KARNATAKA STATE OPEN UNIVERSITY

MANASAGANGOTRI, MYSORE- 570 006

REGULATIONS, SCHEME AND SYLLABUS

(Approved by the BOS in its meeting held on 28-04-2010)

M. Sc. MATHEMATICS COURSE

(Semester Scheme)

M.Sc. Mathematics, DEGREE PROGRAMME

In response to the exponentially growing demand for well trained post-graduates in Mathematics from Institutions with professional excellence, the Karnataka State Open University is offering a Two year **semester based** M.Sc. Mathematics Degree Programme (Two Semester per year-Total Four Semester). The Programme is specially designed for Teachers, Engineers, Computer Scientists and others who are interested in Mathematics but could not pursue a Master degree programme in Mathematics for various reasons. The Karnataka State Open University's M.Sc. Mathematics programme is a tightly scheduled, highly structured, and application oriented. Mathematics is as old as mankind and civilization. Mathematics is advancing at spectacular rate and it is about logical analysis, decision making, deductions, precision and is also about quantity, space, change and structure. Mathematics has a pervasive influence on our everyday lives, and contributes to the wealth of the country. The curriculum is framed using time tested and Internationally well-known books and is also based on the feed back from the best programmes available in our country. The curriculum includes different branches of mathematics that have a wide range of practical applications such as Algebra, Analysis, Mathematical Modeling, Computer programming, Mathematical Statistics and Operation Research. The curriculum is so developed that the study of mathematics can satisfy a wide range of interests and abilities. It develops the imagination; it trains in clear and logical thought.

Those who qualify in M.Sc. Mathematics are in the fortunate position of having a wide range of career choices. The abilities to use logical thought, to make deduction from assumption, to use advanced concepts are all enhanced by a Mathematics degree course. It is for this reason that Mathematicians are increasingly in demand. With M.Sc Mathematics degree, one should be able to turn his/her hand to Finance, Statistics, Engineering, Computers, Teaching or Accountancy with a success not possible to other post graduates.

Regulations Governing M. Sc in Mathematics

Course Title : M. Sc in Mathematics

Course Duration: 2 years (4 Semesters)

Medium of Instructions: English

Eligibility Criteria

1. Candidates who have passed B. Sc / B. A / B. Sc.Ed from a recognized University with Mathematics as one of the major subjects.

or

2. Candidates who have passed BE/ B.Tech from a recognized University/ Institution.

Course of Study

1. The M. Sc in Mathematics course shall be in Semester Scheme. Although the duration of the course is two years, the maximum period for completion of the course shall be four years.

2. There shall be five papers in each semester. Each paper shall be of 100 marks. (80 Exam) + 20 (Internal Assessment).

3. There shall be regular counseling, Contact Programmes for the Candidates.

Scheme of Examinations

1. There shall be a University examination at the end of each semester of the course.

2. Minimum marks for passing is 40 marks in each paper (with minimum 32 marks in Examination).

3. In each paper there shall be 8 questions out of which any 5 questions have to be answered – (16x5)- = 80 Marks.

4. Declaration of class shall be as per the KSOU rules and regulations.

Course Structure for M. Sc in Mathematics

I SEMESTER

Paper code	Title of the Paper	Marks			Total Marks	Min for Pass	Credits
		Exam					
		Theory	Min for Pass	I. A Max			
Math 1.1	Algebra	80	32	20	100	40	3
Math 1.2	Real Analysis- I	80	32	20	100	40	3
Math 1.3	Complex Analysis-I	80	32	20	100	40	3
Math 1.4	Discrete Mathematics	80	32	20	100	40	3
Math 1.5	Differential Equations	80	32	20	100	40	3

II SEMESTER

Paper Code	Title of the Paper	Marks			Total Marks	Min for Pass	Credits
		Exam					
		Theory	Min for Pass	I. A Max			
Math 2.1	Linear Algebra	80	32	20	100	40	3
Math 2.2	Real Analysis- II	80	32	20	100	40	3
Math 2.3	Complex Analysis-II	80	32	20	100	40	3
Math 2.4	Numerical Analysis	80	32	20	100	40	3
Math 2.5	Operation Research	80	32	20	100	40	3

