M.Sc. Mathematics (MATM2PUP)
CBCS
SEMESTER-I (2021-2022)

CORE SUBJECTS

Code	Title of Paper/ Subject
MATM1101T	Algebra-I
MATM1102T	Mathematical Analysis
MATM1103T	Topology-I
MATM1104T	Differential Geometry
AMCM1104P	Software Laboratory-I (C-Programming)

ELECTIVE SUBJECTS (Select any One)

Code	Title of Paper/ Subject
MATM1105T MATM1105L	Introduction to Computer and Programming Using 'C' Software Laboratory-I (C-Programming)
MATM1106T	Mathematical Statistics
MATM1107T	Linear Programming

SEMESTER-II

CORE SUBJECTS

Code	Title of Paper/ Subject
MATM1201T	Algebra-II (Rings and Modules)
MATM1202T	Topology-II
MATM1203T	Differential Equations-I
AMCM1204T	Complex Analysis

ELECTIVE SUBJECTS (Select any One)

Code	Title of Paper/ Subject
MATM1205T MATM1205L	Object Oriented Programming Using C++ (Pre-requisite: CS 405 A) Software Lab-II (C++)
MATM1206T	Functional Analysis
MATM1207T	Classical Mechanics

10/8/21
Head
Mathematics Deptt.
Punjabi University, Patiala

PUNJABI UNIVERSITY, PATIALA

OUTLINES OF TESTS,

SYLLABI AND COURSES OF READING

FOR

M.Sc. Mathematics-I

2020-2021 & 2021-2022

PUBLICATION BUREAU
PUNJABI UNIVERSITY, PATIALA

CBCS

SEMESTER-1

CORE SUBJECTS

Code	Title of Paper/Subject	Hrs/Week	Credit	Max Cont. Asmt.	Marks Univ Exam	Total
MM-401	Algebra-I	6	6	30	70	100
MM-402	Mathematical Analysis	6	6	30	70	100
MM-403	Topology-I	6	6	30	70	100
MM-404	Differential Geometry	6	6	30	70	100

ELECTIVE SUBJECTS (Select any One)

Code	Title of Paper/Subject	Hrs/Week	Credit	Max Cont. Asmt.	Marks Univ Exam	Total
CS-405 A	Introduction to Computer Programming using C	4	4	20	40	60
CS-405 B	Software Laboratory –I (C-Programming)	4	2	10	30	40
MM-406	Mathematical Statistics	6	6	30	70	100
MM-407	Linear Programming	6	6	30	70	100

SEMESTER-II

CORE SUBJECTS

Code	Title of Paper/Subject	Hrs/Week	Credit	Max Cont. Asmt.	Marks Univ Exam	Total
MM-501	Algebra- II (Rings and Modules)	6	6	30	70	100
MM-502	Topology-II	6	6	30	70	100
MM-503	Differential Equations-I	6	6	30	70	100
MM-504	Complex Analysis	6	6	30	70	100

ELECTIVE SUBJECTS (Select any One)

Code	Title of Paper/Subject	Hrs/Week	Credit	Max Cont. Asmt.	Marks Univ Exam	Total
CS-505 A	Object Oriented Programming Using C++ (Pre-requisite: CS 405 A)	4	4	20	40	60
CS-505 B	Software Lab –II (C++)	4	2	10	30	40
MM-506	Functional Analysis	6	6	30	70	100
MM-507	Classical Mechanics	6	6	30	70	100

Open Elective (For Post Graduate Students): Basic Calculus (QUALIFYING PAPER) FOR OTHER DEPARTMENT STUDENTS

MM 401: ALGEBRA - I

L	T	P
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

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

SECTION-A

Review of groups, Normal and subnormal series, Solvable groups, Nilpotent groups, Composition Series, Jordan-Holder theorem for groups. Group action, Stabilizer, orbit, Class equation and its applications permutation groups, cyclic decomposition, conjugacy classes in permutation groups. Alternating group A_n, Simplicity of A_n.

