit-2	Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels, Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homogenous Fredholm equations with degenerate kernels.	22
Unit-3	Green's function, Use of method of variation of parameters to construct the Green's function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green's function, Orthogonal series representation of Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green's function. Hilbert-Schmidt theory for symmetric kernels	25
Unit-4	Motivating problems of calculus of variations, Shortest distance, Minimum surface of revolution, Branchistochrone problem, Isoperimetric problem, Geodesic. Fundamental lemma of calculus of variations, Euler's equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints.	23

Books Recommended :

1. Jerri, A.J., Introduction to Integral Equations with Applications, A Wiley-Interscience Pub.
2. Kanwal, R.P., Linear Integral Equations, Theory and Techniques, Academic Press, New York.
3. Gelfand, J.M. and Fomin, S.V., Calculus of Variations, Prentice Hall, New Jersy, 1963.
4. Weinstock , Calculus of Variations, McGraw Hall.
5. Abdul-Majid wazwaz, A first course in Integral Equations, World Scientific Pub.
6. David, P. and David, S.G. Stirling, Integral Equations, Cambridge University Press.
7. Tricomi, F.G., Integral Equations, Dover Pub., New York.

M.Sc. Mathematics

12MM 415-B : Mathematical Statistics

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

UNIT	CONTENTS	No. Of Periods
Unit-1	Probability: Definition of probability-classical, relative frequency, statistical and axiomatic approach, Addition theorem, Boole's inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes' theorem and its applications.	20
Unit-2	Random Variable and Probability Functions: Definition and properties of random variables, discrete and continuous random variables, probability mass and density functions, distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions. Mathematical Expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties. Chebychev's inequality.	22
Unit-3	Discrete distributions: Uniform, Bernoulli, binomial, Poisson and geometric distributions with their properties. Continuous distributions: Uniform, Exponential and Normal distributions with their properties. Central Limit Theorem (Statement only).	20
Unit-4	Statistical estimation: Parameter and statistic, sampling distribution and standard error of estimate. Point and interval estimation, Unbiasedness, Efficiency. Testing of Hypothesis: Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors. Tests of significance: Large sample tests for single mean, single proportion, difference between two means and two proportions;	28

Books Recommended :

1. Mood, A.M., Graybill, F.A. and Boes, D.C., Mc Graw Hill Book Company.
2. Freund,J.E., Mathematical Statistics, Prentice Hall of India.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.
4. Speigel, M., Probability and Statistics, Schaum Outline Series.

M.Sc. Mathematics

12MM 421: Advanced Abstract Algebra-II

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be compulsory.

UNIT	CONTENTS	No. Of Periods
Unit-1	Cyclic modules, Simple and semi-simple modules, Schur's lemma, Free modules, Fundamental structure theorem of finitely generated modules over principal ideal domain and its applications to finitely generated abelian groups.	20
Unit-2	Neotherian and Artinian modules and rings with simple properties and examples, Nil and Nilpotent ideals in Neotherian and Artinian rings, Hilbert Basis theorem.	20
Unit-3	$Hom_R(R,R)$, Opposite rings, Wedderburn – Artin theorem, Maschk's theorem, Equivalent statement for left Artinian rings having non-zero nilpotent ideals, Uniform modules, Primary modules and Neother- Lasker theorem	25
Unit-4	Canonical forms : Similarity of linear transformations, Invariant subspaces, Reduction to triangular form, Nilpotent transformations, Index of nilpotency, Invariants of nilpotent transformations, The primary decomposition theorem, Rational canonical forms, Jordan blocks and Jordan forms.	25

Books Recommended :

1. I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
3. M. Artin, Algebra, Prentice-Hall of India, 1991.
4. P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
5. I.S. Luther and I.B.S.Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. I – 1996, Vol. II –1990).
6. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
7. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt., New Dlehi, 2000.
8. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999

