B. Sc. Mathematics (Honours)

M-C-1(Calculus)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-1

Hyperbolic functions; higher order derivative ; Leibnitz rule & its application to the problems of the types $e^{ax}.\sin bx$;$.e^{ax}.\cos bx$;$(ax+b)^n .\sin x$ etc ; concavity & inflection points , asymptotes, curve tracing in Cartesian co –ordinates, tracing of standard curves in polar co-ordinates, L-Hospitals" rule.

(2 question)

UNIT-2

Reduction formula, derivatives & illustrations of reduction formula of the type $\sin^n x\,dx$,$\cos^n x\,dx$, $\sin^m x \cos nx$ ($\log x$)$^n dx$, parametric curves , arc lenth of Cartesian &polar curves, volume & surface of revolution.

(2 question)

UNIT-3

Techniques of sketching conics, reflection properties of conics , rotation of axes & second degree equation , classification of second degree equation into conics using the discriminate , polar equations of conics .

(2 questions)

UNIT-4

Triple product ,introduction to vector function , operation with vector valued functions , limits & continuity of vector function , differentiation & integration of vector function (2 questions)

Books Recommended

1. G.B. Thomas & R.L. Finney, Calculus Pearson Education
2. M.J.Strauss G.L Bradley &K.J. Smith Calculus Dorling Kindersley (India) P. Ltd.

3 H. Anton, I.Bivens and S.Davis, Calculus, John wiley and sons (Asia)

4 R Courant and F. John, Introduction to calculus and Analysis (Volume I & II), Springer-Verlag, New York

M-C-2 Algebra

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

Syllabus:

UNIT-I

Polar representation of complex numbers, nth roots of unity, De Moirés theorem for rational indices & its application, logarithm of complex numbers. (2 question)

UNIT-II

Equivalence relation, function& composition of function, invertible function, one to one correspondence & cardinality of a set, well ordering property of positive integers, division algorithm, divisibility &Euclidean algorithm, congruence relation between integers, principal of Mathematical Induction, Statement of fundamental Theorem of Arithmetic. (3 question)

UNIT III

Systems of linear equations, low reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, application of linear systems, linear independence. (1 questions)

UNIT IV

Introduction to linear transformations, Matrix of linear transformation , inverse of a matrix, Characterization of matrices, Subspaces of R^n , Dimension of subspaces of R^n and rank of matrix, Eigen Vectors and Characteristic Equation of a matrix (2 question)

Books Recommended

1.Titu and Reescu and Dorin Andrica, Complex Numbers From A to Z , Birkhauser.

2 Edgar G. Goodaire and Michael M. Parmenter , Discrete Mathematics with graph Theory , Pearson Education

3 David C . Alay Linear algebra and its Application, Pearson Education

M-GE-I Calculus (Except Mathematics hons.)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT- I

Limit And continuity, types of discontinuities, differentiability of functions, successive differentiation Leibnitz's theorem, Partial differentiation, Eluers theorem on homogeneous functions. **(2 question)**

UNIT- II

Tangents & Normal's, curvature, Asymptote, Singular Points, Tracing of Cartesian curves, tracing of parametric curves, tracing of polar curves **(3 questions)**

UNIT-III

Reduction Formulae, Length of curves, volume and area of surface of revolution. **(2 questions)**

Vector differentiation, curl, divergence and gradient **(1 questions)**

M-C-3 (Real Analysis)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Review of Algebraic & order properties of R, S- neighborhoods of point in R,Idea of countable sets, uncountable sets, Sets bounded above and below, bounded and unbounded sets, Suprema and infima of sets, the completeness property of R, Archimedean property, Density of Rational & irrational numbers in R , Concept of intervals, limit point of a set , isolated points , illustrations of Bolzano – Weierstrass Theorem for sets. **(3 Questions)**

UNIT-II

Definition of sequence, Concept of bounded & convergence sequence, Limit of Sequence, Limit Theorem ,Monotonic sequence , monotone convergence theorem, Definition of Sub Sequence and related theorem , Divergence criteria of sequence, monotone subsequence theorem ,Bolzano Weiestrass theorem for sequence(Statement only) Cauchy's Sequence, Cauchy's Convergence criterion. **(2 Questions)**

