Academic Syllabus for

M. Sc. In Mathematics

Binod Bihari Mahto Koyalanchal University, Dhanbad

www.bbmku.ac.in,

Govt. Polytechnic Road

Dhanbad-828130

Email: registrarbbmku@gmail.com

SEMESTER - 01
Paper-I
Foundation Course in Modern Algebra

Time: 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I
Groups: Normal and Subnormal series, Isomorphism theorems, Jordan-Holder theorem, Solvable groups, Nilpotent groups. Group action, orbit -stabilizer theorem, orbit decomposition, Sylow's theorems (proofs using group actions) **(2 Questions)**

Unit - II
Canonical Forms – Similarity of linear transformations. Invariant subspaces. Eigen values and Eigen vectors, Reduction to diagonal and triangular forms. Nilpotent transformations index of nilpotency. Invariants of nilpotent transformation. The primary decomposition theorem. **(2 Questions)**

Unit – III
Field theory-Extension fields, finite extension, Algebraic and transcendental extensions, splitting fields- existence and uniqueness, Separable and inseparable extension. Normal extensions. Perfect fields. **(2 Questions)**

UNIT IV
Finite fields. Primitive elements. Algebraically closed fields. Automorphism of extensions. Galois extension. Fundamental theorem of Galois theory. Solution of polynomial equations by radicals. **(2 Questions)**

References :

1. A First Course in Abstract Algebra (4th edition) – J. B. Fraleigh, Narosa Publishing House, New Delhi, 2002.
2. Abstract Algebra – D.S. Dummit, R.M. Foote, John Wiley & Sons (2003).
3. I.N. Herstein. Topics in Algebra Wiley Eastern Ltd., New Delhi, 1975.
4. P.B. Bhatacharya, S. K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
5. M. Artin. Algebra, Prentice-Hall of India, 1991.
6. P.M.Cohn, Algebra, Vols I, II & III John Wiley & Sons. 1982, 1989, 1991.
7. N. Jacobson, Basic Algebra, Vols I & II, W. H. Freeman, 1980 (Also published by Hindustan Publishing Company).
8. S. Lagn, Algebra, 3rd edition, Addison-Wesley, 1993.
9. I. S. Luther and I.B.S. Passi, Algebra, Vol. I- Groups, Vol. II – Rings, Narosa Publishing House (Vol. I-1996, Vol. II - 1999).
10. D.S. Malik, J.N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra. Mc Graw-Hill, International Edition, 1997.
11. University Algebra, N.S. Gopala Krishnan.
12. Modern Algebra, Singh and Zamiruddin.

SEMESTER – 01
Paper - II
Real Analysis

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I
Definition and existence of Riemann-Stieltjes integral, Properties of the Integral, Integration and differentiation, the fundamental theorem of Calculus (R-S Integral), Fourier series, Bessels inequality, Parseval theorem, Fourier series representation of functions. **(2 Questions)**

Unit - II
Sequences and series of functions, pointwise and uniform convergence. Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's test for uniform convergence and continuity, uniform convergence. **(2 Questions)**

Unit - III
Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem, Power Series, uniqueness theorem for power series, Abel's and Tauber's theorem. **(2 Questions)**

Unit - IV
Functions of several variables, linear transformation, Derivatives in an open subset of R^n, Chain rule, Partial derivatives, interchange of the order of differentiation, Derivatives of higher orders. Young theorem. Schwartz theorem, Taylor's theorem, Inverse function theorem, Implicit function theorem, Jacobians, **(2 Questions)**

References :

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) Mc. Graw-Hill, Kogakushu,1976. International student edition.
2. T.M. Apostal, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
3. Shanti Narain, Real Analysis, S. Chand & Co. New Delhi.
4. Malik and Arora : Mathematical Analysis.

SEMESTER – 01
Paper – III
Topology

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Countable and uncountable sets. Infinite sets and the Axiom of Choice (statement only). Cardinal numbers Schroeder-Bernstein theorem. Cantor's theorem and continuum hypothesis. Zorn's lemma (statement only)

(2 Questions)

Unit - II

Definition and examples of topological spaces. Closed sets, Closure. Dense subsets. Neighbourhoods, Interior, exterior and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topologies.

(2 Questions)

Unit - III

First and Second countable spaces. Lindelof's theorem, separable spaces, second countability and separability. Separation axioms To, T_1, T_2, T_3, T_4 : their Characterizations and basic properties. Urysohn's Lemma. Tietze extension theorem. **(2 Questions)**

Unit - IV

Compactness. continuous functions and compact sets. Basic property of compactness. Compactness and finite intersection property Tychonoff's Theorem, Connected and disconnected spaces and their basic properties. Connectedness and product spaces. **(2 Questions)**

References :

1. K.D. Joshi. Introduction to General Toplogy Wiley Eastern Ltd. 1983.
2. J.L. Kelley, General Topology. Van Nostrand. Reinhold Co, New York 1995.
3. W.J.Pervin. Foundations of General Topology. Academic Press Inc. New York 1964.
4. K.K. Jha, Advanced General Topology, Nav Bharat Prakashan, Delhi.
5. G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill Int. book company.
6. J.R.Munkres, Topolygy A first course, Prentice hall India Pvt. Ltd.
7. S.Lipschutz, General Topology, Schaum's out line series.

