**M.Sc. (MATHEMATICS) Part I**

Outlines of Tests, Syllabi and Courses of Reading

**(Sessions 2018-19)**

**CBCS**

**SEMESTER-1**

**CORE SUBJECTS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Title of Paper/Subject** | **Hrs/Week** | **Max Cont. Asmt.** | **Marks Univ Exam** | **Total** |
| MM-401 | Algebra-I | 6 | 25 | 75 | 100 |
| MM-402 | Mathematical Analysis | 6 | 25 | 75 | 100 |
| MM-403 | Topology-I | 6 | 25 | 75 | 100 |
| MM-404 | Differential Geometry | 6 | 25 | 75 | 100 |

**ELECTIVE SUBJECTS (Select any One)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Title of Paper/Subject** | **Hrs/Week** | **Max Cont. Asmt.** | **Marks Univ Exam** | **Total** |
| MM-405 (A)  MM-405 (B) | Computer Programming Using C-Language  Software Lab | 4  4 | 15  10 | 60  15 | 75  25 |
| MM-406 | Mathematical Statistics | 6 | 25 | 75 | 100 |
| MM-407 | Linear Programming | 6 | 25 | 75 | 100 |

**SEMESTER-II**

**CORE SUBJECTS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Title of Paper/Subject** | **Hrs/Week** | **Max Cont. Asmt.** | **Marks Univ Exam** | **Total** |
| MM-501 | Algebra- II (Rings and Modules) | 6 | 25 | 75 | 100 |
| MM-502 | Topology-II | 6 | 25 | 75 | 100 |
| MM-503 | Differential Equations-I | 6 | 25 | 75 | 100 |
| MM-504 | Functional Analysis | 6 | 25 | 75 | 100 |

**ELECTIVE SUBJECTS (Select any One)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Title of Paper/Subject** | **Hrs/Week** | **Max Cont. Asmt.** | **Marks Univ Exam** | **Total** |
| MM-505 | Complex Analysis | 6 | 25 | 75 | 100 |
| MM-506 | Classical Mechanics | 6 | 25 | 75 | 100 |
| MM-507 | Numerical Analysis | 6 | 25 | 75 | 100 |

**MM 401: ALGEBRA - I**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION-A**

Review of groups, subgroups, cosets, normal subgroups, quotient groups, homomorphisms and isomorphism theorems.Normal and subnormal series, Solvable groups, Nilpotent groups, Composition Series, Jordan-Holder theorem for groups. Group action, Stabilizer, orbit, Review of class equation, permutation groups, cyclic decomposition, Alternating group An, Simplicity of An.

*SECTION-B*

Structure theory of groups, Fundamental theorem of finitely generated abelian groups, Invariants of a finite abelian group, Sylow’s theorems, Groups of order p2, pq. Review of rings and homorphism of rings, Ideals, Algebra of Ideals, Maximal and prime ideals, ideal in Quotient rings, Field of Quotients of integral Domain.

**Books Recommended**

1. Bhattacharya, Jain & Nagpaul : Basic Abstract Algebra, Second Edition (Ch. 6, 7, 8, 10)
2. Surjeet Singh, Qazi Zameeruddin : Modern Algebra
3. I.N. Herstein : Topics in Algebra, Second Edition

**MM 402: MATHEMATICAL ANALYSIS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

SECTION-A

Functional of several variables: Linear transformations, Derivatives in an open subset of **Rn** , Chain Rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor’s theorem, Inverse function theorem, Implicit function theorem. Algebras, σ- algebra, their properties, General measurable spaces, measure spaces, properties of measure, Complete measure, Lebesgue outer measure and its properties, measurable sets and Lebesque measure, A non measurable set.

##### SECTION-B

Measurable function w.r.t. general measure. Borel and Lebesgue measurability. Integration of non-negative measurable functions, Fatou’s lemma, Monotone convergence theorem, Lebesgue convergence theorem, The general integral, Integration of series, Riemann and lebesgue integrals. Differentiation; Vitalis Lemma, The Dini derivatives, Functions of bounded variation, Differentiation of an Integral, Absolute Continuity, Convex Fucntions and Jensen’s inequality.

### Book Recommended

1. H.L. Royden: Real analysis, Macmillan Pub. co. Inc. 4th Edition, New York, 1993. Chapters 3, 4, 5 and Sections 1 to 4 of Chapter 11.
2. Walter Rudin: Principles of Mathematical Analysis, 3rd edition, McGrawHill, Kogakusha, 1976, International student edition. Chapter 9 (Excluding Sections 9.30 to 9.43)

**MM 403: TOPOLOGY I**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION A**

Cardinals: Equipotent sets, Countable and Uncountable sets, Cardinal Numbers and their Arithmetic, Bernstein’s Theorem and the Continumm Hypothesis.

Topological Spaces: Definition and examples, Euclidean spaces as topological spaces, Basis for a given topology, Topologizing of Sets; Sub-basis, Equivalent Basis.

Elementary Concepts: Closure, Interior, Frontier and Dense Sets, Topologizing with pre-assigned elementary operations. Relativization, Subspaces.

Maps and Product Spaces: Continuous Maps, Restriction of Domain and Range, Characterization of Continuity, Continuity at a point, Piecewise definition of Maps and Neighborhood finite families. Open Maps and Closed Maps, Homeomorphisms and Embeddings.

###### SECTION B

Cartesian Product Topology, Elementary Concepts in Product Spaces, Continuity of Maps in Product Spaces and Slices in Cartesian Products.

Connectedness: Connectedness and its characterizations, Continuous image of connected sets, Connectedness of Product Spaces, Applications to Euclidean spaces. Components, Local Connectedness and Components, Product of Locally Connected Spaces. Path Connectedness.

Compactness and Countability: Compactness and Countable Compactness, Local Compactness, One-point Compactification, T­0, T1, and T2 spaces, T2 spaces and Sequences and Hausdorfness of One-Point Compactification.

Axioms of Countablity and Separability, Equivalence of Second axiom, Separable and Lindelof in Metric Spaces. Equivalence of Compact and Countably Compact Sets in Metric Spaces.

###### Books Recommended

1. W.J. Pervin Foundations of General Topology, Ch. 2 (Sections 2.1, 2.2), Section 4.2, and Ch 5 (Sec 5.1 to 5.3).
2. James Dugundji : TOPOLOGY. Relevant Portions from Ch.III (excluding Sec 6 and Sec 10) , Ch IV; (Sections 1-3) and ChV

#### *MM 404: DIFFERENTIAL GEOMETRY*

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION-A**

A simple arc, Curves and their parametric representation, are length and natural parameter, contact of curves, Tangent to a curve, osculating plane, Frenet trihedron, Curvature and Torsion, Serret Frenet formulae, fundamental theorem for spaces curves, helices, contact between curves and surfaces. Evolute and involute, Bertrand Curves, spherical indicatrix, implicit equation of the surface, Tangent plane, the first fundamental form of a surface, length of tangent vector and angle between two tangent vectors, area of a surface.

**SECTION-B**

The second fundamental form, Gaussian map and Gaussian curvature, Gauss and Weingarten formulae, Codazzi equation and Gauss theorem, curvature of a curve on a surface, geodesic curvature. Geodesics, Canonical equations of geodesic, Normal properties of geodesics. Normal Curvature, principal curvature, Mean Curvature, principal directions, lines of curvature, Rodrigue formula, asymptotic Lines, conjugate directions, envelopes, developable surfaces associated with spaces curves, minimal surfaces, ruled surfaces.

**Books Recommended**

1. A. Goetz: Introduction to differential geometry.

2. T.J. Willmore :An introduction to differential geometry.

**MM-405(A): Computer Programming using C**

L T P University Exam: 60

4 0 0 Internal Assessment: 15

Time Allowed: 3 hours Total: 75

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION -A**

Problem Identification, Analysis, Flowcharts, Decision tables, Pseudo codes and algorithms, Program coding, Program Testing and execution, Modular Programming, Top-down and Bottom-up Approaches.

Need of programming languages. C character set, Identifiers and keywords, Data types, Declarations, Statement and symbolic constants, Input-output statements, Preprocessor commands,

**Operators and Expressions**: Arithmetic, relational, logical, unary operators, others operators, Bitwise operators: AND, OR, complement precedence and Associating bitwise shift operators, Input-Output: standard, console and string functions

**Control statements:** Branching, looping using for, while and do-while Statements, Nested control structures, switch, break, continue statements.

**SECTION-B**

**Functions**: Declaration, Definition, Call, passing arguments, call by value, call by reference, Recursion, Use of library functions; Storage classes: automatic, external and static variables.