M.Sc. Mathematics

12MM 422: Real Analysis -II

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Rearrangements of terms of a series, Riemann's theorem. Sequence and series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weirstrass's M test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation, Weierstrass approximation theorem.	28
Unit-2	Power series, its uniform convergence and uniqueness theorem, Abel's theorem, Tauber's theorem. Functions of several variables, Linear Transformations, Euclidean space R_n, Open balls and open sets in R_n, Derivatives in an open subset of R_n, Chain Rule, Partial derivatives, Continuously Differentiable Mapping, Young's and Schwarz's theorems	22
Unit-3	Taylor's theorem. Higher order differentials, Explicit and implicit functions. Implicit function theorem, Inverse function theorem. Change of variables, Extreme values of explicit functions, Stationary values of implicit functions. Lagrange's multipliers method. Jacobian and its properties, Differential forms, Stoke's Theorem	22
Unit-4	Vitali's covering lemma, Differentiation of monotonic functions, Function of bounded variation and its representation as difference of monotonic functions, Differentiation of indefinite integral, Fundamental theorem of calculus, Absolutely continuous functions and their properties. L_p spaces, Convex functions, Jensen's inequalities, Measure space, Generalized Fatou's lemma, Measure and outer measure, Extension of a measure, Caratheodory extension theorem.	28

Books Recommended :

1. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi.
2. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi.
3. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
4. G. De Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition.

M.Sc. Mathematics

12MM 423: Topology -II

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Regular, Normal, T_3 and T_4 separation axioms, their characterization and basic properties, Urysohn's lemma and Tietze extension theorem, Regularity and normality of a compact Hausdorff space, Complete regularity, Complete normality, and T_5 spaces, their characterization and basic properties.	25
Unit-2	Nets : Nets in topological spaces, Convergence of nets, Hausdorffness and nets, Subnet and cluster points, Compactness and nets, Filters : Definition and examples, Collection of all filters on a set as a poset, Finer filter, Methods of generating filters and finer filters, ultra filter and its characterizations, Ultra filter principle, Image of filter under a function, Limit point and limit of a filter, Continuity in terms of convergence of filters, Hausdorffness and filters, Convergence of filter in a product space, Compactness and filter convergence, Canonical way of converting nets to filters and vice versa, Stone-Cech compactification.	27
Unit-3	Covering of a space, Local finiteness, Paracompact spaces, Michaell theorem on characterization of paracompactness in regular spaces, Paracompactness as normal space, A. H. Stone theorem, Nagata- Smirnov Metrization theorem	18
Unit-4	Embedding and metrization : Embedding lemma and Tychonoff embedding theorem, Metrizable spaces, Urysohn's metrization theorem. Homotopy and Equivalence of paths, Fundamental groups, Simply connected spaces, Covering spaces, Fundamental group of circle and fundamental theorem of algebra	20

Books Recommended :

1. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd.
3. J. L. Kelly, General Topology, Springer Verlag, New York, 1991.
4. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
5. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.

M.Sc. Mathematics

12MM 424 : Ordinary Differential Equations

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Preliminaries : Initial value problem and equivalent integral equation. -approximate solution, Cauchy-Euler construction of an - approximate solution, Equicontinuous family of functions, Ascoli-Arzela lemma, Cauchy-Peano existence theorem. Uniqueness of solutions, Lipschitz condition, Picard-Lindelof existence and uniqueness theorem for = dt dy f(t,y), Dependence of solutions on initial conditions and parameters, Solution of initial-value problems by Picard method.	27
Unit-2	Sturm-Liouville BVPs, Sturms separation and comparison theorems, Lagrange's identity and Green's formula for second order differential equations, Properties of eigenvalues and eigenfunctions, Pruffer transformation, Adjoint systems, Self-adjoint equations of second order. 15 Linear systems, Matrix method for homogeneous first order system of linear differential equations, Fundamental set and fundamental matrix, Wronskian of a system, Method of variation of constants for a nonhomogeneous system with constant coefficients, nth order differential equation equivalent to a first order system.	28
Unit-3	Nonlinear differential system, Plane autonomous systems and critical points, Classification of critical points – rotation points, foci, nodes, saddle points. Stability, Asymptotical stability and unstability of critical points,	17
Unit-4	Almost linear systems, Liapunov function and Liapunov's method to determine stability for nonlinear systems, Periodic solutions and Floquet theory for periodic systems, Limit cycles, Bendixson non-existence theorem, Poincare-Bendixson theorem (Statement only), Index of a critical point	18

Books Recommended :

1. Coddington, E.A. and Levinson, N.,, Theory of Ordinary Differential Equations, Tata McGraw Hill, 2000.
2. Ross, S.L., Differential Equations, John Wiley and Sons Inc., New York, 1984.
3. Deo, S.G., Lakshmikantham, V. and Raghavendra, V., Textbook of Ordinary Differential Equations, Tata McGraw Hill, 2006.