SEMESTER – 01
Paper-IV
Complex Analysis

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. -1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I
Complex integration, Cauchy-Goursat Theorem, Cauchy's Integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality and Liouville's theorem. **(2 Questions)**

Unit - II
The fundamental theorem of algebra, Taylor's theorem, Maximum modulus principle, Schwarz lemma. Laurent's series. **(2 Questions)**

Unit - III
Isolated singularities. Meromorphic functions. The argument principle Rouche's theorem Poles and Zeros. undamental theorem. Residues. Cauchy's residue theorem. Evaluation of integrals. **(2 Questions)**

Unit - IV
Bilinear transformations. their properties and classification. Definition and examples of conformal mapping. Analytic continuation. Uniqueness of direct analytic continuation Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. **(2 Questions)**

References :

1. L.V. Ahlfors. Complex Analysis. Mc-Graw Hill. 1979.
2. S. Lang. Complex Analysis. Addison Wesely. 1977.
3. Walter Rudin. Real and Complex Analysis. Mc Graw Hill Book Co. 1966
4. E.C. Titchmarsh. The Theory of Functions. Oxford University Press. London.
5. S. Ponnusamy. Foundation of Complex Analysis. Narosa Publishing House. 1997.
6. E.T.Copson, Complex variables.
7. Shanti Narayan. Complex variables.
8. Churchill and Brown, Complex variables and applications, McGraw-Hill Pub. Company.
9. Murray R. Spiegel , complex variable, Schaum's out line special Indian edition TMH Education New Delhi,

SEMESTER – 02
Paper-V
Complex Analysis
Theory paper

Time : 3 Hrs. **Full Marks :40**

In all ***nine*** questions of equal value (each of ***seven*** marks) will be set out of which candidates are required to answer 5 questions.

Unit - I
Introduction to Computers: Block Diagram of Computer, Functioning of Computer, Generations of Computer, Classification of Computers, Characteristics, Advantages & Limitations of Computer. Computer Memory: Primary & Secondary, Types of Primary Memory. **(2 Questions)**

Unit - II
Number System: Decimal, Binary, Octal, Hexadecimal number systems, features and conversions, binary arithmetic, ASCII & EBCDIC codes.
Algorithm and Flow chart: Algorithm for problem solving: An Introduction, Properties of an algorithm, Classification, Algorithm logic, Flowchart. **(2 Questions)**

Unit - III
C programming: An overview of programming, Programming language classification, history of C, importance of C, basic structure of C programme, executing C programme, compiling and linking.
Scalar data types-Declarations, Different types of integers, Different kinds of integer constants, Floating point types, Initialization, mixing types Enumeration types, the void data type, Typedefs, Find the address of an object, Pointers. **(2 Questions)**

Unit - IV
Operators and expressions-introduction, arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operator, Bitwise operators, Arithmetic expressions, evaluation of expression, precedence of arithmetic operators.
Control flow -conditional branching, the switch statement, looping, nested loops, The "break" and "continue" statements, the go to statement, Infinite loops. Arrays and Pointers, Declaring an array, Arrays and memory, initializing array, Multidimensional arrays. **(3 Questions)**

1. Programming in ANSI C, E Balaguruswamy, Second Edition, Tata-McGraw Hill Publications.
2. Pundir & Pundir : Fundamental of Computer Sciences
3. Bipin C. Desai : Introduction to Database Management System.
4. Balaswamy. Programming in C. TMH.
5. V.Rajaraman, programming in C.
6. Y. Kanitkar,programming in C
7. S.Dey , programming in C.

PRACTICAL
Full Marks- 30

Term work/ Practical: Each candidate will submit a practical note book in which at least 08 practical assignments based on the above syllabus along with the flow chart and program will be submitted.

List of Practical's:

1. Program of bisection method
2. Program of false position method method.
3. Program of Newton's Raphson method.
4. Simpson's 1/3 rule.
5. Gauss elimination method.
6. gauss seidal method.
7. numerical differentiation.
8. Lagranges interpolation formula.
9. newton's interpolation formula
10. Eulers method for first order ordinary differential equation.
11. Runga-Kutta method for first oerder ordinary differential equation.
12. Runga method for first oerder ordinary differential equation.

REFERENCES:

1. Computer Programming in C – V. Rajaraman, Prentice-Hall of India Pvt. Ltd.,2005.
2. Computer Applications of Mathematics and Statistics – A. K. Chattapadhyay and T.Chattapadhyay, Asian Books Pvt. Ltd., New Delhi, 2005.
3. The C Programming Language – B. W. Kernighan and D. M. Ritchie, Prentice Hall, India, 1995.
4. Primes and Programming – An Introduction to Number Theory with Programming – P. Goblin, Cambridge University Press, 1993.

SEMESTER – 02

Paper-VI

DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Introduction of generalized Hypergeometric function. Differential equation satisfied by pFq. Saclschut 'z' Theorem, whipples theorem Dixon's theorem. Integrals involving generalized Hypergeometric function. Contiguous function relations. Kummer's Theorem. Ramanujans theorem. **(2 Questions)**

Unit - II

Introduction of Hermite Polynomials. Recurrence relation. Orthogonal properties, expansion of polynomials generating funtion. Rodrigues formula for Hermite polynomials. **(2 Questions)**

Unit - III

Introduction of Laguerre polymials. Recurrence relations, generating relating. Rodrigues formula and orthogonality. Expamry special results. Laguerre's associated differential equation. More generating function. **(2 Questions)**

Unit - IV

Introduction of Jacobi Polynomials generating function. Rodrigues formula and orthogonality. Introduction of Ellipite function. Properties. Weierstrass ellipite. Jacobion theta function zeros of theta function. **(2 Questions)**

References:

1. W. T. Reid. Ordinary Differential Equations. John Wiley & Sons. NY. (1971).
2. E.A. Coddington and N.Levinson. Theory of Ordinary Differential Equations. Mc Graw-Hill, NY (1955).
3. Sneddon, I. N. (1961) Special Function of Mathematical Physics and Chemistry: Oliver and Boyd. Edinburgh.
4. Morse. P.M. and H. Fash bach (1953) Methods of theoretical Physics. Part-I, Mc-Graw Hill, Book, Conv. Lue.
5. Labedev, N.N. (1965) Special function and their applications: Printice-Hall, Englewodd cliff. N.J.
6. Bailey, W.N. (1963) Generalised Hyper geometric Cambridge Tracks in Mathematics and Mathematical Physics. Cambridge University, Press London.
7. Bell. W.W. (1966) Special function for Scientific and Engineers; D. Van Nontrand Conv. Ltd. London.
8. Rainville, E.D. (1960) Special Functions, Macmillan, New York.
9. Pipes (1958) Applied Mathematics for Engineers, Physicists, Mc Graw Hill Book Company.
10. Ince,E.L. , Ordinary diffential equations.

SEMESTER – 02

Paper-VII

DIFFERENTIAL GEOMETRY AND TENSOR CALCULUS

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Space curves-curvature and torsion. Serret-Frenet formula. Circular helix, the circle of curvature. Osculating sphere, Bertrand curves. **(2 Questions)**

Unit - II

Curves on a surface-parametric curves. fundamental magnitude, curvature of normal section. Principal directions and principal curvatures, lines of curvature, Rodrigue's formula. Dupin's theorem, theorem of Euler, Conjugate directions and Asymptotic lines. **(2 Questions)**

Unit - III

One parameter family of surfaces – Envelope the edge of regression, Developables associated with space curves. Geodesics-differential equation of Geodesic. Torsion of a Geodesic. **(2 Questions)**

Unit - IV

Tensors, Tensor Algebra, Quotient theorem. Metric Tensor, Angle between two vectors. **(2 Questions)**

References:

1. J. N. Sharma and A.R. Vasistha, Differential Geometry.
2. C.E. Weatherburn. Differential geometry of three dimensions.
3. P.P. Gupta & G.S.Malik. Three dimensional differential geometry.
4. C.E. Weatherburn. Tensor calculus.
5. R.S. Mishra, Tensor Calculus and Riemanian Geometry.

SEMESTER – 02

Paper-VIII

Analytical Dynamics and Gravitation

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Generalized coordinates Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Energy equation of conservative fields. **(2 Questions)**

Unit - II

Hamilton's variables, Hamilton canonical equations. Cyclic coordinates Routh's equations, Jacobi-Poisson Theorem. Fundamental lemma of calculus of variations.

Motivating problems of calculus of variations. Shortest distance. Minimum surface of revolution. Brachstochrone problem, Geodesic. **(2 Questions)**

Unit - III

Hamilton's Principle, Principle of least action. Jacobi's equations. Hamilton-Jacobi equations. Jacobi theorem. Lagrange brackets and Poisson brackets. Invariance of Langrange brackets and Poisson brackets under canonical transformations. **(2 Questions)**

Unit - IV

Gravitation

Attraction and potential of rod, spherical shells and sphere. Laplace and Poisson equations. Work done by self attracting systems. Distributors for a given potential. Equipotential surfaces. **(2 Questions)**

References :

1. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
2. I.M.Gelfand and S.V.Fomin Calculus of variation, prentice Hall.
3. S.L. Loney, An elementary treatise on Statics, Kalyani Publishers, N. Delhi 1979.
4. A.S.Ramsey, Newtonian Gravitation. The English Language Book Society and the Cambridge University Press.
5. N.C. Rana & P.S.Chandra Joag, Classical Mechanics. Tata McGraw Hill 1991.
6. Lours N. Hand and Janel, D. Finch, Analytical Mechanics, Cambridge University Press, 1998.

SEMESTER - 03

Paper-IX (Open Elective)

Difference Equations/ Number Theory/ Advanced Discrete Mathematics
(Student should select anyone these paper)

Difference Equations

Time: 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. -1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

The Calculus of finite differences: Introduction of finite difference – Differences. Differences formulae and problems. Fundamental theorem of difference calculus, properties of the operators Δ and E, Relation between operator E of finite differences and differential coefficient D of differential calculus. One or more missing terms method I and II, Factorial notation methods of representing any polynomial, Recurrence relations, Leibnitz rule, effect of an error in a tabular value. **(2 Questions)**

Unit - II

Difference equations: Introduction. definition of difference equation. solution of the difference equations. various type of linear difference equation. differential equation as limit of difference equations. Linearly independent functions. Homogenous difference equation with constant co-efficients. Homogenous linear difference equations with variable coefficients. existence and uniqueness theorem. **(2 Questions)**

Unit - III

Linear difference equation with constant coefficient, method of undetermined coefficient coefficient and special operator method to find particular solution, Solution of linear difference equation with constant coefficient using Variation of parameter, calculation of nth power of a matrix A , matrix method for the solution of system of linear difference equation, generating function technique to solve linear difference equation, applications of difference equations, cobweb phenomenon. **(2 Questions)**

.

Unit - IV

Numerical solution of partial differential equations: Boundary – value problem with boundary conditions. Laplace equations, wave equations. Heat equation. **(2 Questions)**

References:

1. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems. Difference Equations. Continued Fractions and Riccati Equations. Kluwer. Boston 1996.
2. Kolman Busby and Ross, Discreate Mathematical structure, Pearson education.
3. S.Elaydi, Difference equation, springer.

