Scheme of Examination-Semester System
for
M.Sc. Mathematics(Semester-I & II)
(Regular Course)

(*w.e.f. Session 2012-13*)

SEMESTER-I

Paper Code	Title of the Paper	Theory Marks	Internal Assessment Marks	Practicals Marks	Total Marks
12MM 411	Advanced Abstract Algebra-I	80	20	-	100
12MM 412	Real Analysis-I	80	20	-	100
12MM 413	Topology-I	80	20	-	100
12MM 414	Integral Equations and Calculus of Variations	80	20	-	100
12MM 415A	Programming in C (ANSI Features)	60	Nil	40	100
12MM 415B	Mathematical Statistics	80	20	-	100
	Total Marks				500

NOTE: Either of the paper 12MM 415-A or 12MM 415-B to be selected.

Note 1 : The Criteria for award of internal assessment of 20% marks shall be as under:

A) One class test : 10 marks.
B) Assignment & Presentation) : 5 marks
(better of two)
C) Attendance : 5 marks
Less than 65% : 0 marks
Upto 70% : 2 marks
Upto 75% : 3 marks
Upto 80% : 4 marks
Above 80% : 5 marks

Note 2 : The syllabus of each paper will be divided into **four** units of **two** questions each. The question paper of each paper will consist of **five** units. Each of the first four units will contain two questions and the students shall be asked to attempt **one** question from each unit. Unit five of each question paper shall contain **eight to ten** short answer type questions without any internal choice and it shall be covering the entire syllabus. As such unit five shall be **compulsory**.

Note 3 : As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper. For this purpose, tutorial classes shall be held for each theory paper in groups of 8 students for half-hour per week.

Note4: The minimum pass marks for passing the examination shall be as under:

i. 40% in each theory paper including internal assessment.
ii. 40% in each practical examination/viva-voice including internal assessment.

(w.e.f. 2012-13)

Syllabus- 1st SEMESTER

12MM 411: Advanced Abstract Algebra-I

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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 $n \geq 2$.

Unit - II (2 Questions)

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).

Unit - III (2 Questions)

Field theory, Extension of fields, algebraic and transcendental extensions. Splitting fields, Separable and inseparable extensions, Algebraically closed fields, Perfect fields.

Unit - IV (2 Questions)

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 $n \geq 5$ by radicals.

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**.

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.

(w.e.f.2012-13)

12MM 412: Real Analysis -I

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

Riemann-Stieltjes integral, its existence and properties, Integration and differentiation, The fundamental theorem of calculus, Integration of vector-valued functions, Rectifiable curves.

Unit - II (2 Questions)

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_σ and G_δ sets, Non measurable sets.

Unit - III (2 Questions)

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.

Unit - IV (2 Questions)

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.

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**.

Books Recommended :

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.

(w.e.f. 2012-13)

12MM 413 : Topology - I

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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.

Unit - II (2 Questions)

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.

Unit - III (2 Questions)

First countable, second countable and separable spaces, hereditary and topological property, Countability of a collection of disjoint open sets in separable and second countable spaces, Product space as first axiom space, Lindelof theorem. T_0, T_1, T_2 (Hausdorff) separation axioms, their characterization and basic properties.

Unit - IV (2 Questions)

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.

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**.

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.

(w.e.f. 2012-13)

12MM 414 : Integral Equations and Calculus of Variations

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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 λ, Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind.

Unit - II (2 Questions)

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.

Unit - III (2 Questions)

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.

Unit - IV (2 Questions)

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.

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**.

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.

(w.e.f. 2012-13)

12MM 415-A : Programming in C (ANSI Features)

Max. Marks : 60
Time : 3 hours

Unit - I (2 Questions)

An overview of Programming, Programming Language, Classification. Basic structure of a C Program, C language preliminaries.

Operators and Expressions, Two's compliment notation, Bit - Manipulation Operators, Bitwise Assignment Operators, Memory Operators.

Unit - II (2 Questions)

Arrays and Pointers, Encryption and Decryption. Pointer Arithmetic, Passing Pointers as Function Arguments, Accessing Array Elements through Pointers, Passing Arrays as Function Arguments. Multidimensional Arrays. Arrays of Pointers, Pointers to Pointers.

Unit - III (2 Questions)

Storage Classes –Fixed vs. Automatic Duration. Scope. Global Variables. Definitions and Allusions. The register Specifier. ANSI rules for the Syntax and Semantics of the Storage-Class Keywords. Dynamic Memory Allocation.

Structures and Unions. *enum* declarations. Passing Arguments to a Function, Declarations and Calls, Automatic Argument Conversions, Prototyping. Pointers to Functions.

Unit - IV (2 Questions)

The C Preprocessors, Macro Substitution. Include Facility. Conditional Compilation. Line Control.

Input and Output -Streams. Buffering. Error Handling. Opening and Closing a File. Reading and Writing Data. Selecting an I/O Method. Unbuffered I/O. Random Access. The Standard Library for I/O.

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**.

Books Recommended :

1. Peter A. Darnell and Philip E. Margolis, C : A Software Engineering Approach, Narosa Publishing House (Springer International Student Edition) 1993.
2. Samuel P. Harkison and Gly L. Steele Jr., C : A Reference Manual, Second Edition, Prentice Hall, 1984.
3. Brian W. Kernighan & Dennis M. Ritchie, The C Programme Language, Second Edition (ANSI features) , Prentice Hall 1989.
4. Balagurusamy E : Programming in ANSI C, Third Edition, Tata McGraw-Hill Publishing Co. Ltd.
5. Byron, S. Gottfried : Theory and Problems of Programming with C, Second Edition (Schaum's Outline Series), Tata McGraw-Hill Publishing Co. Ltd.
6. Venugopal K. R. and Prasad S. R.: Programming with C , Tata McGraw-Hill Publishing Co. Ltd.

(w.e.f. 2012-13)

PRACTICALS : Based on 12MM 415-A: Programming in C (ANSI Features)

Max. Marks : 40

Time 4 Hours

Notes :

a) The question paper shall consist of **four** questions and the candidate shall be required to attempt any **two** questions.

b) The candidate will first write programs in C of the questions in the answer-book and then run the same on the computer, and then add the print-outs in the answer-book. This work will consist of 20 marks, 10 marks for each question.

c) The practical file of each student will be checked and viva-voce examination based upon the practical file and the theory will be conducted by external and internal examiners jointly. This part of the practical examination shall be of 20 marks.

(w.e.f. 2012-13)

12MM 415-B : Mathematical Statistics

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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.

Unit - II (2 Questions)

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. Transformation of one, two and n-dimensional random variables.

Mathematical Expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties. Chebychev's inequality.

Unit - III (2 Questions)

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).

Unit - IV (2 Questions)

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; Definition of Chi-square statistic, Chi-square tests for goodness of fit and independence of attributes; Definition of Student's 't' and Snedcor's F-statistics, Testing for the mean and variance of univariate normal distributions, Testing of equality of two means and two variances of two univariate normal distributions

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**.

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.

(w.e.f. 2012-13)

SEMESTER-II

Paper Code	Title of the Paper	Theory Marks	Internal Assessment Marks	Practicals Marks	Total Marks
12MM 421	Advanced Abstract Algebra-II	80	20	-	100
12MM 422	Real Analysis-II	80	20	-	100
12MM 423	Topology-II	80	20	-	100
12MM 424	Ordinary Differential Equations	80	20	-	100
12MM 425A	Object Oriented Programming with C++	60	Nil	40	100
12MM 425B	Operations Research Techniques	80	20	-	100
Total Marks Semester-II					500
Total Marks Semester-I					500
Total Marks					1000

NOTE: Either of the paper 12MM 425-A (Pre-requisite Paper 12MM 415-A) or 12MM 425-B (Pre-requisite Paper 12MM 415-B) to be selected.

Note 1 : The Criteria for award of internal assessment of 20% marks shall be as under:

A) One class test : 10 marks.
B) Assignment & Presentation) : 5 marks
(better of two)
C) Attendance : 5 marks
Less than 65% : 0 marks
Upto 70% : 2 marks
Upto 75% : 3 marks
Upto 80% : 4 marks
Above 80% : 5 marks

Note 2 : The syllabus of each paper will be divided into **four** units of **two** questions each. The question paper of each paper will consist of **five** units. Each of the first four units will contain two questions and the students shall be asked to attempt **one** question from each unit. Unit five of each question paper shall contain **eight to ten** short answer type questions without any internal choice and it shall be covering the entire syllabus. As such unit five shall be **compulsory**.

Note 3 : As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper. For this purpose, tutorial classes shall be held for each theory paper in groups of 8 students for half-hour per week.

Note4: The minimum pass marks for passing the examination shall be as under:

i. 40% in each theory paper including internal assessment.
ii. 40% in each practical examination/viva-voice including internal assessment.

(w.e.f. 2012-13)

Syllabus– 2nd SEMESTER

12MM 421: Advanced Abstract Algebra-II

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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.

Unit - II (2 Questions)

Neotherian and Artinian modules and rings with simple properties and examples, Nil and Nilpotent ideals in Neotherian and Artinian rings, Hilbert Basis theorem.

Unit - III (2 Questions)

$Hom_R(R,R)$, 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.

Unit - IV (2 Questions)

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.

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.

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.
9. T.Y Lam, Lectures on Modules and Rings, GTM Vol. 189, Springer-Verlag, 1999.

(w.e.f. 2012-13)

12MM 422: Real Analysis -II

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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.

Unit - II (2 Questions)

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.

Unit - III (2 Questions)

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.

Unit - IV (2 Questions)

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.

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**.

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.

(w.e.f. 2012-13)

12MM 423: Topology -II

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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, $T_{3\frac{1}{2}}$ and T_5 spaces, their characterization and basic properties.

Unit - II (2 Questions)

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.

Unit - III (2 Questions)

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.

Unit - IV (2 Questions)

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.

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**.

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.

(w.e.f. 2012-13)

12MM 424 : Ordinary Differential Equations

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

Preliminaries : Initial value problem and equivalent integral equation. ε-approximate solution, Cauchy-Euler construction of an ε-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 $\frac{dy}{dt}$ = f(t,y), Dependence of solutions on initial conditions and parameters, Solution of initial-value problems by Picard method.

Unit - II (2 Questions)

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.

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.

Unit - III (2 Questions)

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,

Unit - IV (2 Questions)

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.