M.Sc. Mathematics

12MM 425-B : Operations Research Techniques

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Operations Research: Origin, definition, methodology and scope. Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two phase methods, Degeneracy, Duality in linear programming.	20
Unit-2	Transportation Problems: Basic feasible solutions, optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems, transhipment problem. Assignment problems: Solution by Hungarian method, unbalanced problem, case of maximization, travelling salesman and crew assignment problems	20
Unit-3	Queuing models: Basic components of a queuing system, General birth-death equations, steady-state solution of Markovian queuing models with single and multiple servers (M/M/1. M/M/C, M/M/1/k, M/MC/k) Inventory control models: Economic order quantity(EOQ) model with uniform demand and with different rates of demands in different cycles, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.	25
Unit-4	Game Theory : Two person zero sum game, Game with saddle points, the rule of dominance; Algebraic, graphical and linear programming methods for solving mixed strategy games. Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines	25

Books recommended :

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

M.Sc. Mathematics(Final)

12MM 511 : Functional Analysis-I

Max. Marks : 80
Time : 3 Hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

UNIT	CONTENTS	No. Of Periods
Unit-1	Normed linear spaces, Metric on normed linear spaces, Completion of a normed space, Banach spaces, subspace of a Banach space, Holder‟s and Minkowski‟s inequality, Completeness of quotient spaces of normed linear spaces. Completeness of l_p, L_p, R_n, C_n and C[a,b]. Incomplete normed spaces.	22
Unit-2	Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces, Hahn-Banach extension theorem (Real and Complex form).	22
Unit-3	Riesz Representation theorem for bounded linear functionals on L_p and C[a,b]. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, Open mapping theorem and its application projections, Closed Graph theorem	18
Unit-4	Equivalent norms, Weak and Strong convergence, their equivalence in finite dimensional spaces. Weak sequential compactness, Solvability of linear equations in Banach spaces. Compact operator and its relation with continuous operator. Compactness of linear transformation on a finite dimensional space, properties of compact 5 operators, compactness of the limit of the sequence of compact operators, the closed range theorem.	28

Books Recommended 1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.

2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.

3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications.

M.Sc. Mathematics

12MM 512 : Partial Differential Equations and Mechanics

Max. Marks : 80
Time : 3 Hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

UNIT	CONTENTS	No. Of Periods
Unit-1	Method of separation of variables to solve B.V.P. associated with one dimensional heat equation. Solution of two dimensional heat equation and two dimensional Laplace equation. Steady state temperature in a rectangular plate, in the circular disc, in a semi-infinite plate. The head equation in semi-infinite and infinite regions. Temperature distribution in square plate and infinite cylinder. Solution of three dimensional Laplace equation in Cartesian, cylindrical and spherical coordinates. Dirichlets problem for a solid sphere. (Relevant topics from the books by O"Neil)	25
Unit-2	Method of separation of variables to solve B.V.P. associated with motion of a vibrating string. Solution of wave equation for Semi-infinite and infinite strings. Solution of wave equation in two dimensions. Solution of three dimensional wave equation in Cartesian, cylindrical and spherical coordinates. Laplace transform solution of B.V.P.. Fourier transform solution of B.V.P. (Relevant topics from the books by O"Neil)	25
Unit-3	Kinematics of a rigid body rotating about a fixed point, Euler"s theorem, general rigid body motion as a screw motion, moving coordinate system - rectilinear moving frame, rotating frame of reference, rotating earth. Two- dimensional rigid body dynamics – problems illustrating the laws of motion and impulsive motion. (Relevant topics from the book of Chorlton).	20
Unit-4	Moments and products of inertia, angular momentum of a rigid body, principal axes and principal moment of inertia of a rigid body, kinetic energy of a rigid body rotating about a fixed point, momental ellipsoid and equimomental systems, coplanar mass distributions, general motion of a rigid body. (Relevant topics from the book of Chorlton	20

Books Recommended

1. Sneddon, I.N. Elements of Partial Differential Equations, McGraw Hill, New York.
2. O "Neil, Peter V. Advanced Engineering Mathematics, ITO.
3. F. Chorlton Textbook of Dynamics, CBS Publishers
4. H.F. Weinberger, Afirst Course in Partial Differential Equations, John Wiley & Sons, 1965
5. M.D. Raj Singhania, Advanced Differentail equations, S. Chand & Co.