Number Theory

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Divisibity theory : Gretest Common divisor, Least common multiple, linear diophantine equation, Fundamental theorem of arithmetic. **(2 Questions)**

Unit - II

Congruences : Residue system, test of divisibility, linear congruencs, Chinese Remainder Theorem, polynomial congruences, application in solution of Diophantine equation, Fermat's Little theorem(FLT1), Eulers genaralization of FLT1, Wilson's theorem. **(2 Questions)**

Unit - III

Arithmetic functions ($Eulers - \phi, \sigma \text{ and } \tau$), definitions, examples and their properties, perfect numbers, the Mobius Inversion formula, properties of Mobius function, convolution of arithmetic functions, group properties of arithmetic functions, recurrence functions, Fibonacci numbers and their elementary properties. **(2 Questions)**

Unit - IV

Quadratic Residues, Quadratic Reciproctiy law, Euler's criterion, Legendre symbol and its properties, Gauss Lemma,Jacobi symbol and its properties.

Cryptography: some simple cryptosystem, Enciphering matrices, Idea of public key cryptography.

(2 Questions)

References:

1. S.B. Malic, Basic number thery, Vikas publishing house.
2. Niven and Zuckerman, An introduction to the Theory of Numbers,Wiley Publishers.
3. David Burton,Elementary Number Theory.
4. A course in Number Theory and Cryptography, N. Koblitz, Springer.
5. An Introduction to the Theory of Numbers (6th edition) – I. Niven, H. S. Zuckerman and H. L. Montegomery, John Wiley and sons, Inc., New York, 2003.
6. Elementary Number Theory (4th edition) – D. M. Burton, Universal Book Stall, New Delhi, 2002.
7. History of the Theory of Numbers (Vol. II, Diophantine Analysis) – L. E. Dickson, Chelsea Publishing Company, New York, 1971.
8. An Introduction to the Theory of Numbers (6th edition) – G. H. Hardy and E. M. Wright, The English Language Society and Oxford University Press, 1998.
9. An Introduction to the Theory of Numbers (3rd edition) – I. Niven and H. S. Zuckerman, Wiley Eastern Ltd., New Delhi, 1993.

Advanced Discrete Mathematics

Time: 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Languge and grammars, Finite state machines with output, Finite state machines with no output, Finite state Machine, Finite state automata, deterministic finite state automata(DFSA), non-deterministic finite state automata(NDFSA), transition diagram. **(2 Questions)**

Unit - II

Equivalence of DFSA and NDFSA, Moor machine, Mealy machine and Turning machine, Languages and regular expressions,Language determined by finite state automaton, grammars. **(2 Questions)**

Unit - III

Colouring : Vertex colouring, chromatic number, chromatic polynomial, Brooks theorem, edge colouring, chromatic index, map colouring, six colour theorem, Five colour theorem. **(2 Questions)**

Unit - IV

Hamiltonian graph,Ore's theorem, Dirac' theorem, TheShortest path problem, Dijkstra's algorithm. Hall's marriage,theorem, transvalsal theory, Alternative proof of Hall's therem using transversal theory, applications of Hall's theorem. **(2 Questions)**

References:

1. Graph Theory – R. J. Wilson.
2. Kolman Busby and Ross, Discreate mathematical structure, Pearsion education.
3. D. S. Malik and M. K. Sen : Discrete mathematical structures : theory and applications; Thomson; Australia; 2004.
4. Edward R. Scheinerman : Mathematics A Discrete Introduction; Thomson Asia Ltd.; Singapore; 2001.
5. Discrete mathematical structure, R.P.Grimaldi, Pearson education.
6. J. P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science. Mc Graw Hill Book Co. 1997...
7. J.L. Gersting, Mathematical Structures for Computer Science. (3rd edition), Computer Science Press, New York.
8. Seymour Lepschutz. Finite Mathematics (International edition 1983), Mc Graw-Hill Book Company, New York.
9. Narsinghdeo, Graph theory, PHI New Delhi.
10. Kolman Busby and Ross, Discreate mathematical structure, Pearsion education.
11. J. P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science. Mc Graw Hill Book Co. 1997.

SEMESTER - 03
Paper-X

Functional Analysis

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Normed linear spaces. Banach spaces and examples. Quotient space of normed linear spaces and its completeness, equivalent norms. **(2 Questions)**

Unit - II

Bounded linear transformations, normed linear spaces of bounded linear transformations, dual spaces with examples.Hahn-Banach theorem Open mapping and closed graph theorem, the natural imbedding of N in N**. Reflexive spaces. **(2 Questions)**

Unit - III

Inner product spaces. Hilbert spaces. Orthonormal Sets. Bessel's inequality. Complete orthonormal sets and Parseval's identity. Projection theorem. Rietz representation theorem Adjoint of an operator on a Hilbert space. **(2 Questions)**

Unit - IV

Reflexivity of Hilbert spaces. Self-adjoint operators. Positive, normal and unitary operators. Linear transformation & linear functionals. **(2 Questions)**

References:

1. G.F.Simmons,Topology and modern analysis TMH.
2. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
3. R.E. Edwards, Functional Analysis. Holt Rinehart and Winston, New York 1958.
4. C. Goffman and G. Pedrick. First Course in Functional Analysis, Prentice Hall of India, New Delhi. 1987.
5. E.Kreyszig, Functional analysis with application, John wiley and sons.

