Enclosure - II

SARVODAYA KELAVANI SAMAJ MANAGED,

SHREE MANIBHAI VIRANI & SMT.NAVALBEN VIRANI SCIENCE COLLEGE

AN AUTONOMOUS COLLEGE- AFFILIATED TO SAURASHTRA UNIVERSITY, RAJKOT

Re-accredited at the 'A' Level (CGPA 3.28) by NAAC
'STAR' College Scheme & Status by MST-DBT
A College with Potential for Excellence - CPE (Phase-II) by UGC
Accredited at the G-AAA Highest Grade 'A-1′ Level by KCG, Govt. of Gujarat
UGC-DDU KAUSHAL Kendra
GPCB-Government of Gujarat approved Environment Audit Centre

DEPARTMENT OF MATHEMATICS

SYLLABUS FOR THE COURSES OF THE 5TH AND 10TH SEMESTER

OF

Integrated B.Sc.-M.Sc. Mathematics

Integrated B.Sc. - M.Sc. Mathematics

For students admitted from A.Y. 2016-2017 & onwards

SEMESTER – V			
16IMTCC18	**Core 10 :** Programming in C	**3hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze given mathematical problem to solve it using a computer program.
2. Develop algorithm to solve given mathematical problem using C program.
3. Write program to solve given mathematical problem using it.
4. Find errors in the C program and correct it.

Unit 1: Introduction to C **(8hrs)**

- History of C, C character set
- Constants, Variables, Keywords, Type Declaration, Type Conversion
- Hierarchy of operators
- printf & scanf functions
- Simple programs using these basic concepts.

Unit 2: Decisions and Branching **(7hrs)**

- if statement, if-else statements
- Nested if-else, elseif clause
- Logical operators, Conditional operators
- Programs using these concepts

Unit 3: Looping Mechanism and User Defined Functions **(7hrs)**

- While loop, for loop
- do-while loop, break statement
- Continue statement goto statement
- Brief introduction to User Defined Functions
- Programs using these concepts

Unit 4: Data types and Preprocessor **(7hrs)**

- Data types in C Integers: long and short types
- signed and unsigned characters, Signed and unsigned
- float and doubles
- C processors, meaning
- Macro Expansion
- Macros with Arguments
- Programs using these concepts

Unit 5: Introduction to Arrays **(7hrs)**

- Arrays, meaning:
- One dimensional and two dimensional
- Declaration and initialization of one dimensional and two dimensional arrays
- Use of one dimensional and two dimensional arrays in simple programs

TEXT BOOKS: -

1. Yashvant Kanetker, LET US C, 5th Edition, BPB Publications, New Delhi.
2. E. Balagurusamy, Programming in ANSI C, McGrew Hill Education, Seventh Edition.

REFERENCE BOOKS:-

1. Brian W. Karnighan and Dennis M. Ritchie, The ANSI C Programming Language, Prentice Hall, 1988.
2. V. Rajaraman, Computer Programming in C, Prentice Hall of India, 1994.

Semester – V			
16IMTCC19	**CORE 11:** Group Theory	**3hrs/week**	**3Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the basic ideas and notions of abstract algebra.
2. Define and recognize the abstract mathematical structures including group and subgroups.
3. State and criticize the properties of groups.
4. Define and recognize the Isomorphism groups and Homomorphism groups.
5. Define of Permutation groups and cyclic groups and prove theorems of the same.

Unit 1:Introduction to Group (6 hrs)

- Definition and examples of Groups.
- Elementary Properties of Group.
- Finite group, Order of a group, Order of an element.

Unit 2: Subgroups and Normal Subgroups (7 hrs)

- Definition and example of a subgroup.
- Lagrange's Theorem.
- Definition of Centre of a Group and theorems related to it.
- Definition and example of a Normal subgroup.
- Theorems related to Normal Subgroup.

Unit 3: Permutation Groups and Cyclic Group (8 hrs)

- Definition and examples of Permutation Groups.
- Transposition and Cycle.
- Properties of Cyclic Group.
- Classification of Subgroup of Cyclic Group.

Unit 4: Isomorphism of Groups (7 hrs)

- Definition and Examples
- Cayley's Theorem
- Properties of Isomorphism.
- Automorphisms and Inner Automorphisms.

Unit 5:Group Homomorphism (7 hrs)

- Definition and Examples
- Properties of Homorphisms
- Kernal of Homomorphism
- The First Isomorphism Theorem

TEXT BOOKS: -

1. I.H.Sheth, Abstract Algebra, Prentice/Hall of India Private Limited, New Delhi
2. I. N. Herstein, Topics in Algebra, Vikas Publishing, New Delhi.

REFERENCE BOOKS:-

1. Thomas W. Judson, Abstract Algebra Theory and Applications, Stephen F. Austin State University, 2009.
2. Marlow Anderson & Todd Fel, A first course in Abstract Algebra (Rings, Groups & fields), Chrpman & Halilereivy
3. Fraleigh J.B., A First Course in Abstract Algebra, Narosa Publishing, New Delhi.
4. Joseph A. Gallian, Contemporary Abstract Algebra, Forth Edition, Narosa Publishing House.

Semester – V			
16IMTCC20	**CORE 12:** Numerical Analysis - I	**3hrs/week**	**3Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze data and find proper curves to fit the data given.
2. Understand the meaning of roots and find the roots of given equations including Equation with Rational Coefficients and Irrational Roots.
3. Solve and criticize Simultaneous Linear Algebraic Equation.
4. Find finite differences and utilize the same to do interpolation of given data.

Unit 1: Empirical Laws and Curve Fitting (8 hrs)

- Introduction.
- Linear Law.
- Laws reducible to linear law
- Principle of Least Squares.
- Fitting a Straight Line.
- Fitting a Parabola.
- Fitting an Exponential Curve.
- Fitting the curve $y = ax^b$.

Unit 2: Theory of Equation. (8 hrs)

- Introduction.
- Relation between Roots and Coefficients.
- Equation with Real Coefficients and Imaginary Roots.
- Equation with Rational Coefficients and Irrational Roots.
- Symmetric Function of Roots.
- Formation of Equation whose Roots are Given.
- Transformation of Equation.
- Multiple Roots.

Unit 3: Simultaneous Linear Algebraic Equation. (6 hrs)

- Introduction.
- Gauss elimination method.
- Gauss Jordan method.
- Method of factorization (L.U. Decomposition).
- Crout's method.
- Jacobi's method.
- Gauss Seidal's method.

Unit 4: Finite Differences. **(8 hrs)**

- Introduction.
- Finite differences (forward , backward and central).
- Differences of polynomials.
- Factorial polynomial.
- Reciprocal Factorial polynomial.
- Polynomial factorial notation.
- Error propagation in difference table.
- Other difference operators (Shift, averaging, differential and unit) and relation between them.

Unit 5: Interpolation with Equal Intervals. **(6 hrs)**

- Introduction.
- Gregory- Newton forward interpolation formula.
- Gregory- Newton backward interpolation formula.
- Equidistance terms with one or more missing values.

TEXT BOOKS: -

1. Numerical methods by Dr. V. N. Vedamurthy & Dr. N. Ch. S. N. Iyengar, Vikas Publishing house.

REFERENCE BOOKS:-

1. Introduction to Numerical Analysis (2nd Edition) by C. E. Froberg Addision Wasley, 1979
2. Numerical method, Problems & Solutions, by M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International Pvt. Ltd., 1996**.**
3. Numerical Mathematical Analysis, by J. B. Scarforough, Oxford & IBH Publication Co. Pvt. Ltd., 1966

Semester – V			
16IMTCC21	**Core 13:** Set Theory and Logic **(Self Study Course)**	**1hrs/week**	**4Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.
2. Construct truth tables, prove or disprove a hypothesis, and evaluate the truth of a statement using the principles of logic.
3. Solve problems and write proofs using the concepts of set theory, including the methods of Venn diagrams and truth tables.

Unit 1: Sets and Basic Operations on Sets **(3 hrs)**

- Preliminaries: Basic set theory terminology and notation
- Venn Diagrams
- Classes of sets and power set
- Set operations
- Mathematical Induction
- Real Number System R
- Order and Inequalities, Absolute value, Distance, Intervals
- Bounded sets
- Integers Z, Greatest Common Divisor

Unit 2: Cardinal and Ordinal Numbers **(2 hrs)**

- Denumerable and Countable sets
- Cardinal Numbers, Ordering of Cardinal Numbers, Cardinal Arithmetic
- Well Ordered sets
- Ordinal Numbers, Structure of Ordinal Numbers.

Unit 3: Relations and Functions **(3 hrs)**

- Product set, Relations-introduction
- Composition of relation, Types of relation
- Functions-Introduction
- Composition of functions
- One to one, onto and invertible function
- Mathematical functions, exponential, logarithmic function

Unit 4 : Further theory of sets and functions **(2 hrs)**

- Operations of Collections of sets
- Indexed of Collections of sets
- Sequences, Summation symbol
- Fundamental Products
- Functions and Diagrams
- Special kinds of functions, Fundamental Factorization
- Choice function
- Algorithms and functions

- Complexity of Algorithms

Unit 5: Logic and Truth Tables (2 hrs)

- Logic propositions: Truth and falsehood of propositions,
- logic operations
- Tautologies and Contradictions
- Logical equivalence, Equivalences for negations, Equivalent forms of the implications
- Circuits and Logic
- The statement T and F.

TEXT BOOKS: -

1. Set Theory and Related Topics, 2nd edition, Seymour Lipschutz, Schaum's Outline Series, Mc Graw Hill, 1988.
2. Set Theory and Logic, Robert R. Stoll, Dover Publications, New York, 1963.
3. Introduction to Set Theory, Karel Hrbacek and Thomas Jech, Marcel Dekker, 1999.

REFERENCE BOOKS:-

1. A Course on Set Theory, Ernest Schimmerling, Cambridge University Press, 2011.

Semester – V			
16IMTDC01	**DSE – CORE 1:** Metric Space	**3hrs/week**	**3Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the concept of metric space and its structure.
2. Determine closed-ness of the given set with respect to given metric.
3. Discuss and criticize the properties of Countable sets and Cantor set.
4. Evaluate and determine the compactness of the given sets in a metric space.
5. Analyze and criticize the connectedness of sets in metric space.

Unit 1: Metric space **(7 Hrs)**

- Metric Space – definition and problems based on it
- Usual Metric Space and Discrete Metric Space
- Problems based on Discrete Metric Space
- Some important results based on Discrete Metric Space.
- Neighbourhood , Interior point , Open set
- Problems based on Open set and Neighbourhood
- Hausdorff Principle
- Open sets in metric space
- Neighbourhood as an Open set
- Open interval as an open set

Unit 2: Closed Set **(6 Hrs)**

- Limit point, Closed set , Derived set, Dense set , Nowhere Dense
- Problems based on Closed set, derived set
- Results based on Closed set
- Boundary points of a set and problems based on it
- Results based on closure of a set

Unit 3: Countable set and Cantor set **(7 Hrs)**

- Fundamentals of one-one function and onto function
- Definition of Similar sets
- Problems based on similarity of sets
- Countable sets and problems based on Countable set
- Definition of the Cantor set
- Some important properties of the Cantor set
- Representation of Real number or m- based expression

Unit 4: Compact set **(8 Hrs)**

- Separated set in a metric space
- Difference between disjoint & Separated set
- Definition and examples of Cover of a set

- Definition and examples of Sub cover , Open cover
- Compact sets
- Some important results of Compact set
- Heine Boral Theorem
- Problems based on these concepts

Unit 5: Connected set (7 Hrs)

- Connected set
- Some important results based on Connected set
- Boltzano weirstrass theorem
- Nested Interval Theorem
- Totally Bounded sets
- Sequential Compactness
- Results based on Sequential Compactness
- Problems based on these concepts.