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**.

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.
4. Boyce, W.E. and Diprima, R.C., Elementary Differential Equations and Boundary Value Problems, John Wiley and Sons, Inc., New York, 1986, 4th edition.
5. Goldberg, J. and Potter, M.C., Differential Equations – A System Approach, Prentice Hall, 1998
6. Simmons, G.F., Differential Equations, Tata McGraw Hill, New Delhi, 1993.
7. Hartman, P., Ordinary Differential Equations, John Wiley & Sons, 1978.
8. Somsundram, D., Ordinary Differential Equations, A First Course, Narosa Pub. Co., 2001.

(w.e.f. 2012-13)

12MM425-A: Object Oriented Programming with C++

Max. Marks : 60
Time :3 hours

Unit - I (2 Questions)

Basic concepts of Object-Oriented Programming (OOP). Advantages and applications of OOP. Object-oriented languages. Introduction to C++. Structure of a C++ program. Creating the source files. Compiling and linking.

C++ programming basics: Input/Output, Data types, Operators, Expressions, Control structures, Library functions.

Unit - II (2 Questions)

Functions in C++ : Passing arguments to and returning values from functions, Inline functions, Default arguments, Function overloading.

Classes and objects : Specifying and using class and object, Arrays within a class, Arrays of objects, Object as a function arguments, Friendly functions, Pointers to members.

Unit - III (2 Questions)

Constructors and destructors. Operator overloading and type conversions.

Inheritance : Derived class and their constructs, Overriding member functions, Class hierarchies, Public and private inheritance levels.

Polymorphism, Pointers to objects, this pointer, Pointers to derived classes, virtual functions.

Unit - IV (2 Questions)

Streams, stream classes, Unformatted I/O operations, Formatted console I/O operations, Managing output with manipulators.

Classes for file stream operations, Opening and Closing a file. File pointers and their manipulations, Random access. Error handling during file operations, Command-line arguments. Exceptional handling.

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**.

Books Recommended :

1. I.S. Robert Lafore, Object Oriented Programming using C++, Waite's Group Galgotia Pub.
2. E. Balagrusamy, Object Oriented Programming with C++, 2nd Edition, Tata Mc Graw Hill Pub. Co.
3. Byron, S. Gottfried, Object Oriented Programming using C++, Schaum's Outline Series, Tata Mc Graw Hill Pub. Co.
4. J.N. Barakaki, Object Oriented Programming using C++, Prentice Hall of India, 1996.
5. Deitel and Deitel, C++: How to program, Prentice Hall of India

(w.e.f. 2012-13)

PRACTICALS: Based on 12MM 425-A: Object Oriented Programming with C++

Max. Marks : 40

Time 4 Hours

Notes:

a) The question paper shall consist of **four** questions and the candidate shall be required to attempt any **two** questions.

b) The candidate will first write programs in C++ of the questions in the answer-book and then run the same on the computer, and then add the print-outs in the answer-book. This work will consist of 20 marks, 10 marks for each question.

c) The practical file of each student will be checked and viva-voce examination based upon the practical file and the theory will be conducted by external and internal examiners jointly. This part of the practical examination shall be of 20 marks.

(w.e.f. 2012-13)

12MM 425-B : Operations Research Techniques

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

Operations Research: Origin, definition and its scope.
Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two phase methods, Degeneracy, Duality in linear programming.

Unit - II (2 Questions)

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.

Unit - III (2 Questions)

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.

Unit - IV (2 Questions)

Game Theory : Two person zero sum game, Game with saddle points, the rule of dominance; Algebric, 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.
Non-linear Programming: Convex and concave functions, Kuhn-Tucker conditions for constrained optimization, solution of quadratic programming problems.

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**.

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.

Scheme of Examination-Semester System
For
M.Sc. Mathematics(Semester-III & IV)
(Regular Course)

(*w.e.f. Session 2012-13*)

SEMESTER-III

Paper Code	Title of the Paper	Theory Marks	Internal-Assessment Marks	Practicals Marks	Total Marks
12MM 511	Functional Analysis-I	80	20	-	100
12MM 512	Partial Differential Equations and Mechanics	80	20	-	100
12MM 513	Complex Analysis-I	80	20	-	100
12MM 514	One paper out of either Group A_1 or Group B_1	80	20	-	100
12MM 515	One paper out of either Group C_1 or Group D_1	80	20	-	100
Total Marks Semester-III					500
Total Marks Semester-II					500
Total Marks Semester-I					500
GRAND TOTAL					1500

Group A_1

A_{11} Advanced Discrete Mathematics-I

A_{12} Algebraic Coding Theory-I

A_{13} Wavelets-I

A_{14} Sobolev Spaces-I

<u>Group B_1</u>

B_{11} Mechanics of Solids-I

B_{12} Continuum Mechanics-I

B_{13} Computational Fluid Dynamics-I

B_{14} Difference Equations-I

B_{15} Information Theory-I

<u>Group C_1</u> (Pre-requisite : Group A_1)

C_{11} Theory of Linear Operators-I

C_{12} Analytical Number Theory-I

C_{13} Fuzzy Sets and Applications-I

C_{14} Bases in Banach Spaces-I

C_{15} Algebraic Topology-I

<u>Group D_1</u> (Pre-requisite : Group B_1)

D_{11} Fluid Dynamics-I

D_{12} Bio-Mechanics-I

D_{13} Integral Equations and Boundary Value Problems-I

D_{14} Mathematics for Finance and Insurance-I

D_{15} Space Dynamics-I

Note 1 : The Criteria for award of internal assessment of 20% marks shall be as under:

A) One class test	:	10 marks.
B) Assignment & Presentation) (better of two)	:	5 marks
C) Attendance	:	5 marks
Less than 65%	:	0 marks
Upto 70%	:	2 marks
Upto 75%	:	3 marks
Upto 80%	:	4 marks
Above 80%	:	5 marks

Note 2: The syllabus of each paper will be divided into **four** units of **two** questions each. The question paper will consist of **five** units. Each of the first four units will contain two questions and the students shall be asked to attempt **one** question from each unit. Unit five of each question paper shall contain **eight to ten** short answer type questions without any internal choice and it shall be covering the entire syllabus. As such unit five shall be **compulsory**.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper. For this purpose, tutorial classes shall be held for each theory paper in groups of 8 students for half-hour per week.

Note 4: Optional papers can be offered subject to availability of requisite resources/ faculty.

Note 5: The minimum pass marks for passing the examination shall be as under:

40% in each theory paper including internal assessment.

(w.e.f. 2012-13)

Syllabus– 3rd SEMESTER

12MM 511 : Functional Analysis-I

Max. Marks : 80 **Time : 3 Hours**

Unit -I (2 Questions)

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.

Unit -II (2 Questions)

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).

Unit -III (2 Questions)

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.

Unit -IV (2 Questions)

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 operators, compactness of the limit of the sequence of compact operators, the closed range theorem.

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**.

Books Recommended

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4^{th} 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.

(w.e.f. 2012-13)

12MM 512 : Partial Differential Equations and Mechanics

Max. Marks : 80 **Time : 3 Hours**

Unit – I(2 Questions)

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 heat 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)

Unit -II(2 Questions)

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)

Unit-III(2 Questions)

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).

Unit -IV(2 Questions)

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).

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**.

Books Recommended

1.	Sneddon, I.N.	Elements of Partial Differential Equations, McGraw Hill, New York.
2.	O'Neil, Peter V.	Advanced Engineering Mathematics, ITP.
3.	F. Chorlton	Textbook of Dynamics, CBS Publishers, New Delhi.
4.	H.F. Weinberger	A First Course in Partial Differential Equations, John Wiley & Sons, 1965.
5.	M.D. Raisinghania	Advanced Differential equations, S. Chand & Co.

(w.e.f. 2012-13)

12MM 513 : Complex Analysis-I

Max. Marks : 80 **Time : 3 hours**

Unit -I(2 Questions)

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.

Unit -II(2 Questions)

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.

Unit -III(2 Questions)

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.

Unit - IV(2 Questions)

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.

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**.

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.
6. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.
7. S. Lang, Complex Analysis, Addison Wesley, 1977.
8. Mark J. Ablowitz and A.S. Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.

8. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

9. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company.

(w.e.f. 2012-13)

12MM 514 (Option A_{11}) Advanced Discrete Mathematics –I

Max. Marks : 80 **Time :3 Hours**

Unit - I(2 Questions)

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.

Unit -II (2 Questions)

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..

Unit -III (2 Questions)

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.

Unit -IV (2 Questions)

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.

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**.

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.

(w.e.f. 2012-13)

12MM 514 (Option A_{12}) : Algebraic Coding Theory-I

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

The communication channel. The Coding Problem. Types of Codes. Block Codes. Error-Detecting and Error-Correcting Codes. Linear Codes. Hamming Metric. Description of Linear Block Codes by Matrices. Dual Codes.

Unit -II (2 Questions)

Hamming Codes, Golay Codes, perfect and quasi-perfect codes. Modular Representation. Error-Correction Capabilities of Linear Codes. Tree Codes. . Description of Linear Tree

Unit -III (2 Questions)

Bounds on Minimum Distance for Block Codes. Plotkin Bound. Hamming Sphere Packing Bound. Varshamov-Gilbert – Sacks Bound. Bounds for Burst-Error Detecting and Correcting Codes.

Unit -IV (2 Questions)

Convolutional Codes and Convolutional Codes by Matrices. Standard Array. Bounds on minimum distance for Convolutional Codes. V.G.S. bound. Bounds for Burst-Error Detecting and Correcting Convolutional Codes. The Lee metric, packing bound for Hamming code w.r.t. Lee metric.

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**.

Books Recommended

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.

2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.

3. W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.

4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.

5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company.

6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.

7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.

(w.e.f. 2012-13)

12MM 514 (Option A_{13}) : Wavelets –I

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Definition and Examples of Linear Spaces, Bases and Frames, Normed Spaces, The L^p - Spaces, Definition and Examples of Inner Product Spaces, Hilbert Spaces, Orthogonal and Orthonormal Systems.

Unit - II (2 Questions)

Trigonometric Systems, Trigonometric Fourier Series, Convergence of Fourier Series, Generalized Fourier Series.

Fourier Transforms in L^1(R) and L^2(R), Basic Properties of Fourier Transforms, Convolution, Plancherel Formula, Poission Summation Formula, Sampling Theorem and Gibbs Phenomenon.