M.Sc. Mathematics(Final)

12MM 513 : Complex Analysis-I

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Function of a complex variable, continuity, differentiability. Analytic functions and their properties, Cauchy-Riemann equations in Cartesian and polar coordinates. Power series, Radius of convergence, Differentiability of sum function of a power series. Branches of many valued functions with special reference to arg z, log z and z^a.	25
Unit-2	Path in a region, Contour, Simply and multiply connected regions, Complex integration. Cauchy theorem. Cauchy‟s integral formula. Poisson‟s integral formula. Higher order derivatives. Complex integral as a function of its upper limit, Morera‟s theorem. Cauchy‟s inequality. Liouville‟s theorem. The fundamental theorem of algebra. Taylor‟s theorem	25
Unit-3	Zeros of an analytic function, Laurent‟s series. Isolated singularities. Cassorati- Weierstrass theorem, Limit point of zeros and poles. Maximum modulus principle, Minimum modulus principle. Schwarz lemma. Meromorphic functions. The argument principle. Rouche‟s theorem, Inverse function theorem.	20
Unit-4	Calculus of residues. Cauchy‟s residue theorem. Evaluation of integrals. Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings. Space of analytic functions and their completeness, Hurwitz‟s theorem. Montel‟s theorem. Riemann mapping theorem.	20

Books Recommended

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.

M.Sc. Mathematics

12MM 514 (Option A12) Advanced Discrete Mathematics –I

Max. Marks : 80
Time : 3 Hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

UNIT	CONTENTS	No. Of Periods
Unit-1	Graph Theory – Definitions and basic concepts, special graphs, Sub graphs, isomorphism of graphs, Walks, Paths and Circuits, Eulerian Paths and Circuits, Hamiltonian Circuits, matrix representation of graphs, Planar graphs, Colouring of Graph.	20
Unit-2	Directed Graphs, Trees, Isomorphism of Trees, Representation of Algebraic Expressions by Binary Trees, Spanning Tree of a Graph, Shortest Path Problem, Minimal spanning Trees, Cut Sets, Tree Searching..	20
Unit-3	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 and equivalence of its power to that of deterministic finite automata Moore and Mealy machines.	25
Unit-4	Grammars and Languages – 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 lemma, Kleene‟s theorem.	25

Books Recommended

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.
5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors Delhi, 2004.

M.Sc. Mathematics

12MM 515 (Option C_{12}) : Analytical Number Theory-I

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Distribution of primes. Fermat‟s and Mersenne numbers, Farey series and some results concerning Farey series. Approximation of irrational numbers by rations, Hurwitz‟s theorem. Irrationality of e and .(Relevant portions from the Books Recommended at Sr. No. 1 and 4)	22
Unit-2	Diophantine equations ax + by = c, $x_2+y_2 = z_2$ and $x_4+y_4 = z_4$. The representation of number by two or four squares. Warig‟s problem, Four square theorem, the numbers g(k) & G(k). Lower bounds for g(k) & G(k). Simultaneous linear and non-linear congruences Chinese Remainder Theorem and its extension. (Relevant portions from the Books Recommended at Sr. No. 1 and 4)	26
Unit-3	Quadratic residues and non-residues. Legender‟s Symbol. Gauss Lemma and its applications. Quadratic Law of Reciprocity Jacobi‟s Symbol. The arithmetic in Z_n. The group U_n . Congruences with prime power modulus, primitive roots and their existence. (Scope as in Book at Sr. No. 5)	22
Unit-4	The group U_{p^n} (p-odd) and U_{2^n}. The group of quadratic residues Q_n , quadratic residues for prime power moduli and arbitrary moduli. The algebraic structure of U_n and Q_n . (Scope as in Book at Sr. No. 5)	20