SEMESTER - 03
Paper-XI

Partial Differential Equations

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Laplace equation – Fundamental solutions of two- and three-dimensional Laplace equation in Cartesian form. Properties of Harmonic functions. Boundary value problems. **(2 Questions)**

Unit - II

Heat equation – Derivation and fundamental solution of one-dimensional Heat equation in Cartesian form. Application problems. **(2 Questions)**

Unit - III

Wave equation – Derivation and fundamental solution of one-dimensional wave equation in Cartesian form. Application problems. **(2 Questions)**

Unit - IV

Solutions of p.d.e. using Separation of variables, Fourier transform and Laplace transform, Green's function and solutions of boundary value problems. **(2 Questions)**

References :

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998.
2. I.N. Sneddon,Use of integrals transforms McGraw Hill.
3. P. Prasad and R. Ravindran ; Partial Differential equation.
4. K. Sankar Rio, Partial diffential eqution, new age.

SEMESTER - 03
Paper-XII

Fluid Mechanics

Time: 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Kinematics – Lagrangian and Eulerian methods. Equation of continuity in different coordinate system. Boundary surfaces. Stream lines. Path lines and streak lines. Velocity potential, Irrotational and rotational motions. Vortex lines. **(2 Questions)**

Unit - II

Equations of Motion – Lagrange's and Euler's equations of motion. Bernoulli's theorem. Equation of motion by flux method. Impulsive actions. Stream function Irrotational motion. **(2 Questions)**

Unit - III

Complex velocity potential. Sources, sinks doublets and their images in two dimensions. Conformal mapping. Milne-Thomson circle theorem. **(2 Questions)**

Unit - IV

Two-dimensional Irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid. Theorem of Blasius. Motion of a sphere through a liquid at rest at infinity. Liquid streaming past a fixed sphere. Equation of motion of a sphere. **(2 Questions)**

References :

1. W.H.Besaint & A. S. Ramsey. A Treatise on Hydro mechanics. Part II. CBS Publishers. Delhi. 1988.
2. G.K. Batchelor. An Introduction of Fluid Mechanics. Foundation Books. New Delhi. 1994.
3. F. Choriton. Textbook of Fluid Dynamics. C.B.S. Publishers. Delhi 1985.
4. Fluid mechanics – Bansal.
5. Fluid dynamics, M.D. Raisinghania, S.Chand Publication.

SEMESTER – 04
Paper-XIII

Fuzzy Sets and their Applications/Algebric Topology

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Fuzzy Sets and their Applications

Unit - I

Definitions – level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference. T-norms and t-conorms. The Extension Principle – The Zadeh's extension principle. Image and inverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy arithmetic.

(2 Questions)

Unit - II

Fuzzy Relations and Fuzzy Graphs – Fuzzy relations on fuzzy sets. Composition of fuzzy relations. Fuzzy relation equations. Fuzzy graph. Similarity relation. **(2 Questions)**

Unit - III

Possibility Theory – Fuzzy measures. Evidence theory. Necessity measure. Possibility measure. Possibility distribution. Possibility theory and fuzzy sets. Possibility theory versus probability theo Fuzzy Logic – An overview of classical logic. Multivalued logics. Fuzzy propositions. Fuzzy quantifiers. Linguistic variables and hedges. Inference from conditional fuzzy propositions. the compositional rule of inference. **(2 Questions)**

Unit - IV

An Introduction to Fuzzy Control-Fuzzy controllers. Fuzzy rule base. Fuzzy inference engine. Fuzzification. Defuzzification and the various defuzzification methods (the center of area, the center of maxima. and the mean of maxima methods). Decision making in Fuzzy Environment-Individual decision making. Multi-person decision making. Multicriteria decision making. Multistage decision making. Fuzzy ranking methods. Fuzzy linear programming.

(2 Questions)

References :

1. H.J. Zimmermann : Fazzy set theory and its Applications. Allied Publishers Ltd. New Delhi. 1991.
2. G.J. Klir and B. Yuan-Fuzzy Sets and Fuzzy logic. Prentice-Hall of India. New Delhi, 1995.

Algebraic Topology

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Fundamental group functo. homotopy of maps between topological spaces. homotopy equivalence. contractible and simply connected spaces. fundamental groups of S^1 and $S^1 \times S^1$ etc. Calculation of fundamental group of S^n. N>1 using Van Kampen's theorem. fundamental groups of a topological group. Brouwer's fixed point theorem. fundamental theorem of algebra. vector fields on planner sets. Frobenius theorem for 3 x 3 matrices.

(2 Questions)

Unit - II

Covering spaces. unique path lifting theorem. covering homotopy theorems. group of covering transformations. criteria of lifting of maps in terms of fundamental groups. universal covering. its existence. special cases of manifolds and topological groups. Singular homology, reduced homology. Eilenberg Steenrod axioms of homology (no proof for homotopy invariance axiom decision axiom and exact segnence axiom) and theory application. relation between fundamental group and first homology.

(2 Questions)

Unit - III

Calculation of homology of S^n. Brouwer's fixed point theorem for $f : E^n \to E^n$. application spheres. vector fields. Mayer-Vietoris sequence (without proof) & its applications. Singular cohomology modules. Kronecker product. connecting homomorphism. contra-functoriality of singular cohomology modules. naturality of connecting homomorphism. exact cohomology sequence of pair. homotopy invariance. excision properties. cohomology of a point. Mayer vietoris sequence and its application in computation of cohomology of S^n. RP^n. CP^n torus. compact surface of genus g and non-orientable compact surface.