Unit - III (2 Questions)

Definition and Examples of Gabor Transforms, Basic Properties of Gabor Transforms.

Definition and Examples of Zak Transforms, Basic Properties of Zak Transforms, Balian- Low Theorem.

Unit- IV (2 Questions)

Wavelet Transform, Continuous Wavelet Transforms, Basic Properties of Wavelet Transforms, Discrete Wavelet Transforms, Partial Discrete Wavelet Transforms, Maximal Overlap Discrete Wavelet Transforms.

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**.

Books Recommended

1. K. Ahmad and F. A. Shah, Introduction to Wavelet Analysis with Applications, Anamaya Publishers, 2008.
2. Eugenio Hernandez and Guido Weiss, A first Course on Wavelets, CRC Press, New York, 1996.
3. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
4. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, 1992.
5. Y. Meyer, Wavelets, Algorithms and Applications (translated by R.D. Rayan, SIAM, 1993).

(w.e.f. 2012-13)

12MM 514 (Option A_{14}) : Sobolev Spaces -I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Distributions – Test function spaces and distributions, convergence distributional derivatives.

Unit-II (2 Questions)

Fourier Transform – L^1-Fourier transform. Fourier transform of a Gaussian, L^2-Fourier transform, Inversion formula. L^p-Fourier transform, Convolutions.

Unit-III (2 Questions)

Sobolev Spaces - The spaces $W^{l,p}{}_{\infty}(\Omega)$ and $W^{l,p}(\Omega)$. Their simple characteristic properties, density results. Min and Max of $W^{l,p}$ – functions. The space $H^1(\Omega)$ and its properties, density results.

Unit-IV (2 Questions)

Imbedding Theorems - Continuous and compact imbeddings of Sobolev spaces into Lebesgue spaces. Sobolev Imbedding Theorem, Rellich – Kondrasov Theorem.

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**.

Books Recommended

1. R.A. Adams, Sobolev Spaces, Academic Press, Inc. 1975.
2. S. Kesavan, Topics in Functional Analysis and Applications, Wiley Eastern Limited, 1989.
3. A. Kufner, O. John and S. Fucik, Function Spaces, Noordhoff International Publishing, Leyden, 1977.
4. A. Kufner, Weighted Sobolev Spaces, John Wiley & Sons Ltd., 1985.
5. E.H. Lieb and M. Loss, Analysis, Narosa Publishing House, 1997.
6. R.S. Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House, 2001.

(w.e.f. 2012-13)

12MM 514 (Option B_{11}) : Mechanics of Solids-I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Cartesian tensors of different order. Properties of tensors. Symmetric and skew-symmetric tensors. Isotropic tensors of different orders and relation between them. Tensor invariants. Eigen-values and eigen vectors of a second order tensor. Scalar, vector, tensor functions. Comma notation. Gradiant, divergence and curl of a tensor field.

Unit-II(2 Questions)

Analysis of Stress : Stress vector, stress components. Cauchy equations of equilibrium. Stress tensor. Symmetry of stress tensor. Stress quadric of Cauchy. Principal stress and invariants. Maximum normal and shear stresses. Mohr's diagram. Examples of stress.

Unit-III (2 Questions)

Analysis of Strain : Affine transformations. Infinitesimal affine deformation. Geometrical interpretation of the components of strain. Strain quadric of Cauchy. Principal strains and invariants. General infinitesimal deformation. Saint-Venant's equations of Compatibility. Finite deformations. Examples of uniform dilatation, simple extension and shearing strain.

Unit-IV (2 Questions)

Equations of Elasticity : Generalized Hooke's law. Hooke's law in media with one plane of symmetry, orthotroic and transversely isotropic media, Homogeneous isotropic media. Elastic moduli for isotropic media. Equilibrium and dynamic equations for an isotropic elastic solid. Beltrami-Michell compatibility equations. Strain energy function. Clapeyron's theorem. Saint-Venant's Principle.

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** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

1. I.S. Sokolnikoff, *Mathematical Theory of Elasticity*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Teodar M. Atanackovic and Ardeshiv Guran, *Theory of Elasticity for Scientists and Engineers* Birkhausev, Boston, 2000.
3. Y.C. Fung, *Foundations of Solid Mechanics*, Prentice Hall, New, Delhi, 1965.
4. Jeffreys, H., *Cartesian tensors*.
5. Shanti Narayan, *Text Book of Tensors*, S. chand & co.
6. Saada, A.S., *Elasticity- Theory and applications*, Pergamon Press, New York.
7. A.E.H. Love, *A Treatise on a Mathematical Theory of Elasticity*, Dover Pub., New York.
8. D.S. Chandersekhariah and L. Debnath, *Continum Mechanics*, Academic Press, 1994.

(w.e.f. 2012-13)

12MM 514 (Option B_{12}) : Continuum Mechanics - I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Cartesian tensors and their elementary properties.

Analysis of Stress : Stress vector, stress components, Cauchy equations of equilibrium, stress tensor, symmetry of stress tensor, principal stress and invariants, maximum normal and shear stresses.

Unit-II (2 Questions)

Analysis of Strain : Affine transformation, infinitesimal affine deformation, geometric interpretation of the components of strain, principal strains and invariants, general infinitesimal deformation, equations of compatibility, finite deformations.

Unit-III(2 Questions)

Equations of Elasticity : Generalized Hooke's law, Hooke's law in media with one plane of symmetry, orthotropic and transversely isotropic media, Homogeneous isotropic media, elastic moduli for isotropic media, equilibrium and dynamical equations for an isotropic elastic solid, Beltrami – Michell compatibility equations.

Unit-IV (2 Questions)

Two-Dimensional Elasticity : Plane strain, plane stress, generalized plane stress, Airy stress function, problem of half-plane loaded by uniformly distributed load, problem of thick wall tube under the action of internal and external pressures, Rotating shaft.

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**.

Books Recommended

1. S. Valliappan, Continuum Mechanics, Fundamentals, Oxford & IBH Publishing Company, 1981.
2. G.T. Mase and G.E. Mase, Continuum Mechanics for Engineers, CRC Press, 1999.
3. Atanackovic, T.M. A. Guran, Theory of Elasticity for scientists and Engineers, Birkhausev, 2000.
4. D.S. Chandrasekharaiah, Continuum Mechanics, Academic Press, Prism Books Pvt. Ltd., Bangalore.
5. L.S. Srinath, Advanced Mechanics of Fields, Tata McGraw-Hill, New Delhi.

(w.e.f. 2012-13)

12MM 514 (Option B_{13}) : Computational Fluid Dynamics- I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Basic equations of Fluid dynamics. Analytic aspects of partial differential equations- classification, boundary conditions, maximum principles, boundary layer theory.

Unit-II (2 Questions)

Finite difference and Finite volume discretizations. Vertex-centred discretization. Cell-centred discretization. Upwind discretization. Nonuniform grids in one dimension.

Unit-III (2 Questions)

Finite volume discretization of the stationary convection-diffusion equation in one dimension. Schemes of positive types. Defect correction. Non-stationary convection-diffusion equation. Stability definitions. The discrete maximum principle.

Unit-IV (2 Questions)

Incompressible Navier-Stokes equations. Boundary conditions. Spatial discretization on collocated and on staggered grids. Temporal discretization on staggered grid and on collocated grid.

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**.

Books Recommended

1. P. Wesseling : Principles of Computational Fluid Dynamics, Springer Verlag, 2000**.**

2. J.F. Wendt, J.D. Anderson, G. Degrez and E. Dick : Computational Fluid Dynamics : An Introduction, Springer-Verlag, 1996.

3. J.D. Anderson, Computational Fluid Dynamics : The basics with applications, McGraw-Hill, 1995.

4. K. Muralidher and T. Sundarajan : Computational Fluid Flow and Heat Transfer, Narosa Pub. House.

5. T.J. Chung : Computational Fluid Dynamics, Cambridge Uni. Press.

6. J.N. Reddy : An introduction to the Finite Element Methods,McGraw Hill International Edition, 1985.

(w.e.f. 2012-13)

12MM 514 (Option B_{14}) : Difference Equations- I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Introduction, Difference Calculus – The difference operator, Summation, Generating functions and approximate summation.

Linear Difference Equations - First order equations. General results for linear equations.

Unit-II (2 Questions)

Equations with constant coefficients. Applications. Equations with variable coefficients.

Stability Theory - Initial value problems for linear systems. Stability of linear systems.

Unit-III (2 Questions)

Stability of nonlinear systems. Chaotic behaviour.

Asymptotic methods - Introduction, Asymptotic analysis of sums. Linear equations. Nonlinear equations.

Unit-IV (2 Questions)

Self-adjoint second order linear equations –Introduction. Sturmian Theory. Green's functions. Disconjugacy. The Riccati Equations. Oscillation.

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**.

Books Recommended

1. Walter G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications, Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

2. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccatti Equations. Kluwer, Boston, 1996.

(w.e.f. 2012-13)

12MM 514 (Option B_{15}) : Information Theory- I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Measure of Information – Axioms for a measure of uncertainty. The Shannon entropy and its properties. Joint and conditional entropies. Transformation and its properties. Axiomatic characterization of the Shannon entropy due to Shannon and Fadeev.

Unit-II (2 Questions)

Noiseless coding - Ingredients of noiseless coding problem. Uniquely decipherable codes. Necessary and sufficient condition for the existence of instantaneous codes. Construction of optimal codes.

Unit-III (2 Questions)

Discrete Memoryless Channel - Classification of channels. Information processed by a channel. Calculation of channel capacity. Decoding schemes. The ideal observer. The fundamental theorem of Information Theory and its strong and weak converses.

Unit-IV (2 Questions)

Continuous Channels - The time-discrete Gaussian channel. Uncertainty of an absolutely continuous random variable. The converse to the coding theorem for time-discrete Gaussian channel. The time-continuous Gaussian channel. Band-limited channels.

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**.

Books Recommended

1. R. Ash, Information Theory, Interscience Publishers, New York, 1965.
2. F.M. Reza, An Introduction to Information Theory, MacGraw-Hill Book Company Inc., 1961.
3. J. Aczela dn Z. Daroczy, On Measures of Information and their Characterizations, Academic Press, New York.