Books Recommended

1. Hardy, G.H. and Wright, E.M., An Introduction to the Theory of Numbers
2. Burton, D.M., Elementary Number Theory.
3. McCoy, N.H., The Theory of Number by McMillan.
4. Niven, I. And Zuckermann, H.S., An Introduction to the Theory of Numbers.
5. Gareth, A. Jones and J. Mary Jones, Elementary Number Theory, Springer

M.Sc. Mathematics

12MM 521 : Functional Analysis –II

Max. Marks : 80
Time : 3 Hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

UNIT	CONTENTS	No. Of Periods
Unit-1	Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon – Nikodyn theorem Lebesgue decomposition, Lebesgue - Stieltjes integral, Product measures, Fubini‟s theorem.	22
Unit-2	Baire sets, Baire measure, continuous functions with compact support, Regularity of measures on locally compact spaces, Riesz-Markoff theorem. **Hilbert Spaces**: Inner product spaces, Hilbert spaces, Schwarz‟s inequality, Hilbert space as normed linear space.	25
Unit-3	Convex sets in Hilbert spaces, Projection theorem. Orthonormal sets, Bessel‟s inequality, Parseval‟s identity, conjugate of a Hilbert space, Riesz representation theorem in Hilbert spaces	18
Unit-4	Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert space, Self-adjoint operators, Positive and projection operators, Normal and unitary operators, Projections on Hilbert space, Spectral theorem on finite dimensional space	25

Books Recommended

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.
3. S.K. Berberian, Measure and Integration, Chelsea Publishing Company, New York, 1965.
4. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

M.Sc. Mathematics

12MM 522 : Classical Mechanics

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

UNIT	CONTENTS	No. Of Periods
Unit-1	Free & constrained systems, constraints and their classification, holonomic and non-holonomic systems, degree of freedom and generalised coordinates, virtual displacement and virtual work, statement of principle of virtual work (PVW), possible velocity and possible acceleration, D‟ Alembert‟s principle, **Lagrangian Formulation :** Ideal constraints**,** general equation of dynamics for ideal constraints, Lagrange‟s equations of the first kind	25
Unit-2	Independent coordinates and generalized forces, Lagrange‟s equations of the second kind, generalized velocities and accelerations. Uniqueness of solution, variation of total energy for conservative fields. Lagrange‟s variable and Lagrangian function L(t, q_i,), Lagrange‟s equations for potential forces, generalized momenta p_i , Hamiltonian variable and Hamiltonian function H(t, q_i, p_i), Donkin‟s theorem, ignorable coordinates i q	25
Unit-3	Hamilton canonical equations, Routh variables and Routh function R, Routh‟s equations, Poisson Brackets and their simple properties, Poisson‟s identity, Jacobi – Poisson theorem. Hamilton action and Hamilton‟s principle, Poincare – Carton integral invariant, Whittaker‟s equations, Jacobi‟s equations, Lagrangian action and the principle of least action	18
Unit-4	Canonical transformation, necessary and sufficient condition for a canonical transformation, univalent Canonical transformation, free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, method of separation of 42 variables in HJ equation, Lagrange brackets, necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical transformation, conditions of canonicity of a transformation in terms of Poison brackets, invariance of Poisson Brackets under canonical transformation.	22

Books Recommended

1. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975
2. P.V. Panat, Classical Mechanics, Narosa Publishing House, N. Delhi 2005.
3. N.C. Rana and P.S. joag, Classical Mechanics, Tata McGraw- Hill, N. Delhi, 1991
4. K. Sankra Rao , Classical Mechanics, Prentice Hall of India, 2005