SECTION-B

Structure theory of groups, Fundamental theorem of finitely generated abelian groups, Invariants of a finite abelian group, Groups of Automorphisms of cyclic groups, homomorphism between two cyclic groups, Sylow's theorems, Groups of order p^2, pq. Review of rings and homomorphism of rings, Ideals, Algebra of Ideals, Maximal and prime ideals, Ideal in Quotient rings, Field of Quotients of integral Domain, Matrix Rings and their ideals; Rings of Endomorphisms of Abelian Groups.

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
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

Functional of several variables: Linear transformations, Derivatives in an open subset of $\mathbf{R}^n$, 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 9.33)
3. T. Apostol : Mathematical Analysis 2nd Edition, Addison Wesley, 1974.

MM 403: TOPOLOGY I

L	T	P
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions from each sections A and B and compulsory questions 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. T_0, T_1, and T_2 spaces. T_2 spaces and Sequences and Hausdorffness 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, New York, Academic Press, Ch. 2 (Sections 2.1, 2.2), Section 4.2, and Ch 5 (Sec 5.1 to 5.3).
2. James Dugundji : TOPOLOGY. Allyn and Bacon. Relevant Portions from Ch.III (excluding Sec 6 and Sec 10) , Ch IV; (Sections 1-3) and ChV

References:

1. James Munkres: Topology,2nd Edition Pearson.
2. Steen and Seebach : Counterexamples in Topology, Dover Books.
3. Stephen Willard: General Topology Addison Wesley.
4. J. Kelley: Topology. Graduate Texts in Mathematics 27. Springer.

MM 404: Differential Geometry

L	T	P	University Exam: 70
5	1	0	Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

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

Section A

Theory of Space Curves: Curves in the planes and in space, arc length, reparametrization, curvature, Serret-Frenet formulae, osculating circles, evolutes and involutes of curves, space curves, torsion, Serret-Frenet formulae. Theory of Surfaces, smooth surfaces, tangents, normals and orientability, quadric surfaces, the first and the second fundamental forms, Euler's theorem, Rodrigue's formula, Gaussian Curvature, Gauss map and Geodesics: The Gaussian and mean curvatures, the pseudosphere, flat surfaces, surfaces of constant mean curvature.

Section B

Gaussian curvature of compact surfaces, the Gauss map, Geodesics, geodesic equations, geodesics of surfaces of revolution, geodesics as shortest paths, geodesic coordinates.Minimal Surfaces and Gauss's Remarkable Theorem: Plateau's problem, examples of minimal surfaces, Gauss map of a minimal surface, minimal surfaces and holomorphic functions, Gauss's Remarkable Theorem, isometries of surfaces, The Codazzi-Mainardi Equations, compact surface of constant Gaussian curvature

Books Recommended

1. Andrew Pressley, Elementary Differential Geometry, Springer, Fourth Indian Reprint 2009.
2. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, 2012.
3. B. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, 2006.
4. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press 2003.
5. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.
6. S. Lang, *Fundamentals of Differential Geometry*, Springer, 1999.
7. B. Spain, *Tensor Calculus: A Concise Course*, Dover Publications, 200

CS-405 A: Introduction to Computer Programming using C

L	T	P	University Exam: 40
4	0	0	Internal Assessment: 20
Time Allowed: 3 hours			Total: 60

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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 7.5 marks each and section C will be of 10 marks.

INSTRUCTIONS FOR THE CANDIDATES

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

SECTION -A

Characterization of Computers, types of Computers, the Computer generations. Basic Anatomy of Computers: memory unit, input-output unit, arithmetic logic unit, control unit, central processing unit, RAM, ROM, PROM, EPROM. Input-Output Devices

Computer Software: Introduction, types of software: application and systems software. Networking: Basics, types of networks (LAN, WAN, MAN), topologies, communication media, Operating System, Definition, functions and types of operating system.

Computer Languages: Machine Language, assembly language, high level language, 4GL, assembler, compiler and interpreter

Problem Identification, Analysis, Flowcharts, Decision tables, Pseudo codes and algorithms, Program coding, Program Testing and execution,

C Programming: 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 function.