TEXT BOOKS: -

1. J. N. Sharma and A. R. Vashishtha , Mathematical Analysis - I , Krishna Prakashan Mandir , MEERUT(U.P.)
2. J. N. Sharma and A. R. Vashishtha , Mathematical Analysis - II , Krishna Prakashan Mandir , MEERUT(U.P.)

REFERENCE BOOKS:-

1. S.C.Malik & Savita Arora , Mathematical Analysis , New Age Int. Pvt.Ltd .
2. Shantinarayana , A first course of Mathematical Analysis , S. Chand & sons.
3. Tom.M.Apostol , Mathematical Analysis , Narosa Publishing House.
4. R.R.Goldberg , Methods of Real Analysis , Oxford & IBH Publishing Co. Pvt. Ltd.
5. H. L. Royden , Real Analysis , Prentice Hall of India Pvt Ltd. New Delhi.

Semester – V			
16IMTDC02	**DSE-CORE 1:** Number Theory	**3hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Prove results involving divisibility and greatest common divisors;
2. Solve systems of linear congruences;
3. Find integral solutions to specified linear Diophantine Equations;
4. Apply Euler-Fermat's Theorem to prove relations involving prime numbers;
5. Apply the Wilson's theorem.

Unit 1. Introduction: (7 Hrs)

- Algebraic operations with integers,
- Well Ordering Principle, Pigeon Hole Principle, Principle of Mathematical Induction,
- Divisibility and division algorithm,
- Representation of integers in different bases, The greatest Common Divisor,
- The Euclidean Algorithm (without proof), Lame's theorem.

Unit 2. Prime Numbers: (7 Hrs)

- Prime and composite number,
- Fundamental Theorem of Arithmetic (without proof), canonical form of a number, the Sieve of Eratosthenes, Least Common Multiples,
- Linear Diophantine Equations-The function [x] and the "O" and "o" symbols,
- Theory of Congruence: Definition and basic properties of congruence,
- Residue class & complete system of residues,

Unit 3. Congruences: (7 Hrs)

- Introduction to congruences, Residue system,
- Euler's phi- function, Linear congruences, The Chinese Remainder Theorem,
- Theorems of Fermat, Euler and Wilson, problems on Euler's theorem.

Unit 4. Multiplicative Number theoretic Functions: (7 Hrs)

- Definitions and properties, The Euler phi function,
- The Sum of Divisors function,
- The Number of Divisors functions,
- The Mobius function, the Mobius inversion formula,
- The Perfect, Mersenne, and Fermat Numbers.

Unit 5. Primitive roots: (8 Hrs)

- The order of integers and primitive roots,
- Primitive roots for prime,
- Existence of primitive roots.

TEXT BOOKS: -

1. Elementary Number Theory - David M. Burton, Sixth Edition, Universal Book stall, New Delhi.

REFERENCE BOOKS:-

1. An introduction to the Theory of numbers - Niven and Zuckerman, Wiley Eastern Ltd.
2. Elementary Number Theory - Gareth A. Jones & J. Mary Jones, Springer Verlag.
3. Elementary Theory of Numbers - C. Y. Hsiung, Allied Publishers Ltd.-India.
4. Introduction to the theory of Numbers - G. H. Hardy & E. M. Wright, Oxford Uni. Press .

Semester – V			
16IMTDC03	**DSE-CORE - I :** Mechanics	**3hrs/week**	**3 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand and describe elementary principles of motion.
2. Understand and criticize equations of motion and classify the dynamical systems.
3. Derive and utilize Lagrange's equation of motions.
4. Identify, understatnd and solve two body central force problem.

Unit 1 Methods of plane statics: (7hrs)

- Equilibrium of a particle and a system of particles, work and potential energy.
- Application of plane statics.

Unit 2 Mass centers and centers of gravity (7hrs)

- Mass centers and centers of gravity, friction flexible cables.
- Plane kinematics of a particle, motion of a rigid body parallel to a fixed plane.

Unit 3 Methods of plane dynamics (7hrs)

- Motion of a particle motion of a system
- Projectiles without resisitance
- Harmonic oscillators

Unit 4 General motion & Planetary orbits (7hrs)

- General motion under a central force
- Planetary orbits

Unit 5 Motion of a rigid body (8 Hrs)

- Motion of a rigid body and of a system
- Moments of Inertia
- Kinetic energy and angular momentum
- Rigid body rotation about a fixed axis
- General motion of a rigid body parallel to fixed plane
- Stability of equilibrium
- General theory of plane impulsive motion, collisions

TEXT BOOKS:

1. Jhon L. Synge and Byron A. Griffith, Principles of Mechanics, McGrew Hill, Second Edition.

REFERENCE BOOKS:-

1. H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Publishing House
2. C. R. Mondal, Classical Mechanics, Prentice Hall of India Pvt. Ltd.
3. R. G. Takwale, P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill Education, 1979

Semester – V			
16IMTCC22	**CORE PRACTICAL 9 :** Programming in C Practical	**4hrs/week**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze given mathematical problem to solve it using a computer program.
2. Develop algorithm to solve given mathematical problem.
3. Write C program to solve given mathematical problem using the program.
4. Find errors in the C program and correct it.

List of Experiments

1. Write a program to find area of a circle when radius is given.
2. Write a program to calculate the area of a triangle when base and height of the triangle are given.
3. Write a program to find value of one number raised to another number.
4. Write a program to determine whether given number is an even or odd number.
5. Write a program to find largest of three given numbers.
6. Write a program to find largest of four given numbers.
7. Write program to find net salary when basic salary and other required details are given.
8. Write a program to solve the quadratic equation
9. Write a program to reverse an integer with FIVE digits.
10. Write a program to verify a number whether it is palindrome or not.
11. Write a program to find sum of the digits an integer with FIVE digits.
12. Write a program to print Armstrong numbers between1 to 999.
13. Write a program to generate arithmetic and geometric progressions.
14. Write a program to find nPr and nCr for given value of +ve integers n and r.
15. Write a program to find compound interest for given years.
16. Write a program to find number of odd number and even numbers.
17. Write a program to find factorial of a given number.
18. Write a program using UDF with two arguments and a return value.
19. Write a program that utilizes a UDF two find prime numbers between two integers entered through key-board.
20. Write a program to solve the equation by N-R method. (Use of preprocessor)
21. Write a program to find value determinant of a 2X2 and a 3X3 matrix.
22. Write a program to find inverse of a 2X2 matrix.
23. Write a program to find diagonal of a 3X3 matrix entered through key-board.
24. Write a program to find the sum, deference, and multiplication of two 3X3 matrices entered through key-board.

TEXT BOOKS: -

1. Yashvant Kanetker, LET US C, 5th Edition, BPB Publications, New Delhi
2. E. Balagurusamy, Programming in ANSI C, McGrew Hill Education, Seventh Edition.

REFERENCE BOOKS:-

1. Brian W. Karnighan and Dennis M. Ritchie, The ANSI C Programming Language, Prentice Hall, 1988.
   V. Rajaraman, Computer Programming in C, Prentice Hall of India, 1994.

Semester – V			
16IMTCC23	**CORE PRACTICAL 10:** Numerical Analysis - I Practical	**4hrs/week**	**2Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze data and find proper curves to fit the data given.
2. Understand the meaning of roots and find the roots of given equations including Equation with Rational Coefficients and Irrational Roots.
3. Solve and criticize Simultaneous Linear Algebraic Equation.
4. Find finite differences and utilize the same to do interpolation of given data.

List of Experiments

1. Gauss elimination method.
2. Gauss Jordan method.
3. LU decomposition method.
4. Crout's method.
5. Jacobi's method.
6. Gauss Seidel method.
7. Fitting a Straight line.
8. Fitting an exponential curve $y = e^{ax}$.
9. Fitting a Parabola.
10. Fitting the curve of the type $y = ax^b$.
11. Finite differences.
12. Gregory- Newton forward interpolation formula.
13. Gregory- Newton backward interpolation formula.
14. Equidistance terms with one or more missing values.

TEXT BOOKS: -

1. Numerical methods by Dr. V. N. Vedamurthy & Dr. N. Ch. S. N. Iyengar, Vikas publishing house.

REFERENCE BOOKS:-

1. Introduction to Numerical Analysis (2nd Edition) by C.E.Froberg Addision Wasley, 1979.
2. Numerical method, Problems & Solutions, by M. K. Jain, S. R. K.Iyengar, R. K. Jain, New Age International Pvt. Ltd., 1996.
3. Numerical Mathematical Analysis, by J. B.Scarforough, Oxford & IBH Publi.Co. Pvt. Ltd., 1966.

Semester – V			
16IMTCC24	**CORE PRACTICAL 11:** Advanced SCILAB Practical	**4hrs/week**	**2Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concept of open source mathematical software including SCILAB.
2. Understand and utilize the user interface of SCILAB including console, file browser, variable browser, the command history and general commands including clc & clear
3. Utilize pre-defined mathematical constants and variables, operators of Scilab, Input and utilize inbuilt matrix commands including ones(), zeros(), eye(), spac(), diag(), inv(), det(), spec().
4. Solve problems using direct and iterative methods of numerical analysis with scilab.
5. Find and analyze the sub matrices of given matrices

List of Experiments

1. To get understand and utilize the program editor SCINOTE and its interface with small programs.
2. To create programs in SCINOTE understand usage of commands including clear, clear all, clf, clc,.etc.
3. To find the inverse of a matrix using GAUSS-ELIMINATION method.
4. To find inverse of given matrix using GAUSS-JORDAN method.
5. To find Eigen values and Eigen vectors of given matrix.
6. To find inverse of given matrix using CAYLEY-HAMILTON theorem.
7. To solve given system of simultaneous linear algebraic equations using GAUSS-JORDAN method.
8. To solve given system of simultaneous linear algebraic equations using GAUSS-JACOBI method.
9. To solve given system of simultaneous linear algebraic equations using GAUSS-SEIDAL'S method.
10. Introduction to variables and input statement in SCILAB, Introduction to the loop structure of SCILAB.

TEXT BOOKS: -

1. Scilab Group, SCILAB REFERENCE MANUAL, On-line Documentation, INRIA Meta2 Project / ENPC Cergrene, INRIA.

REFERENCE BOOKS:-

1. Vinu V. Das, Programming in Scilab, New Age International (P) Limited, 2008.
2. Domaine de Voluceau - Rocquencourt – B, INTRODUCTION TO SCILAB Consortium SCILAB, November 2010.
3. Gilberto E. Urroz, Programming with SCILAB, September 2002.
4. Tejas Sheth, SCILAB: A Practical Introduction to Programming and Problem Solving, 25 August 2016.