(w.e.f. 2012-13)

12MM 515 (Option C_{11}) : Theory of Linear Operators -I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Spectral theory in normed linear spaces, resolvent set and spectrum, spectral properties of bounded linear operators, Properties of resolvent and spectrum, Spectral mapping theorem for polynomials, Spectral radius of a bounded linear operator on a complex Banach space.

Unit-II (2 Questions)

Elementary theory of Banach algebras. Properties of Banach algebras. General properties of compact linear operators. Spectral properties of compact linear operators on normed spaces.

Unit-III (2 Questions)

Behaviour of compact linear operators with respect to solvability of operator equations. Fredholm type theorems. Fredholm alternative theorem. Fredholm alternative for integral equations. Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space.

Unit-IV (2 Questions)

Positive operators, Monotone sequence theorem for bounded self-adjoint operators on a complex Hilbert space. Square roots of a positive operator. Projection operators, Spectral family of a bounded self-adjoint linear operator and its properties.

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**.

Books Recommended

1. E. Kreyszig, Introductory Functional Analysis with Applications, John-Wiley & Sons, New York, 1978.
2. P.R. Halmos, Introduction to Hilbert Space and the Theory of Spectral Multiplicity, Second-Edition, Chelsea Publishing Co., New York, 1957.
3. N. Dunford and J.T. Schwartz, Linear Operators -3 Parts, Interscience/Wiley, New York, 1958-71.
4. G. Bachman and L. Narici, Functional Analysis, Academic Press, York, 1966.

(w.e.f. 2012-13)

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

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

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 π.(Relevant portions from the Books Recommended at Sr. No. 1 and 4)

Unit-II (2 Questions)

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)

Unit-III (2 Questions)

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)

Unit-IV (2 Questions)

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)

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**.

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.

(w.e.f. 2012-13)

12MM 515 (Option C_{13}) : Fuzzy Sets and their Applications -I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T- norms and T- conorms. (Chapter 1of [1])

Unit-II (2 Questions)

Product Set, Definition of Relation, Characteristics of Relation, Representation Methods of Relations, Operations on Relations, Path and Connectivity in Graph, Fundamental Properties, Equivalence Relation, Compatibility Relation, Pre-order Relation, Order Relation, Definition and Examples of Fuzzy Relation, Fuzzy Matrix, Operations on Fuzzy Relation, Composition of Fuzzy Relation, ~ - cut of Fuzzy Relation, Projection and Cylindrical Extension, Extension by Relation, Extension Principle, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets. (Chapter 2,3 of [1])

Unit-III (2 Questions)

Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, ~ - cut of Fuzzy Graph, Fuzzy Network, Reflexive Relation, Symmetric Relation, Transitive Relation, Transitive Closure, Fuzzy Equivalence Relation, Fuzzy Compatibility Relation, Fuzzy Pre-order Relation, Fuzzy Order Relation, Fuzzy Ordinal Relation, Dissimilitude Relation, Fuzzy Morphism, Examples of Fuzzy Morphism. (Chapter 4 of [1])

Unit-IV (2 Questions)

Interval, Fuzzy Number, Operation of Interval, Operation of ~ - cut Interval, Examples of Fuzzy Number Operation,, Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers, Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number.

Function with Fuzzy Constraint, Propagation of Fuzziness by Crisp Function, Fuzzifying Function of Crisp Variable, Maximizing and Minimizing Set, Maximum Value of Crisp Function, Integration and Differentiation of Fuzzy Function. (Chapter 5,6 of [1])

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**.

Books Recommended

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
3. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

(w.e.f. 2012-13)

12MM 515 (Option C_{14}) : Bases in Banach Spaces –I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2Questions)

Hamel bases. The coefficient functionals associated to a basis. Schauder bases. Bounded bases and normalized bases. Examples of bases in concrete Banach spaces.

Unit-II (2Questions)

Biorthogonal systems. Associated sequences of partial sum operators -E-complete, regular and irregular biorthogonal systems. Characterizations of regular biorthogonal systems. Basic sequences. Banach space (separable or not) and basic sequence.

Unit-III (2Questions)

Some types of linear independence of sequences - Linearly independent (finitely) W-linearly independent and minimal sequences of elements in Banach spaces. Their relationship together with examples and counter-examples.

Problem of uniqueness of basis - Equivalent bases, Stability theorems of Paley-Winer type. Block basic sequences with respect to a sequence (basis) and their existence. Bessaga-Pelczynski theorem.

Unit-IV (2 Questions)

Properties of strong duality. Weak bases and weak Schauder bases in a Banach space. Weak basis theorem. Weak* bases in conjugate spaces and their properties.

Shrinking bases and boundedly complete bases together with their relationship.

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**.

Books recommended

1. Jurg t. Marti, Introduction to Theory of Bases, Springer Tracts in Natural Philosophy 18, 1969.
2. Ivan Singer, Bases in Banach Spaces I, Springer-Verlag, Berlin, Vol. 154 1970.
3. Ivan Singer, Bases in Banach Spaces II, Springer-Verlag, Berlin, 1981.
4. J. Linderstrauss and I. Tzafriri, Classical banach Spaces (Sequence spaces), Springer Verlag, Berlin, 1977.
5. Ivan Singer, Best Approximation in Normed Linear Spaces by Elements of Linear Spaces, Springer-Verlag, Berlin, 1970.

(w.e.f. 2012-13)

12MM 514 (Option C_{15}) : Algebraic Topology -I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Fundamental group function, homotopy of maps between topological spaces, homotopy equivalence, contractible and simple connected spaces, fundamental groups of S^1, and $S^1 \times S^1$ etc.

Unit-II (2 Questions)

Calculation of fundamental group of S^n, n > 1 using Van Kampen's theorem, fundamental groups of a topological group. Brouwer's fixed point theorem, fundamental theorem of algebra, vector fields on planer sets. Frobenius theorem for 3 x 3 matrices.

Unit-III (2 Questions)

Covering spaces, unique path lifting theorem, covering homotopy theorems, group of covering transformations, criterian of lifting of maps in terms of fundamental groups, universal covering, its existence, special cases of manifolds and topological groups.

Unit-IV (2 Questions)

Singular homology, reduced homology, Eilenberg Steenrod axioms of homology (no proof for homotopy invariance axiom, excision axiom and exact sequence axiom) and their application, relation between fundamental group and first homology.

Calculation of homology of S^n, Brouwer's fixed point theorem for $f : E^n \to E^n$, application spheres, vector fields, Mayer-Vietoris sequence (without proof) and its applications.

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**.

Books Recommended

1. James R. Munkres, Topology – A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 1978.
2. Marwin J. Greenberg and J.R. Harper, Algebraic Topology – A First Course, Addison-Wesley Publishing Co., 1981.
3. W.S. Massey, Algebraic Topology – An Introduction, Harcourt, Brace and World Inc. 1967, SV, 1977.

(w.e.f. 2012-13)

12MM 515 (Option D_{11}) : Fluid Dynamics-I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Kinematics - Velocity at a point of a fluid. Eulerian and Lagrangian methods. Stream lines, path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vorticity and circulation. Equation of continuity. Boundary surfaces. Acceleration at a point of a fluid. Components of acceleration in cylindrical and spherical polar co-ordiantes.

Unit-II (2 Questions)

Pressure at a point of a moving fluid. Euler's and Lagrange's equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates.
Bernoulli's equation. Impulsive motion. Kelvin's circulation theorem. Vorticity equation. Energy equation for incompressible flow.

Unit-III (2 Questions)

Acyclic and cyclic irrotational motions. Kinetic energy of irrotational flow. Kelvin's minimum energy theorem. Mean potential over a spherical surface. K.E. of infinite fluid. Uniqueness theorems. Axially symmetric flows. Liquid streaming part a fixed sphere. Motion of a sphere through a liquid at rest at infinity. Equation of motion of a sphere. K.E. generated by impulsive motion. Motion of two concentric spheres.

Unit-IV (2 Questions)

Three-dimensional sources, sinks and doublets. Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface. Two dimensional motion, Kinetic energy of acyclic and cyclic irrotational motion. Use of cylindrical polar co-ordinates. Stream function. Axisymmetric flow. Stoke's stream function. Stoke's stream function of basic flows.

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**.

Books Recommended

1. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
3. O'Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.
4. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
5. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
6. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

(w.e.f. 2012-13)

12MM 515 (Option D_{12}) : Biomechanics- I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Newton's equations of motion. Mathematical modeling. Continuum approach. Segmental movement and vibrations. Lagrange's equations. Normal modes of vibration. Decoupling of equations of motion.

Unit-II (2 Questions)

Flow around an airfoil. Flow around bluff bodies. Steady state aeroelastic problems. Transient fluid dynamics forces due to unsteady motion. Flutter. Kutta-Joukowski theorem. Circulation and vorticity in the wake. Vortex system associated with a finite wing in nonsteady motion. Thin wing in steady flow.

Unit-III (2 Questions)

Blood flow in heart, lungs, arteries, and veins. Field equations and boundary conditions. Pulsatile flow in Arteries. Progressive waves superposed on a steady flow. Reflection and transmission of waves at junctions. Velocity profile of a steady flow in a tube. Steady laminar flow in an elastic tube. Velocity profile of Pulsatile flow. The Reynolds number, Stokes number, and Womersley number. Systematic blood pressure. Flow in collapsible tubes.

Unit-IV (2 Questions)

Micro-and macrocirculation Rheological properties of blood. Pulmonary capillary blood flow. Respiratory gas flow. Intraction between convection and diffusion. Dynamics of the ventilation system.

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**.

Books Recommended

1. Y.C. Fung, Biomechanics: Motion, Flow, Stress and Growth, Springer-Verlag, New York Inc., 1990.

(w.e.f. 2012-13)

12MM 515 (Option D_{13}): Integral Equations and Boundary Value Problems-I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Definition of integral equations and their classification. Eigenvalues and eigenfunctions. Convolution integral. Fredholm integral equations of the second kind with separable kernels and their reduction to a system of algebraic equations. Fredholm alternative. Fredholm theorem, Fredholm alternative theorem. An approximate method.

Unit-II (2 Questions)

Method of successive approximations. Iterative scheme for Fredholm integral equations of the second kind. Neumann series, iterated kernels, resolvent kernel, Iterative scheme for Volterra integral equations of the second kind. Conditions of uniform convergence and uniqueness of series solution.

Unit-III (2 Questions)

Classical Fredholm theory. Fredholm's first, second and third theorems.

