COURSE STRUCTURE FOR TWO YEAR M.SC, P.G PROGRAMME

M.Sc Mathematics

Semester - I

S.No.	Course	L	T	P	Credits
1	Real Analysis	3	1	0	4
2	Mathematical methods	3	1	0	4
3	Probability and Distributions	3	1	0	4
4	Linear Algebra	3	0	0	3
5	Programming Language	3	0	2	4
6	Elective-I	3	0	0	3
7	Seminar	0	0	4	2
	TOTAL	18	3	6	24

Semester - II

S.No.	Course	L	T	P	Credits
1	Complex Analysis	3	1	0	4
2	Discrete Mathematical Structures	3	1	0	4
3	Advanced numerical methods	3	1	0	4
4	Topology	3	1	0	4
5	Applied Statistics	3	0	0	3
6	Elective-II	3	0	0	3
7	Term Paper	0	0	4	2
	TOTAL	18	4	4	24

Semester - III

S.No.	Course	L	T	P	Credits
1	Mathematical Modeling	3	1	0	4
2	Simulation and Modeling	3	1	0	4
3	Optimization techniques	3	1	0	4
4	Cryptography	3	1	0	4
5	Elective-III	3	0	0	3
6	Elective-IV	3	0	0	3
7	Mini project	0	0	4	2
	Total	18	4	4	24

Semester - IV

S.No.	Course	L	T	P	Credits
1	Dissertation	0	0	36	18
	Total	0	0	36	18

Degree with specialization: By doing four Electives with in same specialization M.Sc. Mathematics with specialization in **"Applied Mathematics" or "Statistics " or "Computing"** will be awarded.

Electives:

M.Sc Mathematics with specialization in **Applied Mathematics.**

1. Boundary value problems
2. Advanced boundary value problems.
3. Dynamical Systems
4. Fluid Dynamics

M.Sc Mathematics with specialization in **Statistics.**

1. Statistical Methods
2. Design and Analysis of Experiments
3. Statistical Quality Control
4. Reliability

M.Sc Mathematics with specialization in **Computing.**

1. Design and Analysis of Algorithms
2. Computer Graphics
3. Soft Computing
4. Data ware housing and Mining

DEPARTMENT OF MATHEMATICS

SYLLABUS

M.Sc. FIRST SEMESTER APPLIED MATHEMATICS

12 AM 501: REAL ANALYSIS

(With effect from 2012-2013 Admitted Batch)

Duration: 3 hours **Maximum Marks: 85**

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Basic Topology: finite, countable and uncountable sets, metric spaces, compact sets, perfect sets, connected sets. **(One question is to be set)**

Continuity: limits of functions, continuous functions, continuity and compactness, continuity and connectedness, discontinuities, monotone functions, infinite limits and limits at infinity. (Chapters 2 and 4 of Ref.1). **(One question is to be set)**

The Riemann - Stieltjes integral: linearity properties, integration by parts, change of variable, reduction to a Riemann integral, monotonically increasing integrators, Riemann's condition, comparison theorems, integrators of bounded variation, sufficient conditions for existence of R-S. integrals, necessary conditions for existence of R-S integrals, mean-value theorems for R-S integrals, integral as a function of interval, second fundamental theorem of integral calculus, second mean-value theorem for Riemann integrals. (Sections: 7.1 to 7.7 and 7.11 to 7.22 of Ref.2)

(One question is to be set)

Multivariable Differential Calculus: directional derivative, total derivative, Jacobian matrix, chain rule, mean-value theorem for differentiable functions, sufficient conditions for differentiability and for equality of mixed partial derivatives, Taylor's formula for real valued functions in n real variables. (Chapter 12 of Ref.2).

(One question is to be set)

Sequences and series of functions: uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation. equicontinuous families of functions, the Stone – Weierstrass theorem.
(Chapter 7 of Ref.1) **(Two questions are to be set)**

Text Books: (1) Principles of Mathematical analysis by Walter Rudin (third edition) Mc.Graw Hill international edition, 1976.

(2) Mathematical Analysis by TOM.M.APOSTOL (Second Edition) Addison-Weslay publishing Company.

12 AM 502: MATHEMATICAL METHODS

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Laplace Transforms, Inverse Laplace Transforms, Their properties, finding solutions of ODE, PDE and Integral equations using Laplace transforms

(Chapters 1,2, Chapter 3 Sec 3.1-3.4 and Chapter 4 of Text book 1) **(Two questions are to be set)**

Fourier Series, Fourier Transforms, Inverse Fourier Transforms and their properties

(Chapter 6 only of Text book 1) **(One question is to be set)**

Calculus of variations: Euler's equations, functions of the form $\int_{x_0}^{x_1} F\left(x, y_{1,}\ y_2 \ldots . y_{n,}\ y_1, y_2, \ldots . y_n\right)$ dx. Functional dependence on higher order derivatives, variational problems in parametric form and applications (chapter VI of Text book 2). (One question is to be set)

Integral equations: Basic concepts, solutions of integral equations, Volterre's integral equations and Fredholm's integral equations (Chapters: 1 & 2 of Text book 3) **(One question is to be set)**

Tensor Analysis: N-dimensional space, covariant and contravariant vectors, contraction, second & higher order tensors, quotient law, fundamental tensor, associate tensor, angle between the vectors, principal directions, christoffel symbols, covariant and intrinsic derivatives geodesics

(Chapter 1 to 4 of Text book 4) **(One questions is to be set)**

Text books:

1. A.R.Vasishtha & R.K.Gupta, Integral transforms, Krishna Prakashan Media (P) Ltd,

Meerut, 2003.