M.Sc. Mathematics

12MM 523 : Complex Analysis-II

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Integral Functions. Factorization of an integral function. Weierstrass‟ factorisation theorem. Factorization of sine function. Gamma function and its properties. Stirling formula. Integral version of gamma function. Riemann Zeta function. Riemann‟s functional equation. . Runge‟s theorem. Mittag-Leffler‟s theorem.	22
Unit-2	Analytic Continuation. Natural Boundary. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. Schwarz Reflection principle. Germ of an analytic function. Monodromy theorem and its consequences. Harmonic functions on a disk. Poisson kernel. The Dirichlet problem for a unit disc.	25
Unit-3	Harnack‟s inequality. Harnack‟s theorem. Dirichlet‟s region. Green‟s function. Canonical product. Jensen‟s formula. Poisson-Jensen formula. Hadamard‟s three circles theorem. Growth and order of an entire function. An estimate of number of zeros. Exponent of Convergence. Borel‟s theorem. Hadamard‟s factorization theorem.	25
Unit-4	The range of an analytic function. Bloch‟s theorem. Schottky‟s theorem. Little Picard theorem. Montel Caratheodory theorem. Great Picard theorem. Univalent functions. Bieberbach‟s conjecture(Statement only) and the "1/4 theorem" .	18

Books Recommended

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.

M.Sc. Mathematics
12MM 524 (Option A22) Advanced Discrete Mathematics II

Max. Marks : 80
Time : 3 Hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Formal Logic – Statements. Symbolic Representation and Tautologies. Quantifier, Predicates and Validty. Propositional Logic.	16
Unit-2	Semigroups & Monoids-Definitions and Examples of Semigroups and Monoids (including those pertaining to concatenation operation). Homomorphism of semigroups and monoids. Congruence relation and Quotient Semigroups. Subsemigroup and submonoids. Direct products. Basic Homomorphism Theorem. Pigeonhole principle, principle of inclusion and exclusion, derangements.	28
Unit-3	Lattices- Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. Sublattices, Direct products, and Homomorphisms. Some Special Lattices e.g., Complete. Complemented and Distributive Lattices. Join-irreducible elements. Atoms and Minterms	18
Unit-4	Boolean Algebras – Boolean Algebras as Lattices. Various Boolean Identities. The switching Algebra example. Subalgebras, Direct Products and Homomorphisms. Boolean Forms and Their Equivalence. Minterm Boolean Forms, Sum of Products Canonical Forms. Minimization of Boolean Functions. Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method	28

Books Recommended

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.

2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.

3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.

4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.

5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors

M.Sc. Mathematics

12MM 525 (Option C22) : Analytical Number Theory-II

Max. Marks : 80
Time : 3 hours

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

UNIT	CONTENTS	No. Of Periods
Unit-1	Riemann Zeta Function (s) and its convergence. Application to prime numbers. (s) as Euler‟s product. Evaluation of (2) and (2k). Dirichlet series with simple properties. Eulers products and Dirichlet products, Introduction to modular forms. (Scope as in Book at Sr. No.5).	20
Unit-2	**Algebraic Number and Integers** : Gaussian integers and its properties. Primes and fundamental theorem in the ring of Gaussian integers. Integers and fundamental theorem in Q() where 3 = 1. Algebraic fields. Primitive polynomials. The general quadratic field Q(m), Units of Q(2). Fields in which fundamental theorem is false. Real and complex Euclidean fields. Fermat'‟ theorem i the ring of Gaussian integers. Primes of Q(2) and Q(5) Series of Fibonacci and Lucas. Luca'‟ test for the primality of the mersenne primes. (Relevant sections of Recommended Book at Sr. No. 1).	28
Unit-3	Arithmetic functions (n), (n), (n) and k(n), u(n), N(n), I(n). Definition and examples and simple properties. Perfect numbers the Mobius inversion formula. The Mobius function n, The order and average order of the function (n), (n) and (n). (Scope as in books at Sr. No. 1 and 4).	24
Unit-4	The functions (n), (n) and (n) Bertrand Postulate, Merten‟s theorem, Selberg‟s theorem and Prime number Theorem. (Scope as in Books at Sr. No. 1 and 4).	18

Books Recommended

1. Hardy, G.H. and Wright, E.M., An Introduction to the Theory of Numbers
2. Burton, D.M., Elementary Number Theory.
3. McCoy, N.H., The Theory of Number by McMillan.
4. Niven, I. And Zuckermann, H.S., An Introduction to the Theory of Numbers.
5. Gareth, A. Jones and J. Mary Jones, Elementary Number Theory, Springer Ed. 1998.