**Arrays**: Defining and processing arrays, Passing array to a function, Using multidimensional arrays, Solving matrices problem using arrays.

**Strings:** Declaration, Operations on strings.

Pointers: Pointer data type, pointers and arrays, pointers and functions.

Structures: Using structures, arrays of structures and arrays in structures, union

**Books Recommended**

1. Norton Peter, Introduction to Computers, Tata McGraw Hill (2005).
2. Computers Today: Suresh K. Basandra, Galgotia, 1998.
3. Kerninghan B.W. and Ritchie D.M., The C programming language, PHI (1989)
4. Kanetkar Yashawant, Let us C, BPB (2007).
5. Rajaraman V., Fundamentals of Computers, PHI (2004).
6. Shelly G.B., Cashman T.J., Vermaat M.E., Introduction to computers, Cengage India Pvt Ltd (2008).

**MM-405(B): SOFTWARE LABORATORY (C-Programming)**

L T P University Exam: 15

0 0 4 Internal Assessment: 10

Time Allowed: 3 hours Total: 25

This laboratory course will mainly comprise of exercises on what is learnt under the paper," Computer Programming using C".

**MM-406 MATHEMATICAL STATISTICS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

SECTION-A

Algebra of sets, fields, limits of sequences of subsets, sigma-fields generated by a class of subsets. Probability measure on a sigma-field, probability space. Axiomatic approach to probability.

Real random variables, distribution functions , discrete and continuous random variables, decomposition of a distribution function, Independence of events. Expectation of a real random variable. Linear properties of expectations, Characteristic functions, their simple properties

**Discrete probability distributions**: Binomial distribution, Poisson distribution, negative binomial distribution, geometric distribution, Hypergeometric distribution, power series distribution.

**Continuous probability distributions**: Normal distribution, rectangular distribution, gamma distribution, beta distribution of first and second kind, exponential distribution. distribution of order statistics and range.

**SECTION- B**

***Theory of Estimation:*** Population, sample, parameter and statistic, sampling distribution of a statistic, standard error. Interval estimation, Methods of estimation, properties of estimators, confidence intervals.

***Exact Sampling Distributions:*** Chi-square distribution, Student’s t distribution, Snedecor’s F-distribution, Fisher’s – Z distribution .

***Hypothesis Testing:*** Tests of significance for small samples, Null and Alternative hypothesis , Critical region and level of significance. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Tests of significance based on t, Z and F distributions, Chi square test of goodness of fit. Large Sample tests, Sampling of attributes, Tests of significance for single proportion and for difference of proportions, Sampling of variables, tests of significance for single mean and for difference of means and for difference of standard deviations.

**Books Recommended** :

1. Goon, A. M., Gupta, M. K., & Dasgupta, B. (2003). *An outline of statistical theory(Vol 1 & 2)*. World Press Pvt Limited.

2. Lehmann, E. L., & Casella, G. (1998). *Theory of point estimation* (Vol. 31). Springer

Science & Business Media.

1. Lehmann, E. L., & Romano, J. P. (2006). *Testing statistical hypotheses*. Springer Science & Business Media.
2. Rohatgi, V. K., & Saleh, A. M. E. (2011). *An introduction to probability and statistics*. John Wiley & Sons.

**MM-407- LINEAR PROGRAMMING**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%. Use of scientific calculator is allowed.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C. Use of scientific calculator is allowed.

**Section-A**

Linear programming problems (LPPs); Examples, Mathematical formulation, Graphical solution, Solution by Simplex method, artificial variables, Big-M method and two phase simplex method. Duality in linear programming; Concept, Mathematical formulation, fundamental properties of duality, duality and simplex method and dual simplex method. Sensitivity Analysis: Discrete changes in the cost vector, requirement vector and Co-efficient matrix.

**Section -B**

Transportation problem ; initial basic feasible solution and Optimal solutions using MODI method (for balanced cases only), Assignment problem; solution of balanced and unbalanced assignment problems, maximization case in assignment problem. Sequencing Problems; General Assumptions, Processing n jobs through m machines. Replacement decisions; O.R methodology of solving replacement problems, Replacement of items that deteriorates with time without and with change in the money value.

**TEXT BOOKS**

1. Kanti Swarup, P.K. Gupta and Manmohan : ‘Operations Research’, Sultan Chand   
and Sons, New Delhi, Ed. 1996.

2. V.K. Kapoor: 'Operations Research', Sultan Chand and Sons.

**RECOMMENDED READING**

1. Kasana, H.S. and Kumar K.D. : Introductory Operations Research, SIE 2003

**MM 501: ALGEBRA-II (RINGS AND MODULES)**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION-A**

Unique Factorization Domains, Principal Ideal Domains, Euclidean Domains, Polynomial Rings over UFD, Rings of Fractions. (RR1: Ch. 11 and Section 1 of Chapter 12).

Modules: Definition and Examples, Submodules, Direct sum of submodules, Free modules, Difference between modules and vector spaces, Quotient modules, Homomorphism, Simple modules, Modules over PID. (RR2: Chapter 5)

**SECTION - B**

Modules with chain conditions: Artinian Modules, Noetherian Modules, composition series of a module, Length of a module, Hilbert Basis Theorem (RR2: Chapter 6).

Cohen Theorem, Radical Ideal, Nil Radical, Jacobson Radical, Radical of an Artinian ring. (RR2: Chapter 6)

**Books Recommended**

1. Bhattacharya, Jain and Nagpaul: Basic Abstract Algebra, Second Edition.

2. Musili C., Introduction to Rings and Modules, Second Revised Edition.

**MM 502: TOPOLOGY II**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION-A**

Ordinal Numbers : Order types, Product of Order types, Well Ordered Sets, Similarity Mapping, Ordinal Numbers, Principle of Transfinite Induction, Comparability theorems of ordinal and cardinal numbers, Well Ordering of Ordinal Numbers, The first infinite and the first uncountable Ordinal, Statement of Well Ordering Theorem, Axiom of Choice and Zorn’s Lemma. Burali-Forti Paradox. Crucial property of the first uncountable ordinal.

Higher Separation Axioms : Regular, Completely Regular, Normal and Completely Normal Spaces. Metric Spaces as Completely Normal T2 Spaces. Urysohns Lemma and The Tietze Extension Theorem. Point finite and Locally Finite families.

Products : Products of first countable, Regular, T2 and Completely Regular Spaces. Non invariance of normality under products. Embedding of Tichonov spaces into parallelotope and the Stone Cech Compactification.

**SECTION –B**

Nets and Filters : Nets and Subnets,Convergence and Clustering of a net,Closures and Nets, Nets and Continuity, Nets in Products, Ultrafilter, Relationship between Nets and Filters, Nets and Filter Characterization of Compactness and The Tychonoff Theorem.

Identification Topology: Identification Topology,Identification Map,Subspaces,General Theorem,Transgression,Transitivity Spaces with Equivalance Relation,Quotient Spaces.Cones and Suspensions,Attaching of Spaces, Adjunction Space,The relation K(f) for continous maps and Weak Topologies.

###### Books Recommended

1. W.J. Pervin : Foundations of General Topology, (Sections 2.3 to 2.5), Section 5.5 to 5.6
2. Stephen Willard : GENERAL TOPOLOGY Ch 4 (excluding section 10), Ch 6 (Theorems 17.4 and 17.8 only)
3. James Dugundji : TOPOLOGY. Chapter VI,VII (1.3(3), 2.3(2), 3.3(3), 7.2 to 7.4 only and theorem 8.2 of Chapter XI)

**MM 503: DIFFERENTIAL EQUATIONS-I**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION- A**

Existence of solution of ODE of first order, initial value problem, Ascoli’s Lemma, Gronwall’s inequality, Cauchy Peano Existence Theorem, Uniqueness of Solutions. Method of successive approximations, Existence and Uniqueness Theorem. System of differential equations, nth order differential equation, Existence and Uniqueness of solutions, dependence of solutions on initial conditions and parameters.

**SECTION- B**

Linear system of equations (homogeneous & non homogeneous). Superposition principle, Fundamental set of solutions, Fundamental Matrix, Wronskian, Abel Liouville formula, Reduction of order, Adjoint systems and self adjoint systems of second order, Floquet Theory. Linear 2nd order equations, preliminaries, Sturm’s separation theorem, Sturm’s fundamental comparison theorem, Sturm Liouville boundary value problem, Characteristic values & Characteristic functions, Orthogonality of Characteristic functions, Expansion of a function in a series of orthonormal functions.