2. L. Elsgolts: Differential equations and calculus of variations, Mir Publishers, Moscow,

3. Shanti Swarup- Integral equations, Krishna Prakashan Media (P) Ltd, Meerut, 2003.

4. Barry Spain, Tensor Calculus, Radha Publishing House, Calcutta, Third Edition.

12 AM 503: DISCRETE MATHEMATICAL STRUCTURES

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Mathematical logic: statements structures and notation, connectives, well formed formulas, tautologies, equivalences, implications, normal forms – Disjunctive and conjunctive, Principle disjunctive and conjunctive normal forms.

Theory of Inference: Theory of inferences for statement calculus, validity using truth tables, rules of Inference. Predicate calculus: predicates, predicate formulas, quantifiers, free and bound variables, Inference theory of predicate calculus. (Scope and treatment as in Sections: 1.1 to 1.6 of Text book.1)

(Three questions are to be set)

Relations and ordering: partially ordered relations, Partially ordered sets, representation and associated terminology. (Sections 2-3.1, 2-3.2, 2-3.8, 2-3.9 of Chapter 2 in Text book1)

Lattices, Lattices as partially ordered sets, some properties of Lattices, Lattices as algebraic systems, sub-Lattices, direct product and homomorphism some special Lattices.

(Sections: 4-1.1 to 4-1.5 of chapter 4 of Text book.1).

Boolean Algebra, subalgebra, direct product and Homomorphism, Boolean forms and free Boolean Algebras, values of Boolean expressions and Boolean functions (Sections: 4-2.1, 4-2.2, 4-3.1, 4-3.2 of chapter of Text book 1)

(Three questions are to be set)

Text books:

1. Discrete Mathematical structures with Applications to Computer Science by J.P. Trembly and R.Manohar, Tata Mc.Graw hill Edition.

12 AM 504: NUMERICAL METHODS AND PROGRAMMING IN C

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Fortran 77 programming: Introduction, Flowcharts, Fortran programming preliminaries, Fortran constants and variables, Arithmetic expressions, Input-output statements, control statements, Do statements, Subscripted variables, Elementary format specifications. Logical variables and logical expressions, function subprograms, subroutine subprograms, simple examples on these topics (Scope and treatment as in chapters 3 to 12 and 14 of Text book.1).

(Three questions are to be set)

Numerical techniques of solving transcendental and polynomial equations: Bisection methods, secant method, Newton-Raphson method, Chebyshev method, Rate of convergence, Iteration methods of first and second orders. Methods for multiple roots. Numerical techniques of solving system of lineal Algebraic equations: Triangularization method, Gauss elimination method, Gauss-jordan method, Iterative methods: Jacobi method, Gauss-Seidel method. Numerical techniques of determining the eigen values and eigen vectors of a matrix: Jacobi method, power method and Rutishausher method (Scope and treatment as in chapters 2 and 3 of Text book.2).

(Three questions are to be set)

Text books:

1. V. Rajaraman, Computer programming in Fortran-77, 4th edition Prentice Hall of India Private Ltd.
2. M.K.Jain, S.R.K. Iyengar, R.K. Jain - Numerical Methods for Scientific and Engg. Computation, 3rd Edition, New Age international (P) Ltd. Publishers.

12 AM 505: LINEAR ALGEBRA

Vector spaces over fields, subspaces, bases and dimension.

Systems of linear equations, matrices, rank, Gaussian elimination.

Linear transformations, representation of linear transformations by matrices, rank-nullity theorem, duality and transpose.

Determinants, Laplace expansions, cofactors, adjoint, Cramer's Rule.

Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonal-lization, rational canonical form, Jordan canonical form.

Inner product spaces, Gram-Schmidt orthonormalization, orthogonal projections, linear functionals and adjoints, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators, Rayleigh quotient, Min-Max Principle.

Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness.

Texts / References

M. Artin, Algebra, Prentice Hall of India, 1994.

K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. Prentice-Hall of India, 1991.

S. Lang, Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.

P. Lax, Linear Algebra, John Wiley & Sons, New York,. Indian Ed. 1997

H.E. Rose, Linear Algebra, Birkhauser, 2002.

S. Lang, Algebra, 3rd Ed., Springer (India), 2004.

O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Springer, 1975.

12 AM 506: PROGRAMMING LANGUAGE-C LAB

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1. Program to convert a given decimal number to octal number.

2. Program to solve quadratic equation using switchcase structure.

3. Program to check a given integer is a palindrome.

4. Program to check a given integer is a prime number.

5. Sorting of numbers.

6. Multiplication of two matrices.

7. Finding norm of a matrix using function.

8. Finding numerical integration using Simpson and Tripazodal rules.

9. Solving ODE by first order Adams bashforth method.

10. Solving ODE by forth order Runge Kutta method.

11. Program to check a given string is a palindrome or not.

12. Using pointers copying a string to another string.

13. Using pointers and functions sorting of number.

14. Compute binomical coefficients using recursive function for factorial.

12AM 507: COMPLEX ANALYSIS

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Functions of a complex variable: Analytic functions and Harmonic functions, Cauchy – Riemann equations, Sufficient conditions, Power Series functions, the complex exponential function, Branches of the complex logarithm function, Complex Exponents, Trigonometric and hyperbolic functions.

Complex integration: Contour integration, Cauchy – Goursat theorem, antiderivatives, Integral representation for analytic functions, Theorems of Morera and Liouville and some applications.

Series: Uniform convergence of series, Taylor and Laurent series representations, singularities, Zeros and poles, Applications of Taylor and Laurent series.