5. Perrine Mathieu, Philippe Roux, Scilab, from theory to practice, Scilab: I. Fundamentals, 2016, ISBN: 978-2-8227-0293-5.
6. Dr. M. Affouf, Scilab by example, 2012, ISBN: 978-1479203444

Websites:-

1. http://www.scilab.org/	Main website of Scilab
2. http://www.scilab.org/support/documentation	Official documentation of Scilab
3. http://www.scilab.org/products/scilab/download	Download Scilab software
4. http://help.scilab.org/docs/5.4.0/en_US/	Help on Scilab
5. http://ekalavya.it.iitb.ac.in/contents.do?topic=Scilab	IIT, Bombay portal
6. http://spoken-tutorial.org/Study_Plans_Scilab/	Spoken-tutorial
7. http://scilab.in/	Scilab India

Semester – VI			
16IMTCC27	**CORE 16:** Analysis-II and Ring Theory	**5hrs/week**	**5Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the basic ideas and notions of abstract algebra.
2. Define and recognize the abstract mathematical structures including Rings and sub-rings.
3. State and criticize the properties of Rings.
4. Define and recognize the Ideals of given Rings.
5. Define and recognize the homomorphism of rings and utilize its properties.

Unit 1:Improper Integrals **(12 hrs)**

- Introduction.
- Integration of Unbounded function with finite limit of Integration.
- Comparison Test for Convergence of integral.
- Infinite Range of Integration

Unit 2: Ring And Integral Domains **(12 hrs)**

- Definition and examples of Ring
- Properties of Ring
- Further examples of Rings
- Definition and example of Integral Domain
- Zero divisors
- Characteristic of a Ring
- Solution of the Equation ax=b in a ring R
- Theorems on Integral Domain

Unit 3: Ideals **(12 hrs)**

- Definition of Subring
- Definition of Ideals
- Quotient Ring
- Theorems on Ideals and Its Examples

Unit 4: Homomorphism **(12 hrs)**

- Definition and examples of a Ring homomorphism
- Properties of Ring Homorphism
- Homomorphism and Characteristic
- Examples of Ring Homomorphism

Unit 5: Polynomial Ring and Introduction to Field **(12 hrs)**

- Definitiona and Examples of Polynomial Ring
- Definition and Examples of Field
- Reducible and irreducible polynomials, Factorization of polynomials
- G.C.D. of polynomials, Quaternion

TEXT BOOKS: -

1. I.H.Sheth, Abstact Algebra, Prentice/Hall of India Private Limited, new delhi
2. N. Herstein, Topics in Algebra, Vikas Publishing, New Delhi.
3. S.C. Malik and Savita Arora , Mathematical Analysis, New Age International (P) Ltd, Publishers, 2nd Edition.

REFERENCE BOOKS:-

1. Thomas W. Judson, Abstract Algebra Theory and Applications, Stephen F. Austin State University, 2009.
2. Marlow Anderson & Todd Fel, A first course in Abstract Algebra (Rings, Groups & fields), Chrpman & Halilereivy
3. Fraleigh J.B., A First Course in Abstract Algebra, Narosa Publishing, New Delhi.
4. Joseph A. Gallian, Contemporary Abstract Algebra, Forth Edition, Narosa Publishing House
5. Shantinarayan, A course of Mathematical Analysis, S. Chand & Sons.
6. Walter Rudin, Principle of Mathematical Analysis, MC Graw- Hill Bok & Company, 2nd

SEMESTER – VI			
16IMTCC28	**CORE 17 :** Optimization	**3hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the importance and scope of the subject Operations Research.
2. Develop and formulate problems in mathematics terms from given real life problems.
3. Solve linear programming problems with the methods including Simplex Method.
4. Solve Transportation Problems, Assignment Problems and Sequencing Problems.
5. Understand, analyze and effectively solve the problems related to the theory of games.

Unit 1: Introduction to Operations Research (7 Hrs)

- History and development of Operations Research
- Applications and scope of Operations Research
- The linear programming problems
- Formulation of LPP
- Matrix form of the LPP
- General form, Canonical form
- Standard form of the LPP
- Graphical method to solve LPP
- Some definitions and basic properties of convex sets
- Convex functions and concave function.

Unit 2: Linear Programming Problems (7 Hrs)

- Basic definitions to use Simplex method
- Simplex method (algorithm) to solve LPP
- Big-M method (Penalty method) to solve LPP
- Two phase method to solve LPP
- Problems of LPP based on these methods

Unit 3: Duality in LPP and Assignment problems (7 Hrs)

- Principle of duality in LPP
- Primal LPP and method to find its dual LPP
- Simple problems of duality.
- Mathematical and matrix form of Assignment Problem
- Hungarian method to solve Assignment Problem
- Problems of Assignment and its solution based on this method.

Unit 4: Transportation Problems (7 Hrs)

- The Transportation Problems
- Mathematical and matrix form of TP.
- Initial solution of TP by NWCM, LCM and VAM
- Optimum solution of TP by MODI method (u-v method) (except degenerate solution),
- Balanced and unbalanced TP (Simple problem)

Unit 5: Sequencing and Game Theory **(8 Hrs)**

- Introduction to Game Theory
- Two person zero-sum game
- Minimax and maximin principles
- Saddle point of a game
- Games without a saddle point
- Solution of games by dominance rule.
- Iterative method to solve a game
- Introduction to Sequencing Problems
- Terminology Notations and Assumptions
- Processing n-jobs through two machines
- Processing n-jobs through three machines.

TEXT BOOKS: -

1. J. K. Sharma, Operations Research (theory and Applications), MacMillan Publishing House .
2. R. K. Gupta, Operations Research, Krishna Prakashan Mandir, Meeut.

REFERENCE BOOKS:-

1. Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.
   Kanti Swaroop and Manmohan, Operations Research, Sultanchand and Sons.

Semester – VI			
16IMTCC29	**CORE 18:** Numerical Analysis - II	**3hrs/week**	**3Credits**

Objectives: -

Upon completion of the course students will be able to

1. Understand the concept of interpolation.
2. Analyze and process data with equal or unequal interval and interpolate the same for given non-tabulated values.
3. Perform numerical differentiation using various formulae including Gregory-Newton's forward difference formula and Sterling's formula.
4. Perform numerical integration using various formulae including Trapezoidal rule, Simpson's 1/3 rule and Simpson's 3/8 rule.
5. Solve ordinary differential equations numerically using method including Taylor's series method, Picard's method, Euler's method, Runge's method and Runge-Kutta methods.

Unit 1: Central difference interpolation formulae. (8 hrs)

- Introduction.
- Gauss's forward interpolation formula.
- Gauss's backward interpolation formula.
- Sterling's formula.
- Bessel's formula.
- Laplace- Everett's interpolation formula.

Unit 2: Interpolation with unequal intervals. (8 hrs)

- Introduction.
- Divided differences.
- Properties of divided difference.
- Relation between divided differences and forward difference.
- Newton's divided difference formula.
- Lagrange's interpolation formula.
- Inverse interpolation.
- Lagrange's inverse interpolation formula.

Unit 3: Numerical Differentiation. (6 hrs)

- Introduction.
- Numerical Differentiation.
- Derivatives using Gregory-Newton's forward difference formula.
- Derivatives using Gregory-Newton's backward difference formula.
- Derivative using Sterling's formula.

Unit 4: Numerical Integration. (6 hrs)

- Introduction.
- Numerical Integration.
- General quadrature formula.
- Trapezoidal rule

- Simpson‘s 1/3 rule.
- Simpson’s 3/8 rule.

Unit 5: Numerical solution of ordinary differential equations. (8 hrs)

- Introduction.
- Solution by Taylor’s series method.
- Picard’s method.
- Euler’s method.
- Runge’s method
- Runge-Kutta methods.
- Higher order Runge-Kutta methods.

TEXT BOOKS: -

1. Numerical methods by Dr. V. N. Vedamurthy & Dr. N. Ch. S. N. Iyengar, Vikas Publishing house.
2.

REFERENCE BOOKS:-

1. Introduction to Numerical Analysis (2nd Edition) by C.E.Froberg Addision Wasley, 1979.
2. Numerical method, Problems & Solutions, by M. K. Jain, S. R. K.Iyengar, R. K. Jain, New Age International Pvt. Ltd., 1996**.**
3. Numerical Mathematical Analysis, by J. B.Scarforough, Oxford & IBH Publi.Co. Pvt. Ltd., 1966.

Semester – VI			
16IMTDC04	**DSE-CORE 2:** Graph Theory	**3hrs/week**	**3Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the fundamental concepts in graph theory.
2. Understand the types of a graph and incidence relation.
3. Define subgraph, connected and disconnected graphs. Understand walk, paths, circuits and Define tree and some properties of tree.
4. Define cut-set, connectivity and separability. Define planner graphs and their dual graphs. State and prove Kuratowski's first and second non-planner graph. Define vertex coloring, chromatic number and matrix representation of graphs.
5. Apply the concepts of graph theory in a variety of fields.
6. Understand and to construct mathematical proofs involving graphs.

Unit 1: Introduction **(8 hrs)**

- Basic definitions and simple examples.
- Directed, Undirected, multi-graph, mixed graph.
- Incidence relation and degree of the graph.
- Complete, regular graphs.

Unit 2: Paths and Circuits **(6 hrs)**

- Sub graph, connected and disconnected graphs.
- Walk and unilateral components.
- Euler graphs, Unicursal graph, Operation of graph, Circuit & Tree.
- Hamiltonian path and cycles.

Unit 3: Trees and Fundamental Circuits **(9 hrs)**

- Tree.
- Some properties of Trees.
- Distance and Centres of Trees.
- Rooted and Binary Trees.
- Cut-set, connectivity and separability.
- Fundamental Circuit and Cut-Set.

Unit 4: Planar and Dual Graphs and Vector space associated with a graph. **(9 hrs)**

- Planner graphs and their different representation.
- Dual of a planner graph.
- Euler's formula.
- Kuratowski's first and second non-planner graph.
- Circuit subspace and cut sets subspace.
- Orthogonal space.

Unit 5: Coloring, Covering, Partitioning and Matrix representation of a graph. (6 hrs)

- Vertex coloring , edge coloring.
- Chromatic number, Chromatic partition.
- Cyclic graph and decyclization of cyclic graphs.
- Adjacency matrix, Incidence matrix, Path matrix.

TEXT BOOKS: -

4. Narsingh Deo, Graph Theory with applications to engineering and computer science, Prentice-Hall of India Pvt. Ltd. New Delhi.
5. A First Look at Graph Theory - John Clark and Derek Allan Holton, Allied Publishers Limited.

REFERENCE BOOKS:-

1. R. J. Wilson, Introduction to Graph Theory, Longman.
2. Douglas B. West, Introduction to Graph Theory, Prentice-Hall of India, Second Edition, 2006, ISBN-81-203-2142-1.
3. S. Arumugam, S. Ramchandran, Invitation to Graph Theory, Scitech Publication (India) Pvt. Ltd, Chennai.
4. S. A. Choudum, A First Course in Graph Theory, Macmillan India Limited.