UNIT-III

Infinite Series , Convergence and divergence of infinite series, cauchy's criterion, comparison and ratio test, Cauchy's root test, Raabe's test Demorgan's and Bertrand 's Tests for the convergence and Divergence of series, Alternating Series, Leibniz Test ,Absolute and conditional Convergence, kummer's and logarithmic ratio test **(3 Questions)**

Book Recommended

1 R.G. Bartel and D.R.Sherbert, Introduction to real Analysis, John Wiley and Sons, pvt. Ltd.

M-C-4 (Differential Equations)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

First order exact differential equations, rules to find & integrating factors, first and higher degree equations solvable for x, y, p. Clairaut's form singular Solution, General Solution of second order linear differential equation with constant coefficient. **(2 Questions)**

UNIT-II

General Solution of second order linear homogeneous and nonhomogeneous equations, Linear homogeneous and nonhomogeneous equations of higher order with constant coefficients , The Cauchy's Euler equations, Second order linear differential equations with variable coefficients **(2 Questions)**

UNIT-III

Power Series solution of differential equation about ordinary and singular point, Bessel's and Legendre's differential equation, recurrence formulae, orthogonal properties, Generating Functions **(2 Questions)**

UNIT-IV

Laplace transform, inverse laplace transform and its properties, application of laplace transform to initial value problem upto second order ordinary differential equations. **(2 Questions)**

M-GE-2 Differential Equations (Except Mathematics Hons.)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

First order exact differential equations, rules to find & integrating factors, first and higher degree equations solvable for x, y, p, Methods for solving higher order differential equations. Basic theory of linear differential equations. Wronskian and its properties for a differential equations by reducing its order **(2 Question)**

UNIT-II

Linear Homogeneous equations with constant coefficient , linear nonhomogeneous equations, The method of variation of parameters ,The Cauchy's Euler's equations, Simultaneous differential equation, Total differential equation **(3 Questions)**

UNIT-III

Order and degree of partial differential equation , concept of linear and non linear partial differential equations, formation of first order partial differential equations, linear partial differential equation of first order, Lagrange's method, Charpit's method **(3 Questions)**

Books Recommended

1. **Shepley L.Ross, Differential equation, John Wiley and sons**
2. **I.Sneddon ,elements of partial differential equations,McGraw-Hill**
3.

M-C-5 Theory of Real Function

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Limits of Function (a-b approach), Sequential criterion for limits, divergence criteria, Limit theorem, one sided limit, Infinite Limit and limit at infinity, continuous function, Sequential criterion for continuity and discontinuity. Algebra of continuous function on an interval, intermediate value theorem, location of root theorem, uniform continuity, non-uniform continuity theorem**.** **(3 Questions)**

UNIT-II

Differentiability of a function at a point and in an interval, caratheodory's theorem, algebra of differentiable function, Relative exterma, interior extremum theorem. Rolle's Theorem, mean value theorem, intermediate value property of derivatives, Darboux's theorem. Application of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities. **(3 Questions)**

UNIT-III

Cauchy's mean value theorem Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form remainder, application of Taylor's theorem to convex function, relative extrema . Taylor's series and machlaurin's series expansion of exponential and trigonometric function, In(I+X), 1/ax+b and $(1+X)^n$ **(2 Questions)**

Book Recommended:

1 R.Bartel and D.R. Sherbert, Introduction to Real Analysis, John wily and Sons, 2003

2 K.A Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004

3 A. Mattuck, Introduction to Analysis, Prentice Hall, 1999

M-C-6 Group Theory I

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Symmetries of a Square, Dihedral groups, Definition and examples of group including permutation group and quaternion groups (illustration through matrices), Elementary properties of groups. **(1 Question)**

Subgroups and example and theorem on subgroups, normal subgroup, centralizer, normalize, center of a group **(2 Questions)**

UNIT –II

Properties of a cyclic group, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutation, even and odd permutation, alternating groups. Properties of cosset, Lagrange's theorem and consequences including. Fermat's Little theorem.