(Three questions are to be set)

Residue theory: Residue theorem, calculus of Residues, evaluation of Improper real integrals, Indented contour integrals, Integrals with Branch point. Rouche's theorem.

Conformal mapping: Basic properties of conformal mapping, Bilinear transformations, mappings involving elementary functions.

(Three questions are to be set)

Text book: Complex analysis for Mathematics and Engineering – 3rd Edition by John H. Mathews and Russel W, Howell. Narosa publishing house (chapters: 3, 6, 7, 8 and 9).

12AM 508: TECHNIQUES OF APPLIED MATHEMATICS

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Partial differential equations: Equations of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$, Orthogonal trajectories, Pfaffian differential equations, 1st order partial differential equations; Charpit's method and some special methods. Jacobi's method. Second order Partial differential equations with constant & Variable coefficients, canonical forms, separation of variables method, Monge's method (Chapter 1 (excluding sections 7 & 8), chapter-II (excluding section 14), chapter III (excluding section 10) of Text book.1).

(Three questions are to be set)

Integral equations: Basic concepts, solutions of integral equations, Volterre's integral equations and Fredholm's integral equations (Chapters: 1 & 2 of Text book 2)

(One question is to be set)

Fourier and Laplace Transforms with applications to ordinary, partial differential equations and Integral equations (Chapters 1,2,3,4,5,6 and 8 (section 8.1 & 8.2 only) of Text book 3)

(Two questions are to be set)

Text books:

1. I.N. Sneddon, Elements of partial differential equations. Mc Graw Hill International student Edition, 1964.
2. Shanti Swarup- Integral equations, Krishna Prakashan Media (P) Ltd, Meerut, 2003.
3. A.R.Vasishtha & R.K.Gupta, Integral transforms, Krishna Prakashan Media (P) Ltd, Meerut, 2003.

12AM 509: ADVANCED NUMERICAL METHODS WITH C++

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Solutions of Algebraic and Transcendental Equations: Introduction, the bisection method, the method of false method, the iteration method, Newton-Raphson method, the secant method, the secant method, Muller method, Ramanujan's method Graeffe's root-squaring method, Lin-Bairstow method, the Quotient-difference method.

(Chapter 2 of Ref.1).

Least Squares : Introduction, Least-squares curve fitting procedures: fitting a straight line, nonlinear curve fitting, curve fitting by a sum of exponentials. Weighted least squares approximations: Linear weighted least squares approximation, nonlinear weighted least squares approximation. Method of least squares for continuous functions: Orthogonal polynomials, Gram-schmidt orthogonalization process.

(Chapter 4 of Ref.1)

(Three questions is to be set)

Numerical Differentiation and Integration: Introduction, Numerical differentiation: Errors in numerical differentiation, the cubic spline method. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Boole's and Weddle's rules, use of Cubic splines, Romberg integration, Newton-Cotes integration formulae. Euler-Maclaurin formula. (Chapter 5 of Ref.1)

Matrices and Linear Systems of equations: Solution of linear systems-direct methods: Matrix inversion method, Gauss elimination, Gauss-Jordan method, Modification of the Gauss method to compute the inverse, Number of arithmetic operations, LU decomposition. LU decomposition from Gauss elimination method Solutions of linear systems-iterative methods, the eigenvalue problem. (Chapter 6 of Ref.1)

(Three questions is to be set)

Text Book: Introductory Methods of Numerical Analysis by S.S.Sastry, PHI publications, 4th edition, 2005.

12 AM 510: ALGEBRA

Simple groups and solvable groups, nilpotent groups, simplicity of alternating groups, composition series, Jordan-Holder Theorem. Semidirect products. Free groups, free abelian groups.

Rings, Examples (including polynomial rings, formal power series rings, matrix rings and group rings), ideals, prime and maximal ideals, rings of fractions, Chinese Remainder Theorem for pairwise comaximal ideals.

Euclidean Domains, Principal Ideal Domains and Unique Factorizations Domains. Poly-nomial rings over UFD's.

Fields, Characteristic and prime subfields, Field extensions, Finite, algebraic and finitely generated field extensions, Classical ruler and compass constructions, Splitting fields and normal extensions, algebraic closures. Finite fields, Cyclotomic fields, Separable and inseparable extensions.

Galois groups, Fundamental Theorem of Galois Theory, Composite extensions, Examples (including cyclotomic extensions and extensions of finite fields).Norm, trace and discriminant. Solvability by radicals, Galois' Theorem on solvability. Cyclic extensions, Abelian extensions, Trans-cendental extensions.

Texts / References

M. Artin, Algebra, Prentice Hall of India, 1994.

D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.

J.A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.

N. Jacobson, Basic Algebra I, 2nd Ed., Hindustan Publishing Co., 1984, W.H. Freeman, 1985.

12 AM 511: STATISTICAL METHODS

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

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1. Random variables, distribution functions, Mathematical expectation and Generating functions:

One and two dimensional random variables (Discrete and Continuous), Distribution functions, joint and conditional distribution functions, probability mass function, probability density function, Transformation of Random variables.