Semester –VI			
16IMTDC05	**DSE-CORE 2:** Complex Analysis	**3hrs/week**	**3Credits**

Objectives:-

Upon completion of the course students will be able to

1. Extend concepts of analysis of real variables to complex numbers.
2. Differentiate and Integrate Complex functions.
3. Evaluate contour integration.
4. Apply techniques of Complex analysis to summation of series.
5. Apply conformal mappings to problems from physical science

Unit 1: Analytic Functions **(5Hrs)**

- Functions of Complex variables
- Continuity and Differentiability of Complex Functions
- Definition of Analytic and Entire Functions
- Necessary and Sufficient condition for f(z) to be analytic
- C-R equations in Polar form
- Examples and Theorems of analytic and entire functions

Unit 2: Harmonic Functions **(5 Hrs)**

- Harmonic Functions and Conjugate Harmonic Functions
- Laplace Equation in Polar and Cartesian form
- Example based on Harmonic Functions
- Milne Thomson Theorem
- Examples on Milne Thomson Theorem

Unit 3: Contour Integral **(9Hrs)**

- Definite integral contours, line integrals
- Cauchy-Goursat theorem **(without proof)**
- Cauchy's integral formula and Higher order derivative of analytic function
- Morera's theorem, Cauchy's inequality and Liouville's theorem
- Fundamental theorem of algebra
- Maximum modulus theorem.

Unit 4: Power series and, Residues and poles **(8 Hrs)**

- Definition of complex sequence, complex series and power series
- Expansion of a complex function in Taylor's series and Laurent's series.
- Definition of a singular point, Isolated singular points,
- Zeros of complex functions, Poles and residues of complex function
- Cauchy's residue's theorem,
- Evaluation of improper real integrals by residue theorem
- Evolution of definite integral of trigonometric functions by residue theorem.

Unit 5: Mapping and Conformal mapping: **(9 Hrs)**

- Elementary functions, mapping by elementary functions,
- Linear function, Bilinear mapping **w=(az+b)/(cz+d)**,
- Discuss the mapping $w = z^2$, $w = \frac{1}{z}$, $w = e^z$
- Some more Transformations.

TEXT BOOKS: -

1. Shanti Narayan and Dr. P. K. Mittal , Theory of Functions of a Complex variable , S. Chand Publishing, 1956.
2. Dennis G. Zill and Patrick D. Shanahan, A First Course in Complex Analysis with Applications, 2nd edition, Jones and Bartlett Publishers, 2009.

REFERENCE BOOKS:-

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., Mc Graw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

Semester – VI			
16IMTDC06	**DSE – CORE 2:** Mathematical Modelling	**3hrs/week**	**3Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand concept of Mathematical Modelling.
2. Analyze Non-linear growth & decay models.
3. Solve the Models involving Differential Equations.
4. Critically analyze effect of immigration & emigration of population size using Mathematical Modelling.
5. Apply Mathematical Modelling for scientific and economic laws.

Unit 1: Introduction of Mathematical Modelling (7 hrs)

- Mathematical modelling through ordinary differential equation of first order, Linear growth models
- Linear decay models
- Models for growth of Science & scientists

Unit 2: Non-linear growth & decay models (7 hrs)

- Non-linear growth & decay models
- Model of Logistic law of population
- Spread of technological innovation
- Spread of infectious diseases.

Unit 3: Models involving Differential Equations (7 hrs)

- Mathematical models of geometrical problems through ordinary differential equation of first order
- Simple geometrical problems
- Orthogonal trajectories

Unit 4: Different areas of application of Mathematical Modelling (7 hrs)

- Mathematical modelling of effect of immigration & emigration of population size
- Mathematical models of rate of compound interest
- Mathematical models of radioactive decay
-

Unit 5:Application of Mathematical Modelling for scientific and economic laws. (7 hrs)

- Mathematical modelling of Newton's cooling law
- Mathematical modelling of Fick's law of diffusion
- Mathematical modelling of change in price of commodity.

TEXT BOOKS: -

1. J.N. Kapoor, Mathematical Modelling, New Age International Publishers, New Delhi.
2. Kerysin, Advanced Engineering Mathematic, John Wiley, New York, 1999

REFERENCE BOOKS:

1. J.K. Sharma, OR Theory & Applications, Mac Milian India Ltd., 1998
2. G.Hadley, Linear Programming, Narosa Publishing House, New Delhi,1995
   G. Paria, Linear Programming, Transportation, Assignment, Game, Books & Allied Pvt. Ltd. Calcutta-9

Semester – VI			
16IMTCC30	**CORE PRACTICAL 12:** Optimization Practical	**4hrs/week**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the importance and scope of the subject Operations Research.
2. Develop and formulate problems in mathematics terms from given real life problems.
3. Solve linear programming problems with the methods including Simplex Method.
4. Solve Transportation Problems, Assignment Problems and Sequencing Problems.
5. Understand, analyze and effectively solve the problems related to the theory of games.

List of Experiments

1. Solve the given LPP using Graphical method.
2. Solve the given LPP using Simplex method.
3. Solve the given LPP using BIG -M method.
4. Solve the given LPP using TWO-PHASE method.
5. Obtain DUAL of the given Primal LPP;
6. Find the initial solution of given transportation problem using NWCM method.
7. Find the optimum solution of given transportation problem using LCM method.
8. Find the optimum solution of given transportation problem using VAM method.
9. Find the optimum solution of given transportation problem using MODI method.
10. Find the optimum solution of given assignment problem.
11. Find the optimum solution of given two-person zero sum game without saddle point.
12. Find the optimum solution of given two-person zero sum game using iterative method.
13. To find optimum solution of sequencing problem with n-jobs through two machines.
14. To find optimum solution of sequencing problem with n-jobs through three machines.

TEXT BOOKS: -

1. J. K. Sharma, Operations Research (theory and Applications), MacMillan Publishing House
2. R. K. Gupta, Operations Research, Krishna Prakashan Mandir, Meeut.

REFERENCE BOOKS:-

1. Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.
2. Kanti Swaroop and Manmohan, Operations Research, Sultanchand and Sons.

Semester – VI			
16IMTCC31	**CORE PRACTICAL 13:** Numerical Analysis - II Practical	**4hrs/week**	**2Credits**

Objectives: -

Upon completion of the course students will be able to

1. Understand the concept of interpolation.
2. Analyze and process data with equal or unequal interval and interpolate the same for given non-tabulated values.
3. Perform numerical differentiation using various formulae including Gregory-Newton's forward difference formula and Sterling's formula.
4. Perform numerical integration using various formulae including Trapezoidal rule, Simpson's 1/3 rule and Simpson's 3/8 rule.
5. Solve ordinary differential equations numerically using method including Taylor's series method, Picard's method, Euler's method, Runge's method and Runge-Kutta methods.

List of Experiments

1. Gauss forward interpolation formula.
2. Gauss backward interpolation formula.
3. Sterling's formula.
4. Bessel's formula.
5. Laplace-Everett's formula.
6. Interpolation with unequal intervals.
7. Numerical differentiation.
8. Numerical integration.
9. Taylor's formula.
10. Picard's formula.
11. Euler's method.
12. Runge's method
13. Runge-Kutta's method
14. Milne's method

TEXT BOOKS: -

1. Numerical methods by Dr. V. N. Vedamurthy & Dr. N. Ch. S. N. Iyengar, Vikas Publishing house.

REFERENCE BOOKS:-

1. Introduction to Numerical Analysis (2nd Edition) by C. E. Froberg Addision Wesley, 1979.
2. Numerical method, Problems & Solutions, by M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International Pvt. Ltd., 1996**.**
3. Numerical Mathematical Analysis, by J. B. Scarforough, Oxford & IBH Publication Co. Pvt. Ltd., 1966.

Semester – VI			
16IMTCC32	**CORE PRACTICAL 14:** Introduction to SAGE Practical	**4hrs/week**	**2Credits**

Objectives:-

1. Install and use SAGE on computer with different operating systems.
2. Understand and utilize the interface of SAGE effectively.
3. Utilize SAGE commands to solve mathematical problems of symbolic nature.
4. Apply techniques of SAGE to solve mathematical problems numerically.
5. Plot 2D and 3D graphs using the SAGE software.
6. Slove problems of mathematics including Calculus, Linear Algebra, Abstract Algebra and Group Theory.

List of Experiments

1. Introduction and practice of usage of variables, constants, data types, some inbuilt (library) constants & functions ,how to enter a matrix, how to enter a vector, operators, how to get help etc.
2. To learn the usage of SAGE commands including Solve(), binomial(), maximum_on_intervals(), sum(), binomial(), prod(),...etc
3. To find limit, derivative, maxima-minima, partial derivative, indefinite and definite integral, numerical integral and Taylor series expansion of a given function
4. To draw a line passing through a given points, polygon, circle and using options in plotting of 2D graphs.
5. To draw the graph of given function in 3D including line, sphere, platonic solids and using options in plotting of 3D graphs
6. Practical based on Simplification, Factorization and expansion of symbolic functions.
7. Practical based on Partial Fractions.
8. Find the solution of problems of Linear Algebra by using SAGE Commands.
9. Find the solution of problems of Number Theory by using SAGE Commands.
10. Find the solution of various problems of Group Theory and Graph Theory by using SAGE Commands.

TEXT BOOKS: -

1. David Joyner, William Stein, Sage Tutorial.

REFERENCE BOOKS:-

1. Craig Finch, Sage Beginner's Guide, Packt publishing (Open Source Community).

Websites:-

1. Down-load SAGE for windows platform http://www.sagemath.org/download-windows.html
2. Sage Feature Tour:- http://www.sagemath.org/tour.html
3. Sage standard documentation:- http://www.sagemath.org/help.html
4. SAGE DOCUMENTATION:- http://www.sagemath.org/doc/
5. Personal Web page of William Stein :- http://modular.math.washington.edu/
6. Downloading VMware Player:- http://www.vmware.com/products/player/.
7. Latest version of VMware Player:- https://my.vmware.com/web/vmware/free#desktop_end_user_computing/vmware_player/6_0
8. VMware Player FAQs:- http://www.vmware.com/products/player/faqs.htm

Semester – VII			
16IMTCC33	**Core 19:** Algebra – I	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand basic principles of algebraic structures like groups, fields rings and division rings.
2. Recognize and understand the concept of Ideals.
3. Recognize and understand the concepts of Euclidean domains, Unique factorization domains, polynomial rings as well as Einstein irreducibility criterion.

Unit 1 Basic concepts of group theory **(10hrs)**

1) Abelian group
2) Permutation Group.
3) Cyclic group

Unit 2 Homomorphism of Groups **(10hrs)**

- Normal subgroup
- Quotient group
- Group isomorphism and their properties
- Cayley's theorem, Automorphisms of groups

Unit 3 Direct Products **(10hrs)**

- Direct Products
- Finitely Generated Abelian Groups
- Invariants of a finite Abelian Groups
- Sylow Theorems

Unit 4 Quick look at basic ring theory **(9hrs)**

- Euclidean ring
- Quotient ring and zero divisors
- Ideals and ideal rings
- Principal ideal
- Maximal ideal and prime ideal
- Homomorphisms of ideals
- Sum and Direct Sum of Ideals
- Nilpotent and Nil Ideals

Unit 5 Euclidean domains **(9hrs)**

- Euclidean domains
- Principal Ideal Domains
- Unique Factorization Domains
- Polynomial Rings over UFD

- Polynomial rings over rational field
- Irreducible polynomials
- Einstein irreducibility criterion

Text books

1) I. N. Herstein, Topics in Algebra, Second Edition, Wiley Pub. , New York, 1975.
2) N. S. Gopalakrishnan, University Algebra, New Age International Private Ltd. Publishers, New Delhi, Sixth Reprint, 1998.

