Course Title: Real Analysis **Course Code: PGMAT1C001T**

Duration of Examination: 3 hours **Maximum marks: 100**

Unit -1

- Euclidean Space $\mathbf{R}^n$, Open ball and open set in $\mathbf{R}^n$, Structures of open sets in R, Closed sets, Adherent and accumulation points, Closure of a set, Derived set
- Bolzano's Weierstrass theorem, Cantor Intersection theorem, Lindeloff covering theorem, Heine-Borel theorem, Compactness in $\mathbf{R}^n$.

Unit-2

- Definition and existence of Reimann-Stieltjies intergral, conditions for R-S integrability, properties of the R-S intergral, Integration and differentiation.
- Fundamental theorem of calculus, Integration of vector valued functions, Rectifiable curves

Unit-3

- Sequences and series of functions, Point-wise and uniform convergence, Cauchy's criterion for uniform convergence.
- Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity.

Unit -4

- Uniform convergence and Reimann-Stieltjies integration, uniform convergence and differentiation, Weierstrass approximation theorem
- Power series, uniqueness theorem for power series, Abel's and Tauber's theorems
- Functions of bounded variation, continuous functions of bounded variation

1.

Course Code: PGMAT1C002T
Course Title: Abstract Algebra

Objectives: To provide a first approach to the subject of Algebra, which is one of the basic pillars of modern mathematics and to study of certain structures called Groups, rings, fields and some related structures.

Learning outcomes:

1. Students will be able to understand the set relation by demonstrating Venn diagrams
2. Students will be able to understand the concept of equivalence relation by applying different examples to the definition
3. Students will be able to prove a statement by mathematical induction by using sequence of consecutive integers
4. Students will be able to understand the concept of binary operations by definition and examples
5. Students will be able to determine whether a given binary operation on the given set gives a group structure by applying the axioms
6. Students will be able to determine whether a given group is Abelian by checking the properties
7. Students will be able to prove that a given subset of a group is a subgroup by applying the properties.
8. Students will be able to describe all elements in a cyclic subgroup by using generators.
9. Students will be able to compute the expression of permutation groups by using permutation multiplication
10. Students will be able to understand the homomorphism by using the relationship between groups
11. Students will be able to understand the isomorphism by using the relationship between groups

Course code: PGMAT1C002T

Course title: Abstract Algebra

Course credits: 4

Unit-1

- Groups, Matrix and Permutation groups, subgroups, normal subgroups, Quotient group. group homomorphism, fundamental isomorphism theorems
- Group action on a set, Orbit-Stablizer formula, Conjugation, Automorphism, Computation of automorphism groups of $\mathbb{Z}_n$, $\mathbb{Z}$ and $\mathbb{S}_3$

Unit-2

- Class equation and its Applications, Cauchy Theorem
- Sylow theorems for finite groups, Simple groups, Simplicity of A_n; $n \geq 5$

Unit-3

- Direct sums, Structure theorem for finite Abelian groups and its applications
- Composition series, Jordan-Hölder theorem, Solvable groups

Unit-4

- Rings, subrings, Ideals, Quotient rings, ring homomorphism, Isomorphism theorems, Matrix and Polynomial rings, prime and maximal ideals
- Integral domain, Field of fractions of an integral Domain, prime and irreducible elements Unique factorization domains

Unit-5

- Principal ideal domains and Euclidean Domains
- Polynomial rings over unique factorization domain: Gauss Lemma and Gauss theorem. Eisenstein crietria of irreducibility of polynomials

Recommened Texts

1. N. Jacobson, Basis Algebra, Vol. I, second edition, Dover Publications, 2012.
2. I. N Herstein, Topics in Algebra, Wiley Eastern Ltd., Second Edition, New Delhi, 2011.

References

1. M. Artin, Algebra, Prentice-Hall of India, Second Edition, 2011.
2. N. S. Gopalakrishnan, University Algebra, New Age International(P) Ltd., Publishers. Second Edition: 1986, (Reprint: 2004)
3. I. S. Luther and I. B. S. Passi, Algebra, Vol 1-Groups, Vol II-Rings, Narosa Publishing House (Vol. I-1996, Vol. II-1999).
4. W. A. Adkins and S. H. Weintraub, Algebra An approach by module theory, Springer. 1999.