**Books Recommended**

1. E. Coddington & N. Levinson, Theory of Ordinary Differential Equations, Tata Mc-Graw Hill, India

2. S.L. Ross, Differential Equations, 3rd edition, John Wiley & sons (Asia).

3. D.A. Sanchez, Ordinary Differential Equations & Stability Theory, Freeman & company.

4. A.C. King, J. Billingham, S.R. Otto, Differential Equations, Linear, Nonlinear, Ordinary, Partial, Cambridge University Press.

**MM 504: FUNCTIONAL ANALYSIS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

## SECTION-A

Normed Linear spaces, Banach spaces, Examples of Banach spaces and subspaces. Continuity of Linear maps, Equivalent norms. Normed spaces of bounded linear maps. Bounded Linear functional. Hahn-Banach theorem in Linear Spaces and its applications.

Hahn-Banach theorem in normed linear spaces and its applications.Uniform boundedness principle, Open mapping theorem, Projections on Banach spaces, Closed graph theorem.

SECTION-B

The conjugate of an operator. Dual spaces of lp and C [a,b], Reflexivity. Hilbert spaces, examples, Orthogonality, Orthonormal sets, Bessel's inequality, Parseval's theorem. The conjugate space of a Hilbert spaces. Adjoint operators, Self-adjoint operators, Normal and unitary operators. Projection operators. Spectrum of an operator, Spectral Theorem, Banach Fixed Point Theorem, Brower's Fixed Point Theorem. Schauder Fixed Point Theorem, Picards Theorem. Applications of Fixed point theorem in differential equations and integral equations.

**Books Recommended**

1. G.F.Simmons : Introduction to Toplogy and modern Analysis, Chapters IX, X , XII

and appendix one.

**Reference Books**

1. George Bachman & Lawrence Narici: Functional Analysis.

2. E. Kreyszig, Introductory Functional Analysis with applications

3. Abul Hasan Siddiqi , Applied Functional Analysis. Marcel Dekker.

**MM 505: COMPLEX ANALYSIS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25 Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION-A**

Function of complex variable, Analytic function, Cauchy-Riemann equations, Harmonic function and Harmonic conjugates, Branches of multivalued functions with reference to arg z, logz and , Conformal Mapping. Complex Integration, Cauchy’s theorem, Cauchy Goursat theorem Cauchy integral formula, Morera’s theorem, Liouville's theorem, Fundamental theorem of Algebra, Maximum Modulus Principle. Schwarz lemma.

**SECTION-B**

Taylor’s theorem. Laurent series in an annulus. Singularities, Meromorphic function. Cauchy’s theorem on residues. Application to evaluation of definite integrals. Principle of analytic continuation, General definition of an analytic function. Analytic continuation by power series method, Natural boundary, Harmonic functions on a disc, Schwarz Reflection principle, Mittag-Leffler’s theorem (only in case when the set of isolated singularities admits the point at infinity alone as an accumulation point).

**Books Recommended**

1. L.V.Ahlfors, Complex Analysis, 3rd edition.

2. E.T.Copson, An introduction to Theory of Functions of a Complex Variable

3 H.S. Kasana, Complex Variables, Prentice Hall of India

4. Herb Silverman, Complex Variables, Houghton Mifflin Company Boston

### MM 506-CLASSICAL MECHANICS

L T P University Exam:75

5 1 0 Internal Assessment : 25

Time Allowed : 3 hours Total : 100

###### INSTRUCTIONS FOR THE PAPER – SETTER

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

##### SECTION-A

**Basic Principles**: Mechanics of a Particle and a System of Particles, Constraints , Generalized Coordinates, Holonomic and Non-Holonomic Constraints. D’AlembertsPriciple and Lagrange’s Equations, Velocity Dependent Potentials and the Dissipation Function, Simple Applications of the Lagrangianformulation.

**Variational Principles and Lagrange’s Equations**: Hamilton’s Principle, Derivation of Lagrange’s Equations from Hamilton’s Principle, Extension of Hamilton’s Principle to Non-Holonomic Systems.

**Conservation Theorems and Symmetry Properties**: Cyclic Coordinates, Canonical Momentum and its Conservation, The Generalized Force, and Angular Momentum Conservation Theorem.

**The Two-Body Central Force Problem**: Reduction to the Equivalent One-Body Problem, The Equation of Motion, The Equivalent One Dimensional Problem and the Classification of Orbits, The Virial Theorem, Conditions for Closed Orbits, Bertrand’s Theorem.

###### SECTION - B

**The Kepler Problem**: Inverse Square Law of Force, The Motion in Time in the Kepler Problem, Kepler’s Laws, Kepler’s Equation, The Laplace-Runge-Lenz Vector.

**Scattering in a Central Force Field**: Cross Section of Scattering, Rutherford Scattering Cross Section, Total Scattering Cross Section, Transformation of the Scattering Problem to Laboratory Coordinates.

**The Kinematics of Rigid Body Motion**: The Independent Coordinates of Rigid Body, The Transformation Matrix, The Euler Angles, The Cayley-Klein Parameters and Related Quantities, Euler’s Theorem on the Motion of Rigid Bodies, Finite Rotations, Infinitesimal Rotations, The Coriolis Force.

###### BOOKS RECOMMENDED

1. Herbert Goldstein: Classical Mechanics

**MM 507: NUMERICAL ANALYSIS**

L T P University Exam:75

5 1 0 Internal Assessment : 25

Time Allowed : 3 hours Total : 100

###### INSTRUCTIONS FOR THE PAPER – SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%. Use of scientific calculator is allowed.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C. Use of scientific calculator is allowed.

##### SECTION-A

**Solution of Differential Equations**: Tayler's series, Euler's method, Improved Euler method, Modified Euler method, and Runge-Kutta methods (upto fourth order), Predictor Corrector methods. Stability and convergence of Runge-Kutta and Predictor Corrector Methods.

**Parabolic Equation:** Explicit and Implicit schemes for solution of one dimensional equations, Crank-Nicolson, Du fort and Frankel schemes for one dimension equations. Discussion of their compatibility, stability and convergence.Peaceman-Rachford A.D.I. scheme for two dimensional equations.

**SECTION - B**

**Elliptic Equation:** Finite difference replacement and reduction to block tridiagonal form and its solution; DIrichlet and Neumann boundary conditions. Treatment of curved boundaries; Solution by A.D.I. method.

**Hyperbolic equations:** Solution by finite difference methods on rectangular and characteristics grids and their stability.**Approximate methods:** Methods of weighted residual, collocation, Least-squares and Galerkin' s methods. Variational formulation of a given boundary value problem, Ritz method. Simple examples from ODE and PDE.

###### BOOKS RECOMMENDED

1. Smith, G D, Numerical solution of partial differential equations, Oxford Univ. Press (1982).

2. R.S. Gupta, Elements of Numerical Analysis, Macmillan India Ltd., 2009.

3. Mitchell, A. R., Computational methods in partial differential equations, John Wiley (1975).

4. Froberg, C. E., Introduction to Numerical Analysis, Addision-Wesley, Reading, Mass (1969).

5. Gerald, C. F., Applied Numerical Analysis Addision Wesley, Reading, Mass (1970).

6. Jain, M. K., Numerical solutions of Differential equations, John Wiley (1984).

7. Collatz, L., Numerical Treatment of Differential Equations, Springer - Verlag, Berlin (1966)

**SYLLABUS**

**M.Sc. Mathematics (Part – II)**

**Session 2018-19**

**Third Semester**

**LIST OF ELECTIVES (Any five of the followings)**

MM 601 : DIFFERENTIABLE MANIFOLDS

MM 602 : FIELD THEORY

MM 603 : DIFFERENTIAL EQUATIONS -II

MM 604 : CATEGORY THEORY - I

MM 605 : NUMERICAL ANALYSIS-I

MM 606 : COMPLEX ANALYSIS - II

MM 607 : CLASSICAL MECHANICS

MM 608 : ALGEBRAIC TOPOLOGY

MM 609 : ANALYTIC NUMBER THEORY

MM 610 : OPTIMIZATION TECHNIQUES-I

MM 611 : FUZZY SETS AND APPLICATIONS

MM 612 : SOLID MECHANICS

MM 613: MATHEMATICAL METHODS

**Fourth Semester**

**LIST OF ELECTIVES (Any five of the followings)**

MM 701: HOMOLOGY THEORY

MM 702: THEORY OF LINEAR OPERATORS

MM 703: GEOMETRY OF DIFFERENTIABLE MANIFOLDS

MM 704: CATEGORY THEORY – II (Prerequisite: Category Theory –I)

MM 705: OPTIMIZATION TECHNIQUES-II

MM 706: HOMOLOGICAL ALGEBRA (Prerequisite: Category Theory –I)

MM 707: FINITE ELEMENTS METHODS

MM 708: FLUID MECHANICS

MM 709: ALGEBRAIC CODING THEORY

MM 710: COMMUTATIVE ALGEBRA

MM 711: OPERATIONS RESEARCH

MM 712: WAVELETS

MM 713: NON LINEAR PROGRAMMING

MM 714: NUMERICAL ANALYSIS-II

**MM 601: DIFFERENTIABLE MANIFOLDS**

L T P University Marks: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections A, B and C. Sections A and B will have four

questions from the respective sections of the syllabus and Section C will consist of one

compulsory question having ten short answer type questions covering the entire syllabus

uniformly. The weightage of Section A and B will be 30% and that of Section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each section

A and B and compulsory question of Section C.