Mathematical expectation, Moments of a distribution function, moment generating functions, characteristic functions and their properties, Chebychev inequality, probability generating functions. (Chapter 5, Chapter 6 except section 6.7 and

Chapter 7-Sections 7.1, 7.2, 7.3, 7.5 and 7.9)

(One question is to be set on the above topics)

2. Probability Distributions:

Discrete Distributions-Binomial, Poisson and geometric distributions and their properties with applications. (Sections 8.1-8.5 and 8.7 of Chapter8)

Continuous distributions – Gamma, Beta, Cauchy, Normal distributions and their properties with applications

(Sections 9.1, 9.2, 9.5, 9.6,9.7 and 9.12 of chapter 9)**(Two questions are to be set)**

3. Correlation and Regression:

Correlation, Karl pearson's coefficient of correlation, Calculation of correlation coefficient for Bivariant frequency distribution, Spearman's rank correlation coefficient. Linear regression- regression coefficients and their properties, angle between regression lines, standard error of estimate, curvilinear regression.

(Chapter 10 and Chapter 11) **(One question is to be set)**

4. **Sampling Distributions:**

Sampling and Large sample Tests, Exact sampling distributions, χ^2 , t, F distributions and their applications.

(Chapter -14, Chapter 15 up to 15.6.4 and Chapter 16 up to 16.6 except 16.4)

(Two questions are to be set)

TEXT BOOK: Fundamentals of Mathematical Statistics-S.C.Gupta and V.K.Kapoor, 11 edition Sultan Chand and Sons, New Delhi

REFERENCE: An introduction to probability theory and mathematical statistics –

V.K.Rohatgi Wiley Eastern Ltd, New Delhi

12 AM 513: MATHEMATICAL MODELLING

Mathematical Modelling Through Ordinary Differential Equations of First Order:

Mathematical Modelling Through Differential Equations, Linear Growth and Decay Models, Non-Linear Growth and Decay Models, Compartment Models, Mathematical Modelling in Dynamics Through Ordinary Differential Equations of First Order, Mathematical Modelling of Geometrical Problems Through Ordinary Differential Equations of First Order.

Mathematical Modelling Through Systems of Ordinary Differential Equations of the First Order:

Mathematical Modelling in Population Dynamics, Mathematical Modelling of Epidemics Through Systems of Ordinary Differential Equations of First Order, Compartment Models Through Systems of Ordinary Differential Equations, Mathematical Modelling in Economics Through Systems of Ordinary Differential Equations of First Order, Mathematical Models in Medicine, Arms Race, Battles and International Trade in Terms of Systems of Ordinary Differential Equations, Mathematical Modelling in Dynamics Through Systems of Ordinary Differential Equations of First Order.

Mathematical Modelling Through Ordinary Differential Equations of Second Order:

Mathematical Modelling of Planetary Motions, Mathematical Modelling of Circular Motion and Motion of Statellites, Mathematical Modelling Through Linear Differential Equations of Second Order, Miscellaneous Mathematical Models Through Ordinary Differential Equations of the Second Order.

Mathematical Modelling Through Difference Equations:

The Need for Mathematical Modelling Through Difference Equations: Some Simple Models, Basic Theory of Linear Difference Equations with Constant Coefficients, Mathematical Modelling Through Difference Equations in Economics and Finance, Mathematical Modelling Through Difference Equations in Population Dynamics and Genetics, Mathematical Modelling Through Difference Equations in Probability Theory, Miscellaneous Examples of Mathematical Modelling Through Difference Equations.

Mathematical Modeling through Partial Differential Equations:

Situations Giving Rise to Partial Differential Equations Models, Mass-Balance Equations: First Method of Getting PDE Models, Momentum-Balance Equations: The Second Method of Obtaining Partial Differential Equation Models, Variational Principles: Third Method of Obtaining Partial Differential Equation Models, Probability Generating Function, Fourth Method of Obtaining Partial Differential Equation Models, Model for Traffic Flow on a Highway, Nature of Partial Differential Equations, Initial and Boundary Conditions.(Chapters 1 to 6 of Text Book 1)

(Four questions are to be set from the above portion)

Text Books: 1) Mathematical Modelling by J.N.Kapur, Wiley Eastern Ltd.

2) Numerical Solutions of Differential Equations by M.K.Jain, Wiley

Eastern Ltd.

12AM 514: NUMBER THEORY

Infinitude of primes, discussion of the Prime Number Theorem, infinitude of primes in specific arithmetic progressions, Dirichlet's theorem (without proof).

Arithmetic functions, Mobius inversion formula. Structure of units modulo n, Euler's phi functionCongruences, theorems of Fermat and Euler, Wilson's theorem, linear congruences, quadratic residues, law of quadratic reciprocity.

Binary quadratics forms, equivalence, reduction, Fermat's two square theorem, Lagrange's four square theorem. Continued fractions, rational approximations, Liouville's theorem, discussion of Roth's theorem, transcendental numbers, transcendence of "e" and "pi".

Diophantine equations: Brahmagupta's equation (also known as Pell's equation), the Thue equation, Fermat's method of descent, discussion of the Mordell equation.

Optional Topics: Discussion of Waring's problem.Discussion of the Bhargava-Conway "fifteen theorem" for positive definite quadratic forms.The RSA algorithm and public key encryption. Primality testing, discussion of the Agrawal-Kayal-Saxena theorem. Catalan's equation, discussion of the Gelfond-Schneider theorem, discussion of Baker's theorem.

Texts / References

W.W. Adams and L.J. Goldstein, Introduction to the Theory of Numbers, 3rd ed., Wiley Eastern, 1972.

A. Baker, A Concise Introduction to the Theory of Numbers, Cambridge University Press, Cambridge, 1984.

I. Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, 4th Ed., Wiley, New York, 1980.