Course Code: PGMAT1C003T
Course Title: Number Theory

OBJECTIVES: This is an introductory course in Number Theory for students interested in mathematics and the teaching of mathematics. The course begins with the basic notions of integers and sequences, divisibility, and mathematical induction. It also covers standard topics such as Prime Numbers; the Fundamental Theorem of Arithmetic; Euclidean Algorithm, Congruence Equations and their Applications (e.g. Fermat's Little Theorem); Multiplicative Functions (e.g. Euler's Phi Function).

LEARNING OUTCOMES:

- Effectively express the concepts and results of Number Theory
- Revising basic notions of Integers, sequences and divisibility.
- Understand various algorithms and theorems related to numbers, prime numbers.
- Understanding concept of Modulus and related results.
- Construct Mathematical proofs of statements and find counter example to false the statement.
- Collect and use numerical data to form conjectures about integers.
- Understand the logics and methods behind the major proofs in number theory .
- Work effectively as part of a group to solve challenging problem in number theory .

Course Title: Number Theory Course Code: PGMAT1C0031
Course Type: P.G. Course Credits: 04

Unit I

Number theory- Divisibility, Euclidean algorithm, Linear Diophantine equations, Prime numbers, The series of reciprocals of primes, The Euclidean algorithm, Congruences, Residue classes, Solutions of linear congruences, The fundamental theorem of Arithmetic.

Unit-II

Fermat and Mersenne numbers. Farey series, Farey dissection of the continuum, Chinese Remainder Theorem, Euler's totient function, Euler's theorem, Fermat theorem, Wilson's theorem, Non-linear congruences.

Unit-III

Hensel's lemma, primitive roots and power residues, Quadratic residues and the law of quadratic reciprocity, the Jacobi symbols, The greatest integer function. Arithmetic functions- Mobius function and Mobius inversion formula, The Euler' function and Sigma function, The Dirichlet product of Arithmetical functions, Multiplicative functions.

Unit-IV

Irrational numbers- Irrationality of mth root of N, e and π, Approximation of irrational numbers, Hurwitz's Theorem, Representation of a number by two or four squares, Perfect numbers. The series of Fibonacci and Lucas.

Unit-V

Continued fractions - Finite continued fractions, Infinite continued fractions, Convergent of a continued fraction, Continued fractions with positive quotients, Simple continued fractions, The continued fraction algorithm and Euclid's algorithm, the representation of an irrational number by an infinite continued fraction.

Books for Reference:

1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, Oxford University Press, 2008, 6th Ed.,
2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.,
3. Bruce C. Berndt – Ramanujan's Note Books Volume-I to 5, Springer.
4. G. E. Andrews – Number Theory, Dover Books, 1995.
5. T. M. Apostol – Introduction to Analytic Number Theory, Narosa Publishing House, New Delhi.

Course Code: PGMAT1C00?T

Course Title: ORDINARY DIFFERENTIAL EQUATIONS WITH APPLICATIONS.

OBJECTIVES: The objective of this course is to equip the students with fundamental knowledge and problem solving skills in Power series methods of solution of ODE, Existence and Uniqueness theory of Initial Value Problems and Solution of system of differential equations. It helps the students to master mathematical techniques and concepts used to analyze and understand differential equations.The students will also learn to interpret the real-world meanings and implications of the mathematical results.Students learn to discover and derive.

LEARNING OUTCOMES:

The main purpose of the course is to introduce students to the theory and methods of ordinary differential equations.

- Students will know that the subject of differential equations has two parts, namely first order differential equations and higher order differential equations.
- Students will also study the various methods of solving several types of differential equations. Some applications for first order and second order differential equations are also included.
- Classify first order differential equations according to type, order, degree and linearity.
- Identify the type of first order differential equations as separable, linear, homogeneous, exact or Bernoulli and then solve the equations.
- Solve second order homogeneous and non-homogeneous.
- Solve application problems of first and second order differential equations.
- The main purpose of the course is to introduce students to the theory and methods of ordinary differential equations.

