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

(*w.e.f. Session 2014-15*)

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 415-A	Programming in C (ANSI Features)	60	Nil	40	100
12MM 415-B	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 marks of internal assessment of each paper shall be splited as under :

A) One class test of 10 marks. The class test will be held in the middle of the semester.

B) Assignment & Presentation : 5 marks

C) Attendance : 5 marks

65% but upto 75% : 1 marks

More than 75% but upto 85% : 2 marks

More than 85% but upto 90% : 3 marks

More than 90% but upto 95% : 4 marks

Above 95% : 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.

Note 4 : In order to pass a particular paper, the student has to pass in theory paper separately.

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.

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.

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.

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.

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.

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.

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. 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;

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.

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 425-A	Object Oriented Programming with C++	60	Nil	40	100
12MM 425-B	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 MM 415-A) or 12MM 425-B (Pre-requisite Paper 12MM 415-B) to be selected.

Note 1 : The marks of internal assessment of each paper shall be splited as under :

A) One class test of 10 marks. The class test will be held in the middle of the semester.

B) Assignment & Presentation : 5 marks

C) Attendance : 5 marks

65% but upto 75% : 1 marks

More than 75% but upto 85% : 2 marks

More than 85% but upto 90% : 3 marks

More than 90% but upto 95% : 4 marks

Above 95% : 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.

Note 4 : In order to pass a particular paper, the student has to pass in theory paper separately.

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.

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.

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.

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.

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

PRACTICALS: Based on MM 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.

12MM 425-B : Operations Research Techniques

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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

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; Algebraic, graphical and linear programming methods for solving mixed strategy games. Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

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.