**SECTION-A**

Differentiable Manifolds, examples of differentiable manifolds, Differentiable maps on

manifolds, tangent vectors and tangent space, cotangent space, Vector Fields, Lie-bracket of

vector fields. Jacobian of a map. Integral curves, Immersions and embeddings. Tensors and forms. Exterior product and Grassman algebra, Connections, Difference tensor, existence of parallelism and geodesics, covariant derivative, exterior derivative , Contraction, Lie-derivative.

**SECTION-B**

Torsion tensor and curvature tensor of a connection, properties of torsion and curvature tensor,

Bianchi's identities, Structure equations of Cartan. Riemannian manifolds, Fundamental theorem

of Riemannian geometry, Riemannian connection. Riemannian curvature tensor and its properties. Bianchi's identities, Sectional curvature, Theorem of Schur. Sub-manifolds and hyper-surfaces, Normals, induced connection, Gauss and Weingartan formulae.

**BOOKS RECOMMENDED:**

1. Y. Matsushima : Differentiable Manifolds, Marcel Dekker, Inc. New York , 1972.

2. U.C. De : Differential Geometry of Manifolds, Alpha Science Int. Ltd., Oxford,U.K.

3. Hicks, N. J. : Notes on Differential Geometry (Relevant Portion), Van Nostrand

Reinhold Company, New York and Canada.

**MM 602: FIELD THEORY**

L T P University Exam: 75

5 1 0 Internal Assessments: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answer covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections

A and B and compulsory question of section C.

**SECTION –A**

Fields, examples, Algebraic and transcendental elements, Irreducible polynomials. Gauss

Lemma, Eisenstein's criterion, Adjunction of roots, Kronecker's theorem, algebraic extensions,

algebraically closed fields. Splitting fields, Normal extensions, multiple roots, finite fields, Separable extensions, perfect fields, primitive elements, Lagrange's theorem on primitive elements.

**SECTION – B**

Automorphism groups and fixed fields, Galois extensions, Fundamental theorem of Galois theory, Fundamental theorem of algebra, Roots of unity and cyclotomic polynomials. Cyclic extension, Polynomials solvable by radicals, Symmetric functions, cyclotomic extension, quintic equation and solvability by radicals.

**BOOKS RECOMMENDED**

1. Bhattacharya & Jain: Basic abstract algebra (Chapters 15-17, Chapter and Nagpaul 18 :

excluding section 5)

2. M. Artin: Algebra

**MM 603-Differential Equations –II**

L T P University Exam: 75

5 1 0 Internal Assessments: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answer covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections

A and B and compulsory question of section C.

**SECTION- A**

Existence and uniqueness of solutions of first order differential equations for complex systems.

Maximum and minimum solution. Caratheodory theorem. Continuation of solution. Uniqueness of solutions and Successive approximations. Variation of Solutions.

**SECTION- B**

Partial Differential Equations: Occurrence and elementary solution of Laplace equation. Family

of equipotential surface. Interior and exterior Dirichlet boundary value problem for Laplace

equation. Separation of Variables. Axial symmetry, Kelvin’s inversionn theorem. Green’s function for Laplace equation. Dirichlet’s problem for semi infinite space and for a sphere. Copson’sTheorem (Statement only)

**References**

1. E.Coddington& N. Levinson, Theory of Ordinary Differential Equations, Tata Mc-Graw

Hill, India.

2. Simmons G.F., Differential Equations with Applications and Historical Notes, Tata

McGraw Hill (1991).

3. Sneddon I.N., Elements of Partial Differential Equations, Tata McGraw Hill (1957).

**MM 604**: **CATEGORY THEORY - I**

L T P University Exam: 75

5 1 0 Internal Assessment: 25 Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR SETTERTHE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answers covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each sections A and B and compulsory question of section C.

**SECTION – A**

**Categories:** Introduction with Functions of Sets, Definition and examples of Categories: Sets, Pos, Rel, Mon, Groups, Top, Dis (X),. Finite Category, Abstract Mappings, Additive Categories, The category of modules, The concept of functor and the category Cat, Functors of several variables. Isomorhism. Constructions: Product of two categories, The Dual Category, The Arrow Category, The Slice and Co- Slice Category.

**Free Categories:** Free Monoids and their Universal Mapping Property, The category Graphs, the category C (G) generated by a graph, Homomorphism of Graphs and the Universal Mapping Property of C (G).

**Abstract Structures:** Epis and mono, Initial and Terminal objects, Generalized elements, Sections and Retractions, Product diagrams and their Universal Mapping Property, Uniqueness up to isomorphism, Examples of products: Product of Sets, Product in Cat, Poset, Product in Top. Categories with Products, Hom-Sets, Covariant representable functors, Functors preserving binary product. (R.R 1: Chapter 2 excluding example 6 of section 2.6)

**SECTION –B**

**Duality:** The duality principle, Formal duality, Conceptual duality, Coproducts, Examples in Sets, Mon, Top, Coproduct of monoids, of Abelian Groups and Coproduct in the category of Abelian Groups. Equalizers, Equalizers as a monic, Coequalizers, Coequalizers as an epic. Coequalizer diagram for a monoid.

**Limits and Co-limits:** Subojects, Pullbacks, Properties of Pullbacks, Pullback as a functor, Limits, Cone to a diagram, limit for a diagram, Co-cones and Colimits. Preservation of limits, contra variant functors. Direct limit of groups. Functors Creating limits and co-limits.

**Naturality** : Exponential in a category, Cartesian Closed categories, Category of Categories, Representable Structure, Stone Duality; ultrafilters in Booleanm Algebra, Naturality, Examples of natural transformations.

**RECOMMENDED BOOKS**

1.Steven Awodey: Category Theory, (Oxford Logic Guides, 49, Oxford University Press.) Chapter 1 to 3 Excluding Example 6 of Sec 2.6 and Chapter 5 and Sections 6.1, 6.2 and Chapter 7; Sections 7.1 to 7.5).

**MM 605: NUMERICAL ANALYSIS-I**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

**Solution of Differential Equations**: Tayler's series, Euler's method, Improved Euler method,

Modified Euler method, and Runge-Kutta methods (upto fourth order), Predictor Corrector

methods. Stability and convergence of Runge-Kutta and Predictor Corrector Methods.

**Parabolic Equation:** Explicit and Implicit schemes for solution of one dimensional equations,

Crank-Nicolson, Du fort and Frankel schemes for one dimension equations. Discussion of their

compatibility, stability and convergence.Peaceman-Rachford A.D.I. scheme for two dimensional

equations.

**SECTION-B**

**Elliptic Equation:** Finite difference replacement and reduction to block tridiagonal form and its

solution; DIrichlet and Neumann boundary conditions. Treatment of curved boundaries; Solution

by A.D.I. method.

**Hyperbolic equations:** Solution by finite difference methods on rectangular and characteristics

grids and their stability.**Approximate methods:** Methods of weighted residual, collocation,

Least-squares and Galerkin' s methods. Variational formulation of a given boundary value

problem, Ritz method. Simple examples from ODE and PDE.

**RECOMMENDED BOOKS**

1. Smith, G D, Numerical solution of partial differential equations, Oxford Univ. Press (1982).

2. R.S. Gupta, Elements of Numerical Analysis, Macmillan India Ltd., 2009.

3. Mitchell, A. R., Computational methods in partial differential equations, John Wiley (1975).

4. Froberg, C. E., Introduction to Numerical Analysis, Addision-Wesley, Reading, Mass

(1969).

5. Gerald, C. F., Applied Numerical Analysis Addision Wesley, Reading, Mass (1970).

6. Jain, M. K., Numerical solutions of Differential equations, John Wiley (1984).

7. Collatz, L., Numerical Treatment of Differential Equations, Springer - Verlag, Berlin (1966)

**MM 606-COMPLEX ANALYSIS–II**

L T P University Exam: 75

5 1 0 Internal Assessments: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answer covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections

A and B and compulsory question of section C.