Applications integral equations to ordinary differential equations. Initial value problems transformed to volterra integral equations. Boundary value problems equivalent to Fredholm integral equations. Dirac delta function.

Unit-IV (2 Questions)

Construction of Green's function for a BVP associated with a nonhomogeneous ordinary differential equation of second order with homogeneous boundary conditions by using the method of variation of parameters, Basic four properties of the Green's function. Alternative procedure for construction of a Green's function by using its basic four properties. Green's function approach for IVP for second order equations. Green's function for higher order differential equations. Modified Green's function.

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**.

Books Recommended

1. Kanwal, R.P., Linear Integral Equations – Theory and Technique, Academic Press, 1971.
2. Kress, R., Linear Integral Equations, Springer-Verlag, New York, 1989.
3. Jain, D.L. and Kanwal, R.P., Mixed Boundary Value Problems in Mathematical Physics.
4. Smirnov, V.I., Integral Equations and Partial Differential Equations, Addison-Wesley, 1964.
5. Jerri, A.J., Introduction to Integral Equations with Applications, Second Edition, John-Wiley & Sons, 1999.
6. Kanwal, R.P., Linear Integration Equations, (2^{nd} Ed.) Birkhauser, Boston, 1997.

(w.e.f. 2012-13)

12MM 515 (Option D_{14}) : Mathematics for Finance and Insurance-I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Financial Management – AN overview. Nature and Scope of Financial Management. Goals of Financial Management and main decisions of financial management. Difference between risk, speculation and gambling.

Time value of Money - Interest rate and discount rate. Present value and future value- discrete case as well as continuous compounding case. Annuities and its kinds.

Unit-II (2 Questions)

Meaning of return. Return as Internal Rate of Return (IRR). Numerical Methods like Newton Raphson Method to calculate IRR. Measurement of returns under uncertainty situations. Meaning of risk. Difference between risk and uncertainty. Types of risks. Measurements of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model. Sharpe's Single Index Model- Systematic Risk and Unsystematic Risk.

Unit-III (2 Questions)

Taylor series and Bond Valuation. Calculation of Duration and Convexity of bonds.

Insurance Fundamentals – Insurance defined. Meaning of loss. Chances of loss, peril, hazard, and proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures- feature of a loss that is ideal for insurance.

Unit-IV (2 Questions)

Life Insurance Mathematics – Construction of Morality Tables. Computation of Premium of Life Insurance for a fixed duration and for the whole life.

Determination of claims for General Insurance – Using Poisson Distribution and Negative Binomial Distribution –the Polya Case.

Determination of the amount of Claims of General Insurance – Compound Aggregate claim model and its properties, and claims of reinsurance. Calculation of a compound claim density function F, recursive and approximate formulae for F.

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**.

Books Recommended

1. Aswath Damodaran, Corporate Finance - Theory and Practice, John Wiley & Sons, Inc.
2. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of Indian Private Limited.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.
4. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englwood Cliffs, New Jersey.
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.
6. Salih N. Neftci, An Introduction to the Mathematics of Financial Derivatives, Academic Press, Inc.
7. Robert J. Elliott and P. Ekkehard Kopp, Mathematics of Financial Markets, Sprigner-Verlag, New York Inc.
8. Robert C. Merton, Continuous – Time Finance, Basil Blackwell Inc.
9. Tomasz Rolski, Hanspter Schmidli, Volker Schmidt and Jozef Teugels, Stochastic Processes for Insurance and Finance, John Wiley & Sons Limited.

(w.e.f. 2012-13)

12MM 515 (Option D_{15}) : Space Dynamics- I

Max. Marks : 80 **Time : 3 hours**

Unit-I (2 Questions)

Basic Formulae of a spherical triangle - The two-body Problem : The Motion of the Center of Mass. The relative motion. Kepler's equation. Solution by Hamilton Jacobi theory.

Unit-II (2 Questions)

The Determination of Orbits – Laplace's Gauss Methods.

The Three-Body problem – General Three Body Problem. Restricted Three Body Problem.

Unit-III (2 Questions)

Jacobi integral. Curves of Zero velocity. Stationary solutions and their stability.

The n-Body Problem – The motion of the centre of Mass. Classical integrals.

Unit-IV (2 Questions)

Perturbation – Osculating orbit, Perturbing forces, Secular & Periodic perturbations. Lagrange's Planetory Equations in terms of pertaining forces and in terms of a perturbed Hamiltonian.

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**.

Books Recommended

1. J.M. A. Danby, Fundamentals of Celestial Mechanics. The MacMillan Company, 1962.
2. E. Finlay, Freundlich, Celestial Mechanics. The MacMillan Company, 1958.
3. Theodore E. Sterne, An Introduction of Celestial Mechanics, Intersciences Publishers. INC., 1960.
4. Arigelo Miele, Flight Mechanics – Vol . 1 - Theory of Flight Paths, Addison-Wesley Publishing Company Inc., 1962.

(w.e.f. 2012-13)

SEMESTER-IV

Paper Code	Title of the Paper	Theory Marks	Internal-Assessment Marks	Practicals Marks	Total
12MM 521	Functional Analysis-II	80	20	-	100
12MM 522	Classical Mechanics	80	20	-	100
12MM 523	Complex Analysis-II	80	20	-	100
12MM 524	One paper out of either Group A_2 or Group B_2	80	20	-	100
12MM 525	One paper out of either Group C_2 or Group D_2	80	20	-	100
Total Marks Semester-IV					500
Total Marks Semester-III					500
Total Marks Semester-II					500
Total Marks Semester-I					500
GRAND TOTAL					2000

Group A_2 (Pre-requisite paper A_{1i})

A_{21} Advanced Discrete Mathematics-II

A_{22} Algebraic Coding Theory-II

A_{23} Wavelets-II

A_{24} Sobolev Spaces-II

Group B_2 (Pre-requisite paper B_{1i})

B_{21} Mechanics of Solids-II

B_{22} Continuum Mechanics-II

B_{23} Computational Fluid Dynamics-II

B_{24} Difference Equations-II

B_{25} Information Theory-II

Group C_2 (Pre-requisite : Group A_2 and paper C_{1i})

C_{21} Theory of Linear Operators-II

C_{22} Analytical Number Theory-II

C_{23} Fuzzy Sets and Applications-II

C_{24} Bases in Banach Spaces-II

C_{25} Algebraic Topology-II

Group D_2 (Pre-requisite : Group B_2 and paper D_{1i})

- D_{21} Fluid Dynamics-II
- D_{22} Bio-Mechanics-II
- D_{23} Integral Equations and Boundary Value Problems-II
- D_{24} Mathematics for Finance and Insurance-II
- D_{25} Space Dynamics-II

Note 1 : The Criteria for award of internal assessment of 20% marks shall be as under:

A)	One class test	:	10 marks.
B)	Assignment & Presentation) (better of two)	:	5 marks
C)	Attendance	:	5 marks
	Less than 65%	:	0 marks
	Upto 70%	:	2 marks
	Upto 75%	:	3 marks
	Upto 80%	:	4 marks
	Above 80%	:	5 marks

Note 2: The syllabus of each paper will be divided into **four** units of **two** questions each. The question paper will consist of **five** units. Each of the first four units will contain two questions and the students shall be asked to attempt **one** question from each unit. Unit five of each question paper shall contain **eight to ten** short answer type questions without any internal choice and it shall be covering the entire syllabus. As such unit five shall be **compulsory**.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper. For this purpose, tutorial classes shall be held for each theory paper in groups of 8 students for half-hour per week.

Note 4: Optional papers can be offered subject to availability of requisite resources/ faculty.

Note4: The minimum pass marks for passing the examination shall be as under:

40% in each theory paper including internal assessment.

(w.e.f. 2012-13)

Syllabus– 4th SEMESTER

12MM 521 : Functional Analysis –II

Max. Marks : 80 **Time : 3 Hours**

Unit-I (2 Questions)

Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon – Nikodyn theorem Lebesgue decomposition, Lebesgue - Stieltjes integral, Product measures, Fubini's theorem.

Unit-II (2 Questions)

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.

Unit-III (2 Questions)

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.

Unit-IV (2 Questions)

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.

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**.

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.

(w.e.f. 2012-13)

12MM 522 : Classical Mechanics

Max. Marks : 80 **Time : 3 hours**

Unit –I(2 Question)

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.

Unit –II(2 Question)

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, $\dot{q}_i$), 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.

Unit -III(2 Question)

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.

Unit -IV(2 Question)

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 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.

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**.

Books Recommended

1.	F. Gantmacher	Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
2.	P.V. Panat	Classical Mechanics, Narosa Publishing House, New Delhi, 2005.
3.	N.C. Rana and P.S. Joag	Classical Mechanics, Tata McGraw-Hill, New Delhi, 1991.
4.	Louis N. Hand and Janet D. Finch	Analytical Mechanics, CUP, 1998.
5.	K. Sankra Rao	Classical Mechanics, Prentice Hall of India, 2005.
6.	M.R. Speigal	Theoretical Mechanics, Schaum Outline Series.

(w.e.f. 2012-13)

12MM 523 : Complex Analysis-II

Max. Marks : 80 **Time : 3 hours**

Unit - I(2 Question)

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.

Unit - II(2 Question)

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.

Unit - III(2 Question)

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.

Unit -IV(2 Question)

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" .

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**.

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.
6. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.
7. S. Lang, Complex Analysis, Addison Wesley, 1977.
8. Mark J. Ablowitz and A.S. Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
9. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

(w.e.f. 2012-13)

12MM 524 (Option A_{21}) Advanced Discrete Mathematics II

Max. Marks : 80 **Time :3 Hours**

Unit- I (2 Questions)

Formal Logic – Statements. Symbolic Representation and Tautologies. Quantifier, Predicates and Validty. Propositional Logic.

Unit -II (2 Questions)

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.

Unit -III (2 Questions)

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.

Unit -IV (2 Questions)

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.

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**.

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, (3^{rd} 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.

(w.e.f. 2012-13)

12MM 524 (Option A_{22}) : Algebraic Coding Theory-II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Cyclic Codes. Cyclic Codes as ideals. Matrix Description of Cyclic Codes. Hamming and Golay Codes as Cyclic Codes. Error Detection with Cyclic Codes. Error-Correction procedure for Short Cyclic Codes. Short-ended Cyclic Codes. Pseudo Cyclic Codes.