12 AM 515: OPTIMIZATION TECHNIQUES

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Linear Programming an its Applications: Formulation of L.P. problems, slack and surplus variables, convex sets, simplex method, artificial variables techniques, big M-method, degeneracy, revised simplex method. (Chapter I (expect 1,3),Chapter II, Chapter III, Chapter IV of unit 2 and Appendix – A of Unit-6 of text book 1)

(Two questions are to be set)

Duality in linear programming, the dual simplex method, Integer linear programming, Gomory's cutting plane method, branch and bound method (Chapter V, Chapter VI and Chapter VIII of unit –2 of text book 1)

(Two questions are to be set)

Assignment models, Hungarian method, the traveling salesman problem, transportation models, methods for initial basic feasible solutions, MODI method, degeneracy in transportation problems. (Chapter IX, Chapter X, of unit 2 of text book1)

Dynamic programming, concepts of dynamic programming, Bellman's principle of optimality, simple models (7.1 to 7.9 of Chapter VII of unit 5 of text book 1.)

(Two questions are to be set)

Text book: 1. S.D. Sharma, Operations research, Kedarnath Ramnath & Company.

Reference book: Linear Programming by G. Hadley, Oxford, IBH publishing Co

12AM 519: THEORY OF COMPUTER SCIENCE

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

The Theory of Automata: Definition of an automata, Description of a Finite Automation, Transition Systems, Properties of Transition Functions, Acceptability of a string by a finite Automation, Non Deterministic finite State Machines, The Equivalence of DFA and NDFA, Mealy and Moore models, Minimization of Finite Automaton.

Formal Languages: Basic definitions and examples, Chomsky classification of Languages, Languages and their relation, Recursive and recursively enumerable sets, operations of languages, Languages and Automaton.

(**Three questions are to be set)**

Regular sets and Regular Grammars: regular expressions, Finite Automata and regular expressions, Pumping lemma for Regular sets, Application of Pumping lemma, Closure properties of regular sets, Regular sets and Regular grammars.

Context-free Languages: Context-free languages and derivation trees, Ambiguity in Context-free Grammars, Simplification of Context-free Grammars, Normal forms for Context-free Grammars.

Turing Machines: Turing Machine model, Representation of Turing Machines, Languages Acceptability by Turing Machines, Design of Turing Machines, Universal Turing Machines and other modifications.

(**Three questions are to be set)**

Text book: Theory of Computer Science (Automata, Languages and Computation)

Chapters: 2,3,4,5.1 to 5.4 and 7.1 to7.5 By K.L.P. Mishra,

N. Chandrasekharan, PHI, Second edition

12 AM 520: ADVANCED OPTIMIZATION TECHNIQUE

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Game Theory, Solution of Games with and without saddle points, minimax / maximini principle, principle of Dominance, matrix method for (m X n) Games without saddle point, algebraic method. **(Chapter 1 of Unit 4(except 1.22)**

(One question is to be set)

Inventory, classification inventory models, EOQ models with and without shortages, multi item deterministic models, dynamic demand Models.

(Chapter 2 of unit 4 (2.1 to 2.17))

(One question is to be set)

Replacement Models: Replacement of items that deteriates with time, individual replacement. Group replacement policies, recruitment and production problem. Equipment and renewal problem systems reliability. **(Chapter 4 of unit 4)**

(One question is to be set)

Queuing theory: distribution in queuing systems, poison process. Classification and solutions of Queuing model, models 1-4 **(Chapter 5 of unit 4) (5.1 to 5.15)**

(One question is to be set)

Jog Sequencing: Processing of n-jobs through 2/3/m^{machines} (**Chapter 6 of unit 4)**

(One question is to be set)

Net work analysis, PERT/ CPM Techniques network diagram representation time estimates and critical path in net work analysis, uses of PERT / CPM Techniqu **(Chapter 07 of unit 4)**

(One question is to be set)

Text book: Operations Research by S.D.Sarma (12 th Edition), kedarnath Ramnath and company.

12AM 521: CRYPTOGRAPHY

1. **FOUNDATIONS:** Terminology – Steganography – Substitution ciphers – Transposition ciphers – Simple XOR – one -Time pads.

2. **MATHEMATICAL BACKGROUND:** Information theory – complexity theory– Number theory (Modular Arithmetic, Chinese Remainder Theorem, Quadratic Residues) – Factoring – Discrete Logarithm in a finite field.

3. **PUBLIC-KEY ALGORITHMS:** Background – Knapsack Algorithm – RSA Algorithm – Polig-Hellman – Rabin Algorithm – El-Gamal Public-Key Cryptosystem – Mc Elice Public-key Algorithm.

4. **PUBLIC-KEY DIGITAL SIGNATURE ALGORITHMS:** Digital Signature Algorithm (DSA) – DSA Variants – GOST Digital Signature Algorithm – RSA signature scheme – El-Gamal signature scheme – Schnorr signature scheme.

5. **IDENTIFICATION SCHEMES:** Fiege- faith Shamir identification scheme – Guillou-Quisqater (GQ) Identification scheme – Schnorr identification scheme – Converting identification schemes to signature schemes.

6. **SPECIAL ALGORITHMS FOR PROTOCOLS:** Secret Sharing Algorithms – Undeniable Signatures – Designated Confirmer Signatures – Blind Signatures.

Note: To answer **five** questions in 3 hours duration out of **eight** questions to be set.
(Examination for 100 marks).