Course Title: Ordinary differential equations with Applications **Course Code:** PG MAT1C004T

Duration of Examination: 3 hours

Maximum Marks: 100

Objective: This course is the source of most of ideas and theories which constitute higher analysis. The aim is to develop a strong background on finding solutions to linear differential equations with constant and variable coefficients with singular points, and to study the existence and uniqueness of the solutions of first order differential equations.

A pre-requisite for this course is course on Calculus and differential equations at undergraduate level.

Unit-1

• Mathematical modeling by means of ordinary differential equations, Existence and uniqeness of solutions of initial value problems for first order differential equations, Picard's theorem(statement only), Picards Method of Succcessive Approximations, Singular solutions of first order ODEs, Lipschitz condition

• Linear systems, Gronwall's Lemma, Linear dependence and independence of solutions, Wronskian

Unit-2

• Solutions of homogeneous linear system of first order ODEs with constant coefficients

• General theory of homogeneous and non-homogeneous linear ODEs, The General solution of the Homogeneous equation, The use of known solution to find another, Homogeneous equation with constant coefficients, Method of undetermined coefficients.

Unit-3

• Method of Variation of Parameters, Green's function

• Qualitative properties of solutions: Oscillations and the Sturm Sepration Theorem, Sturm-Liouville boundary value problem, Sturm-Liouville equations, Eigen value problems

Unit-4

• Series solutions of non-autonomous systems: Second order Linear Equations, Ordinary points, Regular Singular points, Legendre and Bessel series, Frobenius method.

Unit-5

• Discrete dynamical systems, Stability of dynamical systems, Lyapunov exponential and asymptotic stability and their characterization

Textbooks:

1. G F Simmons, Differential equations with applications and historical notes, Tata McGraw-Hill Edition, 2003.

Reference books:

1. S L Ross, Differential equations, Blaisdell publishing company, First Edition, 1964.

2. G Birkhoff and G C Rota, Ordinary differential equations, Boston, 1962.

3. E A Coddington and N Levinson, Theory of Ordinary differential equations, McGraw-Hill, New York, 1955.

4. Saber N Elaydi, An introduction to Differential Equations, Springer-verlag, Second edition, 1995. 5. V I Arnold, Ordinary Differential equations, PHI, New Delhi, 1998.

Course Code: PGMAT1E001T

Course Title: INTRODUCTION TO COMPUTER PROGRAMMING

Objectives: The core of computer science is programming. Other areas of the subject are either side issues or specializations from the main programming. Machines, computer applications, and even the role of computers in society are all considerably different today than they were ten, twenty, or thirty years ago, and we can be confident that they will be different again in ten, twenty, or thirty years. Moreover, programming softwares like MATLAB, LaTeX etc. are important and integral part in many research areas of Mathematics such as cryptography, modeling, queueing theory, differential equations etc.

Learning Outcomes: After course completion the students will have the following learning outcomes:

- understanding foundation concepts of information and information processing in computer systems: a matter of information, data representation, coding systems;
- understanding of an algorithm and its definition;
- understanding of a programming language syntax and its definition by example of C language;
- knowledge of basic principles of imperative and structural programming;
- ability to write simple programs in C language by using basic control structures (conditional statements, loops, switches, branching, etc.);
- ability to create a programmable model for a problem given;
- understanding a function concept and how to deal with function arguments and parameters;
- ability to use pointers and pointer arithmetic in the simple cases;
- basic knowledge of working with arrays in C language;
- understanding a defensive programming concept.Ability to handle possible errors during program execution;
- elementary knowledge of programming code style.

Course Title: Introduction to Computer Programming Course Code: PGMA [illegible]

Credits: 02

Course Type: P.G. Course

Unit-I

Review-basic Computer Fundamentals, Introduction to computer systems: Number system Integer, Signed integer, Fixed and floating point representations, IEEE standards. Integer and floating point arithmetic, CPU organization, ALU, Registers, Memory, The idea of program execution at micro level.

Introduction to Programming- Input/output; Constants, Variables, Expressions and operators. Naming conventions and styles,

UNIT II

What is C? Background concept of algorithms, Flow charts, Data flow diagrams. Data types variables, Sample program, Components of a program in C, Naming conventions for C. Variables printing and initializing, Variables array, Exercises based on above topics.