Unit -II (2 Questions)

Quadratic residue codes of prime length, Hadamard Matrices and non-linear Codes derived from them. Product codes. Concatenated codes.

Unit -III (2 Questions)

Code Symmetry. Invariance of Codes under transitive group of permutations. Bose-Chaudhary-Hoquenghem (BCH) Codes. BCH bounds. Reed-Solomon (RS) Codes. Majority-Logic Decodable Codes. Majority- Logic Decoding. Singleton bound. The Griesmer bound.

Unit -IV (2 Questions)

Maximum – Distance Separable (MDS) Codes. Generator and Parity-check matrices of MDS Codes. Weight Distribution of MDS code. Necessary and Sufficient conditions for a linear code to be an MDS Code. MDS Codes from RS codes. Abramson Codes. Closed-loop burst-error correcting codes (Fire codes). Error Locating Codes.

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**.

Books Recommended

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.
2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
3. W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.
4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.
5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company.
6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.
7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.

(w.e.f. 2012-13)

12MM 524 (Option A_{23}) : Wavelets –II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Definition and Examples of Multiresolution Analysis, Properties of Scaling Functions and Orthonormal Wavelet Bases, The Haar MRA, Band- Limited MRA, The Meyer MRA.

Unit - II (2 Questions)

Haar Wavelet and its Transform, Discrete Haar Transforms, Shannon Wavelet and its Transform.

Haar Wavelets, Spline Wavelets, Franklin Wavelets, Battle- Lemarie Wavelets, Daubechies Wavelets and Algorithms.

Unit -III (2 Questions)

Biorthogonal Wavelets, Newlands Harmonic Wavelets, Wavelets in Higher Dimensions, Generalized Multiresolution Analysis, Frame Multiresolution Analysis, AB- Multiresolution Analysis, Wavelets Packets, Multiwavelet and Multiwavelet Packets, Wavelets Frames.

Unit -IV (2 Questions)

Applications of Wavelets in Image Processing, Integral Opertors, Turbulence, Financial Mathematics : Stock Exchange, Statistics, Neural Networks, Biomedical Sciences.

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**.

Books Recommended

1. K. Ahmad and F. A. Shah, Introduction to Wavelet Analysis with Applications, Anamaya Publishers, 2008.
2. Eugenio Hernandez and Guido Weiss, A first Course on Wavelets, CRC Press, New York, 1996.
3. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
4. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, 1992.
5. Y. Meyer, Wavelets, Algorithms and Applications (translated by R.D. Rayan, SIAM, 1993).

(w.e.f. 2012-13)

12MM 524 (Option A_{24}) : Sobolev Spaces -II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Other Sobolev Spaces - Dual Spaces, Fractional Order Sobolev spaces, Trace spaces and trace theory.

Unit -II (2 Questions)

Weight Functions - Definiton, motivation, examples of practical importance. Special weights of power type. General Weights.

Weighted Spaces - Weighted Lebesgue space $P(\Omega, \sigma)$, and their properties.

Unit -III (2 Questions)

Domains - Methods of local coordinates, the classes C^o, $C^{o,k}$, Holder's condition, Partition of unity, the class K (x_0) including Coneproperty.

Unit -IV(2 Questions)

Inequalities – Hardy inequality, Jensen's inequality, Young's inequality, Hardy-Littlewood - Sobolev inequality, Sobolev inequality and its various versions.

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**.

Books Recommended

1. R.A. Adams, Sobolev Spaces, Academic Press, Inc. 1975.
2. S. Kesavan, Topics in Functional Analysis and Applications, Wiley Eastern Limited, 1989.
3. A. Kufner, O. John and S. Fucik, Function Spaces, Noordhoff International Publishing, Leyden, 1977.
4. A. Kufner, Weighted Sobolev Spaces, John Wiley & Sons Ltd., 1985.
5. E.H. Lieb and M. Loss, Analysis, Narosa Publishing House, 1997.
6. R.S. Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House, 2001.

(w.e.f. 2012-13)

12MM 524 (Option B_{21}) : Mechanics of Solids-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 short answer type questions without any internal choice covering the entire syllabus and shall be compulsory.

Unit-I (2 Questions)

Two-dimensional Problems : Plane strain and Plane stress. Generalized plane stress. Airy stress function for plane strain problems. General solutions of a Biharmonic equation using Fourier transform as well as in terms of two analytic functions. Stresses and displacements in terms of complex potentials. Thick walled tube under external and internal pressures. Rotating shaft.

Unit-II (2 Questions)

Torsion of Beams : Torsion of cylindrical bars. Torsional rigidity. Torsion and stress functions. Lines of shearing stress. Simple problems related to circle, ellipse and equilateral triangle cross-section. Circular groove in a circular shaft.

Extension of Beams: Extension of beams by longitudinal forces. Beam stretched by its own weight.

Unit-III (2 Questions)

Bending of Beams: Bending of Beams by terminal Couples, Bending of a beam by transverse load at the centroid of the end section along a principal axis.

Variational Methods: Variational problems and Euler's equations. The Ritz method-one dimensional case, the Ritz method-Two dimensional case, The Galerkin method, Applications to torsion of beams, The method of Kantrovitch. (Relevant topics from the Sokolnikoof's book)

Unit-IV (2 Questions)

Waves: Simple harmonic progressive waves, scalar wave equation, progressive type solutions, plane waves and spherical waves, stationary type solutions in Cartesian and Cylindrical coordinates.

Elastic Waves: Propagation of waves in an unbounded isotropic elastic solid. P. SV and SH waves. Wave propagation in two-dimensions.

<u>Books Recommended:</u>

1. I.S. Sokolnikof, *Mathematical theory of Elasticity*. Tata McGraw Hill publishing Company Ltd. New Delhi, 1977.
2. Teodar M. Atanackovic and Ardeshiv Guran, *Theory of Elasticity for Scientists and Engineers*, Birkhausev, Boston, 2000.
3. A.K. Mal & S.J. Singh, *Deformation of Elastic Solids*, Prentice Hall, New Jersey, 1991
4. C.A. Coluson, Waves
5. A.S. Saada, *Elasticity-Theory and Applications*, Pergamon Press, New York, 1973.
6. D.S. Chandersekhariah and L. Debnath, *Continuum Mechanics*, Academic Press.
7. S. Valliappan, *Continuum Mechanics-Fundamentals*, Oxford & IBH Publishing Company, New Delhi-1981

(w.e.f. 2012-13)

12MM 524 (Option B_{22}) : Continuum Mechanics - II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Thermoelasticity : Basic concepts of thermoelasticity, Stress-strain relation for thermo-elasticity, Navier equations for thermoelasticity, thermal stresses in a long circular cylinder and in a sphere.

Unit -II (2 Questions)

Viscoealsticity : Viscoelastic models – Maxwell model, Kelvin model and Standard linear solid model. Creep compliance and relaxation modulus, Hereditary integrals, visco-elastic stress-strain relations, correspondence principle and its application to the deformation of a viscoelastic thick-walled tube in plane strain.

Unit -III (2 Questions)

Fluid Dynamics : Viscous stress tensor, Stokesian and Newtonian fluid, Basic equation of viscous flow, Navier stokes equations, specialized fluid, steady flow, irrotational flow, potential flow, Bernollies equation, Kilvin's theorem (As Chapter 7 of the Book by Mase and Mase).

Unit -IV (2 Questions)

Plasticity : Basic concepts, yield criteria, yield surface, equivalent stress and equivalent strain, elastic – plastic stress-strain relation, plastic stress-strain relatin, plastic flow of anisotropic material, special cases of plane stress, plane strain and axis-symmetry.

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**.

Books Recommended

1. S. Valliappan, Continuum Mechanics, Fundamentals, Oxford & IBH Publishing Company, 1981.
2. G.T. Mase and G.E. Mase, Continuum Mechanics for Engineers, CRC Press, 1999.
3. Atanackovic, T.M. A. Guran, Theory of Elasticity for scientists and Engineers, Birkhausev, 2000.
4. D.S. Chandrasekharaiah, Continuum Mechanics, Academic Press, Prism Books Pvt. Ltd., Bangalore.
5. L.S. Srinath, Advanced Mechanics of Fields, Tata McGraw-Hill, New Delhi.

(w.e.f. 2012-13)

12MM 524 (Option B_{23}) : Computational Fluid Dynamics-II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Iterative methods. Stationary methods. Krylov subspace methods. Multigrade methods. Fast Poisson solvers.

Unit -II (2 Questions)

Iterative methods for incompressible Navier-Stokes equations. Shallow-water equations – One and two dimensional cases. Godunov 's order barrier theorem.

Unit -III (2 Questions)

Linear schemes. Scalar conservation laws. Euler equation in one space dimension – analytic aspects. Approximate Riemann solver of Roe.

Unit -IV (2 Questions)

Osher scheme. Flux splitting scheme. Numerical stability. Jameson – Schmidt – Turkel scheme. Higher order schemes.

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**.

Books Recommended

1. P. Wesseling : Principles of Computational Fluid Dynamics, Springer Verlag, 2000.
2. J.F. Wendt, J.D. Anderson, G. Degrez and E. Dick, Computational Fluid Dynamics : An Introduction, Springer-Verlag, 1996.
3. J.D. Anderson, Computational Fluid Dynamics : The basics with applications, McGraw-Hill, 1995.
4. K. Muralidher, Computational Fluid Flow and Heat Transfer, Narosa Pub. House.
5. T.J. Chung, Computational Fluid Dynamics, Cambridge Uni. Press.
6. J.N. Reddy, An introduction to the Finite Element Methods,McGraw Hill International Edition, 1985.

(w.e.f. 2012-13)

12MM 524 (Option B_{24}) : Difference Equations- II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Sturm-Liouville problems - Introduction, Finite Fourier Analysis. A non- homogeneous problem.

Discrete Calculus of Variations - Introduction. Necessary conditions. Sufficient Conditions and Disconjugacy.

Unit -II (2 Questions)

Nonlinear equations that can be linearized. The z-transform.

Boundary value problems for Nonlinear equations. Introduction. The Lipschitz case. Existence of solutions.

Unit -III (2 Questions)

Boundary value problems for differential equations. Partial Differential Equations.

Unit -IV (2 Questions)

Discretization of Partial Differential Equations. Solution of Partial Differential Equations.

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**.