(2 Questions)

UNIT –III

External direct product of a Finite number of groups, normal subgroups, factors groups, cauchy's theorem for finite abelian groups. **(1 Questions)**

Group homeomorphisms, properties of homeomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems. **(2 Questions)**

Book Recommended:

1. John B. Farleigh, A First Course in Abstract Algebra, 2nd ed. Pearson, 2011

2 M. Artin, Abstract Algebra, 2nd ed. Pearson 2011

3 Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed. Narosa Publishing House, New Delhi, 1999

M-C-7 PDE and System of ODE

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Partial Differential Equations-Base concept and definitions, Mathematical problems. First order equation: Classification, Construction and Geometrical Interpretation. Method of Characterstics for obtaining General Solution of Quasi Equations. Canonical forms of solving first order partial differential equations. **(2 Questions)**

UNIT-II

Introduction of heat equation, wave equation, and Laplace equation. Classification of second order linear equations as hyperbolic, Parabolic or elliptic. Reduction of second order linear Equations as hyperbolic, Parabolic or elliptic. Reduction of second order Linear Equation to canonical forms. **(2 Questions)**

UNIT-III

Non Linear partial differential equation, standard forms I,II,III and IV , Charpit's method, Monge's method to solve equation of the form (i)$Rr+Ss+Tt=V$ and (ii) $Re+Ss+ Tt+U(rt=S^2)=V$

(2 Questions)

UNIT-IV

Systems of linear differential equations, types of linear systems, differential operators, an operator's method for linear system with constant coefficient, Basic Theory of Linear Systems in normal form. **(2 Questions)**

Book Recommended

1 Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th Edition, Springer, Indian reprint, 2006

2 S.L.Ross Differential equations 3rd Ed., John Wiley and sons, India, 2004

M-GE-3 Real Analysis(Except mathematics hons.)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Finite and infinite sets, example of countable and uncountable sets, Real line bounded sets suprema and infima, completeness property of R. Archimedean property of R. intervals, Concept of cluster points and statement of Bolzano- weierstrass theorem. **(2 Questions)**

UNIT-II

Real sequence, Bounded sequence, Cauchy's convergence criterion for sequence, cauchy's theorem on limits , order preservation and squeeze theorem, ,monotone sequences and their convergence(monotone sequences theorem without proof) **(3 Questions)**

UNIT-III

Infinite series ,Cauchy's criterion for the convergence of series, positive term series, convergence of geometric series, comparison test, convergence of p-series, root test, ratio test, Leibnitz test for the convergence of alternating series ,definition &examples of absolute & conditional convergence.

BOOKS RECOMMENDED

1-T.M.Apostle,Calculus,JhonWilley & sons(ASIA) Pvt. Ltd.

2. R.G. Bartle and D.R Sherbert , introduction to Real Analysis, John Wiley and Sons(Asia) P.Ltd, 2002

3.E.Fischer, Intermediate Real Analysis , Springer Verlag, 1983

4. K.A.Ross , Elementry Analysis – The Theory of calculus series- Undergraduate Texts in Mathematics , Springer Verlag, 2003

M-SEC-1 Logic and Sets

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators, Propositional equivalence: Logical equivalences, predicates and quantifiers: Introduction, quantifiers, Binding variable and Negations.

UNIT-II

Sets, subsets, Set operation and the laws of set theory and Venn diagrams. Examples of finite and indefinite sets. Finite sets and counting principle. Empty set properties of empty set, Standard set operations. Classes of sets, Power set of a set countability of a set.

UNIT-III

Difference and Symmetric difference of two sets, Set identifiers, generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, equivalence relations, Partial ordering relation, n-ary relations, and lattices.

BOOKS RECOMMENDED

1. R.P Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998
2. P.R Halmos, Naïve set theory, Springer, 1974
3. E Kamke Theory of sets, Dover publishers, 1950

M-C-8 Numerical Methods

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

Use of Scientific calculator is allowed

UNIT-I

Algorithms, Convergence, Error: Relative, Absolute, Round off, Truncation **(1 Question)**

Transcendental and Polynomial equations: Bisection method, Newton's method secant method. Rate of convergence of these methods. **(1 Question)**

UNIT-II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. **(1 Question)**

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton's Gregory forward and backward difference interpolation. **(2 Question)**

UNIT-III

Numerical differentiation, Numerical Integration: Trapezoidal rule, Simpson's rule Simpsons $3/8^{th}$ rule, Boole's Rule.

Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule **(2 Questions)**

Ordinary Differential Equations: Euler's method.Runge- Kutta methods of order two and four.

(1 Questions)

Book Recommended:

M.K.Jain, S.R.K Iyengar and R.K. Jain Numerical Methods for Scientific and Engineering Computation, 6^{th} Ed., New International Publisher, India, 2007.