(2 Questions)

Unit - IV

Compact connected 2-manifolds. their orientabiligy and non-orientabiligy. examples. connected sum. construction of projective space and Klein's bottle from a square. Klien's bottle as union of two Mobius strips. canonical of sphere. torus and projective plannes. Klin's bottle as union of two Mobius strips. triangulation of compact surfaces.
Classification theorem for compact surfaces. connected sum of tours and projective plans as the connected sum of three projective planes. Euler characteristic as a topological invariant of compact surfaces. connected sum formula. 2-manofolds with boundary and their classifications. Euler characteristic of a bordered surface, models of compact bordered surfaces in R^3.

(2 Questions)

References :

1. James R. Munkres. Topology – A first Course. Prentice Hall of India Pvt. Ltd., New Delhi, 1978.

SEMESTER – 04

Paper-XIV

Mechanics of Solids/Operations Research/Differentiable Structure on a Manifold/Information Theory

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Mechanics of Solids

Unit - I

Analysis off Strain-Affine transformation. Infinite simal affine deformation. Geometrical interpretation of the components of stain. Strain quadric of Cauchy. Principal strains and invariants. General infinite simal deformation. Saint-Venant's equations of Compatibility. Finite deformations. **(2 Questions)**

Unit - II

Analysis of Stress-Stress tensor. Equations of equilibrium. Transformation of coordinates. Stress qudric of Cauchy.Principal stress and invariants. Maximum normal and shear stresses. **(2 Questions)**

Unit - III

Equations of Elasticity. Generalized Hooke's law. Homogeneous isotropic media. Elasticity moduli for isotropic media. Elasticity moduli for isotropic media. Equilibrium and dynamic equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's law. Uniqueness of solution Beltrami-Michell compatibility equations. Saint-Venant's principle. Torsion-Torsion of cylindrical bars. Tortional rigidity. Torsion and stress functions. Lines of shearing stress. Simple problems – Plane stress. Generalized plane stress. Airy stress function. General solution of Biharmonic equation. Stresses and displacements in terms of complex potentials. Simple problems. Stress function appropriate to problems of plane stress problems of semi-infinite solids with displacements or stresses prescribed on the plane boundary. **(2 Questions)**

Unit - IV

Waves-Propagation of waves in an isotropic elastic solid medium. Waves of dilation and distortion. Plane waves. Elastic surface waves such as Rayleigh and Love waves. Variational methods – Theorems of minimum potential energy. Theorem of minimum complementary energy. Reciprocal theorem of Betti and Rayleigh. Deflection of elastic string central line of a beam and elastic membrane. Torsion of cylinders. Variational problem related to biharmonic equation. Solution of Euler's equation by Ritz. Galerkin and Kantorovich methods. (**2 Questions)**

References :

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity. Tata McGraw-Hill Publishing Company Ltd., New Delhi. 1977.
2. E. Love. A Treatise on the Mathematical Theory of Elasticity. Cambridge University Press. London. 1963.
2. Y.C. Fung Foundations of Solid Mechanics. Prentice Hall, New Delhi. 1965.
3. S. Timoshenko and N. Goodier. Theory of Elasticity, McGraw Hill, New York 1970.

Operations Research

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Sequencing : Introduction, sequencing problem with n-jobs and two machines. optimal sequencing problems with n-jobs and three machine. Problems with n-jobs and m-machine, graphical solution. **(2 Questions)**

Unit - II

Replacement Problems : Introduction, replacement of item that Deteriorate with time, Replacement of items whose maintenance costs change with time and the value of money remains same during the period. replacement of items whose maintenance costs increase with time and the value of money also changes with time. replacement of items that fail completely, individual replacement policy, group replacement policy.

Queuing theory : Introduction, characteristics of queuing system, queue discipline, symbols etc. Poisson process and exponential distribution, properties of Poisson process, classification of queues. definition of transient and steady state, model (M/M/L) (D/f1 Fo), (M/M/I) (SIRO) (M/M/I) (MFIFO). **(2 Questions)**

Unit - III

Non-Linear programming – Introduction, definitions of general non-linear programming problems, problems of constrained maxima and minima; necessary and sufficient conditions for non-linear programming problems, Hessian – matrix, Lagrangian functions with Lagrangian multiplier. constraints are not all equality constraints. sufficiency of saddle point problem. Kuhn-Tucker condition. **(2 Questions)**

Unit - IV

Non-linear programming techniques – Introduction of GMPP & GN 1 PP its sanction by Wolfe's method. Beale's method. **(2 Questions)**

References :

- F.S. Hillier and G. J. Lieberman. Introduction to Operations Research (Sixth Edition). McGraw Hill International Edition. Industrial Engineering Series. 1995 (This book comes with a CD containing tutorial software).
- G. Hadley, Linear Programming. Narosa Publishing House. 1995.
- G. Haadly. Nonlinear and Dynamic Programming. Addisor-Wisely. Reading Mass.
- Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
- S. S. Rao. Optimization Theory and Applications. Wiley Eastern Ltd., New Delhi.
- Prem Kumar Gupta and D.S. Hira. Operations Research-An Introduction, S. Chand & Company Ltd. New Delhi.
- H.A.Taha , Oprations research, Prentice Hall India.1997.