SECTION-B

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

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).

CS-405 B: SOFTWARE LABORATORY (C-Programming)

L T P	University Exam: 30
0 0 4	Internal Assessment: 10
Time Allowed: 3 hours	Total: 40

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
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

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.
3. Lehmann, E. L., & Romano, J. P. (2006). *Testing statistical hypotheses*. Springer Science & Business Media.
4. 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: 70
5	1	0	Internal Assessments: 30

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 questions from each Section A and B and compulsory question of section C. Use of scientific calculator is allowed.

Section-A

Linear programming problems (LPPs): Examples, Mathematical formulation of the problem, Graphical solution method, Canonical and standard forms of LPP, Solution by Simplex method, Artificial variables, Big-M method and Two phase simplex method, .

Duality in linear programming: Concepts: General primal dual pair, Mathematical formulation of a dual problem, Fundamental properties of duality, Duality Theorems, Complimentary Slackness Theorem, Duality and Simplex method and Dual simplex method.

Section -B

Sequencing Problems; General Assumptions and basic terms used in sequencing, Processing n jobs through 2 machines, processing n jobs through 3 machines, Processing n jobs through m machines, Processing 2 jobs through m machines

Replacement decisions; O.R methodology of solving replacement problems, Replacement of items that deteriorates with time without change in the money value, Replacement of items that deteriorates with time 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
2. Hamdy A Taha, Operations Research – An Introduction, Pearson.
3. Chander Mohan and Kusum Deep: Optimization Techniques, New Age International, 2009.

MM 501: ALGEBRA-II (RINGS AND MODULES)

L	T	P
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

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. Artinian Implies Noetherian in Rings, 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. Nil Radical and Jacobson Radical of Polynomial Rings R[x], R commutative. (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
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

Higher Separation Axioms : Regular, Completely Regular, Normal and Completely Normal Spaces. Metric Spaces as Completely Normal T_2 Spaces. Urysohns Lemma and The Tietze Extension Theorem.

Products: Products of first countable, Regular, T_2 and Completely Regular Spaces. Non invariance of normality under products. Embedding of Tichonov spaces into parallelotope and the Stone Cech Compactification.

Filters: Filter and filterbase, convergence and clustering, filter characterization of closure, continuity and filter convergence, ultrafilters, filter characterization of compactness and the Tychonoff Theorem.

SECTION –B

Identification Topology: Identification Topology, Identification Map, Subspaces. General Theorem. Transgression, Transitivity Spaces with Equivalance Relation, Quotient Spaces.

Categories and Functors: Categories: Definition and Examples, The Arrow Category, Congruence in a Category, Quotient Category, Functors, Duality, Contravariance and Duality, Homotopy as Congruence in Top, The Category hTop, homotopy equivalence, nullhomotopy, convexity, contractibility and cones, the path component functor, invariance of path components under homotopy type.

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)
4. 4. Joseph J. Rotman: An Introduction to Algebraic Topology. Relevant Portions from Chapter 0 and Chapter 1.

References:

1. James Munkres: Topology,2nd Edition Pearson.
2. Steen and Seebach : Counterexamples in Topology, Dover Books.
3. Stephen Willard: General Topology Addison Wesley.
4. J. Kelley: Topology. Graduate Texts in Mathematics 27. Springer.

MM 503: DIFFERENTIAL EQUATIONS-I

L	T	P
5	1	0

Time Allowed: 3 hours

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

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 2^{nd} 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, 3^{rd} 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: COMPLEX ANALYSIS

L	T	P	University Exam: 70
5	1	0	Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

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 z^c, 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
   H.S. Kasana, Complex Variables, Prentice Hall of India
3. Herb Silverman, Complex Variables, Houghton Mifflin Company Boston

CS 505(A): Object Oriented Programming Using C++

L	T	P
4	0	0

Time Allowed: 3 hours

University Exam: 40
Internal Assessment: 20
Total: 60

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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 7.5 marks each and section C will be of 10 marks.