III SEMESTER

Paper Code	Title of the Paper	Marks			Total Marks	Min for Pass	Credits
		Exam					
		Theory	Min for Pass	I. A Max			
Math 3.1	Topology	80	32	20	100	40	4
Math 3.2	Measure Theory	80	32	20	100	40	4
Math 3.3	Functional Analysis	80	32	20	100	40	4
Math 3.4	Mathematical Modeling	80	32	20	100	40	4
Math 3.5	Computer Programming	80	32	20	100	40	4

IV SEMESTER

Paper Code	Title of the Paper	Marks			Total Marks	Min for Pass	Credits
		Exam					
		Theory	Min for Pass	I. A Max			
Math 4.1	Number Theory	80	32	20	100	40	4
Math 4.2	Graph Theory and Algorithms	80	32	20	100	40	4
Math 4.3	Fluid Mechanics	80	32	20	100	40	4
Math 4.4	Mathematical Statistics	80	32	20	100	40	4
Math 4.5	Dissertation	80	32	20	100	40	4
	Grand Total				**2000 Marks**		**70 Credits**

Note: Submission of Assignment is compulsory. Assignments should be submitted during the year of admission only. Assignments submitted in subsequent years will not be accepted.

Math 1.1: Algebra

Block I: Group Theory.

1. Groups - Lagrange's Theorem, homomorphisms and isomorphisms;
2. Normal subgroups and factor groups, the Fundamental theorem of homomorphism, two laws of isomorphism, direct product of groups;
3. Permutation groups and Cayley's theorem;
4. Conjugate classes, Sylow theorems.

Block II: Ring Theory.

1. Rings, integral domains and fields, field of quotients;
2. Homomorphisms, ideals and quotient rings, prime and maximal ideals;
3. Factorization, Euclidean domains, principal ideal domains and unique factorization domains;
4. Polynomial rings, roots of polynomials, factorization of polynomials, irreducibility criterion.

Block III: Field Theory.

1. Vector spaces, subspaces, linear dependence and independence, basis and dimension;
2. Field extensions: finite extensions, algebraic and transcendental extensions, separable and inseparable extensions;
3. Normal extensions, Galois extensions, theorem on the primitive element, the Fundamental theorem of Galois theory;
4. Finite fields, perfect and imperfect fields, geometric constructions.

References:

1. N. S. Gopalakrishnan – University Algebra, New Age International, 2nd Ed.
2. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons, 1999.
3. J. B. Fraleigh – A First course in Abstract Algebra, Addison-Wesley,

4. Michael Artin – Algebra, Prentice-Hall of India, New Delhi.
5. J. A. Gallian – Contemporary Abstract Algebra, Narosa Publishing House, 4th Ed.,
6. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.

Math 1.2: Real Analysis – I

Block I: Real number system and topology of the real line.

1. The extended real number system, Euclidean space.
2. Finite, infinite, countable and uncountable sets.
3. Limit points of a set, Open and closed sets.
4. Compact and connected sets.

Block II: Sequences of Real numbers.

1. Convergent and divergent sequences.
2. Algebra of sequences.
3. Monotonic sequences and upper and lower limits.
4. Cauchy sequences.

Block III: Series of Real numbers.

1. Infinite series, series of non-negative terms.
2. Comparison test, Cauchy's root test, D'Alemberts ratio test.
3. Integral test and Kummer's test.
4. Multiplication of series and rearrangements.

References:

1. W. Rudin – Principles of Mathematical Analysis, McGraw-Hill International Editions, Third edition, 1976.
2. T. M. Apostol – Mathematical Analysis, Narosa Publishng House, New Delhi, 2002.

Math 1.3: Complex Analysis – I

Block I: Complex numbers.

1. Arithmetic operations, Conjugation, Absolute value, Inequalities.
2. Geometric addition and multiplication, the binomial equation, the spherical representation.
3. Lines and Circles.
4. Limits and Continuity.