**SECTION-A**

Normal families of analytic functions. Montel's theorem, Hurwitz's theorem, Riemann Mapping

theorem, Univalent functions. Distoration and growth theorems for the class S of normalized

univalent functions.Koebe 1/4 theorem.Bieberbach Conjecture (statement only) Littlewood's

inequality for the class S. Coefficient inequalities for functions in S in case of real coefficients

only. Principle of analytic continuation, The general definition of an analytic function. Analytic

continuation by power series method.Natural boundary.Schwarz reflection principle, Monodromy theorem.Mittag-Leffler's theorem (only in the case when the set of isolated

singularities admits the point at infinity alone as an accumulation point). Cauchy's method of

expansion of meromorphic functions. Partial fraction decomposition of cosec Z, Representation

of an integral function as an infinite product.Infinite product for sin z.

**SECTION-B**

The factorization of integral functions.Weierstrass theorem regarding construction of an integral

function with prescribed zeros. The minimum modules of an integral function.Hadamard's three

circle theorem.The order of an integral function. Integral functions of finite order with no zeros.

Jensen's inequality.Exponent of convergence.Borel's theorem on canonical products.Hadmard's

factorization theorem. Basic properties of harmonic functions, maximum and minimum principles, Harmonic functions on a disc.Harnack's inequality and theorem.Subharmonic and superharmonic functions.Dirichlet problem.Green's function.

**RECOMMENDED BOOKS**

1. Zeev Nihari : Conformal Mapping, Chap.III (section 5), Chap.lV, Chap.V (pages173-178, 209-220)

2. G. Sansone and : Lectures on the theory of functions ofJ. Gerretsen a complex variable, sections 4.11.1 and 4.11.2 only.

3. J. B. Conway : Functions of one complex variable. Springer-vertag-Internationalstudent edition, Narosa Publishing House, 1980 (Chap.X only)

4. E. T. Copson : Theory of Functions of a Complex Variable (OxfordUniversityPress), Chapter IV (4.60, 4.61, 4.62) Chap. VII (excl. Section 7.7) Chap.VIII (Section 8.4)

**MM 607-CLASSICAL MECHANICS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answer covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections

A and B and compulsory question of section C.

**SECTION-A**

**Basic Principles**: Mechanics of a Particle and a System of Particles, Constraints , Generalized

Coordinates, Holonomic and Non-Holonomic Constraints. D’AlembertsPriciple and Lagrange’s

Equations, Velocity Dependent Potentials and the Dissipation Function, Simple Applications of

the Lagrangianformulation.

**Variational Principles and Lagrange’s Equations**: Hamilton’s Principle, Derivation of

Lagrange’s Equations from Hamilton’s Principle, Extension of Hamilton’s Principle to Non-

Holonomic Systems.

**Conservation Theorems and Symmetry Properties**: Cyclic Coordinates, Canonical Momentum and its Conservation, The Generalized Force, and Angular Momentum Conservation

Theorem.

**The Two-Body Central Force Problem**: Reduction to the Equivalent One-Body Problem, The

Equation of Motion, The Equivalent One Dimensional Problem and the Classification of Orbits,

The Virial Theorem, Conditions for Closed Orbits, Bertrand’s Theorem.

**SECTION –B**

**The Kepler Problem**: Inverse Square Law of Force, The Motion in Time in the Kepler Problem,

Kepler’s Laws, Kepler’s Equation, The Laplace-Runge-Lenz Vector.

**Scattering in a Central Force Field**: Cross Section of Scattering, Rutherford Scattering Cross

Section, Total Scattering Cross Section, Transformation of the Scattering Problem to Laboratory

Coordinates.

**The Kinematics of Rigid Body Motion**: The Independent Coordinates of Rigid Body, The

Transformation Matrix, The Euler Angles, The Cayley-Klein Parameters and Related Quantities,

Euler’s Theorem on the Motion of Rigid Bodies, Finite Rotations, Infinitesimal Rotations, The

Coriolis Force.

**RECOMMENDED BOOKS**

1. Herbert Goldstein: Classical Mechanics

**MM 608: ALGEBRAIC TOPOLOGY**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answer covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections

A and B and compulsory question of section C.

**SECTION A**

The Fundamental group: Homotopy of paths, Homotopy classes, The Fundamental group, change of base point, Topological invariance, covering spaces, The Fundamental group of the

circle. Retractions and fixed points, No Retraction Theorem, The Fundamental theorem of Algebra, The Borsuk - Ulam theorem, The Bisection theorem, Deformation Retracts and Homotopy type, Homotopy invariance.

**SECTION B**

Direct sums of Abelian Groups, Free products of groups, uniqueness of free products, least

normal subgroup, free groups, generators and relations, The Seifert-Van Kampen theorem, also

classical version, The Fundamental group of a wedge of circles.Classification of covering spaces: Equivalence of covering spaces, The general lifting lemma, the universal covering space, covering transformation, existence of covering spaces.

**BOOKS RECOMMENDED**

James R. Munkres: Topology, Pearson Prentice Hall, Chapter – 9(51-58), Chapter –11(67-71),

Chapter - 13 (79-82).

**MM 609-ANALYTIC NUMBER THEORY**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION -A**

Arithmetical functions: Mobius function, Euler’s totient function, Mangoldt function,

Liouville’s function, The divisor functions, Relation connecting and , product formula for

(n), Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion

formula, Multiplicative functions, Dirichlet multiplication, The inverse of a completely

multiplicative function, Generalized convolutions. Averages of arithmetical functions: The big oh notation, Asymptotic equality of functions, Euler’s summation formula, Elementary asymptotic formulas, Average order of d(n), (n),(n), (n), n), The Partial sums of a Dirichlet product, applications to (n) and (n), Legendre’s identity.

**SECTION -B**

Some elementary theorems on the distribution of prime numbers: Chebyshev’s functions (x)

&(x), Relation connecting (x) and (x), Abel’s identity, equivalent forms of Prime number

theorem, inequalities for (n) and Pn, Shapiro’s Tauberian theorem, applications of Shapiro’s

theorem, Asymptotic formula for the partial sums px(1/p). Elementary properties of groups , Characters of finite abelian groups, The character group, Orthogonality relations for characters, Dirichlet characters, Dirichlet’s theorem for primes of the form 4n-1 and 4n+1, Dirichlet’s theorem in primes on Arithmetical progression, Distribution of primes in Arithmetical progression.

**RECOMMENDED BOOKS**

1. T.M. Apostol : Introduction to Analytic Number Theory

**MM 610-OPTIMIZATION TECHNIQUES-I**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

**Introduction:** Definition of operation research, models in operation research, general methods

for solving O.R. models, Elementary theory of convex sets.

**Linear Programming Problems:** Definition of LPP, examples of LPPs, mathematical

formulation of the mathematical programming problems, Graphical solution of the problem.

Simplex method, Big M method, Two Phase method, problem of degeneracy.

**Duality in linear programming:** Concept of duality, fundamental properties of duality, duality

theorems, complementary slackness theorem, duality and simplex method, dual simplex method.

**Sensitivity Analysis:** Discrete changes in the cost vector, requirement vector and co-efficient

matrix, addition of a new variable, deletion of a variable, addition of new constraint, deletion of a

constraint.

**Integer Programming:** Introduction, Gomory's all-IPP method, Gomory's mixed-integer

method, Branch and Bound method.

**SECTION-B**

**Transportation Problem:** Introduction, mathematical formulation of the problem, initial basic

feasible solution using North West Corner Method, Least Cost Method and Vogel's

Approximation Method, Optimal solution using MODI method, degeneracy in transportation

problems, some exceptional cases in transportation problems,

**Assignment Problems:** Introduction, mathematical formulation of an assignment problem,

assignment algorithm, unbalanced assignment problems, Travelling Salesman problem.

**Games & Strategies**: Definition & characteristics of Games. Two person zero sum games,

Maximin-minimax principle, Games without saddle points, Mixed Strategies, Graphical method

for solving and games, Concept of Dominance, Reducing the game problem to LPP,

Limitations.

**RECOMMENDED BOOKS**

1. Kanti Swarup, P. K. Gupta and Man Mohan: Operations Research, Sultan Chand and Sons,

New Delhi.

2. Chander Mohan and Kusum Deep: Optimization Techniques, New Age International, 2009.

3. H.S. Kasana and K.D. Kumar: Introductory Optimization, Springer

3. Hadley, G: Linear Programming

**MM 611-Fuzzy Sets and Applications**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

**Classical Sets and Fuzzy Sets:** Overview of Classical Sets, Membership Function, a-cuts,

Properties of a-cuts, Decomposition Theorems, Extension Principle.