M-C-9 Riemann Integration and Series of Functions

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT –I

Riemann Integrations; inequalities of upper and lower sums; Riemann conditions of integrability**.**

Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone function. Intermediate value theorem for Integrals; Fundamental theorem of calculus **(2 Questions)**

UNIT-II

Improper integrals and their convergence, convergence of Beta and Gamma functions.

(1 Questions)

Pointwise and uniform convergence of sequence of functions. Theorem on continuity, derivability and integrability of the limit function of a sequence of function. Series of function; Theorem on the continuity and derivability of the sum function of a series of function; Cauchy criterion for uniform convergence and weierstrass M-test. **(2 Questions)**

UNIT-III

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem Weierstrass Approximation Theorem. **(2 Questions)**

Books Recommended

1 K.A.Ross, Elementary Analysis, The Theory of Calculus, Undergraduate texts in Mathematics Springer (SIE) Indian reprint, 2004

2 Charles G. Denlinger, Element of Real Analysis, John and Bartlett.2011

M-C-10 Ring Theory and Linear Algebra I

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Definition and examples of rings, properties of rings,subring,integral domain and field, characteristic of a ring, ideal, ideal generated by a subset of a ring , factor rings,operation on ideal ,prime and maximal ideals **(3 Questions)**

UNIT –II

Ring homeomorphisms, Properties of ring homomorhisim,Isomorphism theorem I,II and III , Field of quotients **(1 Questions)**

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, Linear independence, basis and dimension, dimension of subspaces, theorem

(2 Questions)

UNIT-III

Linear transformation, null space, range, rank and nullity of a linear transformation matrix representation of a linear transformation, algebra of linear transformations,Isomorphisms, Isomorphism theorem,invertibility and isomorphism's, change of coordinate matrix

(2 Questions)

Book Recommended

1 M.Artin, Abstract Algebra, 2nd Ed. Pearson, 2011

2 S.Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005

3 Gilbert Strang, Linear Algebra and its Application, Thomson, 2005

4 D.A.R.Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998

M-GE-4 Algebra (Except Mathematics Hons.)

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Definition and example of group, Example of abelin and non –abelin groups, The group Zn of integer under addition modulo n and the group U(n) of units under multiplication modulo n , Cyclic groups from number system, Complex roots of unity, circle group, The general linear group GLn(n,R) **(2 Questions)**

UNIT-II

Subgroups, Cyclic Subgroups, The concept of a subgroup generated by a subset and the commutator subgroup of group, example of subgroups including the center of a group. Cosets index of subgroup, Lagrange's theorem, order of an element, Normal Subgroups: their definition, example and characterization, Quotient groups **(3 Questions)**

UNIT-III

Definition and example of Rings, Example of commutative and non - commutative rings; rings from number system ,Zn the ring of integer modulo n , ring of real quaterions rings of matrices, Polynomial rings, and rings of continous function. Subrings and ideals, integral domain and field, example of fields: Zp, Q, R and C **(3 Questions)**

Books Recommended

1 John B.Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson,2002

2 M. Artin, Abstract, 2nd Ed. Pearson, 2011

3 Joseph A Gallian, Contemporary Abstract Algebra, 4th Ed. , Narosa, 1999

4 George E Andrews, Number Theory, Hindustan Publishing Corporation, 1984

M-SEC 2 Graph Theory

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Definition, example and basic properties of graphs, pseudo graph complete graph, bi-bartite graphs, isomorphism of graph **(2 Questions)**

UNIT-II

Eulerian circuits, Eulerial graph, Semi-Eulerian graph, Theorem, Hamiltonian cycle, Cycle, theorem **(2 Questions)**

Representations of a graph by matrix by matrix, the adjacency matrix, incidence matrix, weighted graph **(2 Questions)**

UNIT-III

Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, warshall algorithm

Book Recommended

1 B.A.Davey and H.A Priestley, Introduction to lattices and order, Cambridge University Press, 1990

2 Edgar G.Goodaire and Michael M Parmenter, Discrete Mathematics with Graph Theory , 2nd Edition , Pearson Education(Singapore) P. Ltd., Indian Reprint 2003

M-C-11 Multivariate Calculus

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Function of several variable, limit and continuity of function of two variable partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, Exterma of functions of two variable, method of Lagrange multipliers. **(2 Questions)**

UNIT-II

Double Integration over rectangular region, double integration over non-rectangular region, Double integrals in polar Co-ordinates, Triple integrals, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, Cylindrical and spherical Co-ordinates.