Block II: Analytic functions and power series.

1. Analytic functions, Cauchy – Riemann equations, Harmonic functions, rational functions.
2. Elementary theory of power series, sequences, uniform convergence, Abel's limit theorem.
3. The exponential, logarithmic and trigonometric functions.
4. Topology of the complex plane, Linear transformations, elementary conformal mappings.

Block III: Complex Integration.

1. Line integrals, rectifiable arcs.
2. Cauchy's theorem for a rectangle, Cauchy's theorem in a disc.
3. The index of a point with respect to a closed curve, Cauchy's integral formula, Liouville's theorem, The fundamental theorem of Algebra.
4. Removable singularities, Taylor's theorem, zeros and poles, The maximum principle.

References:

1. L. V. Ahlfors – Complex Analysis, McGraw – Hill, 1979, 3rd Edition.

2. B. C. Palka – An Introduction to Complex Theory, Springer – Verlag, 1991.
3. S. Ponnusamy – Foundations of Complex Analysis, Narosa Publishing House, New Delhi, 1995.

Math 1.4: Discrete Mathematics

Block I: Mathematical Logic.

1. Fundamentals of Logic, Logical inferences
2. Methods of proof, Quantified propositions, Rules of Inference, Normal forms.
3. Mathematical induction and examples.
4. The Principle of inclusion-exclusion, Pigeon-hole principle.

Block II: Counting Methods and Recurrence Relations.

1. Generalized permutations and combinations.
2. Binomial coefficients and combinatorial identities.
3. Recurrence relations, Modeling with recurrence relations with examples of Fibonacci numbers and Tower of Hanoi problem.
4. Divide and Conquer relations with examples, Difference equations and generating functions.

Block III: Relations.

1. Definitions and types of relations
   Representing relations using matrices and digraphs
2. Closures of relations paths in digraphs. Transitive closures.
   Warshall's Algorithm
3. Partial ordering, Totally ordered set, Dual order.
   Hasse diagram, Lexicomorphic ordering
4. Minimal and maximal elements
   Lattices. Some properties of Lattices.

References:

1. C.L.Liu, Elements of Discrete Mathematics, Tata McGraw-Hill, 2000.
2. J.L.Mott, A.Kanal and T.P.Baker, Discrete Mathematics for Computer Scientist and Mathematicians, Prentice Hall of India, 2000.

3. J.P.Tremblay and R.P.Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw Hill, 1975.
4. F.Harary, Graph Theory, Addison Wesley, 1969.

Math 1.5: Differential Equations

Block I: Ordinary Differential Equations.

1. Existence and uniqueness of solution of first and n^{th} order system linear differential equations of n^{th} order – Properties of n^{th} order homogeneous linear differential equations.
2. Fundamental sets of solutions – Wronskian - Adjoint – self - adjoint equations – the n^{th} order nonhomogeneous linear equations.
3. Variation of parameters - zeros of solutions – comparison and separation theorems – Eigenvalue problems – self - adjoint problems- Sturm-Liouville problems.
4. Orthoganality of eigen functions - Eigen function expansion in a series of orthonormal functions - Green's function – examples.

Block II: Solutions to Ordinary Differential Equations.

1. Power series solution - Solution near an ordinary point and a regular singular point.
2. Frobenius method - Hypergeometric equation. Laguerre, Hermite and Chebyshev equations and their polynomial solutions (with standard properties).
3. Linear system of homogeneous and non-homogeneous equations (matrix method)
4. Non-linear equations - Autonomous systems - Phase plane - Critical points – stability - Liapunov direct method - Bifurcation of plane autonomous systems.

Block III: Partial Differential Equations.

1. Basic concepts and definitions of PDE- Domain of Partial Differential Equations, continuous dependence on data (initial conditions, boundary conditions, ill-posed and well posed problems.