Differentiable Structures on a Manifold

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Almost Hermite manifolds. Riem Almost analytic vector fields. Curvature tensor. Linear connections. Kahler manifolds. Affine Connections. Holomorphic sectional curvature. Curvature tensor. Almost Analytic Vector fields. **(2 Questions)**

Unit - II

Nearly Kahler manifolds. Curvature identities. Constant Holomorphic sectional curvature. Almost analytic Vector Fields. **(2 Questions)**

Unit - III

Almost Kahler manifolds. Analytic vector fields. Conformal transformation. Curvature identities, Almost Contact Metric manifolds – Almost Grayan manifolds. K-Contact Riemannian manifolds. Sasakian manifolds. Cosymplectic manifolds. **(2 Questions)**

Unit - IV

Subamanifolds of almost Hermite and Kahler manifolds. Sub-manifolds of almost contact metric manifolds. CR-Submanifolds of Kahler manifolds and Sasakian manifolds. The integrability of distributions. **(2 Questions)**

References :

1. R.S. Mishra. Structures on a differentiable manifold and their applications. Chadrama Prakashan. Allahabad, 1984.

Information Theory

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Measures of information. Axioms for a measure of uncertainty. The Shannon entropy and its properties. Joint and conditional entropies. Transformation and its properties. Noiseless coding – ingredients of noiseless coding problem. Uniquely decipherable codes. Necessary and sufficient condition for the existence of instaneous codes. Construction of optimal codes. **(2 Questions)**

Unit - II

Discrete memory less channel. Classification of channels. Information processed by a channel. Calculation of channel capacity. Decoding schemes. The ideal observer. The fundamental theorem of Information theory and its strong and weak converses. **(2 Questions)**

Unit - III

Continuous channels – The time-descrete Gaussian channel. Uncertainty of an absolutely continuous random variable. The converse to the coding theorem for time-discrete Gaussian channel. The time-continuous Gaussian channel. Band-limited channels. **(2 Questions)**

Unit - IV

Information functions, the fundamental equation of information, information functions continuous at the origin, nonnegative bounded information functions, measurable information functions and entropy. Axiomatic characterizations of the Shannon entropy due to Tverberg and Leo. The general solution of the fundamental equation of information. Derivations and their role in the study of information functions. The branching property. Some characterizations of the shannon entropy based upon the branching property. Entropies with the sum property. The Shannon inequality. Sub additive. additive entropies. **(2 Questions)**

References :

- R.Ash. Information Theory, Inter science Publishers. New York 1965.
- F.M.Reza. An introduction to information Theory. Mc Graw-Hill Book Company inc. 1961.
- J. Aczel and Z. Daroczy. On measures of information and their characterizations. Academic press. New York.

SEMESTER – 04

Paper-XV :
Integral Transforms/ Algebraic Coding Theory/ Mathematics of Finance and Insurance / Applied Statistics/ Boundary Layer Theory

Integral Transforms

Time: 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

SYLLABUS :

Unit - I
Fundamental Formulae-The Laplace Transform-Definition Region of convergence. abscissa of convergence, absolute convergence, Uniform convergence of Laplace Transform. Complex Inversion formula.

The Stieltje transform-Elementary properties of the transform. Relation to the Laplace transform. Complex Inversion formulae. **(2 Questions)**

Unit - II
The Fourier transform : Dirichlet's conditions. Definition of Fourier transform. Fourier Sine Transform, Fourier cosine transform. Inversion theorem for complex fourier transform. Difinition of convolution and convolution theorem for Fourier transforms. Parseval's identity of Fourier transforms. **(2 Questions)**

Unit - III
The Mellin transform : Definition of Mellin transform and its properties. Mellin transforms of derivatives and certain integral expressions. **(2 Questions)**

Unit - IV
Hankel Transform: Definition of Hankel transform and its elementary properties. Inversion formula for the Hankel transform. Hankel transform of derivatives, Parseval's theorem. **(2 Questions)**

References :

1. The Laplace Transforms - D. V. Widder
2. Use of Integral Transforms- Sneddon

Algebraic Coding Theory

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Coding theory, Introduction, examples, Inpotant code parameters, Correcting and detecting errors, Sphere-packing bound, Gilbert-Varshamov bound, Sigleton bound. **(2 Questions)**

Unit - II

Linear codes: Vector spaces over finite fields,Linear codes,Binary linear , Hamming weight, Bases of linear codes, Generator matrix and parity check matrix. **(2 Questions)**

Unit - III

Equivalence of linear codes, Encoding with a linear code,Decoding of linear codes, Cosets, Nearest neighbour decoding for linear codes, Syndrom decoding. **(2 Questions)**

Unit - IV

Cyclic codes: Definitions, Generator and parity check polynomials, Generator and parity check, matrices, Decoding of cyclic codes, Burst-error-correcting codes.Reed-Solomon codes. **(1 Questions)**

Some special cyclic codes: BCH codes, RS codes, Defintions, Parameters of BCH codes,Decoding of BCH codes.Reed-Muller Codes.Maximum-distance Separable (MDS) Codes. Generator and Parity-check matrics of MDS Code. Weight Distribution of MDS Code. MDS codes from RS codes. Codes derived from Hadamard Matrices.
(1 Questions)

Reference:

3. R.Hill, Afirst course in codding theory, oxford university press.
4. F.Macwwilliams and N.Sloane, The Theory of error correcting codes, North Holland Publishing company, Amsterdom.
5. San Ling and Chaoing xing, Coding Theory- A First Course.
6. Applied Abstract Algebra - Lid and Pilz 2nd Edition.
7. Todd K. Moon, Error Correction Coding, Wiley India
8. Steven Roman, Coding and Information Theory, Springer-Verlag.
9. Algebraic coding theory, E.R. Berlekamp
10. Error Correcting Coding Theory,Man Young Rhee.
11. Error-Correcting Codes,W.W. Peterson and E.J. Weldon, Jr.
12. Algebraic Coding Theory, E.R. Berlekamp

Mathematics of Finance and Insurance

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Prerequisite – Application of Mathematics and Finance & Insurance Optional Paper BMG 1 304 (a & b) F)

Financial Derivatives – An Introduction : Types of Financial Derivatives – Forwards and Futures : Options and its kind : and SWAPS.