Reference Books:

1) J. A. Gallian, Contemporary Abstract Algebra, Fourth Edition, Narosa Publishing House, New Delhi, 1999.
2) P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra**,** Second Edition, CambridgeUniversity Press, 1995.
3) M. Artin, Algebra, Prentice-Hall of India Private Ltd., New Delhi, 1994.

Semester – VII			
16IMTCC34	**Core 20:** Topology – I	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Recognize and interpret the topological structures and their characterizations.
2. Identify and understand the subspace topology and product topology.
3. Identify and classify the type of topology including quotient topology and metric topology.
4. Understand and differentiate the hierarchy of the topological spaces and their characterizations.

Unit 1 Topological spaces **(10hrs)**

- Topological spaces
- Basis for a Topology

Unit 2 The Subspace Topology **(10hrs)**

- The Subspace Topology
- Order Topology

Unit 3 Product Topology **(10hrs)**

- Product Topology and related concepts
- Closed sets and limit points

Unit 4 Continuity **(9hrs)**

- Continuous functions
- Metric Topology

Unit 5 Hierarchy in topological spaces **(9hrs)**

- T_1- spaces
- Hausdorff spaces
- Regular spaces and Normal spaces
- Urysohn's Lemma and Tietze extension theorem

Text book:

1) Munkres J., Topology: A first course, Prentice-Hall of India Pvt. Ltd, New Delhi.

Reference Books:

1) Simmons G. F., Introduction to Topology and Modern Analysis, McGraw Hill Company, Tokyo.
2) Willards S., General Topology, Addition-Wesley, Reading, 1970.

Semester – VII			
16IMTCC35	**Core 21:** Functions of Several Variables	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Identify and define functions of the form $T: R^n \to R^m$
2. Introduce the concepts including limit, continuity for the functions of several variables.
3. Understand and criticize the concepts of partial derivative of first and higher order for functions of several variables.
4. Recognize and understand the concepts of tensor algebra on finite dimensional vector spaces, alternating and symmetric tensors, wedge products, vector fields and forms as well as their basic properties.

Unit 1 Euclidean Space and its basic properties **(10hrs)**

- Euclidean Space R^n and its basic properties
- Functions From: $R^n \to R^m$
- Limit, Continuity and Oscillation
- Relation between Linear Transformation $T: R^n \to R^m$ and m * n Matrices

Unit 2 Differentiation **(10hrs)**

- Differentiations and their Basic Prosperities
- Chain Rule and Jacobian Matrix

Unit 3 Partial Differentiation **(10hrs)**

- Partial Derivatives and its Relation with Jacobian Matrix
- Partial Derivatives of Higher Order
- Picard's Method of successive Approximations

Unit 4 Partial Derivative and Continuity **(9hrs)**

- Young's Theorem, and Schwarz's Theorem
- Directional Derivative its Basic Properties its Relation with Derivative
- Partial Derivative and Continuity

Unit 5 Tensor algebra on Finite Dimensional Vector Space **(9hrs)**

- Tensor algebra on Finite Dimensional Vector Space
- Alternating and Symmetric Tensors
- Wedge Product and Relation Among Them
- Vector Fields and Forms, their Basic Properties

Text books

1) M. Spivak, Calculus on Manifolds, W.E. Benjamin Inc., 1965.

Reference Books:

1. W. Rudin, Principles of Mathematical Analysis, (Third Edition), Tata McGraw-Hill Publ. Co., New Delhi, 1983.
2. S. R. Ghorpade and B. V. Limaye, A Course in Multivariable Calculus and Analysis, Springer, 2010.

Semester – VII			
16IMTCC36	**Core 22:** Theory of Differential Equations	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the meaning of Ordinary Differential Equations.
2. Understand and solve Partial differential equation.
3. Identify and solve Gauss hyper geometric equation.
4. Understand, identify and solve Cauchy Problem including Charpit's and Jacobi's method.

Unit 1 Review of Simultaneous Ordinary Differential Equations (10hrs)

- Review of Simultaneous Ordinary Differential Equations
- Second order differential equations: the method of variation of parameters
- Review of Simultaneous Ordinary Differential Equations of First Order
- Ordinary and singular points, series solution
- Frobenious method: solution in series near regular singular point, point at infinity

Unit 2 Some special kind of equations (10hrs)

- Legendre equation
- Legendre polynomial and its properties
- Bessel's equation
- Bessel's function of first and second kind and their properties

Unit 3 Partial differential equations (10hrs)

- Partial differential equation
- Partial differential equation of first order
- Compatible system of first order partial differential equations
- Picard's Method of successive Approximations

Unit 4 Gauss hyper geometric equations (9hrs)

- Gauss hyper geometric equation
- Gauss hyper geometric function and its properties

Unit-5 Solution of partial differential equations (9hrs)

- Charpit's and Jacobi's method
- Cauchy Problem

Text books

1) Sneddon, I. N., Elements of Partial Differential Equations, McGraw-Hill Publ. Co., 1957.
2) Raisinghania, M. D. Advanced Differential Equations, S. Chand \& Co., 1995.

Reference Books:

1) G. F. Simmons, Differential equations with applications and historical notes, McGraw-Hill International Editions, second edition.
2) Amarnath, T., Elementary Course in Partial Differential Equations, Narosa Publ. House, New Delhi, 1997.

3) Rabenstein, A. L., Introduction to Ordinary Differential Equations, Academic Press.
4) Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, (36th Edition), Khanna Publ., New Delhi, 2000.
5) Somasundaram, D., Ordinary Differential Equations: A First Course, Narosa Publ. House, New Delhi, 2002.
6) William E. Boyce, Richard C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 10th Edition.

Semester – VII			
16IMTDC07	**DISCIPLINE SPECIFIC ELECTIVE - ID - 3 :** Classical Mechanics - I	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

5. Understand and describe elementary principles of motion.
6. Understand and criticize equations of motion and classify the dynamical systems.
7. Derive and utilize Lagrange's equation of motions.
8. Identify, understatnd and solve two body central force problem.

Unit 1 Survey of elementary principles (10hrs)

- Conservation theorem for linear momentum and angular momentum for a particle
- Conservation theorem for linear momentum and angular momentum for a system of particles
- Classification of dynamical system

Unit 2 D'Almbert's principle and Lagrange's equation of motions (10hrs)

- Constraints.
- Virtual displacement and principle of virtual work.
- Generalized force in holonomic system
- Mathematical expression for principle of virtual work
- D'Almbert's principle
- Lagrange's equation for holonomic system
- Lagrange's equation for conservative non-holonomic system
- Problems on above topics

Unit 3 Variational principle and Lagrange's equations (10hrs)

- Variational principle
- Calculus of variations
- Hamilton's principle
- Derivation of Hamilton's principle from Lagrange's equation
- Derivation of Lagrange's equations from Hamilton's principle
- Cyclic co-ordinates
- Conservation theorems
- Problems on above topics

Unit 4 Two Body Central force problem (9hrs)

- Reduction to equivalent one body problem
- The equations of motion and first integrals
- The equivalent one dimensional problem and classification of orbits
- The inverse square law of force

Unit 5 Equations of Motion and Rigid bodies **(9 Hrs)**

- Independent co-ordinates of rigid bodies
- Generalized co-ordinates of a rigid bodies
- Euler angles and Cayley-Klein parameters and related quantities
- Components of angular velocity along the body set of axes
- Euler's theorem on the motion of a rigid body, rate of change of a vector
- The coriolis force
- Euler's equations of motion for a rigid body
- Finite rotations
- Infinitesimal rotations

Text books:

1) C. R. Mondal, Classical Mechanics, Prentice Hall of India Pvt. Ltd.

Reference Books:

1) H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Publishing House.

Semester – VII			
16IMTDC08	**DISCIPLINE SPECIFIC ELECTIVE - ID - 3** Fuzzy Mathematics	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Recognize and understand concepts of fuzzy sets and their types.
2. Understand and utilize operations on fuzzy sets.
3. Identify, understand and solve fuzzy relation equations.

Unit 1 Fuzzy sets **(10hrs)**

- Fuzzy sets – and their basic types
- Basic concepts , α-cuts ,Additional properties of α-cuts
- Extension principle for Fuzzy sets

Unit 2 **Operations on Fuzzy sets** **(10hrs)**

- Operations on Fuzzy sets and Types of operations
- Fuzzy complements
- t-Norms
- Fuzzy Unions
- Combinations of operations

Unit 3 Fuzzy Arithmetic **(10hrs)**

- Fuzzy numbers
- Arithmetic operations on intervals
- Arithmetic operations on Fuzzy numbers

Unit 4 Fuzzy relations **(9hrs)**

- Binary fuzzy relations
- Fuzzy equivalence relations
- Fuzzy compatibility relations
- Fuzzy ordering relations
- Fuzzy morphisms

Unit 5 Fuzzy Relation Equations **(9hrs)**

- Fuzzy Relation Equations General discussion
- Problem partitioning, Solution method
- Fuzzy Relation Equations based on Sup-i Compositions – Fuzzy Relation Equations based on inf-ωi Compositions

Reference Books:

1. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 2004.

2. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, New Delhi, 1991.
3. G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 1995.

Semester – VIII			
16IMTCC37	**Core 23:** Algebra – II	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. List and understand advance concepts of Algebra.
2. Identify, define and perform operations on modules.
3. Define and verify automorphisms and homomorphism of modules.

Unit 1 Division ring and Field **(10hrs)**

- Division ring and Field
- Extension fields
- Algebraic and transcendental extensions

Unit 2 Extensions **(10hrs)**

- Splitting fields
- Normal extensions
- Multiple roots
- Finite fields
- Separable extensions

Unit 3 Automorphism fixed fields **(10hrs)**

- Automorphism fixed fields
- Galois extension
- Fundamental theorem of Galois Theory
- Fundamental theorem of Algebra

Unit 4 Modules **(9hrs)**

- Modules (Definitions and examples)
- Submodules and Operation on modules

Unit 5 Homomorphism of Modules **(9hrs)**

- Homomorphisms of modules and quotient modules
- Completely reducible module
- Finitely generated modules

Text books

1) I. N. Herstein, Topics in Algebra, Second Edition, Wiley Pub. , New York, 1975.

Reference books

1) M. Artin, Algebra, Prentice-Hall of India Private Ltd., New Delhi, 1994.
2) J. A. Gallian, Contemporary Abstract Algebra, Fourth Edition, Narosa Publishing House, New Delhi, 1999.
3) P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra**,** Second Edition, Cambridge University Press, 1995.
4) N. S. Gopalakrishnan, University Algebra, New Age International Private Ltd. Publishers, New Delhi, Sixth Reprint, 1998.

Semester – VIII			
16IMTCC38	**Core 24**: Topology – II	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand, define and verify connectedness of topological spaces.
2. Understand, define and verify nets and filters.
3. State and prove the Tychonoff's theorem.
4. List, compare and classify the separation axioms of topological spaces.
5. Understand, define and verify concept of compact spaces.