Text Book:

1. For serial No. 1 to 5 scope as given in chapters 1,11,19,20,21 in "Applied Cryptography " by Bruce schneier John Wiely & Sons Publications,2e,1996.
(Available at http://www.cse.iitk.ac.in/users/anuag/crypto.pdf)

References:

1. Cryptography & Net work security by William Stallings , Fourth Edition, 2010,

2. A course in Number theory and Cryptography by Neal. Koblitz, Springer-Verlag publications, Newyork, 1994.
3. Cryptography: Theory and Practice, by D.R.Stinson, C.R.C Press, Boca Raton, Florida, Second Edition, 2002.
4. RSA & Public key Cryptography, by Richard A. Mollin, CRC Press, Florida, 2002.
5. Introduction to Cryptography, by Johnnes Buchmann, 2e, Springer-verlag, 2004.
6. "Handbook of Applied Cryptography, by A.J. Menezes, P.C. van Oorschot, and S.A. Vanstone. CRC Press, 1996.

ELECTIVES:

1. **Stochastic Processes**

Stochastic processes: Description and definition. Markov chains with finite and countably infinite state spaces. Classification of states, irreduci-bility, ergodicity. Basic limit theorems.

Markov processes with discrete and continu-ous state spaces. Poisson process, pure birth process, birth and death process. Brownian motion.

Applications to queueing models and relia-bility theory. Basic theory and applications of renewal processes, stationary processes. Branching processes. Markov Renewal and semi-Markov processes, regenerative processes.

Texts / References :

V.N. Bhat, Elements of Applied Stochastic Processes, Wiley, 1972.

V.G. Kulkarni, Modeling and Analysis of Stochastic Systems, Chapman and Hall, London, 1995.

J. Medhi, Stochastic Models in Queueing Theory, Academic Press, 1991.

R. Nelson, Probability, Stochastic Processes, and Queuing Theory: The Mathematics of Computer Performance Modelling, Springer-Verlag, New York, 1995.

S. Ross, Stochastic Processes, 2nd ed., Wiley, New York,1996.

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2. **BOUNDARY VALUE PROBLEMS**

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Elementary Topology on Metric spaces: Mappings on metric spaces, Existence and uniqueness theorem via the principle of contraction. Continuation of solutions, Dependence of solutions on initial conditions and on parameters.

(Chapter 2 of text book l) **(one question is to be set)**

General theory for linear first order system of equations, solution space, The non-homogeneous equation. The nth order linear homogeneous equation, The nth order non-homogeneous equation, The adjoint vector equation, The adjoint nth order equation, The relationship between scalar and vector adjoints. **(Chapter 3 of text book l)**

(one question is to be set)

Linear equation with constant coefficients, Real distinct eigenvalues, The general solution. Direct solutions, Real solutions associated with complex eigenvalues. **(Chapter 4, Section: 4.1, 4.2, 4.3, of text book l)**

The two point boundary value problem: The two point homogeneous boundary value problem, the adjoint boundary value problem, The non-homogeneous boundary value problem and Green's matrix. The nth order boundary value problem, The nth order adjoint boundary value problem, the nth order non-homogeneous boundary value problems and Green's function. Self-adjoint boundary value problem

(Chapter 6 of text book l) **(Two questions are to be set)**

Linear Control System: Controllability, Observability, Controllability and Polynomials, linear feed back, state observers, Relization of constant systems.

(Chapter 4 of text book 2) **(Two questions are to be set)**

Text books:

1. Theory of Ordinary differential equations, Randal H.Cole Appleton-Century-Crafts,

New York (1968)

2. Introduction to Mathematical Control Theory, S.Barnett, R.G.Camarol, Clarendon

Press, 1985.

Reference book: Theory of Ordinary differential equations by E.A. Coddington and Normal Levinson, Tata Mcgraw Hill Inc., New York (1980)

3. RELATIVITY AND COSMOLOGY

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Space-time continuum, the three plus one dimensions of space-time, the geometry corresponding to space-time, the signature of the line element and the three kinds of interval, Lorentz rotation of axes, transformation to proper coordinates. **(Chapter II, Articles 13-18 of Text book 1)**

(One question is to be set)

The mass of a moving particle, the transformation equations for mass, work and kinetic energy, the relations between mass, energy and momentum, Four-dimensional expressions of the mechanics of a particle **(Chapter III , Articles 23-28 of Text book 1)**

(One question is to be set)

The Maxwell-Lorentz Field Equations, The transformation equations for E, H and Q. The force on a moving charge, The energy and momentum of electromagnetic field, electromagnetic stresses, Four dimensional expressions for electron theory(Chapter IV, Articles 39-43 & 46 of Text book 1)

(Two questions are to be set)

Riemann Christoffel Tensor, covariant curvature tensor and its properties, Ricci Tensor, Curvature invariant, Einstein space, Bianchi's identity , Riemannian Curvature, Einstein space, flat space, space of constant curvature, for, Schur's Theorem **(Chapter V of Text book 2)**

(Two questions are to be set)

Text Books:

1. R.C. Tolman, Relativity , Thermodynamics and Cosmology, Clarendon Press, Oxford.
2. Bary Spain, Tensor Calculus-Radha Publishing House, Calcutta

Books for further reference:

3. Introduction to Special Relativity by Robert Resnick, Johnwiley & Sons. New York
4. Theory of Relativity by S.R. Roy and Raj bali Jaipur Publishing House, Jaipur.
5. J.K. Goyal and K.P. Gupta, Theory of Relativity, Krishna Prakasan Media(P) Ltd. Meerut

4. Fluid Dynamics

A total of seven questions are to be set and student has to answer 5(Five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabus.

Two-dimensional flows stream function. The complex potential for two dimensional, irrotational incompressible flow complex velocity potentials for standard two-dimensional flows uniform stream, line source, line sink, line doublets, line vortices. Two-dimensional image system, the Miline-Thomson circle theorem, Applications of circle theorem, Blasius theorem, (Sections 5.1 to 5.9 of chapter 5 of Text book.1)

Some three dimensional flows, source, sinks and doublets, Images in a rigid infinite plane, and in solid sphere. Axi – symmetric flows, stokes stream function, some special forms of the stokes stream function for axi-symmetric irrotational motions.