The Arbitrage Theorem and Introduction to portfolio Selection and Capital Market Theory – Static and Continuous – Time Model. **(2 Questions)**

Unit - II

Pricing by Arbitrage – A Single – Period Option Pricing Model: Multi Pricing Model-Cox-Ross-Rubinstein Model : Bounds on Option Prices. The Dynamics of Derivative Prices-Stochastic Differential Equations (SDEs) – Major Models of SDEs. Lonear Constant Coefficient SDEs: Geometric SDEs : Square Root Process: Mean Reverting Process and Omstein-Uhlenbeck Process. Martingale Measue and Risk-Neutral Probabilities : Pricing of Binomial Options with equivalent martingale measures. **(2 Questions)**

Unit - III

The Black-Scholes Option Pricing Model- Using no arbitrage approach, limiting case of Binomial Option Pricing and Risk-Neutral probabilities.The American Option Pricing-Extended Trading Strategies; Analysis of Amerivan Put Options: early exercise premium and relation to free boundary problems. Concepts from Insurance : Introduction : The Claim Number Process : The Claim Size Process: Solvability of the Portfolio: Reinsurance and Ruin Problem.Premium and Ordering of Risks-Premium Calculation Principles and Ordering Distributions. **(2 Questions)**

Unit - IV

Distributions of Aggregate Claim Amount-Individual and Collective Model:Compound Distributions : Claim Number of Distributions: Recursive Computation Methods: Lundberg Bounds and Approximation by Compound Distributions. Risk Processes-Time-Dependent Risk Models: Poisson Arrival Processes : Ruin Probabilities and Bounds Asymptotic and Approximation.Time Dependent Risk Models – Ruin Problems and Computations of Ruin Functions; Dual Queuing Model : Risk Models in Continuous Time and Numerical Evaluation of Ruin Functions.
(2 Questions)

References :

- John C. Hull, Options. Futures and other derivatives. Prentice Hall of India Pvt. Ltd.
- Sheldon M. Ross. An Introduction to Mathematical Finance. Cambridge University Press.

Applied Statistics

Time : 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q.No. 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Demand analysis. price elasticity and demand. partial elasticity of demand. Lontieg's method. Pigou's method. Engle's curve and Engle's law. Paretv's law of income distribution, curves of concentration. **(2 Questions)**

Unit - II

Analysis of Variance. One way classification, statistical analysis of the mode.Design experiment-statistical analysis of C.R.D. (Completely randomized design) least square estimates of effects. exception of sum of squares. randomized block design (R.B.D.) – statistical analysis of R.B.D. for one observation per experiment unit. Variance of estimates. expectation of sum of squares. efficiency of R.B.D. relative to C.R.D. **(2 Questions)**

Unit - III

Design of sample survey. Principle steps in a sample survey sampling and non-sampling error. types of sampling. selection of a simple random sample, simple random sampling, stratified random sampling.

Psychological and educational statistics – scaling of scores on a test. percentile scores, scaling of rankings, scaling of normal probability curves. scaling of ratings in terms of normal curve, reliability of test scars, error variance, index of reliability, parallel test method of determining test reliability. **(2 Questions)**

Unit - IV

Vital Statistics – uses of vital statistics, methods of obtaining vital statistics, measurement of population, measurement of mortality, crude death rate (C.D.R.) specific death rate (SDR). specific rate, life table or (Mortality table). abridged life table, fertility measurement of population growth. **(2 Questions)**

References:

1. Fundamental of Applied Statistics – S.C.Gupta & V. K. Kappor
2. Statistical Method – S.P. Gupta
3. An Introduction to statistical method – S.B.Gupta

Boundary Layer Theory

Time: 3 Hrs. **Full Marks :70**

In all ***nine*** questions will be set out of which candidates are required to answer 5 questions. Q. No. - 1 is compulsory consist of ***seven*** very short answer type questions each of **2 marks** covering entire syllabus.

Unit - I

Exact solution of Navier-Stoke's equation – flow between two concentric rotating cylinders. Hiemenz flow. flow due to lane wall suddenly set in motion, flow due to an oscillating wall. **(2 Questions)**

Unit - II

Theory of very slow motion – flow past a sphere. (Stroke's flow). Flow past a sphere (Osceen's flow), Lubrication Theory. Theory of laminar boundary layer – (a) two dimensional boundary layer equation for flow over a plane wall, boundary layer on a flat plate. (Blassius-Topler solution). **(2 Questions)**

Unit - III

Characteristic of boundary layer parameters. (b) Similar solution of the boundary layer equation. boundary layer. How past a wedge boundary layer along the wall of a convergent channel. boundary layer on a symmetrically placed cylinder and body of evolution. **(2 Questions)**

Unit - IV

Boundary layer control in laminar flow – methods of boundary layer control in laminar flow, boundary layer suction. **(2 Questions)**

References :

1. Boundary layer theory –Slicsting.
2. Foundation of fluid dynamics – S.W. Yuan, Prentice Hall of India (F)
3. Laminar boundary layer – L. Rosenheard. C.U.P. Clarendon Press.
4. Viscous fluid dynamics – J. L. Bansal. Oxford & IBM pub. co.

SEMESTER – 04
Paper-XVI

DESSERTAION

PROJECT

Time: 6 hours **F.M. 100**

ANY ONE OF SPECIAL PAPER

****