Books Recommended

1. Walter G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications, Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

2. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccatti Equations. Kluwer, Boston, 1996.

(w.e.f. 2012-13)

12MM 524 (Option B_{25}) : Information Theory- II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Some imuitive properties of a measure of entropy – Symmetry, normalization, expansibility, boundedness, recursivity, maximality, stability, additivity, subadditivity, nonnegativity, continuity, branching, etc. and interconnections among them. Axiomatic characterization of the Shannon entropy due to Shannon and Fadeev.

Unit -II (2 Questions)

Information functions, the fundamental equation of information, information functions continuous at the origin, nonnegative bounded information functions, measurable information functions and entropy. Axiomatic characterizations of the Shannon entropy due to Tverberg and Leo.

Unit -III (2 Questions)

The general solution of the fundamental equation of information. Derivations and their role in the study of information functions. The branching property. Some characterisations of the Shannon entropy based upon the branching property. Entropies with the sum property.

Unit -IV (2 Questions)

The Shannon inequality. Subadditivie, additive entropies. The Renji entropies. Entropies and mean values. Average entropies and their equality, optimal coding and the Renji entropies. Characterisation of some measures of average code length.

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**.

Books Recommended

1. R. Ash, Information Theory, Interscience Publishers, New York, 1965.
2. F.M. Reza, An Introduction to Information Theory, MacGraw-Hill Book Company Inc., 1961.
3. J. Aczela dn Z. Daroczy, On Measures of Information and their Characterizations, Academic Press, New York.

(w.e.f. 2012-13)

12MM 525 (Option C_{21}) : Theory of Linear Operators II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Spectral representation of bounded self adjoint linear operators. Spectral theorem. Properties of the spectral family of a bounded self-adjoint linear operator. Unbounded linear operators in Hilbert Space. Hellinger - Toeplitz theorem. Hilbert adjoint operators.

Unit -II (2 Questions)

Symmetric and self-adjoint linear operators, Closed linear operators and closures. Spectrum of an unbounded self-adjoint linear operator. Spectral theorem for unitary and self-adjoint linear operators. Multiplication operator and differentiation operator.

Unit -III (2 Questions)

Spectral measures. Spectral integrals. Regular spectral measures. Real and complex spectral measures. Complex spectral integrals. Description of the spectral subspaces. Characterization of spectral subspaces. The spectral theorem for bounded normal operators.

Unit -IV(2 Questions)

The Problem of Unitary Equivalence, Multiplicity Functions in Finite-dimensional Spaces, Measures, Boolean Operations on Measures, Multiplicity Functions, The Canonical Example of a Spectral Measure, Finite dimensional Spectral Measures, Simple finite dimensional Spectral Measures.

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**.

Books Recommended

1. E. Kreyszig, Introductory Functional Analysis with Applications, John-Wiley & Sons, New York, 1978.
2. P.R. Halmos, Introduction to Hilbert Space and the Theory of Spectral Multiplicity, Second-Edition, Chelsea Publishing Co., New York, 1957.
3. N. Dunford and J.T. Schwartz, Linear Operators -3 Parts, Interscience/Wiley, New York, 1958-71.
4. G. Bachman and L. Narici, Functional Analysis, Academic Press, York, 1966.

(w.e.f. 2012-13)

12MM 525 (Option C_{22}) : Analytical Number Theory-II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Riemann Zeta Function $\zeta(s)$ and its convergence. Application to prime numbers. $\zeta(s)$ as Euler's product. Evaluation of $\zeta(2)$ and $\zeta(2k)$. Dirichlet series with simple properties. Eulers products and Dirichlet products, Introduction to modular forms. (Scope as in Book at Sr. No.5).

Unit -II (2 Questions)

Algebraic Number and Integers : Gaussian integers and its properties. Primes and fundamental theorem in the ring of Gaussian integers. Integers and fundamental theorem in $Q(\omega)$ where $\omega^3 = 1$. Algebraic fields. Primitive polynomials. The general quadratic field $Q(\sqrt{m})$, Units of $Q(\sqrt{2})$. Fields in which fundamental theorem is false. Real and complex Euclidean fields. Fermat's theorem in the ring of Gaussian integers. Primes of $Q(\sqrt{2})$ and $Q(\sqrt{5})$ Series of Fibonacci and Lucas. Luca's test for the primality of the mersenne primes. (Relevant sections of Recommended Book at Sr. No. 1).

Unit -III (2 Questions)

Arithmetic functions $\phi(n)$, $\tau(n)$, $\sigma(n)$ and $\sigma_k(n)$, u(n), N(n), I(n). Definition and examples and simple properties. Perfect numbers the Mobius inversion formula. The Mobius function μ_n, The order and average order of the function $\phi(n)$, $\tau(n)$ and $\sigma(n)$. (Scope as in books at Sr. No. 1 and 4).

Unit -IV (2 Questions)

The functions $\Lambda(n)$, $\psi(n)$ and $\vartheta(n)$ Bertrand Postulate, Merten's theorem, Selberg's theorem and Prime number Theorem. (Scope as in Books at Sr. No. 1 and 4).

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**.

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.

(w.e.f. 2012-13)

12MM 525 (Option C_{23}) : Fuzzy Sets and their Applications - II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Probability Theory, Probability Distribution, Comparison of Probability and Possibility, Fuzzy event, Crisp Probability of Fuzzy Event, Fuzzy Probability of Fuzzy Event, Uncertainty Level of Element, Fuzziness of Fuzzy Set, Measure of Fuzziness, Measure using Entropy, Measure using Metric Distance. (Chapter 7 of book at serial no. 1)

Unit -II (2 Questions)

Proposition Logic, Logic Function, Tautology and Inference Rule, Predicate Logic, Quantifier, Fuzzy Expression, Operators in Fuzzy Expression, Some Examples of Fuzzy Logic Operations, Linguistic Variable, Fuzzy Predicate, Fuzzy Modifier, Fuzzy Truth Values, Examples of Fuzzy Truth Quantifier, Inference and Knowledge Representation, Representation of Fuzzy Predicate by Fuzzy Relation, Representation of Fuzzy Rule.

Extension Principle and Composition, Composition of Fuzzy Sets, Composition of Fuzzy Relation, Example of Fuzzy Composition, Fuzzy if-then Rules, Fuzzy Implications, Examples of Fuzzy Implications, Decomposition of Rule Base, Two- Input/ Single-Output Rule Base, Compositional Rule of Inference, Fuzzy Inference with Rule Base, Inference Methods, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method. (Chapter 8,9 of book at serial no. 1)

Unit -III (2 Questions)

Advantage of Fuzzy Logic Controller, Configuration of Fuzzy Logic Controller, Choice of State Variables and Control Variables, Fuzzification Interface Component, Data Base, Rule Base, Decision Making Logic, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method, Mean of Maximum Method, Center of Area Method(COA), Bisector of Area, Lookup Table, Design Procedure of Fuzzy Logic Controller, Application Example of FLC Design, Fuzzy Expert Systems. (Chapter 10 of book at serial no. 1)

Unit -IV (2 Questions)

Applications of Fuzzy Set Theory in Natural, Life and Social Sciences, Engineering, Medicine, Management and Decision Making, Computer Science, System Sciences. (Chapter 6 of book at serial no. 2)

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**.

Books Recommended

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall of India Private Limited, New Delhi-110 001, 2005.
3. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
4. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

(w.e.f. 2012-13)

12MM 525 (Option C_{24}) : Bases in Banach Spaces –II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2Questions)

Different types of convergence in a Banach space. Unconditional bases. Unconditional basis sequences. Symmetric Bases.

Bases and structure of the space Bases and completeness. Bases and reflexivity.

Unit -II (2 Questions)

Generalized bases. Generalized basic sequences. Boundedly complete generalized bases and shrinking generalized bases. M-Bases (Markusevic bases) and M-Basic sequences.

Bases of subspaces (Decomposition-Existence of a decomposition in Banach spaces. The sequences of co-ordinate projections associated to a decomposition.

Unit -III (2Questions)

Schauder decompositions. Characterization of a Schauder decomposition. Example that a decomposition is not always Schauder. Various possibilities for a Banach space to possess a Schauder decomposition. Shrinking decompositions, boundedly complete decompositions and unconditional decompositions. Reflexivity of Banach spaces having a Schauder decomposition). Bases and decompositions in the space C[0,1].

Unit -IV (2 Questions)

Best approximation in Banach spaces. Existence and uniqueness of element of best approximation by a subspace. Proximinal subspaces. Semi Cebysev subspaces and Cebysev subspaces.

Monotone and strictly monotone bases, co-monotone and strictly co-monotone bases. Examples and counter-examples.

T-norm, K-norm and KT-norm on Banach spaces having bases. Their characterization in terms of monotone and comonotone bases. Various equivalent norms on a Banach space in terms of their bases.

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**.

Books recommended

1. Jurg t. Marti, Introduction to Theory of Bases, Springer Tracts in Natural Philosophy 18, 1969.
2. Ivan Singer, Bases in Banach Spaces I, Springer-Verlag, Berlin, Vol. 154 1970.
3. Ivan Singer, Bases in Banach Spaces II, Springer-Verlag, Berlin, 1981.
4. J. Linderstrauss and I. Tzafriri, Classical banach Spaces (Sequence spaces), Springer Verlag, Berlin, 1977.
5. Ivan Singer, Best Approximation in Normed Linear Spaces by Elements of Linear Spaces, Springer-Verlag, Berlin, 1970.

(w.e.f. 2012-13)

12MM 525 (Option C_{25}) : Algebraic Topology -II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Mayer Vietoris sequence and its application to calculation of homology of graphs, torus and compact surface of genus g, collared pairs, construction of spaces by attaching of cells, spherical complexes with examples of S^n, r-leaved rose, torus, **RP^n, CP^n** etc.

Unit -II (2 Questions)

Computation of homology of **RP^n, CP^n**, torus, suspension space, XVY, compact surface of genus g and non-orientable surface of genus h using Mayer Vietoris sequence, Betti numbers and Euler characteristics and their calculation for S^n, r-leaved rose, **RP^n, CP^n, S^2 x S^2, X + Y** etc.

Unit -III(2 Questions)

Singular cohomology modules, Kronecker product, connecting homomorphism, contra-functoriality of singular cohomology modules, naturality of connecting homomorphism, exact cohomology sequence of pair, homotopy invariance, excision properties, cohomology of a point. Mayer Vietoris sequence and its application in computation of cohomology of **S^n, RP^n, CP^n, torus, compact surface of genus g and** non-orientable compact surface.