Unit 1 Connected Spaces **(10hrs)**

- Connected spaces
- Components
- Path components

Unit 2 Nets and Filters **(10hrs)**

- Nets and Filters
- Tychonoff's theorem

Unit 3 Product and quotient topologies **(10hrs)**

- The product and quotient topologies
- Separation properties in products.

Unit 4 Compact spaces **(9hrs)**

- Compact spaces
- Product of compact spaces

Unit 5 Locally compactness **(9hrs)**

- Limit point and Compactness
- Locally compactness

Reference Books:-

1. Munkres J., Topology: A first course, Prentice Hall of India Pvt. Ltd, New Delhi.
2. Kelly J. L., General Topology, Van Nostrand Reinhold Company, 1965.
3. Willards S., General Topology, Addition-Wesley, Reading, 1970.

Semester – VIII			
16IMTCC39	**Core 25**: Real Analysis	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand, define algebra of sets.
2. Define and understand measurable sets and various types of measures.
3. Define, understand and utilize the concept of differentiation of monotone functions and absolute continuity.
4. State and prove theorems including Holder's inequality and Minkowski's inequality.

Unit 1 Algebra of Sets **(10hrs)**

- Algebra of sets, σ-algebra of sets
- Borel sets
- Lebesgue outer measure
- Measurable sets
- Lebesgue measure

Unit 2 Nonmeasurable Set **(10hrs)**

- A nonmeasurable set
- Measurable Functions
- Littlewood's three principles

Unit 3 Riemann integral **(10hrs)**

- Riemann integral
- The Lebesgue integral of a bounded function over a set of finite measure
- The integral of a nonnegative function
- The general Lebesgue integral
- Convergence in measure

Unit 4 Differentiation of monotone functions **(9hrs)**

- Differentiation of monotone functions
- Functions of bounded variation
- Differentiation of an integral
- Absolute continuity

Unit 5 lL^p spaces **(9hrs)**

- lL^p spaces
- The Holder's inequality
- The Minkowski's inequality
- Convergence and completeness

Reference Books:-

1. H. L. Royden, Real Analysis, Third Edition, PHI Learning Private Limited (2009) New Delhi.
2. N. L. Carothers, Real Analysis, Cambridge University Press (2000).
3. G de Barra, Measure Theory and Integration, Wiley Eastern Limited, First Wiley Eastern Reprint (1987).
4. V. Karunakaran, Real Analysis, Pearson (2012).
5. S. K. Berberian, Fundamentals of Real Analysis, Universitext, Springer (1999).
6. I. K. Rana, An introduction to Measure and Integration, Narosa Publishing House, New Delhi.

Semester – VIII			
16IMTCC40	**Core 26**: Theory of Partial Differential Equations	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Identify and understand the higher order partial differential equations.
2. Understand and utilize the methods to solve the given partial differential equations
3. Understand and solve the given Boundary value problems and Equipotential surfaces.

Unit 1 Second order partial differential equations **(10hrs)**

- Origin of second order partial differential equations
- Linear second order partial differential equations with constant coefficients
- Solutions for f(x; y) to be polynomial
- Exponential, sin/cos functions
- General method for homogeneous equations

Unit 2 Classification of second ordered partial differential equations **(10hrs)**

- Classification of second ordered partial differential equations
- Canonical form

Unit 3 Non-linear second order partial differential equations **(10hrs)**

- Non-linear second order partial differential equations
- solution by Monge's method
- Special case and general case

Unit 4 Second order partial differential equations with variable coefficients **(9hrs)**

- Second order partial differential equations with variable coefficients
- Method of changing variables for special type of equations
- Separation of variable Method
- Solution of three special equations –Laplace
- Wave and diffusion equation
- Solution of these equations in different coordinate systems

Unit 5 Boundary value problems **(9hrs)**

- Boundary value problems
- Dirichlet boundary value problems
- Neumann boundary value problems
- Maximum and minimum principles
- Harnack's theorem
- Green's functions
- Equipotential surfaces

Reference Books:-

1. Amarnath, T., Elementary Course in Partial Differential Equations, Narosa Publ. House, New Delhi, 1997.
2. Sneddon, I. N., Elements of Partial Differential Equations, McGraw- Hill Publ. Co., 1957
3. Grewal, B. S. and Grewal, J. S., Higher Engineering Mathematics, (36th Edition), Khanna Publ. New Delhi, 2000.
4. Raisinghania, M. D. Advanced Differential Equations, S. Chand & Co., 1995.
5. Phoolan Prasad and Ravindran, R., Partial Differential Equations, Wiley Eastern.

Semester – VIII			
16IMTDC09	**DSE Elective- 4** Classical Mechanics - II	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand, define and verify Rigid Body Equations of Motion.
2. Understand and compare theory of relativity in classical mechanics.
3. Derive the Hamilton's equation of motion.
4. Understand and utilize the Canonical transformations and Generating functions.

Unit 1 The Rigid Body Equations of Motion **(10hrs)**

- Angular momentum and kinetic energy of motion about a point
- The inertia tensor and moment of inertia
- The heavy symmetrical top with one point fixed

Unit 2 Special Relativity in Classical Mechanics **(10hrs)**

- The basic program of special relativity
- The Lorentz transformations
- Lorentz transformations in real four dimensional spaces
- Further descriptions of the Lorentz transformation

Unit 3 Covariant four – dimensional formulations **(10hrs)**

- Covariant four – dimensional formulations
- The force and energy equations in relativistic mechanics

Unit 4 Hamilton's equation of Motion **(9hrs)**

- Derivation of Hamilton's equation of motion
- Routh's procedure
- Derivation of Hamilton's equation from Hamilton's Principle
- Principle of least action
- Problem related to above topics

Unit 5 Canonical transformations and Generating functions **(9hrs)**

- Poisson's brackets and their properties
- Hamilton-Jacobi theory
- Problem related to above topics

Reference Books:-

1. H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Publishing House
2. C. R. Mondal, Classical Mechanics, Prentice Hall of India Pvt. Ltd.

Semester – VIII			
16IMTDC10	**DSE Elective- 4** Mathematical Methods	**4 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand, define and utilize Fourier series and Summation of infinite series.
2. Understand, define and utilize Laplace transform, Inverse Laplace transform, Convolution theorem, Apply these concept to solve the ordinary differential equations.
3. Understand and utilize Green's function and its applications, Gram-Schmidt orthonormalization method to Legendre polynomials, Hermite polynomials, Jacobi polynomials, Z-transform.

Unit 1 Fourier series and applications **(10hrs)**

- Fourier series and applications to boundary value problems
- Summation of infinite series.

Unit 2 Fourier integral representation and applications **(10hrs)**

- Fourier integral representation and applications
- Fourier transforms
- Computations of Fourier transforms of functions
- Properties of Fourier transforms

Unit 3 Convolution and Fourier transform **(10hrs)**

- Convolution and Fourier transform
- Applications to the boundary value problems involving Heat equation
- Wave equation and Laplace equations

Unit 4 Laplace transform **(9hrs)**

- Laplace transform
- Laplace transforms of some functions
- Properties of Laplace transform
- Inverse transform
- Convolution theorem
- Applications to solutions of ordinary differential equations
- Applications to the solutions of diffusion equation and wave equation

Unit 5 Green's function and its applications **(9hrs)**

- Green's function and its applications
- Gram-Schmidt orthonormalization method to Legendre polynomials
- Hermite polynomials
- Jacobi polynomials
- Z-transform

Reference Books:-

1. Shankar Rao, Introduction to Partial Differential Equations.
2. Courant and Hilbert; Mathematical Methods.
3. N. Sneddon; Special Functions of Mathematical Physics and Chemistry.

4. L.A. Pipes, Applied Mathematics for Engineers and Physicists.
5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 2004
6. M. D. Raisinghania Advanced Differential Equations.

Semester – VIII			
16IMTDC41	**CORE – 27:** Life and work of Mathematicians **(Self study course)**	**1 hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will

1. Know about the life and work of Indian and international mathematicians.
2. Get inspiration and motivation from life and work of mathematicians.
3. Read and comprehend the information about mathematicians
4. Know open problems of mathematics and improve their writing skills.
5. Get training of lifelong learning.

- "Life and work of Mathematicians" is a self study course.
- Groups of 3 to 5 students will be formed.
- Students will determine name/s of mathematician/s for their group study.
- Students will study the life and works of mathematicians in their groups.
- Evaluation norms of this self study course will be as per general norms of any other self-study course.

Semester – IX			
16IMTCC42	**CORE – 28: Complex Analysis**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concept of complex plane and generalize the concept of coordinate plane.
2. Determine continuity/differentiability/analyticity of a complex function and find the derivative of a function.
3. Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula.
4. Compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line.
5. Analyze and classify the singularities of complex function in given region.

Unit 1: Introduction to complex plane (10 Hrs)

- The extended complex plane and its spherical representation
- Analytic functions, bilinear transformations, their properties and classifications
- Branches of many valued functions with special reference to arg z, log z and z^a, elementary Riemann surfaces
- Definition and properties of conformal mapping.

Unit 2: Riemann – Steiltjes integral and cauchy's integral formula (10 Hrs)

- Riemann – Steiltjes integral and ie properties
- Line integral and its properties, fundamental theorem of calculus for line integral
- Leibnitz rule, Taylor's theorem
- Cauchy's integral formula dn Cauchy's theorem for analytic functions on an open disc
- Winding number of a closed rectifiable curve with respect to a point outside the curve and its properties
- Cauchy's integral formula first version and second version
- Cauchy's theorem first version.

Unit 3: Cauchy – Goursat theorem and its related theorems. (10 Hrs)

- Cauchy – Goursat theorem, Moreras theorem
- Cauchy's inequality, entire functions
- Liouville's theorem, identity theorem
- Fundamental theorem of algebra, maximum modulus theorem and minimum modulus theorem.

Unit 4: Schwartz lemma and Inverse function theorem (9 Hrs)

- Schwartz lemma, meromorphic functions
- Argument principle, Rouche's theorem
- Open Mapping Theorem
- Inverse function theorem.

Unit 5: Singularities and their classifications (9 Hrs)

- Isolated singularities, classifications of singularities
- Laurent's series
- Residue theorem
- Evaluation of integrals.

Text Books:

1. John B. Conway, **Functions of One Complex Variable,** Springer International Student Edition, Narosa Publishing House, Third Edition. (The course is covered by relevant portions from this text book)

Reference Books:-

1. L. V. Ahlfors, Complex Analysis, International Student Edition, Mc Graw – Hill Book Company, 1979.
2. Karunakaran, Complex Analysis Narosa Publishing House, Second Edition, 2006.
3. Dennis G. Zill and Patrik D. Shanahan, A First Course in Complex Analysis with Applications Jones & Bartlett Second Edition, Student Edition, 2010.
4. S. Lang, Complex Analysis, Addison-Wesley, 1977.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1977.
6. E. B. Saff and A. D. Snider, Fundamentals of Complex Analysis with Applications to Engineering and Science, Pearson Education. Third Edition.
7. D. Sarasan, Notes on Complex Function Theory, Hindustan Book Agency, 1994.