2. Linear super position principle, The Cauchy problem of first order PDE, geometrical interpretation- The method of characteristics for semi-linear, quasi-linear and nonlinear partial differential equations of first order PDEs,
3. Complete integrals of special nonlinear equations- Applications to dynamics, discontinuous solution and shockwaves.
4. The method of characteristics, the Cauchy problem of second order PDEs, Classification of second-order linear partial differential equations - Canonical forms for hyperbolic, parabolic and elliptic PDEs.

References:

1. G.F. Simmons, Differential Equations, TMH Edition, New Delhi, 1974.
2. S.L. Ross, Differential equations (3rd edition), John Wiley & Sons, NewYork, 1984.
3. I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, 1957.
4. Shankar Rao, Partial Differential Equations, PHI.

Math 2.1: Linear Algebra

Block I: Vector Spaces, Linear Transformations and Matrices.

1. Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets;
2. Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation, Composition of Linear Transformations and Matrix Multiplication, Invertibility and Isomorphisms, The Change of Coordinate Matrix, The Dual Space;
3. Elementary Matrix Operations and Elementary Matrices, The Rank of a Matrix and Matrix Inverses, Systems of Linear Equations;
4. Properties of Determinants, Cofactor Expansions, Elementary Operations and Cramer's Rule;

Block II: Diagonalization and Inner Product Spaces.

1. Eigenvalues and Eigenvectors, Diagonalizability, Invariant Subspaces and the Cayley-Hamilton Theorem;
2. Inner Products and Norms, The Gram-Schmidt Orthogonalization Process and Orthogonal Complements;
3. The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem;
4. Bilinear and Quadratic Forms;

Block III: Canonical Forms.

1. The Diagonal form, The Triangular form;
2. The Jordan Canonical Form;
3. The Minimal Polynomial;
4. The Rational Canonical Form

References:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI, 2009.
2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.
4. Hoffman and Kunze – Linear Algebra, Prentice-Hall of India, 1978, 2nd Ed.,
5. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand, 1958.
6. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000.

Math 2.2: Real Analysis – II

Block I: Continuity and Differentiation.

1. Limit of a function, Continuity and uniform continuity.
2. Continuity and compactness, continuity and connectedness.
3. Discontinuity and Monotonic functions.
4. The derivative of a function, Mean value theorems, Taylor's theorem, Maxima and minima.

Block II: The Riemann – Steiltje's Integral.

1. Definition, Criterion for Riemann – Steiltje's integrability.
2. The properties and classes of integrable functions.
3. Mean value theorems for integrals, Integration and differentiation.
4. Functions of Bounded variations.

Block III: Sequences and Series of Functions.

1. Pointwise and uniform convergence.
2. Uniform convergence and continuity, uniform convergence and differentiation, uniform convergence and integration.
3. Everywhere continuous but nowhere differentiable functions, Stone – Weierstrass theorem.
4. Power series, the exponential, logarithmic and trigonometric functions.

References:

1. W. Rudin – Principles of Mathematical Analysis, McGraw-Hill International Editions, Third edition, 1976.
2. T. M. Apostol – Mathematical Analysis, Narosa Publishng House, New Delhi, 2002.

Math 2.3: Complex Analysis – II

Block I: The Calculus of Residues and Harmonic functions.

1. The residue theorem, The argument principle.
2. Evaluation of definite integrals.
3. Definition and basic properties of Harmonic functions, The mean value property.
4. Poisson's formula, Schwarz's theorem, The reflection principle.

Block II: Power series expansions and Factorization.

1. The Weierstrass theorem, The Taylor series.
2. The Laurent series, Partial fractions, Mittag – Leffer's theorem.
3. Infinite products. Canonical products.
4. The Gamma and Beta functions, Sterling's formula.

Block III: Entire functions and the Riemann zeta – function.

1. Jensen's formula.
2. Hadamard's theorem.
3. Definition and the properties of the Riemann zeta – function, the product development.
4. Extention of zeta – function to the whole plane, the functional equation, the zeros of the zeta – function.

References:

1. L. V. Ahlfors – Complex Analysis, McGraw – Hill, 1979, 3rd Edition.
2. B. C. Palka – An Introduction to Complex Theory, Springer – Verlag, 1991.
3. S. Ponnusamy – Foundations of Complex Analysis, Narosa Publishing House, New Delhi, 1995.