**Operations on Fuzzy Sets:** Compliment, Intersections, Unions, Combinations of operations,

Aggregation Operations.

**Fuzzy Arithmetic:** Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on intervals

and Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

**Fuzzy Relations:** Crisp and Fuzzy Relations, Projections and Cylindric Extensions, Binary

Fuzzy Relations, Binary Relations on single set, Equivalence, Compatibility and Ordering

Relations, Morphisms, Fuzzy Relation Equations.

**SECTION-B**

**Possibility Theory:** Fuzzy Measures, Evidence and Possibility Theory, Possibility versus

Probability Theory.

**Fuzzy Logic:** Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers,

Linguistic Hedges.

**Uncertainty based Information:** Information and Uncertainty, Nonspecificity of Fuzzy and

Crisp sets, Fuzziness of Fuzzy Sets. Applications of Fuzzy Logic.

**References**

1. Klir G. J. and Folyger T. A., Fuzzy Sets: Uncertainty and Information, PHI (1988).

2. Klir G. J. and Yuan B., Fuzzy sets and Fuzzy logic: Theory and Applications, PHI

(1995).

3. Zimmermann H. J., Fuzzy Set Theory and its Applications, Allied Publishers (1991).

4. **Chander Mohan**, An Introduction to Fuzzy Set Theory and Fuzzy Logic, M V Learning

Publishers(2015), New Delhi (INDIA) and London (UK).

**MM612: SOLID MECHANICS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**Section A**

Tensor Algebra: Coordinate-transformation, Cartesian Tensor of different order. Properties of

Tensors, Isotropic tensors of different orders and relation between them, symmetric and skewsymmetric tensors. Tensor Invariants, Deviatoric tensors, eigenvalues and eigen-vectors of a tensor. Tensor analysis: scalar, vector, tensor functions, Comma notation, gradient, divergence and curl of a vector/tensor field. (Relevant portions of Chapters 2 and 3 of book by D.S.

Chandrasekharaiah and L. Debnath) Analysis of strain: Affine transformation, Infinitesimal affine deformation, Geometrical Interpretation of the components of strain. Strain quadric of Cauchy. Principal strains and invariance, General infinitesimal deformation, Saint-Venants equations of compatibility, Finite deformations Analysis of Stress: Stress tensor, Equations of equilibrium, Transformation of coordinates, Stress quadric of Cauchy, Principal stress and invariants, Maximum normal and shear stresses. (Relevant portion of Chapter 1 & 2 of book by I.S. Sokolnikoff).

**Section B**

Equations of Elasticity: Generalized Hooks Law, Anisotropic medium, Homogeneous isotropic

media, Elasticity, moduli for Isotropic media. Equilibrium and dynamic equations, for and

isotropica elastic solid, Strain energy function and its connection with Hooke's Law, Uniqueness

of solution. Beltrami-Michell compatibilty equations, Saint-Venant's principle. (Relevant portion of Chapter 3 of book by I.S. Sokonikoff). Two dimensional problems: Plane stress, Generalized plane stress, Airy stress function. General solution of biharmonic equation. Stresses and displacements in terms of complex potentials. The structure of functions of (z) and (z). First and second boundary-value problems in plane elasticity. Existence and uniqueness of the solutions (Section 65-74 of I.S.Sokolnikoff).

**Recommended Books:**

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata-McGraw Hill Publishing

company Ltd. New Delhi, 1977.

2. A.E.H. Love, ATreatise on the Mathematical theory of Elasticity, dover Publications,

New York.

3. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New delhi, 1965.

4. D.S. Chandrasekharai and L. Debnath, Continuum Mechanics, Academic Press, 1994.

5. Shanti Narayan, Text Book of Cartesian Tensor, S. Chand & Co., 1950.

6. S. Timeshenki and N. Goodier. Theory of Elasticity, McGraw Hill, New York, 1970.

7. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 19

**MM 613-MATHEMATICAL METHODS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION –A**

Linear integral equations of first and second kind, Abel’s problem, Relation between linear

differential equation and Volterra’s equation, Non linear and Singular equations, Solution by

successive substitutions, Volterra’s equation, iterated and reciprocal functions, Volterra’s

solution of Fredholm’s equation. Fredholm’s equation as limit of finite system of linear equations, Hadamard’s theorem, convergence proof, Fredholm’s two fundamental relations, Fredholm’s solution of integral equation when D()0,Fredholm’s solution of Dirichlet’s problem and Neumann’s problem, Lemmas on iterations of symmetric kernel, Schwarz’s inequality and its applications

**SECTION –B**

Simple variational problems, Necessary condition for an extremum, Euler’s equation, End point

problem, Variational derivative, Invariance of Euler’s equation, Fixed end point problem for nunknown functions, Variational problem in parametric form, Functionals depending on higher

order derivatives. Euler Lagrange equation, First integral of Euler-Lagrange equation, Geodesics, The brachistochrone, Minimum surface of revolution, Brachistochrone from a given curve to a fixedpoint, Snell’s law, Fermat’s principle and calculus of variations.

**RECOMMENDED BOOKS**

1. F.B. Hildebrand, Method of Applied Mathematics. Prentice Hall, India.

2. I.M. Gelfand& S.V. Fomin, Calculus of Variations, Prentice Hall, India.

3. W.W. Lovitt, Linear Integral Equations, Tata-McGraw Hill, India.

4. Robert Weinstock, Calculus of Variations, McGraw Hill, London.

5. L.B. Chambers, Integral Equations, International Text Book Co.

Semester-IV

**MM 701: HOMOLOGY THEORY**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION - A**

**Singular Homology Theory :** Euclidean Simplexes, Linear Maps, Singular p-simplex, the group

Cp (E;*G*), induced homomorphism on chains. The Boundary Operator d, the boundary of a

singular simplex, the boundary of a p-chain. Cycles & Homology; the group Zp(E; *G*), the

homology groups Hp(E;*G*), Hp(E,F;*G*). induced homomorphism on relative homology groups,

the dimension theorem, the Exactness theorem; exact sequence, the boundary homomorphism &

the exactness of the singular homology sequences. (R.R. : Sec 1-1 to 1-9)

**Singular and Simplicial Homology :** Homotopic maps of pairs, the prism operator P. The

homotopy theorem. The Excision Theorem; the barycentric subdivision operator B. The Axiomatic Approach; Simplicial Complexes, traingulable space, triangulation, The Direct Sum

Theorem. The Direct Sum Theorem for complexes.(R.R. : Sec 1-10 to 2-4)

**SECTION - B**

**Simplicial Homology :** Homology groups of cells and spheres, Orientation, Homology groups of

a Simplicial pair, Formal description of Simplicial Homology; the oriented chain group, the

oriented boundary operator, the oriented simplicial homology group, simplicial map, cell

complexes, canonical Basis, the Betti group Bp and the Torsion Group Tp. (R.R. : Sec 2-5 to 210)

**Chain Complexes :** Singular chain complex, oriented simplicial chain complex, the group Kp of

p-chains of a chain Complex, the group Kp of Co-chains, Co-boundary operator, the co-chain

complex & the pth Co-homology group Hp(K), Chain homomorphism, induced homomorphism

on homology and co -homology groups. Chain homotopy and the Algebraic homotopy theorem.

(R.R. : Sec 3-1 to 3-6)

**BOOKS RECOMMENDED**

1. A.H. Wallace: Algebraic Topology : Homology and Cohomology

**MM 702 -THEORY OF LINEAR OPERATORS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%

.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

Spectral theory in normed linear spaces, resolvant set and spectrum. Spectral properties of

bounded linear operator. Properties of resolvant and spectrum. Spectral mapping theorem for

polynomials, spectral radius of bounded linear operator on a complex Banach space.

Elementary theory of Banach algebras. Resolvant set and spectrum. Invertible elements,

Resolvant equation. General properties of compact linear operators.

**SECTION-B**

Spectral properties of compact linear operators on normed space. Behaviour of compact linear

operators with respect to solvability of operator equations. Fredholm type theorems. Fredholm

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

**RECOMMENDED BOOKS**

1. E. Kreyszic : Introductory Functional Analysis with Applications.

2. Bachman and Narici : Functional Analysis

**MM 703 - GEOMETRY OF DIFFERENTIABLE MANIFOLDS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections A, B and C. Sections A and B will have four

questions from the respective sections of the syllabus and Section C will consist of one

compulsory question having ten short answer type questions covering the entire syllabus

uniformly. The weightage of Section A and B will be 30% and that of Section C will be 40% .