Unit -IV (2 Questions)

Compact connected 2-manifolds, their orientability and non-orientability, examples, connect sum, construction of projective space and Klein's bottle from a square, Klein's bottle as unity of two Mobius strips, canonical form of sphere, torus and projective palnes. Kelin's bottle. Mobious strip, triangulation of compact surfaces.

Classification theorem for compact surfaces, connected sum of torus and projective plan as the connected sum of three projective planes. Euler characteristic as a topological invariation of compact surfaces. Connected sum formula, 2-manifolds with boundary and their classification Euler characteristic of a bordered surface, models of compact bordered surfaces in $\mathbf{R}^3$ **.**

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**.

Books Recommended

1. James R. Munkres, Topology – A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 1978.
2. Marwin J. Greenberg and J.R. Harper, Algebraic Topology – A First Course, Addison-Wesley Publishing Co., 1981.
3. W.S. Massey, Algebraic Topology – An Introduction, Harcourt, Brace and World Inc. 1967, SV, 1977.

(w.e.f. 2012-13)

12MM 525 (Option D_{21}) : Fluid Dynamics-II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Irrotational motion in two-dimensions. Complex velocity potential. Milne-Thomson circle theorem. Two-dimensional sources, sinks, doublets and their images. Blasius theorem. Two- dimensional irrotation motion produced by motion of circular, co-axial and elliptical cylinders in an infinite mass of liquid.

Unit -II (2 Questions)

Vortex motion. Kelvin's proof of permanence. Motions due to circular and rectilinear vortices. Spiral vortex. Vortex doublet. Image of a vortex. Centroid of vortices. Single and double infinite rows of vortices. Karman vortex street. Applications of conformal mapping to fluid dynamics.

Unit -III (2 Questions)

Stress components in a real fluid. Relations between rectangular components of stress. Gradients of velocity. Connection between stresses and gradients of velocity. Navier-Stoke's equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates.

Plane Poiseuille and Couette flows between two parallel plates. Theory of lubrication. Flow through tubes of uniform cross-section in form of circle, annulus, ellipse and equilateral triangle under constant pressure gradient. Unsteady flow over a flat plate.

Unit -IV (2 Questions)

Dynamical similarity. Inspection analysis. Reynolds number. Dimensional analysis. Buckingham π-theorem. Prandtl's boundary layer.

Boundary layer equation in two-dimensions. Blasius solution. Boundary layer thickness, displacement thickness, momentum thickness. Karman integral conditions. Karman-Pohlmansen method. Separation of boundary layer flow.

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**.

Books Recommended

1. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
3. O'Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.
4. O'Neill, M.E. and Chorlton, F. , Viscous and Compressible Fluid Dynamics, Ellis Horwood Limited, 1989.
5. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
6. H. Schlichting, Boundary-Layer Theory, McGraw Hill Book Company, New York, 1979.
7. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
8. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

(w.e.f. 2012-13)

12MM 525 (Option D_{22}) : Biomechanics- II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Laws of thermodynamics. Gibbs and Gibbs – Duhem equations. Chemical potential. Entropy in a system with heat and mass transfer. Diffusion, filtration, and fluid movement in interstitial space in thermodynamic view. Diffusion from molecular point of view.

Unit -II (2 Questions)

Mass transport in capillaries, tissues, interstitial space, lymphatics, indicator dilution method, and peristalsis. Tracer motion in a model of pulmonary microcirculation.

Unit -III (2 Questions)

Descrption of internal deformation and forces. Equations of motion in Lagrangian description. Work and strain energy. Calculation of stresses from strain energy function.

Unit -IV (2 Questions)

Stress, strain and stability of organs. Stress and strains in blood vessels. Strength, Trauma, and tolerance. Shock loading and structural response. Vibration and the amplification spectrum of dynamic structural response. Impact and elastic waves.

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**.

Books Recommended

1. Y.C. Fung, Biomechanics: Motion, Flow, Stress and Growth, Springer-Verlag, New York Inc., 1990.

(w.e.f. 2012-13)

12MM 525 (Option D_{23}): Integral Equations and Boundary Value Problems-II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Application to Partial Differential Equations. Integral representation formulas for the solutions of the Laplace and Poisson equations. Newtonian single layer and double layer potentials. Interior and exterior Dirichlet and Neumann problems for Laplace equation. Green's function for Laplace equation in a free space as well as in a space bounded by a grounded vessel. Integral equation formulation of BVPs for Lapalce equation. The Helmholftz equation.

(Relevant topics from the chapters 5 and 6 of the book by R.P. Kanwal).

Unit -II (2 Questions)

Symmetric kernels. Complex Hilbert space. Orthonormal system of functions. Riesz-Fischer theorem (statement only). Fundamental properties of eigenvalues and eigenfunctions for symmetric kernels. Expansion in eigenfunctions and bilinear form. A necessary and sufficient condition for a symmetric L_2-kernel to be separable. Hilbert-Schmidt theorem. Definite and indefinite kernels. Mercer's theorem (statement only). Solution of integral equations with symmetric kernels by using Hilbert-Schmidt theorem.

Unit -III (2 Questions)

Singular integral equations. The Abel integral equation. Inversion formula for singular integral equation with kernel of the type $[h(s) - h(t)]^{-\alpha}$ with $0 < \alpha < 1$. Cauchy principal value for integrals. Solution of the Cauchy type singular integral equations. The Hilbert kernel. Solution of the Hilbert-type singular integral equations. Integral transform methods. Fourier transform. Laplace transform. Applications to Volterra integral equations with convolution type kernels. Hilbert transforms and their use to solve integral equations.

Unit -IV (2 Questions)

Applications to mixed BVP's. Two-part BVP's, Three-part BVP's Generalized two-part BVP's. Perturbation method. Its applications to Stokes and Oseen flows, and to Navier-Cauchy equations of elasticity for elastostatic and elastodynamic problems.

(Relevant topics from the chapters 9 to 11 of the book by R.P. Kanwal).

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**.

Books Recommended

1. Kanwal, R.P., Linear Integral Equations – Theory and Technique, Academic Press, 1971.
2. Kress, R., Linear Integral Equations, Springer-Verlag, New York, 1989.
3. Jain, D.L. and Kanwal, R.P., Mixed Boundary Value Problems in Mathematical Physics.
4. Smirnov, V.I., Integral Equations and Partial Differential Equations, Addison-Wesley, 1964.
5. Jerri, A.J., Introduction to Integral Equations with Applications, Second Edition, John-Wiley & Sons, 1999.
6. Kanwal, R.P., Linear Integration Equations, (2nd Ed.) Birkhauser, Boston, 1997.

(w.e.f. 2012-13)

12MM 525 (Option D_{24}) : Mathematics for Finance and Insurance-II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Financial Derivatives – Futures. Forward. Swaps and Options. Call and Put Option. Call and Put Parity Theorem. Pricing of contingent claims through Arbitrage and Arbitrage Theorem.

Financial Derivatives – An Introduction; Types of Financial Derivatives-Forwards and Futures; Options and its kinds; and SWAPS.

Unit -II (2 Questions)

The Arbitrage Theorem and Introduction to Portfolio Selection and Capital Market Theory : Static and Continuous – Time Model.

Pricing Arbitrage - A Single-Period option Pricing Model ; Multi-Period Pricing Model - Cox – Ross - Rubinstein Model; Bounds on Option Prices. The lto's Lemma and the Ito's integral.

Unit -III (2 Questions)

The Dynamics of Derivative Prices - Stochastic Differential Equations (SDEs) - Major Models of SDEs : Linear Constant Coefficient SDEs; Geometric SDEs; Square Root Process; Mean Reverting Process and Omstein - Uhlenbeck Process.

Martingale Measures and Risk - Neutral Probabilities : Pricing of Binomial Options with equivalent martingale measures.

Unit -IV (2 Questions)

The Black-Scholes Option Pricing Model - using no arbitrage approach, limiting case of Binomial Option Pricing and Risk-Neutral probabilities.

The American Option Pricing - Extended Trading Strategies; Analysis of American Put Options; early exercise premium and relation to free boundary problems.

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**.

Books Recommended

1. Aswath Damodaran, Corporate Finance - Theory and Practice, John Wiley & Sons, Inc.
2. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of Indian Private Limited.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.
4. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englwood Cliffs, New Jersey.
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.
6. Salih N. Neftci, An Introduction to the Mathematics of Financial Derivatives, Academic Press, Inc.
7. Robert J. Elliott and P. Ekkehard Kopp, Mathematics of Financial Markets, Sprigner-Verlag, New York Inc.
8. Robert C. Merton, Continuous – Time Finance, Basil Blackwell Inc.
9. Tomasz Rolski, Hanspter Schmidli, Volker Schmidt and Jozef Teugels, Stochastic Processes for Insurance and Finance, John Wiley & Sons Limited.

(w.e.f. 2012-13)

12MM 525 (Option D_{25}) : Space Dynamics- II

Max. Marks : 80 **Time : 3 hours**

Unit -I (2 Questions)

Motion of the moon – The perturbing forces. Perturbations of Keplerian elements of the Moon by the Sun.

Unit -II (2 Questions)

Flight Mechanics – Rocket Performance in a Vacuum. Vertically ascending paths. Gravity Twin trajectories. Multi stage rocket in a Vacuum. Definiton spertinent to single stage rocket.

Unit -III (2 Questions)

Performance limitations of single stage rockets, Definitions pertinent to multi stage rockets. Analysis of multi stage rockets neglecting gravity. Analysis of multi stage rockets including gravity.

Unit -IV (2 Questions)

Rocket Performance with Aerodynamic forces. Short range non-lifting missiles. Ascent of a sounding rocket. Some approximate performance of rocket-powered air-craft.

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**.

Books Recommended

1. J.M. A. Danby, Fundamentals of Celestial Mechanics. The MacMillan Company, 1962.
2. E. Finlay, Freundlich, Celestial Mechanics. The MacMillan Company, 1958.
3. Theodore E. Sterne, An Introduction of Celestial Mechanics, Intersciences Publishers. INC., 1960.
4. Arigelo Miele, Flight Mechanics – Vol . 1 - Theory of Flight Paths, Addison-Wesley Publishing Company Inc., 1962.