Math 2.4: Numerical Analysis

Block I: Transcendental and Polynomial Equations.

1. Bisection Method, Iteration Methods, Muller Method, Chebyshev Method, Multipoint Iteration Methods to find roots of the equations.

2. Rate of convergence - Secant Method, Regula – Falsi Method, Newton – Raphson Method, Muller Method, Chebyshev Method,

3. General Iteration Methods - higher order Methods, Acceleration of the convergence, Efficiency of a Method, Methods for Multiple roots, System of nonlinear equations,

4. Polynomial equations - Descartes' Rule of signs, Iterative Methods, Birge-Vieta Method, Bairstow Method, Direct Method..

Block II: Interpolation, Approximation and Differentiation.

1. Lagrange and Newton Interpolations, Finite Difference Operators ,Interpolating Polynomials using finite differences.

2. Hermite Interpolation, Piecewise and Spline Interpolation, Bivariate Interpolation.

3. Approximation - Least Squares Approximation, Uniform Approximation, Rational Approximation.

4. Numerical Differentiation, Optimum Choice of Step – Length, Extrapolation Methods.

Block III: Integration and Ordinary Differential Equations.

1. Numerical Integration -Methods Based on Interpolation and Undetermined Coefficients Composite Integration Methods, Romberg Integration, Double Integration.

2. Difference Equations - Numerical Methods, Singlestep Methods, Stability Analysis of Single step Methods, Multistep Methods.

3. Predictor – Corrector Methods, Stability Analysis of Multistep Methods, Stiff System.

4. Initial Value Problem Method - Linear Second Order Differential Equations, Non- Linear Second Order Differential Equations, Finite Difference Methods.

References:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical methods for scientific and engineering computation, New age international Publishers 2008, Fifth Edition.
2. C . F. Gerald, and P. O. Wheatly, Applied Numerical methods, Low – Priced edition, Pearson Education Asia 2002, Sixth Edition.
3. S . S. Sastry, Introductory Methods of Numerical Analysis, Prentice – hall of India 2008, Fourth Edition.
4. Kendall Atkinson and Weimin Han, Elementry Numerical Analysis, Wiley Student Edition, 2009, Third Edition.

Math 2.5: Operation Research

Block I: Linear programming.

1. Introduction
2. Concept of linear programming model: product mix problem, assumption in linear programming, properties of linear programming solution.
3. Formulation of L.P.P : Graphical method, simplex method, Big-M method, dual simplex method, two phase method.
4. Concept of duality: Formulation of dual problems, application of duality.

Block II: Transportation problem and Assignment problem.

1. Introduction
2. Mathematical model for transportation problem, types of transportation problem-balance and unbalanced transportation problem.
3. Method to solve transportation problem- finding the initial basic solution, optimizing basic feasible solution applying U-V method, transshipment model.
4. Assignment problem-zero one programming model for assignment problem, Hungerian method, branch and bound technique for assignment problem.

Block III: Game theory and Queuing theory.

1. Game theory- Game with pure strategies, game with mixed strategies.
2. Graphical method for 2Xn or mX2 games, solution by linear programming for game theory.
3. Queuing theory-Pure Birth and Death model ,specialized Poisson queues
4. Concept of queues, Kendall's notation ,m/m/1 ,m/m/s queues and their variants.

References:

1. H.A. Taha, Operation Research, an introduction, Prentice Hall of India, 2002
2. F.S. Hiller and G.J. Liebermann, Introduction to Operations Research, McGraw Hill, 1995
3. S.D. Sharma, Operation Research, Kedar Nath Ram Nath Meerut-U.P.
4. R. Panneerselvam, Operations Research, Prentice Hall of India(PHI), 2008

Math 3.1: Topology

Block I: Topological spaces.

1. Topological spaces, basis for a topology, the order topology, the product topology, the subspace topology.
2. Closed sets, limit points, Hausdorff spaces.
3. Continuous functions.
4. The metric topology.