Change of variable in double integrals and triple integrals. **(3 Questions)**

UNIT-III

The gradient, maximal and normal property of the gradient , tangent planes,Definition of vectors field, divergence and curl Line integrals, Applications of line integrals: Mass and work fundamental theorem for line integrals, conservative vector fields, independence of path, Green's theorem, Surface integrals, integrals over parametrically defined surfaces. Stroke's theorem

(3 Questions)

Books Recommended

1 G.B Thomas and R.L. Finney, Calculus, 9th Ed. , Pearson Education, Delhi 2005

2 M.J. Strauss, G.L. Bradley and K.J.Smith, Calculus, 3rd Ed. Dorling Kindersley (India) Pvt Ltd. (Pearson Education), Delhi 2007

M-C-12 Group Theory II

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group.

UNIT-I

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristics subgroups, Commutator and its properties.

UNIT-II

Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

UNIT-III

Groups acting themselves by conjugation, class equation and consequences, conjugacy in Sn, p-groups, Sylow's theorems and consequences, Cauchy's theorem.

UNIT-IV

Groups acting themselves by conjugation, class equation and consequences, conjugacy in Sn, p-groups, Sylow's theorems and consequences, Cauchy's theorem.Simplicity of A_n for $n \geq 5$, non simplicity tests.

(3 Questions)

Books Recommended

1 John B.Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson,2002

2 M.Artin, Abstract Algebra, 2nd Ed. Pearson, 2011

3 Joseph A Gallian, Contemporary Abstract Algebra, 4th Ed. , Narosa, 1999

M-DSE 1 Linear Programming

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group

UNIT I

Introduction to linear programming problem, convex sets and their properties, theory of simplex method, optimality and unboundedness, the simplex algorithm ,simplex method in tableau format, introduction to artificial variable , two phase method, Big- M Method and their comparison. **(3 Questions)**

UNIT II

Duality, formulation of the dual problem, primal-dual relationship, economic interpretation of the dual **(1 Question)**

Transportation problem and its mathematical formulation , northwest- corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation , Hungarian method for solving assignment problem **(3 Question)**

UNIT III

Game theory : formulation of two person zero sun games ,solving two person zero sum games with mixed strategies, graphical solution procedure , linear programming solution of games.

(1 Question)

Book Recommended

1 Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows , and Ed. , John Wiley and sons and Sons India, 2004

2 F.S Hillier and G.J. Lieberman, Introduction to operations Research, 9^{th} Ed., Tata McGraw Hill , Singapore 2009

3 G.Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002

M-DSE 2 Probability and Statistics

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group

UNIT I

Sample Space ,Probability axioms , real random variables(discrete and continuous), cumulative distribution function , probability mass/ density function, mathematical expectation , moments, moment generating function, Characteristic function , distributions: uniform , binomial ,poisson,geometric, negative binomial , continuous distributions: uniform, normal, exponential

(3 Questions)

UNIT II

Joint cumulative distribution function and its properties, joint probability density function, marginal and conditional distributions , expectation of function of two random variable ,conditional expectations, independent random variables , bivariate normal distribution, correlation coefficient , joint moment generation and calculations of covariance , linear regression for two variables **(3 Questions)**

UNIT III

Chebyshev's inequality, Statement and interpretations of law of large numbers and strong law of large numbers, central limit theorem for independence and identically distributed random variables with finite variance **(2 Questions)**

Books Recommended

1 Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007

2 Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Application, 7^{th} Ed.,Pearson Education, Asia , 2006

M-C-13 Metric Spaces and Complex Analysis

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group

UNIT I

Metric Spaces: definition and example, Sequence in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighborhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, cantor's theorem Subspaces, dense set, separable spaces.

(2 Questions)

UNIT II

Continuous mapping, sequential criterion and other characterization of continuity, uniform continuity, Homomorphism, Contraction mapping , Banach fixed point Theorem **(2 Question)**

UNIT III

Limits, Limit involving the point at infinity, continuity, Properties of complex number, regions in the complex plane , function of complex variable , mapping , Derivative , differentiation formulas , Cauchy – Riemann equation , Sufficient condition for differentiability **(2 Question)**

UNIT IV

Analytic function , example of analytic function , exponential function , logarithmic function, trigonometric function, derivative of function, bilinear transformation, cross ratio, conformal mapping.