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each section

A and B and compulsory question of Section C.

**SECTION-A**

Topological groups, Lie groups and Lie algebras. Product of two Liegroups, One parameter

subgroups and exponential maps. Examples of Lie groups, Homomorphism and Isomorphism,

Lie transformation groups, General Linear groups. Principal fibre bundle, Linear frame bundle, Associated fibre bundle, Vector bundle, Tangent bundle, Bundle homomorphism.

**SECTION-B**

Sub-manifolds, induced connection and second fundamental form. Normals, Gauss formulae,

Weingarten equations, Lines of curvature, Gauss and Mainardi–Codazzi equations. Almost Complex manifolds , Nijenhuis tensor, Contravariant and covariant almost analytic vector fields, F-connection.

**RECOMMENDED BOOKS**:

1. K. Yano and M. Kon : Structure of Manifolds, World. Scientific Publishing Co. Pvt. Ltd.,

1984 (Rel. Portion).

2. Y. Matsushima : Differentiable Manifolds , Marcel Dekker , Inc. New York, 1972.

3. Nomizu and Kobayashi: Foundation of Differential Geometry

**MM 704 :CATEGORY THEORY -II**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answers covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each sections A and B and compulsory question of section C.

**SECTION- A**

**Equivalence** : The functor category Fun (C D) and natural isomorphism. (R.R: Sections 6.1, 6.2 and 7.1 to 7.5) Equivalence : Exponentials of Categories, The Bifunctor Lemma, Cat is cartesian closed, Functor Categories, Equivalence of Categories, Examples of Equivalence : Setsfin and Ordfin., Pointed Set and partial maps, slice categories and indexed families, stone duality.(R.R 7.6 to 7.9)

**Categories of Diagrams :** Set-valued functor categories, The Yoneda embedding, The Yoneda Lemma, Applications of the Yoneda lemma, Limits, Colimits and Exponentials in Categories of diagrams. Hom (X, GP ) and Hom ( X x P , Q) . (R.R. : Sections 8.1 to 8.7)

**SECTION- B**

**Adjoints:** Adjunction between categories, left and right adjoints, Hom-Set definition of adjoints. Examples of Adjoints, Uniqueness up to isomorphism. Order Adjoints and interior operation in Topology as an order adjoint. Preservation of Limits (Co limits) by Right (Left) Adjoints. UMP of the Yoneda Embedding and Kan Extensions.The Adjoint Functor Theorem.

**Monads and Algebras:** The Triangle Identities, Monads and Adjoints, Algebras for a monad, The Elinberg- Moore Category and the Kliesli Category, Comonads and Colagebras. (R.R. Chapter 9; Sections 9.1 to 9.4, 9.6 AFT from Sec 9.8 and Chapter 10; Sections 10.1 to 10.4)

**RECOMMENDED BOOKS**

Steve Awodey: Category Theory, (Oxford Logic Guides, 49, Oxford University Press.)

**MM 705: Optimization Techniques –II**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**Section A**

**Quadratic Programming**: Wolfe’s Modified Simplex Method, Beale’s method for Quadratic

Programming, Separable, Convex programming.

**Linear Complimentary Problem**: Lemke’s Complementary Pivoting Algorithm, Solution of

Quadratic programming, Problems using Linear Complementary method.

**Separable Programming**: Introduction, Reduction of Separable Programming to Linear

programming Problem, Separable Programming Algorithm.

**Goal Programming**: Introduction, formulation of linear Goal Programming, Graphical &

Simplex Method for Goal Programming.

**Section B**

**Geometric Programming:** Introduction, constrained & unconstrained Geometric Programming

Problem, Complementary Geometric programming.

**Fractional Programming:** Introduction, Mathematical formulation of Linear fractional

programming problem, Method due to Charnes and Cooper, Problems of Fractional

Programming.

**Dynamic Programming**: Introduction, nature of Dynamic Programming (DP), Solution of

Discrete DPP, Application of DP in Linear Programming.

**Decision Theory**: Introduction & components of Decision Theory, EMV,EOL, Decision making

under uncertainty, Decision making under utilities, Decision making under Risk.

**Simulation:** Introduction, Advantages & disadvantages, Event –type, Monte-Carlo simulation,

Application to Inventory, Queueing, Capital Budgeting, Financial Planning, Maintenance, Job

Sequencing, Networks.

**RECOMMENDED BOOKS**

1. Sharma, S.D.: Operation Research, Kedar Nath and Co., Meerut.

2. Chander Mohan and Kusum Deep: Optimization Techniques, New Age International,

2009.

3. Kanti Swarup, P.K. Gupta and Man Mohan: Operations Research, Sultan Chand and

Sons.

4. Hamdy A. Taha: Operations Research; An Introduction, PHI, New Delhi.

5. Kasana H.S. and Kumar, K.D.: Introductory Operation Research, Springer.

**MM 706 : HOMOLOGICAL ALGEBRA**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER,-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

**Homology functors** : Diagrams over a ring, Translations of diagrams, Translation category, split

exact sequence, images and kernel as functors, Homology functors, The connecting

homomorphism, Complexes, boundary homomorphism, differentiation homomorphism,

homology modules, right and left complexes, exact homology sequence and Homotopic translations. (R. R. : Chapter 4 of Northcott)

**Projective and injective modules** : Projective modules, injective modules, An existence

theorem for injective modules, Complexes over a modules, right and left complexes over a

module, augmentation translation and augmentation homomorphism, acyclic right and acyclic

left complexes over a module, Projective and injective resolutions of a module, Properties of

resolutions of a module. (R.R ; Sections 5.1 to 5.5)

**SECTION-B**

**Derived Functors**: Projective and injective resolutions of an exact sequence, Properties of

resolutions of sequences, Functors of complexes, Associted translations, Functors of two

complexes, Right-derived functors, the defining systems and the connecting homomorphisms,

the functor R0T, Left-derived functors, the functor L0T. (R.R. Sections 5.6 to 6.4)

**Torsion and Extension Functors**: Connected sequences of functors, Connected right and left

sequences of covariant and contravariant functors, homomorphism and isomorphism as a natural

equivalence between connected sequences of functors. Torsion functors Torn , Basic properties of

Torsion functors, Extension functors Extn and Basic properties of extension functors.

(R.R. Sections 6.5 to 7.4)

**RECOMMENDED BOOKS**

1. D. G. Northcott : An introduction to Homological Algebra.

**MM 707 : FINITE ELEMENT METHOD**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER,-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

Introduction to finite element methods, comparison with finite difference methods. Methods of weighted residuals, collocations, least squares and Galerkin’s method, Variational formulation of boundary value problems, equivalence of Galerkin and Ritz methods. Applications to solving simple problems of ordinary differentialequations

**SECTION-B**

Linear, quadratic and higher order elements in one dimensional and assembly, solution of

assembled system, Simplex elements in two and three dimensions, quadratic triangular elements,

rectangular elements, serendipity elements and isoperimetric elements and their

assembly.discretization with curved boundaries, Interpolation functions, numerical integration,

and modeling considerations, Solution of two dimensional partial differential equations under

different Geometric conditions Suggested Books:

**1** Reddy J.N., “Introduction to the Finite Element Methods”, Tata McGraw-Hill. **2003**

**2** Bathe K.J., Finite Element Procedures”, Prentice-Hall. **2001**

**3** Cook R.D., Malkus D.S. and Plesha M.E., “Concepts and Applications of FiniteElement

Analysis”, John Wiley.**2002**

**4** Thomas J.R. Hughes “The Finite Element Method: Linear Static and Dynamic

Finite Element Analysis”

**5.** George R. Buchanan “Finite Element Analysis”, **1994**

**MM 708-FLUID MECHANICS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

Equations of Fluid Mechanics : Real and continuous fluids, differentiation following the motion,

equation of continuity, Stream function, Stream lines, Pressure, Euler's equation of motion.

Bernoulli's theorem Steady irrotational non-viscous compressible flow. Vorticity, circulation, Kelvin's theorem on constancy of circulation, Kinetic energy. Three dimensional problems : Laplace's equation. Three dimensional sources and dipoles. Spherical obstacle in a uniform steam Moving sphere, images.

**SECTION-B**

Application of complex variable method : Conjugate functions in plane, complex potential,

incompressible flow in two dimensions, uniform stream, Source and sink, Vortex, Two

dimensional dipole, Superposition, Joukowski's transformation. Milne Thomson circle theorem,

Blasius theorem, Drag and lift. Source and vortex filaments, vortex pair, rows of vortices, Karman cortex street. Viscous flow : Navier Stokes equations, Dissipation of energy. Diffusion of vorticity in an incompressible fluid, condition of no slip, Steady flow between two parallel infinite flat plates, steady flow through a straight circular pipe (Poiseuille Flow).