Block II: Connected and Compact spaces.

1. Connected spaces, connected sets on the real line, path connectedness.
2. Components, Path components, local connectedness.
3. Compact spaces, compact sets on the real line.
4. Limit point compactness, local compactness.

Block III: Countability and Separation axioms.

1. First and second countability axioms, Lindelof spaces and separable spaces.
2. Regular and Normal spaces.
3. Urysohn's lemma.
4. Tietze's extention theorem, Urysohn's metrization theorem.

Block IV: Compact and Paracompact spaces.

1. Partitions of unity, Tychonoff theorem.
2. Local finiteness.
3. Paracompactness.
4. Normality of paracompact spaces, Stones theorem.

References:

1. James R. Munkres – A first course in topology, Prentice Hall, India, 2000, 2nd Edition.
2. J. L. Kelley – General Topology, Van Nostrand and Reinfhold Co., New York, 1955.

Math 3.2: Measure Theory

Block I: Lebesgue Measure.

1. Algebra of sets, σ – algebra and Borel sets.
2. Outer measure and measurable sets.
3. Lebesgue measure, nonmeasurable sets.
4. Measurable functions, Littlewood's three principles.

Block II: The Lebesgue Integral.

1. The Riemann integral.
2. The Lebesgue integral of a bounded function over a set of finite measure, bounded convergence theorem.
3. The integral of a nonnegative function, Fatou's lemma, Monotone convergence theorem.
4. The general Lebesgue integral, Lebesgue convergence theorem.

Block III: Differentiation and Integration.

1. Differentiation of monotone functions, Vitali lemma.
2. Functions of bounded variations.
3. Differentiation of an integral.
4. Absolute continuity.

Block IV: General Measure and Integration theory.

1. Measure spaces, Finite measure, σ – finite measure, Complete measure, Measurable functions.
2. Integration, Fatou's lemma, Monotone convergence theorem, Lebesgue convergence theorem.
3. Signed measures, Hahn decomposition theorem, The Radon – Nikodym theorem.
4. Measure and outer measure and measurability, the product measures.

References:

1. H. L. Royden – Real Analysis, Prentice Hall of India, 2001, 3rd Edition.
2. P. R. Halmos – Measure Theory, Springer – Verlag, 1974.
3. G. de Barra – Measure Theory and Integration, Wiley Eastern Limited.

Math 3.3: Functional Analysis

Block I: Metric spaces.

1. Metric spaces, Completeness.
2. Banach contraction mapping theorem and applications.
3. Baire's category theorem
4. Ascoli-Arzela theorem.

Block II: Linear space.

1 Linear spaces, Linear operator
2 Normed spaces, F-Riesz lemma,.
3 Hahn-Banach extension theorem
4 Stone-Weierstrass theorem

Block III: Banach space.

1 Banach spaces, Quotient and subspaces of a Banach spaces
2 Continuous linear transformations, The Hahn- Banach theorem
3 The open mapping theorem, Closed graph theorem
4 Uniform bounded principle, the Banach-Steinhous theorem

Block 1V: Hilbert space.

1 Hilbert spaces, Properties of Hilbert spaces
2 Orthogonality and orthogonal complements,
3 The conjugate space H*, Riesz representation
4 Adjoint of an operator, Self adjoint operator.

References:

1 G.F.Simmons- Introduction to Topology and Modern Analysis, Tata McGraw-Hill, New Delhi.

2 B.V.Limaye- Functional Analysis, New AGE International Publishers, 2008. II edition

3 J.B.Conway- A Coures in Functional Analysis, GTM Vol 96, Springer,1985.

4 C.Goffman and G.Pedrick- A First course in Functional Analysis, Prentice Hall of India, New Delhi,1987.

Math 3.4: Mathematical Modeling

Block I: Concept of Mathematical Modeling, Modeling through Ordinary Differential Equations.