Semester – IX			
16IMTCC43	**CORE – 29: Number Theory – 1**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the basic concepts of number theory.
2. Recognize and identify the properties of prime numbers.
3. Understand the concepts of congruences.
4. Utilize the concept of combinatorial number theory.
5. Construct mathematical proofs of statements and find counterexamples to false statements in number theory.

Unit 1: Number System **(10 Hrs)**

- Divisibility
- Prime Numbers.

Unit 2: Congruences and related concepts **(10 Hrs)**

- Congruences
- Linear Congruences and their solutions.

Unit 3: Basic results of number theory **(10 Hrs)**

- Chinese Remainder Theorem
- Degree of a Congruence relation and related theorems.

Unit 4: Primitives rules and its related results **(9 Hrs)**

- Primitive rules and related Theorems and Examples
- Related Congruences and their solutions.

Unit 5: Combinatorial number theory and related concepts **(9 Hrs)**

- Greatest Integer functions and related results
- Arithmetic Functions
- The Mobius inversion formula, Recurrence function
- Combinatorial Number Theory.

Text Books:-.

1. Ivan Niven ,Herbert S. Zuckerman, Hugh L. Montgomery , The Theory Of Numbers, John Wiley & Sons Inc

Reference Books:-.

1. Z. I. Borevich And I. R. Shafarevich, Number Theory, Academic Press, New York
2. J. W. S. Cassels An Introduction To The Geometry Of Numbers, Springer-Verlag Berlin New York 1971
3. L. E. Dickson, History Of The Theory Of Numbers, Carnegie Institute of Washington, Washington

Semester – IX			
16IMTCC44	**CORE – 30: Discrete Mathematics**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the algebraic structures including semigroups and monoids.
2. State and prove basic results of homomorphism between semigroups.
3. Understand the concept of Boolean algebra and derive related results.
4. Understand and apply the finite state machine and coding theory.

Unit 1: Semigroups and Monoids **(10 Hrs)**

- Semigroups and Monoids
- Homomorphism of Semigroups and Monoids
- Products and Quotients of semigroups
- Fundamental theorem of Homomorphism of Semigroups
- Subsemigroups and submonoids
- Relations, Transitive Closure and Warshall's Algorithm.

Unit 2: Latices and Boolean algebra **(10 Hrs)**

- Lattices as partially ordered sets, Properties of Lattices
- Lattices as algebraic systems, Sublattices
- Direct product and Homomorphisms of Lattices
- Some Special Lattices
- Finite Boolean Algebras, Functions on Boolean Algebras, Karnaugh Map Method.

Unit 3: Languages and Grammars **(10 Hrs)**

- Languages and Grammars, Finite State Machines, Semigroups
- Machines and Languages, Moore Machines, Simplification of Machines
- Moore Machines and Regular Languages
- Kleene's Theorem
- Pumping Lemma
- Nondeterministic Finite State Automata.

Unit 4: Logical operations **(9 Hrs)**

- Propositions and Logical operations
- Truth tables
- Conditional statements and Logical Equivalence
- Quantifiers, Rules of Inference.

Unit 5 Coding Theory **(9 Hrs)**

- Elements of Coding Theory
- The Hamming Metric
- The Parity-Check and Generator Matrices
- Group Codes: Decoding with Coset Leaders
- Hamming Matrices.

Test Books:-

1. Grimaldi, R. P, Discrete and Combinatorial Mathematics,3rd Edition, Addison-Wesley Publishing Company, 1994.
2. Tremblay, J.P., Manohar,R., Discrete Mathematical Structures with Applications to Computer Science, Tata-McGraw Hill Publishing Company Limited, New Delhi,21st Reprint, 2004.

Reference Books:-

1. Johnsonbaugh, R., Discrete Mathematics, Pearson Education,First Indian Reprint,2001.
2. Kolman,B, Busby,R.C., Ross,S.C., Discrete Mathematical Structures, 5th Edition, Pearson Education,2006.
3. Lawson,M.V., Finite Automata, Chapman and Hall/CRC Press, 2004.

Semester – IX			
16IMTCC45	**CORE – 31: Linear Algebra**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concepts of linear algebra including transformations and canonical transformations.
2. State, prove and apply the Cayley-Hamilton theorem
3. Analyze and select proper methods to solve a given system of linear equations
4. Understand and utilize the Sylvester's law of inertia.
5. Understand the concept of bilinear and quadratic forms.

Unit 1: Linear Transformations **(10 Hrs)**

- The Algebra of linear transformations
- Characteristic roots
- Matrices.

Unit 2: Canonical Forms **(10 Hrs)**

- Canonical Forms: Triangular Form
- Nilpotent linear transformations
- Invariants of a nilpotent linear transformation.

Unit 3: Rational canonical Form **(10 Hrs)**

- Canonical Forms: The primary decomposition theorem
- Jordan Form
- Rational canonical Form.

Unit 4: Matrices and transformations **(9 Hrs)**

- Trace and Transpose
- Determinants
- Cramer's rule
- Cayley-Hamilton theorem
- A quick review of inner product spaces
- Hermitian
- Unitary and Normal transformations.

Unit 5: Bilinear and Quadratic Forms **(9 Hrs)**

- Real Quadratic Forms
- Sylvester's law of inertia
- Bilinear Forms, Symmetric Bilinear Forms, Skew-Symmetric Bilinear Forms, Groups preserving Bilinear Forms.

Text Books:

1. I. N. Herstein, Topics in Algebra, Second Edition, Wiley Pub. , New York, 1975.
2. K.Hoffman and R.Kunze, **Linear Algebra,** Prentice Hall of India,New Delhi, Tenth printing,1992, Second Edition

Reference Books:-

1. N.S.Gopalakrishnan, University Algebra, New Age International(P) Limited,Publishers,New Delhi, Sixth Reprint,1998.
2. M. Artin, Algebra, Prentice Hall of India, New Delhi, 1994.
3. N.Jacobson, Lectures in Abstract Algebra, Volume II-- Linear Algebra, Van Nostrand, East West Press, 1964.

Semester – IX			
16IMTDC11	**Discipline Specific Elective – 5: Financial Mathematics**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Categorize the various financial markets including stock markets, currency market and bond markets.
2. Differentiate between options and contracts.
3. State and prove Ito's lemma.
4. State and prove Black – Sholes theorem.

Unit 1: Introduction to Options and Market **(10 Hrs)**

- An introduction to options and market
- Basic option theory
- Types of options.

Unit 2: Interest Rates and Contracts **(10 Hrs)**

- Interest rates and present value
- Asset price
- Forward and future contracts.

Unit 3: Random walks and Black Sholes model **(10 Hrs)**

- Random walk, Ito's lemma
- The elimination of randomness
- Black-Sholes model
- Arbitrage theorem, option values.

Unit 4: Black – Sholes formulae **(9 Hrs)**

- The Black – Sholes formulae
- An initial value problem
- Hedging the practice
- Partial differential equations and Black – Sholes formulae.

Unit 5: Variations in Black – Sholes model (9 Hrs)

- Variations in Black – Sholes model to include dividends as well as forward and future contracts
- American Options.

Text Books:-

1. P. Willmontt, S. Howison and J. Dewynne, the Mathematics of Financial Derivatives, Cambridge Univ. Press, 1995.

Reference Books:-

1. Sheldon M. Ross, An elementary introduction to Mathematical Finance, Cambridge Univ. Press, 2003.

Semester – IX			
16IMTDC12	**Discipline Specific Elective - 5: Cryptography**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concept of modular arithmetic.
2. Define the concept of public key cryptography.
3. State and prove the Chinese remainder theorem.
4. Understand the concept of integer factorization using elliptic curves.

Unit 1: Modular arithmetic (10 Hrs)

- Modular arithmetic
- The language of rings and fields
- Finding multiplicative inverses in $\mathbb{Z}/n$
- Fermat's little theorem
- The primitive root theorem for $\mathbb{F}p$.

Unit 2: Public key cryptography (10 Hrs)

- The basic idea of public key cryptography
- Diffie – Hellman key exchange and the ElGamal cryptosystem.

Unit 3: The Chinese Remainder Theorem. (10 Hrs)

- Language for measuring the complexity of algorithms, and lengths of running times
- Attempts to break codes by solving the Discrete Logarithm Problem
- Brute force attacks, the collision method, and the Pohlig - Hellman algorithm
- The Chinese Remainder Theorem.

Unit 4: Euler's formula for powers and the RSA cryptosystem (9 Hrs)

- Euler's formula for powers in $\mathbb{Z}/(pq)$, and the RSA cryptosystem
- How to find large primes: the Prime Number Theorem and some Monte Carlo Methods (e.g. the Miller-Rabin test)
- Algorithms for factoring large integers: Pollards $p-1$ algorithm.

Unit 5: Integer factorization using elliptic curves (9 Hrs)

- Elliptic curves. Smoothness
- The point at infinity, the group law. Using elliptic curves for cryptography
- Classification of finite abelian groups
- Integer factorization using elliptic curves (Lenstra's method).

Text Book:-

1. Hoffstein, Jill Pipher & Joseph H. Silverman, **An Introduction to Mathematical Cryptography,** Jeffrey Springer – Verlag, 2008. (Chapters 1, 2, 3 & 5)

Reference Books:-

1. Paul Garrett, **Making, Breaking Codes: Introduction to Cryptology**, 1/e, Prentice Hall, (2000).
2. Douglas Stinson, **Cryptography: Theory and Practice**, 2/e, Chapman & Hall/CRC, (2002).
3. J. H. Silverman, **A friendly introduction to number theory**, Prentice Hall, (2001).
4. J. Menezes, P. C. Van Oorschot & S. A. Vanstone, **The handbook of Applied Cryptography**, CRC Press, (1996).
5. Neal Noblitz, **Algebric Aspects of Cryptography**, Springer, (1998).
6. J. A. Buchmann, **Introduction to Cryptography**, Springer – Verlag, (2000).

Semester – X			
16IMTCC46	**Core 32: Functional Analysis**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concept of Normed Linear Spaces and Banach Spaces.
2. Classify the weak and strong convergence of sequences.
3. State and prove uniform boundedness theorem.
4. Understand the structures of Inner Product Spaces and Hilbert Spaces.
5. State and Prove the Hahn-Banach Theorem.

Unit 1: Normed Linear Spaces and Banach Spaces (10 Hrs)

- Normed linear spaces
- Banach spaces
- Quotient space of a normed linear spaces and its completeness
- Bounded linear transformations
- Normed linear spaces of bounded linear transformations
- Dual spaces with examples.

Unit 2: Convergence in Normed Linear Spaces (10 Hrs)

- Weak convergence in normed linear spaces, equivalent norms, Riesz lemma
- Basic properties of finite dimensional normed linear spaces and compactness
- weak convergence in normed linear spaces, reflexive spaces.

Unit 3: Uniform Boundedness theorem and its consequences. (10 Hrs)

- Uniform Boundedness theorem and its consequences
- Open mapping theorem, closed graph theorem
- Hahn-Banach theorem for normed linear spaces
- Compact operations, solvability of linear equations in Banach spaces
- The closed range theorem.