Books recommended.

1. Satish hirali & Harikishan L.vasudeva, Metric spaces, Springer Verlag

2.S. Kumaresan,Topolo of metric spaces , Narosa Publishing House

3.G.F. Simon ,introduction to topology& MODERN Analysis, McGraw-Hill

4.JAMES Ward Brown& Ruel V. Churchil,Cmplex variables & APPLICATIONS

M-C-14 Ring theory &Linear Algebra II

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group

UNIT I

Polynomial rings over commutative ring, division algorithm & consequences, principal ideal domain, factorization of polynomials, reducibility & irreducibility test, Eisenstein criterion,

Unique factorization in z(x).divisility in integral domain, irreducible primes, unique factorization domains, Euclidean domains.

UNIT II

Dual spaces, dual basis. Double dual, transpose of linear transformation& its matrix in dual basis, annihilators, Eigen spaces of a linear operator, diagonalisability, invariant sub spaces &Caley-Hamilton theorem, the minimal polynomial for a linear operator.

UNIT III

Inner product spaces & norms, Gram-Schmidt orthogonalisation process, orthogonal compliments,Bessels,inequality , the adjoint of a linear operator, minimal solution of system of linear equations, normal & self adjoint operators, orthogonal projection and Spectral Theorem.

Book Recommended

1 John B.Fraleigh, A First Courses in Abstract, 7th Ed. Pearson, 2002

2 M Artin, Abstract Algebra, 2nd Ed., Pearson, 2011

3 Joseph A. Gallian , Contemporary Abstract Algebra , 4th Ed. Narosa Publishing House ,1999

4Stephen H. Freidberg, Arnod J. Insel, Lawrence E. Spence, Linear Algebra

5 S. Lang Introduction to linear Algebra, Springer Verlag.

6 Kenneth Hoffman , Linear Algebra,Prentice Hall of India.

M-DSE-3 Theory of equation

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group

UNIT I

General Properties of polynomials , Graphical representation of a polynomial , maximum and minimum values of a polynomials, General properties of equation , Descarte's rule of sign positive and negative rule , Relation between the roots and the coefficients of equation.

(2 Questions)

UNIT II

Symmetric function, Application of symmetric of the roots, Transformation of equation, Solution of reciprocal and bionomial equation Algebraic solution of the cubic and biquadratic , Properties of the derived function. **(2 Questions)**

UNIT III

Symmetric function of the roots, Newton's theorem on the sums of power of roots, homogeneous products, limit of the root of equation. **(2 Questions)**

UNIT IV

Separation of the roots of equations, Strums theorem, Application of Strum's theorem, Condition for reality of the roots of equation. **(2 Questions)**

Books Recommended

1 W.S Burnside and A.W Panton , the theory of Equation, Dublin University Press, 1954

2 C.C MacDuffee, Theory of Equation , John Wiley and Son's Inc., 1954

M-DSE-4 Differential Geometry

Full Marks-80 **Time:3 Hours**

Question paper will have two sections.

Section-1(Compulsory) This section consists of eight short answer type questions of two marks each(8x2=16 marks) from the entire syllabus uniformly.

Section-2:In this section eight long type question will be set divided into two parts (a) and (b) of eight marks each out of which candidates are requested to answer any four questions(16x4=64 marks) selecting at least one from each unit/ group

UNIT I

Theory of space curves ,planer curves, curvature , torsion and serret- Frenet formulae. Osculating circles, Osculating circles and spheres, Existence of space curves . Evolutes and involutes of curves **(2 Questions)**

UNIT II

Theory of surface ,Parametric curves on surface , Direction Coefficient, First and second fundamental forms. Principal and Gaussian curvature Lines of curvature , Euler's theorm , Rodrigue's formula , Conjugate Asymptotic lines. **(2 Questions)**

UNIT III

Developable: Developable associated with space curves and curveson surface , Minimal surface **(2 Questions)**

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution Clairaut theorm Normal Property of geodesics Torsion of a geodesic , Geodesic curvature, Gauss- Bonnet theorem **(2 Questions)**

Books Recommended

1 T.J Willmore, An Introduction of Differential Geometry, Dover Publication , 2012

2 B.O Neill, Elementry Differential Geometry , 2nd Ed., Academic Press, 2006

3 C.E Weatherburn , Differential Geometry of three Dimensions , Cambridge university press 2003