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

Programming Paradigms: Introduction to the object oriented approach towards programming by discussing Traditional, Structured Programming methodology, its shortcomings, Advantages of OOPS (Object Oriented Programming Style), Traditional Vs OOPS Software Life Cycle.

Objects & Classes: Object Definition, Instance, Encapsulation, Data Hiding, Abstraction, Inheritance, Messages, Method, Polymorphism, Classes, Candidate & Abstract Classes, Defining member functions, Members access control, Use of scope resolution, Nesting of member functions, Memory allocation for objects, Static data members, Static member functions, Array of objects, Friend functions and friend classes.

Constructors and Destructors: Types of constructors- default, parameterized and copy constructors, Dynamic constructors, Multiple constructors in a class, Destructors for destroying objects, Rules for constructors and destructors, Dynamic initialization of objects, new and delete operator.

Operator Overloading and Type Conversions: Overloading unary, binary operators, Operator overloading using friend functions, Rules for overloading operators.

SECTION-B

Inheritance: General concepts of Inheritance, Types of derivation-public, private, protected. Types of inheritance: Single, Multilevel, Multiple, Hybrid inheritance, Polymorphism with pointers, pointer to objects, this pointer, pointer to derived class, Virtual functions, Pure Virtual functions.

Files and Streams: Streams, Stream classes for console operations, Unformatted I/O operations, Formatted console I/O operations, Managing output with manipulators, File Streams, opening, reading, writing to file. File pointers and their manipulators, Exception handling, Basics of Exception handling, C++ versus java

BOOKS RECOMMENDED

1. Deitel and Deitel, C++ How to Program, Pearson Education (2004).
2. Balaguruswamy E., Objected Oriented Programming with C++, Tata McGraw Hill (2008).
3. Schildt Herbert, The complete Reference C++, Tata McGraw Hill (2003).
4. Designing Object Oriented Software Rebacca Wirfs - Brock Brian Wilerson, PHI.
5. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia Publication.
6. Designing Object Oriented Applications using C++ & Booch Method, Robert C. Martin.

CS -505 (B): SOFTWARE LABORATORY-II (C++ PROGRAMMING)

L	T	P		
0	0	4	Internal Assessment:	10
Time Allowed: 3 hours			Total:	40

This laboratory course will mainly comprise of exercises on what is learnt under the paper." Object Oriented Programming Using C++".

MM 506: FUNCTIONAL ANALYSIS

L	T	P	University Exam: 70
5	1	0	Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

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.
4. B.V. Limaye: Functional Analysis.

MM 507-CLASSICAL MECHANICS

L T P
5 1 0
Time Allowed: 3 hours

University Exam:70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

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

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 ransformation Matrix, The Euler Angles, The Cayley-Klein Parameters and Related Quantities, ler's Theorem on the Motion of Rigid Bodies, Finite Rotations, Infinitesimal Rotations, The olis Force.

'S RECOMMENDED

Herbert Goldstein: Classical Mechanics

Open Elective (For Post Graduate Students) (QUALIFYING PAPER)

Basic Calculus

L	T	P
3	0	0

Time Allowed: 3 hours
3 Credit Course

University Exam: 70
Internal Assessment: 30
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. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

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

Section-A

Functions,Limits and Continuity, Right and Left Hand Limits, Theorems on Limits (Without Proofs). Continuity, The Derivative, Rules for Differentiating Functions, Composite Functions, Chain Rule, Higher Derivatives. Implicit Differentiation, Increasing and Decreasing Funtions, Maximum and Minimum Values.

Section-B

Antiderivative, The Definite Integral. Area under a curve, properties of the definite integral. The Mean Value Theorem for Integrals. Average Value of a Function on a closed Interval, Fundamental Theorem of Calculus. Exponential Growth and Decay. Arc and Arc length.

Text

1. **Frank Ayre, Jr and Elliot Mendelson**: *Calculus* Sixth Edition, Schaum's Outlines. McGraw Hill (Relevant Portions from Chapters 7 to 11, Chapter 13 to 14, Chapters 22 -24 and Chapters 28 to 29.