Unit 4: Inner Product Spaces and Hilbert Spaces (9 Hrs)

- Inner product space
- Hilbert space
- Orthonormal sets
- Bessel's inequality
- Complete orthonormal sets
- Parseval's identity.

Unit 5: Structure of Hilbert Spaces **(9 Hrs)**

- Structure of Hilbert spaces
- Projection theorem
- Riesz representation theorem for bounded linear functional on Hilbert spaces
- Reflexivity of Hilbert spaces.

Text Book:-

1. E. Kreyszig, **Introductory Functional Analysis with Applications,** John Wiley and Sons, New york, 1978.

Reference Books:-

1. Bachman G. and Warici L, Functional Analysis, Academic Press, 1966.
2. Convway J. B., A Course in Functional Analysis, Springer-verlag, Newyork, 1990.
3. Krishnan V. K. , Text Book of Functional Analysis; A Problem oriented approach, Printice Hall of India, 2001.
4. Limaye B. V., Functional Analysis, New Age International Pvt. Ltd., 2001.
5. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw – Hill book company, Newyork, 1963.
6. Tayor A. E., Introduction to Functional analysis, John Wiley and Sons, Newyork, 1958.

Semester – X			
16IMTCC47	**Core 33: Number Theory-II**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand, analyse and solve the Diophantine Equations.
2. Approximate Irrationals by Rationals.
3. State and prove the Hurwitz's Theorem.
4. Understand the concepts of partition function and ferrers graphs.

Unit 1: Diophantine Equations **(10 Hrs)**

- Some Diophantine Equations
- Simultaneous linear equations, The equation ax+by = c
- Pythagorean Triplets
- Some other Examples.

Unit 2: Approximation of Irrationals by Rationals. **(10 Hrs)**

- Farey Fractions
- Irrational numbers
- Farey Fractions and Approximation of Irrationals by Rationals.

Unit 3: Hurwitz's Theorem. **(10 Hrs)**

- Continued Fractions(Finite and Infinite)
- Approximations of Irrationals by Rationals
- Hurwitz's Theorem.

Unit 4: Pell's Equations and Numerical Computations. **(9 Hrs)**

- Periodic Continued Fractions
- Pell's Equations
- Numerical Computations.

Unit-5: Partition function and Euler's formula **(9 Hrs)**

- Partition function
- Ferrers Graphs
- Formal Power Series
- Generating Functions, and Euler's Identity
- Euler's Formula
- Bounds on $p(n)$.

Text Books:-

1. L. E. Dickson, History Of The Theory Of Numbers, Carnegie Institute of Washington, Washington
2. Ivan Niven ,Herbert S. Zuckerman, Hugh L. Montgomery , The Theory Of Numbers, John Wiley & Sons Inc.

Reference Books:-

1. Z. I. Borevich And I. R. Shafarevich, Number Theory, Academic Press, New York
2. J. W. S. Cassels An Introduction To The Geometry Of Numbers, Springer-Verlag Berlin New York 1971

Semester – X			
16IMTCC48	**Core 34: Graph Theory**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the fundamental concepts of graphs.
2. Characterize the Euler and Hamiltonian Graphs.
3. Understand and apply the Kruskel's and Prim's algorithm.
4. Determine the planarity of the given graph.
5. Understand the concept of graph coloring.

Unit 1: Basic concepts related to graphs **(10 Hrs)**

- A quick review of Graph
- Degree of a vertex
- Path
- Circuit
- Connected and disconnected graphs
- Components.

Unit-2 Eulerian and Hamiltonian graphs **(10 Hrs)**

- Euler trail, Euler tour, Euler Graph
- Characterizations of Eulerian graph
- Hamiltonian Paths and Cycles.

Unit 3: Trees **(10 Hrs)**

- Trees and their properties
- Bridges
- Spanning trees
- Kruskal's algorithm
- Prime's algorithm.

Unit 4: Planer graphs **(9 Hrs)**

- Planar Graphs
- Kuratowski's two graphs
- Different representation of planarity
- Detection of Planarity.

Unit 5: Graph Coloring **(9 Hrs)**

- Coloring of graphs
- Chromatic number
- Chromatic polynomial
- The four color problem.

Text Books:-

1. A first Look at Graph Theory by Clerk and Holton- World Scientific
2. Graph theory by F. Harary – Addision – Wesley 1969

Reference Books:-

3. Introduction to Graph theory by R. J. Wilson, Pearson Education Asia (Low Price).
4. R. J. Willson & J. J. Walkms: Graphs: An introductory approach wiley, 1990.

Semester – X			
16IMTCC49	**Core 35: Differential Geometry**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand and define the curves and surfaces.
2. Understand the concepts of curvature and torsion.
3. State and prove frenet – serret theorem.
4. Derive the formulae for first and second fundamental forms.

Unit 1: Local Curve Theory **(10 Hrs)**

- Local theory of curves, space curves, examples
- Planar curves, Helices, Frenet – Serret apparatus
- Existence of space curves
- Involutes and evolutes of curves.

Unit 2: Local Surface Theory **(10 Hrs)**

- Local theory of surfaces – parametric patches on surface
- First Fundamental form and arc length.

Unit 3: Curvature and related concepts **(10 Hrs)**

- Normal curvature
- Geodesic curvature and Gauss formulae
- Shape operator Lp of a surface at a point, vector field a curve.

Unit 4: Fundamental forms **(9 Hrs)**

- Second and third fundamental forms of a surface
- Weingarten map
- Principal curvatures, Gaussian curvature, mean and normal curvatures.

Unit 5: Riemannian Curvature **(9 Hrs)**

- Riemannian curvatures, Gauss theorem of Egregium
- Isometric groups and fundamental existence theorem for surfaces.

Text Books:-

1. R. S. Milman and G. D. Parker, Elements of Differential Geometry, Prentice – Hall, 1977.
2. J. A. Thorpe, Introduction to Differential Geometry, Springer – Verlag.

Reference Books:-

1. B. O' Neil, Elements of Differential Geometry, Academic Press, 1966.
2. M. Docermo, Differential Geometry of curves and surfaces, Prentice – Hall, 1976.
3. S. Sternberg, Lecture notes on Differential Geometry, Prentice – Hall, 1964.

Semester – X			
16IMTDC13	**Discipline Specific Elective – ID – 6 : Mathematical Statistics**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the statistical parameters.
2. Analyse sampling and sampling distributions.
3. Test the given data using student tests.
4. Test the hypotheses using various techniques.

Unit 1: Introduction to Statistical Parameters: (10 Hrs)

- Significant figures, scientific notations
- Average- Mean, Mode, Median
- Geometric mean, harmonic mean
- Root-mean-square and root-sum-squares average
- Standard deviation, variance.

Unit 2: Probability and Probability Distributions: (10 Hrs)

- Introduction to probability
- Random Experiments
- Sample Space, Events and their probabilities: Some basic results of probability, Conditional probability
- Random variables: Probability distributions, Expected value & variance of a probability distribution
- Discrete probability distributions: Binomial, Poisson. Continuous probability distributions: Exponential, Normal.

Unit 3: Sampling, Sampling Distribution & Interval Estimation: (10 Hrs)

- Simple random sampling, point estimation,
- Introduction to sampling distributions, sampling distributions of $\bar{x}$, Sampling distribution of sample proportion $\bar{p}$
- Properties of point estimation, Other sampling methods
- Interval estimation: Population mean: σ known, σ unknown, determining the sample size. Sampling distribution of variance.

Unit 4: Statistical Inferences, Testing of Hypotheses: (9 Hrs)

- Introduction
- Test of significance for large samples: Difference between small & large samples
- Two-tailed test for difference between the means of two samples
- Standard error of the difference between two standard deviations

Unit 5: Test of Significance (9 Hrs)

- Test of significance for small samples: The assumption of normality, Students'-distribution

- Properties and application of t-distribution
- testing difference between means of two samples (Independent samples; Dependent samples)
- Definition of chi-square, degrees of freedom; chi-square distribution, Conditions for applying chi-square test, Uses of chi-square test, Misuse of chi-square test.

Text Books:

1. S P Gupta, “Statistical Methods”, 30th edition S Chand.
2. S.C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics (11th Edition), Sultan Chand & Sons.

Reference Books:

1. Anderson, Sweeney, Williams, “Statistics for business and economics”, 9th edition, Thomson Publication.
2. Johnson Richard A., Miller and Freund's - Probability and Statistics (8th Edition) , PHI.

Semester – X			
16IMTDC14	**Discipline Specific Elective 6: Operation Research**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1. Identify and solve inventory related problems.
2. Evaluate optimum solution using dynamic programming for different applications.
3. Choose / devise appropriate queuing model for practical application.
4. Solve different problems related to network.
5. Calculate the optimum replacement cost and suggest proper solution of replacement problems.

Unit 1: Sensitivity Analysis **(10 Hrs)**

- Sensitivity Analysis
- Change in Objective function coefficients
- Change in the Availability of resources
- Change in Input – out coefficients
- Addition of a new variable
- Addition of a new constraint

Unit 2: Inventory Control: **(10 Hrs)**

- Inventory classification
- Different cost associated to Inventory
- Economic order quantity
- Inventory models with deterministic demands
- Problems related to deterministic demands.

Unit 3: Queuing Theory: **(10 Hrs)**

- Basis of Queuing theory
- Elements of queuing theory
- Kendall's Notation
- Operating characteristics of a queuing system
- Classification of Queuing models
- Preliminary examples

Unit 4: Replacement theory: **(9 Hrs)**

- Introduction to the Replacement theory
- Replacement of capital equipment which depreciated with time
- Replacement by alternative equipment
- Group and individual replacement policy.

Unit 5: Decision Theory: **(9 Hrs)**

- Introduction
- Decision under certainty
- Decision under risk
- Decision under uncertainty:
- Laplace criterion
- MaxiMin criterion
- MiniMax criterion

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- Savage MiniMax regret criterion

Text Books:-

1. Hamdy A. Taha, Operations Research: An Introduction, Prentice-Hall, 1997.
2.
3. Kapoor V.K., Operations Research – Concepts, Problems & Solutions, Sultan Chand & Sons, 5th Revised Edition, 2014.
4.

Reference Books:

1. Frederick K. Hiller and Bodhibrata Nag, Introduction to Operations Research, McGraw Hill Education; 9th edition, 2011.
2. A.P. Verma, Introduction to Operations Research, S.K. Kataria & Sons, 2012.
3. J K Sharma, Operations Research : Theory and Application, MACIN; 5th Edition, 2012.
4. R. K. Gupta, Oprations Research, Krishna Prakashan Mandir, Meerut.
7. N D Vohra, Quantitative Techniques in Management, Tata McGraw-Hill.

Semester – X			
16IMTCE01	**Writing Summary of a Research Paper**	**4hrs/wk**	**4 Credits**

Objectives:

Upon completion of the course students will be able to

1) Read and understand research papers in mathematics
2) Know about open problems in the field of mathematics.
3) Learn new terms and concepts of their subject area.
4) Interpret the results they read and apply as and when needed.
5) Write the content they have studied in a comprehensive and organized manner.

Evaluation of the course

The evaluation norms of this course will be as follows

1) This is a course with 100% continuous internal assessment.
2) Total marks of this course is 50 marks.
3) General norms of 100% CIE course will be applicable to this course.