**RECOMMENDED BOOKS**

1. D. E. Rutherford : Fluid Dynamics,

2. F. Chorlton : Fluid Dynamics, (Relevant portion).

**MM 709- ALGEBRAIC CODING THEORY**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

Introduction to error-correcting codes, The main coding theory problem, An introduction to finite

fields, Introduction-to Linear codes, Encoding & Decoding with a linear code. The dual code, the parity-check matrix and syndrome decoding, incomplete decoding.

**SECTION-B**

Hamming codes, extended binary Hamming codes, Q-ary Hamming codes, Perfect codes, Golay

codes, sphere packing bound. Cyclic codes, Hamming codes as cyclic codes, BCH codes, Quadratic residue codes.

**RECOMMENDED BOOKS**

1. Raymond Hill : Introduction to Error Correcting Codes (Ch 1-0 & 12)

2. F. J. Macwilliams& NJA Sloane : Theory of Error Correcting Codes

**MM 710- Commutative Algebra**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

Nil radical and Jacobson radical of Ring, Operation on ideals, Extension and Contraction of

Ideals, The Prime Spectrum of Ring, Zairiski Topology Exact sequence of Modules, Tensor product of modules, Restriction and Extension of Scalars, Exactness property of Tensor product, Flat Modules, Tensor product of Algebras.

**SECTION-B**

Rings and Modules of Fractions, Local properties, Extended and Contracted ideals in rigs of

Fractions. Primary decomposition : Primary ideals, Decomposable Ideals, First Uniqueness Theorem, Isolated prime ideals, Second Uniqueness Theorem, behavior of primary ideals under

localozation.

**RECOMMENDED BOOKS**

1. M.F. Atiyah, I.G MacDonald : Introduction to Commutative Algebra (Chapter 1-4)

2. David S. Dummit M. Foote : Abstract Algebra second edition.

**MM 711-OPERATIONS RESEARCH**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION-A**

**Queueing Problems:** Characteristics of queueing system. Distribution in queueing systems,

Poission arrivals and exponential Service time. Transient and steady state. Probabilistic

Queueing Models (Model I (M/M/1)( ∞/FCFS), Model II (General Erlang Queueing Model),

Model III (M/M/1) : (N/FCFS) , Model-IV (M/M/S):(∞/FCFS), Model V(M/ Ek /1):( ∞/FCFS),

Model VI (Machine Repairing Model), Model VII Power supply model, Model VIII: Economic Cost Profit Model, Model IX (M/G/1): (∞ / GD ), Mixed & deterministic Queueing Models (X, XI)

**Inventory Models**: Classification of inventory models, Deterministic inventory model (DIM),

Basic Economic order Quantity (EOQ)models with no shortages, DIM with Shortages, EOQ

with finite replenishment, EOQ with price break, single multi- item deterministic inventory

models. Inventory problems with uncertain demand, Probabilistic (Stochastic) inventory models,

Determination of Reserve Stock, Q-System/ P System, Uniform Demand & discrete units, instant

demand & discrete units.

**SECTION B**

**Replacement & Maintenance Problems**: Replacement policy when money value changes &

does not change with time, Group replacement of item that fails suddenly, the general renewal

process.

**Network Analysis**: Introduction to Networks, Minimal Spanning Tree problem, shortest path

problems, Dijkastra’s algorithm, Floyd’s Algorithm, Maximum Flow problem,

**Project Management**: Critical Path method, critical path computations, optimal Scheduling by

CPM, Project Cost Analysis, PERT, Distinction between CPM and PERT.

**RECOMMENDED BOOKS**

1. Sharma, S.D.: Operation Research, Kedar Nath and Co., Meerut.

2. Chander Mohan and Kusum Deep: Optimization Techniques, New Age International,

2009.

3. Kanti Swarup, P.K. Gupta and Man Mohan: Operations Research, Sultan Chand and

Sons.

4. Hamdy A. Taha: Operations Research; An Introduction, PHI, New Delhi.

5. Kasana H.S. and Kumar, K.D.: Introductory Operation Research, Springer.

**MM 712: WAVELETS**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**Section A**

Fourier transforms and its basic properties, Poisson’s summation formula, Gibb’s phenomenon,

Heisenberg uncertainty principle. Applications of Fourier tansforms to ordinary and partial

differential equations. Classification and joint time frequency analysis of signals. Definition, examplesand basic properties of Gabor transforms. Frames and frame operators. Zak transforms: definition and basic properties.

**Section B**

Discrete and discrete- time and continuous wavelet transforms. Scaling functions, Multi

Resolution Analysis (MRA), wavelet functions, Parseval’s Theorem.Examples of wavelet

expansions. Wavelet transforms for partial differential equations: General procedure, error estimation by wavelet basis. Introduction to signal and image processing, representation of signals by frames.

**RECOMMENDED BOOKS**

1. Introduction to Wavelets and Wavelet Transforms, C. S. Burrus, R. A. Gopinath, H. Guo,

Prentice Hall.

2. An Introduction to Wavelets, C.K. Chui, Academic Press

3. Wavelet Transforms and Their Applications, Loknath Debnath, Birkhauser

4. Applied Functional Analysis, Abul Hasan Siddiqi, Marcel Decker.inc

**MM 713 - Nonlinear Programming**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**SECTION –A**

**Non-linear Programming**: Definition & examples of non-linear programming, its formulation,

unconstrained problems, constrained problems with equality & inequality constraints, Fritz John

and Kuhn-Tucker optimality conditions , saddle point , Lagrange’s method of solution.

**Direct Search Methods:** Solution of unconstrained non-linear optimization problems One-Dimensional Problems: Dichotomous Search, Fibonacci Search, Golden-Section Search,

Rosen Brock search Method, Methods requiring function to be differentiable: Bisection Method, Method of False Position, Newton- Raphson Method, Quadratic interpolation method, Cubic interpolation method,

**Direct Search Methods for multidimensional optimization problems**: Evolutionary search

method, Simplex search method.

**Section B**

**Gradient search based methods for Multidimensional nonlinear optimization problems**:

Unconstrained problems: Hooke & Jeeves method, Steepest Descent method, Newton-Raphson

Method, Marquardt’s method, Conjugate Direction Methods: Concept of Conjugate Directions,

Basic Conjugate- Directions method, method of Fletcher-Reeves, Partan method.

**Constrained optimization Problems:** Solution through Kuhn-Tucker conditions, Penalty

function Methods (Interior Penalty function method and Exterior Penalty function method),

Methods of Feasible Directions: Zoutendijk method, Gradient Projection method, Wolfe’s

reduced Gradients method.

**RECOMMENDED BOOKS**

1. Bazaraa, M.S., Sherali, Hanif D and Shetty, C.M., Nonlinear programming: Theory and

Algorithm, John Wiley, Second Edition, 1993.

2. Chander Mohan and Kusum Deep, Optimization Techniques, New Age International,

2009.

3. Simmons, D.M., Non-Linear Programming for Operations Research, Prentice Hall,

1975.

4. Avriel, M., Non-linear Programming: Analysis & methods, Englewood Cliffs, Prentice

Hall, 1976.

**MM-714: NUMERICAL ANALYSIS-II**

L T P University Exam: 75

5 1 0 Internal Assessment: 25

Time Allowed: 3 hours Total: 100

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four

questions each from the respective sections of the syllabus. Sections C will consist of one

compulsory question having ten short answers covering the entire syllabus uniformly. The

weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each

sections A and B and compulsory question of section C.

**Section A**

Introduction to Hermite interpolation and computation of piecewise cubic Hermite polynomials,

Piecewise Hermite interpolation and computation of piecewise Hermite polynomials,

HermiteBirkhoff interpolation problem, Runge example. Piecewise cubic Bessel interpolation.

Basic properties of splines.Construction of local basis.B-splines.Equally spaced knots.Perfect Bsplines. Dual basis. Zero properties. Sign properties of green’s function.Derivatives, piecewise

polynomial representation.

**Section B**

Piecewise constants and linear function.Direct theorems in intermediate spaces. Lower bounds.

N-Widths Periodic splines, natural splines, g-splines, monosplines, discrete splines. Green’s function, Tchebycheffian spline functions.

**References**

1. A Practical Guide to Splines, Carl de Boor, *Springer*.

2. Splines and Variational Methods, P.M. Prenter, Dover Publications.

3. Spline Functions: Basic Theory, Larry L Schumaker, Cambridge Mathematical Library.