(Chapter 4 of Text book 1)

(Three questions are to be set from the above topics)

Dynamics of real fluids, Introduction, Navier stokes equations of motions vorticity and circulation in a viscous fluid, exact solutions of N.S. equations unstead of flows.

(Sections 5.1 to 5.3 excluding 5.3.4 of Chapter 5 of the Text book 2)

Boundary layer theory, Introduction, Duration of two dimensional boundary layer equations, Integral equations of the boundary layer, Analytic solutions of the boundary layer equation. Flow parallel to a semi-infinite flat plate. Flow near the stagnation points of cymater.

(Sections 6.1, 6.2 and 6.3.1 and 6.3.2 of chapter 6 of Text book 2)

Text books: 1. Textbook of fluid Dynamics by F.Chorlton, CBS publishers and distributors, New Delhi.

2. Modern Fluid Dynamics Vol. **1**. Incompressible flow by N curl and H.Davis D.Van No strand company Ltd., London.

5. **ADVANCED BOUNDARY VALUE PROBLEMS**

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Stability of linear and weakly non-linear systems, continuous dependence and stability properties of linear, non-linear and weakly non-linear systems. Two dimensional systems. (chapter III of text book-1)
(Two questions are to be set)

Stability by Liapunov second method, Autonomous systems, quadratic forms, Krasovski'sMethod. Construction of Liapunov functions for linear systems with constant coefficients. Selection of total energy

function as a Liapunov Function, Stability based on first approximation (Chapter V of text book-1) **(One question is to be set)**

Mathematical Models in Population Dynamics: Introduction, single species Models, Two species Lotka volterra Models, Multi species Models. (chapter VI of text book-1)

(One question is to be set)

Analysis and Methods of non-linear differential equations, Existence theorem, extremal solutions, upper and lower solutions. Existence via upper and lower solutions, Monotone iterative Method and Method of quasilinearlization, Bihari's inequality, Application of Bihari's integral inequality. Non-linear variation of parameters formula Alekseev's formula. (Chapter VI of text book-2) **(One question is to be set)**

Oscillations of second order equation, sturms comparison theorems Elementary linear Oscillations, comparison theorem of Hille Winter. (Chapter VIII of text book-2)

(One question is to be set)

Text Books:

1. M.Rama Mohan Rao, Ordinary Differential equations, Theory methods and applications, Affiliated East-West Press Pvt.Ltd., New Delhi. (1980).
2. V.Lakshmikantam, S.G.Deo and V.Raghavendra, Text book of ordinary differential equations (second edition) Tata Mc Graw Hill, New Delhi. (1997).

6. ADVANCED RELATIVITY AND COSMOLOGY

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

The Fundamental Principles of General Relativity, Principle of Covariance, Principle of equivalence, Principle of Mach, Gravitational field in empty space, Gravitational field in the presence of matter and energy.

Simple consequences of principle of equivalence, Newton's theory as a first approximation. The Schwarzschild line element, the three crucial tests of Relativity.

(Chapter VI-Articles 72-75& 77-83 of Text book)

(Two questions are to be set)

Line elements for systems with spherical symmetry, static line element with spherical symmetry, schwarzschild exterior and interior solutions, Non-static line elements with spherical symmetry-Birkhoff's theorem. The generalized Lorentz Electron theory the field equations. The gravitational field of a charged particle. **(Chapter VII-Articles 94-99,102 &107 of Text book)**

(Two questions are to be set)

Application of general relativity to cosmology, The three possibilities for a homogeneous static universe, The Einstein line element, the de-sitter line element, Special relativity line element, The geometry of the Einstein universe, Density and pressure of material in Einstein universe. Behaviour of test particles and light rays in

the Einstein universe, Comparison of Einstein model with actual universe. Geometry of the de-sitter universe. Absence of matter and radiation from de-sitter universe Behavior of test particles and light rays in the de-sitter universe.

(Chapter X-Articles 133-144 of Text book)

(Two questions are to be set)

Text Books:

Relativity, Thermodynamics and Cosmology, R.C. Tolman, Clarendon Press, Oxford.

Books for reference:

1. Lectures on General Relativity by T.M, Karade etal, sonu Nilu, 5 Bandu Soni Layout, Gayatri Road, Parsodi, Nagpur-440 023.
2. Theory of Relativity by S.R. Roy and Raj bali, Jaipur Publishing House, Jaipur
3. Theory of Relativity by J.K. Goyal & K.P Gupta, Krishna Prakashan Media (P) Ltd. Meerut.

7. COMPUTATIONAL FLUID DYNAMICS

(A total of seven questions are to be set and the student has to answer 5 (five) questions. All questions carry equal marks. The first question which is compulsory carries 17 marks. It consists of 4 short answer sub questions covering the entire syllabus. The remaining six questions each carrying 17 marks are to be set as suggested in the body of the syllabi.)

