Enclosure - II

Yogi Divine Society inspired,
Sarvodaya Kelavani Samaj managed

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot.

Autonomous

(Affiliated to Saurashtra University, Rajkot)

Re-Accredited at 'A' Level by NAAC
STAR college Scheme & Status by MST-DBT
UGC- College with Potential for Excellence (CPE)
UGC-DDU KAUSHAL Kendra
GAAA – Highest Grade A-1 by KCG, Government of Gujarat
GPCB-Government of Gujarat approved Environment Audit Center
UGC-Autonomous College

DEPARTMENT OF MATHEMATICS

SYLLABI FOR THE COURSES OF THE 3RD & 4TH SEMESTERS OF

M.Sc. Mathematics

M.Sc. MATHEMATICS

Syllabi for Semester – III and IV
For Students Admitted From A.Y. 2016-2017 & Onwards

Semester – III			
16PMTCC12	**CORE – 9: 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 – III			
16PMTCC13	**CORE – 10: 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 – III			
16PMTCC14	**CORE – 11: 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 – III			
16PMTCC15	**CORE – 12: 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 – III			
16PMTDC05	**Discipline Specific Elective –ID - III: 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 – III			
16PMTDC06	**Discipline Specific Elective - ID- III: 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 – III			
16PMTCC16	**PRACTICAL: PROGRAMMING OF NUMERICAL METHODS IN SCILAB PRACTICAL**	**8 hrs/week**	**3 Credits**

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, variables and operators of Scilab, Input and utilize inbuilt matrix commands and library functions to write programs.
4. Solve numerical problems using Scilab programs.
5. Interpolate the value using tabulated data and numerical methods combined with customised Scilab program.
6. Find value of integration for tabulated data using numerical methods combined with Scilab program.

List of Practical

1. Revision and practice of the user interface of SCILAB including console, file browser, variable browser and the command history and Sci-notes with help of small program.
2. Revision and practice of the programming concepts of Scilab including pre-defined constants and variables and operators.
3. Revision and practice of the fundamental concepts of SCILAB as a programming language including looping (for statement, break and continue statements) and branching (if statement) and input statement. Functions, defining a function, function libraries, managing output arguments and the return statement.
4. Write a SCILAB program for the solution of given non-linear equations using False Position Method.
5. Write a SCILAB program for the solution of given non-linear equations using Secant Method.
6. Scilab programs to find solution of given equation using fixed point iteration method
7. Scilab program to find the lagrange's interpolation polynomial to fit the given data.
8. Scilab programs to fit a straight line to the given set of data and verifying the solution by plotting a graph of data points and the straight line found.
9. Scilab programs to fit a polynomial of degree 2 to the given set of data and verifying the solution by plotting a graph of data points and the curve found.
10. Scilab program to find value of numerical integration using Trapezoidal rule.

11. Scilab programs to find value of numerical integration using Simpson's 1/3 rule and Simpson's 3/8 rule.
12. Scilab program to solve the given differential equation using Fourth – Order Range-Kutta Method.
13. Scilab program to solve the given differential equation using Euler's method.

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 – IV			
16PMTCC17	**Core 13: 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 – IV			
16PMTCC18	**Core 14: 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 – IV			
16PMTCC19	**Core 15: 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 – IV			
16PMTCC20	**Core 16: 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 – IV			
16PMTDC07	**Discipline Specific Elective – ID – IV : 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 (11^{th} Edition), Sultan Chand & Sons.

Reference Books:

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

Semester – IV			
16PMTDC08	**Discipline Specific Elective IV: 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
- 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.
5. N D Vohra, Quantitative Techniques in Management, Tata McGraw-Hill.