UNIT III

Programming using C- C data types, int, char, float etc., C expressions, arithmetic operation, relational and logic operations, C assignment statements, extension of assignment of the operations. C primitive input and output using getchar and putchar, Exposure to the scanf and printf functions, Compiling and executing a Program in C, Conditional execution using if and else.

UNIT IV

Iterations and Subprograms- Concept of loops, Example of loops in C using for, while and do-while, One dimensional and two dimensional arrays, Exercise on iterative programs using arrays, Matrix computations using array. Concept of sub-programming, Design of functions. void and value returning functions, parameters, Passing by value, Passing by reference

UNIT V

Pointers and Strings- Pointers, Relationship between arrays and pointers, Argument passing using pointers, Structure and unions, Defining C structures, Passing strings as arguments. Exercises based on above topics.

Text books: 1. Yashawant Kanetkar, —Let us C, 6th edition, BPB Publications, 2001.
2. Sinha P.K. and Sinha P., Computer Fundamentals, BPB Publications, 2004

Reference Books:-
1. Deitel H.M. and Deitel P.J., C++ How to Program. Prentice Hall, 8th edition.
2. Mullis Cooper, Spirit of C, Jacob Publications.
3. Kerninghan B.W. and Ritchie D.M., The C Programming Language, PH Publications.
4. Yashwant Kanetkar, Pointers in C, BPB Publications.
5. Gotterfied B., Programming in C, Tata McGraw Hill Publications.

Course Code: PGMAT1F006T

Course Title: INTRODUCTION TO SET THEORY

OBJECTIVES: Set theory is a branch of mathematical logic where students learn sets and their properties.Set theory is commonly employed as a foundational system for the whole of mathematics. Besides its foundational role, set theory also provides the framework to develop a mathematical theory of infinity, and has various applications in other fields. Set theis a branch of mathematical logic where students learn sets and their properties.

LEARNING OUTCOMES: After completion of the course, students will be able to do the following:

- understanding of limit points and what is meant by the continuity of a function are based on set theory.
- Students who successfully complete the course will be able to understand and apply the basic axioms and concepts of set theory.
- They will be able to read, write and present theorems and proofs in higher mathematics.
- Demonstrate an understanding of set theory as a sub-area of logic and contrast it with other areas of logic.
- Describe the various types of set theoretical objects that can be constructed using the different axioms, with a special focus on the axiom of choice.
- Formulate, derive and apply basic arithmetic for cardinal and ordinal numbers.
- Formulate and present set theoretical constructions of number systems including the natural and real numbers, as well as verify their most central properties using the axioms of set theory.

...oduction to Set Theory
...e: Foundation Compulsory
...ration of Examination: 2 Hours

Course No: PGJMAT1F0041T

Maximum Marks: 50

Objective: This is a foundation course in Mathematics useful for everybody working in any area of Mathematics. Pre-requisite for this course is under-graduate elementary logic and set theory.

Unit-1

The Axiom of Choice and some of its equivalent forms: Motivation and historical remarks, family of sets and Cartesian product of family sets, partial ordered sets, Hausdorff Maximality Principle, fixed point theorem (statement only), Zorn's lemma, applications of Zorn's lemma, well-ordering principle, equivalence of the above three concepts, Principle of transfinite induction.

Unit-2

Denumerable and non-denumerable sets: finite and infinite sets, equipotent of sets, examples and properties of denumerable and non-denumerable sets, cardinal numbers, ordering of the cardinal numbers, cardinal number of a power set, Cantor theorem, Schroder Berstein Theorem (statement only), addition and multiplication of cardinal numbers, exponential of cardinal numbers, the continuum hypothesis and its generalization.

Unit-3

Ordinal Numbers, ordering of the ordinal numbers, addition and multiplication of ordinal numbers, set of ordinal numbers is well ordered, non-existence of a set of all ordinals, problems and exercises based on these concepts.

Text Books:

1. Shwu-Yeng T Lin, Set Theory with Applications, Mariner Pub. Co.: Enlarged 2nd Edition (1981)

Reference Books:

1. Paul R Halmos, Naive Set Theory, Springer-Verley New York Inc, 1974
2. Robert R. Stoll, Set Theory and Logic, W.H. Freeman and Co. 1963.