Flow of compressible fluids. Thermo dynamics and Physical properties of gases, equation of state, perfect gas, First and second law of thermodynamics entropy, Real gas, One dimensional flow of an inviscid compressible fluid, energy equation, velocity of sound, Mach number one dimensional steady flow in a nozzle, unsteady one dimensional flow, sound wave, Relation ship between pressure and velocity in isentropic flow, one dimensional steady flow with heat addition, formation of shock, Normal and oblique shockwaves in an ideal gas fundamental equations of a compressible inviscid, and non heat conducting fluid, Kelvin's theorem, irrotational motion two dimensional and axially symmetrical steady isentropic irrotational flow, method of small perturbations. Linearized theory, Two and three dimensional steady flows. Flow past an infinite wave shaped wall subsonic two dimensional flow over wall of arbitrary shape, Fourier integral method. (Scope and treatment as in Text book.1)

(Three questions are to be set)

Method of characteristics- applied to supersonic homentropic irrotational gas flow, Flow round a shape convex corner, Prandtl-Meyer expansion

Magneto hydro-dynamics introduction, Maxwell's field equations- medium at rest and in motion (No derivation) equations motion of a conducting fluid magnetic Reynolds number, Alfven's theorem, Magnetic body force. Ferraro's law of isorotation magneto hydro dynamic waves, Alfven waves steady flow of a viscous conducting fluid between parallel wall's in transverse magnetic field

(Three questions are to be set)

(Scope and treatment as in Text book.2.)

Text books:

1. Introduction to the theory of compressible Flow by S-I PAI

Van nostrand Rein hold, East-West press, New Delhi, Student Edition 1970

2. Text Book of Fluid Dynamics by F Charlton, CBS publishers and Distributors

1985, Edition

8. Financial Mathematics

The purpose of this course is to review some key concepts of finance and probability and to discuss a range of mathematical definitions and techniques that set the agenda for the Financial Mathematics MSc as a whole. Also, this course will incorporate an introduction to programming with C++.

This course is composed of two components:

The first component is concerned with the common mathematical background that is assumed by the MSc Financial Mathematics and addresses some aspects of the mathematical theory that is central to the foundations of the programme: a review of sets and set operations, functions and inverse functions is first developed; probability spaces, random variables, distributions, expectations and moment generating functions are then discussed; special emphasis is placed on the binomial, the normal and the log-normal distributions; the concepts of conditional probability and conditional expectation as random variables are introduced using intuitive arguments and simple examples; stochastic processes, martingales, the standard Brownian motion and the Poisson process are introduced; Itô's formula and Girsanov's theorem are discussed on a formal basis.

The second component is an introduction to programming with languages such as C++.

Indicative reading

Lecture notes will be provided for the mathematics component of this module. For the programming elements of the pre-sessional, we will use Derek Capper, Introducing C++ for Scientists, Engineers and Mathematicians, Springer 2001. For those with prior programming experience, a standard reference book on the C++ programming language is Bjarne Stroustrup, The C++ Programming Language, Addison Wesley, 1997.

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9. Modern Control Theory

Content: Will include the study of controllability, stabilization, observability, filtering and optimal control. Furthermore connections between these concepts will also be studied. Both linear and nonlinear systems will be considered. The module will comprise six chapters. The necessary background material in linear algebra, differential equations and probability will be developed as part of the course.

1. Introduction to Key Concepts.
2. Background Material.
3. Controllability.
4. Stabilization.
5. Observability and Filtering.
6. Optimal Control.

Books:

E. D. Sontag, *Mathematical Control Theory*, Texts in Applied Mathematics No 6, Springer Verlag, 1990.

J. Zabczyk, *Mathematical Control Theory: An Introduction*, Systems and Control, Birkhauser, 1992.

10.DYNAMICAL SYSTEMS:

Prerequisites: Linear algebra and differential equations and multivariable calculus

Description: The course will begin with the second part of the textbook, focusing on the iteration of one-dimensional maps and including topics such as fixed points, periodic points, stability, bifurcations, and chaos. Higher dimensional maps or continuous dynamical systems.

Textbook: *An Introduction to Dynamical Systems: Continuous and Discrete* by R. Clark Robinson.

11. ARTIFICIAL INTELLIGENCE

Intelligent Agents – Agents and environments - Good behavior – The nature of environments – structure of agents - Problem Solving - problem solving agents – example problems – searching for solutions – uniformed search strategies - avoiding repeated states – searching with partial information.

Informed search and exploration – Informed search strategies – heuristic function – local search algorithms and optimistic problems – local search in continuous spaces – online search agents and unknown environments - Constraint satisfaction problems (CSP) – Backtracking search and Local search for CSP – Structure of problems - Adversarial Search – Games – Optimal decisions in games – Alpha – Beta Pruning – imperfect real-time decision – games that include an element of chance.

First order logic – representation revisited – Syntax and semantics for first order logic – Using first order logic – Knowledge engineering in first order logic - Inference in First order logic – prepositional versus first order logic – unification and lifting – forward chaining – backward chaining - Resolution - Knowledge representation - Ontological Engineering - Categories and objects – Actions - Simulation and events - Mental events and mental objects.
Learning from observations - forms of learning - Inductive learning - Learning decision trees - Ensemble learning - Knowledge in learning – Logical formulation of learning – Explanation based learning – Learning using relevant information – Inductive logic programming - Statistical learning methods - Learning with complete data - Learning with hidden variable - EM algorithm - Instance based learning - Neural networks - Reinforcement learning – Passive reinforcement learning - Active reinforcement learning - Generalization in reinforcement learning.

TEXT BOOK

1. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 2nd Edition, Pearson Education / Prentice Hall of India, 2004.

REFERENCES

1. Nils J. Nilsson, “Artificial Intelligence: A new Synthesis”, Harcourt Asia Pvt. Ltd., 2000.
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, 2nd Edition, Tata McGraw-Hill, 2003.

3. George F. Luger, “Artificial Intelligence-Structures And Strategies For Complex Problem Solving”, Pearson Education / PHI, 2002.