1. Need, Techniques, Classifications of Mathematical Models, Characteristics of Mathematical Models.
2. Limitations of Mathematical Modeling.
3. Setting up of first order differential equations, Qualitative solution and sketching for first order differential equations.
4. Linear and Non-linear growth and Decay models, Compartment models, Mathematical Modeling of Geometrical Problems through ordinary differential equations of first order, Spread of Technological innovations.

Block II: Study of models through higher orders.

1. Higher order linear models, spring and dashpot systems, electrical circuit equation,
2. Model for detection of diabetes, Mixing processes, Non-linear system of equations,
3. Combat models, Predator-prey equation, qualitative theory of differential equation.
4. Mathematical modeling of Planetary motions, circular motion and motion of satellites.

Block III: Modeling through partial differential equations.

1. Situations giving rise to partial differential equations models, Mass-Balance equations, Momentum –Balance equations.

2. Variational principles, Probability generating function, Model for traffic flow on a highway.
3. Model for Flood waves in rivers, model for glacier flow, model for roil waves.
4. Convection diffusion processes – Burger's equation, Convection reaction processes – Fisher's equation.

Block IV: Air pollution.

1. Background for environment pollution - History and origin, Atmospheric composition,
2. Sources of air pollution, primary and secondary air pollutant, effects of air pollution.
3. Mathematical Principles of air pollution using gradient diffusion model, conservation of mass, momentum and species/turbulent flow in the atmosphere.
4. Mixture of SPM and atmospheric fluid, Dispersion of SPM.

References:

1. A.C. Fowler, Mathematical Models in Applies Sciences, Cambridge University Press, 1997.
2. Neil Gerschenfeld, The nature of Mathematical Modeling, Cambridge University Press, 1999.
3. J.N. Kapur, Mathematical Modeling, New Age International Publishers, 1998.

Math 3.5: Computer Programming

Block I: Introduction to Computers.

1. Evaluation of computers. Generation of computers. Classification of computers. Basic concepts of Hardware and Software.
2. Classification of software. Evolution of programming languages and operating systems.
3. Program analysis, Algorithm development, Flowchart, Decision tables. Pseudocode.
4. Parallel computers and network.

Block II: C-Programming.

1. Concepts, style, conversations and syntax. History of C.
2. Data types. Identifiers. Keywords. Size and storage allocation. Variable. Constant. Storage classes.
3. Operators -- Arithmetic, Logical, Bit, Increment and Decrement operators, ternary operator. Precedence. Character Input and output.
4. Control of flow of relations operators. If statement. Nested ifs. Switch statement. Control structure – The for loop. The while loop. Do while loops, comma operator. Breaking out of loops.

Block III: Arrays and Functions.

1. Array – notation. declaration and initialization, processing with arrays. Character array. Searching -- linear and binary.
2. Multidimensional array, Sorting- Bubble sort, selection sort & Quick sort Function.
3. Return statement. Arguments, local and global variables. Preprocessors. Header files. Standard functions. Recursive functions.
4. Pointers – Pointers declaration – Pointer arithmetic – Pointers and functions (call by value and call by reference) – Pointers and array

Block IV: Application of C-programming to Numerical methods.

1. Algorithms and C-programs – (i) Input a real number x. To find the sum of first 10 terms of the sine series. (ii) To find whether the entered number is prime number. (iii) To input two matrices A and B and display A, B, A+B, A*B. (iv) to find the factorial of a number.
2. Algorithms and C-programs – (v) Program for Fixed point iterative method. (vi) Bisection method (vii) Secant method (viii) Newton Raphson method.
3. Algorithms and C-programs -- (ix) Gauss elimination method (x) Gauss-Seidel method.
4. Algorithms and C-programs – (xi) Trapezoidal, Simpson's 1/3 and 3/8. Weddles rule (xii) Runge-Kutta 2^{nd} and 4^{th} order methods.

References:

1. Sanders. G. B., Computer Today, 1982.
2. Rajaraman. V, Fundamentals of Computers, PHI, 1984.
3. Byron S. Gottfried, C-Programming, Schaum Series, 1988.
4. Yeshavant P. Kanitkar, Let us C, 8^{th} Edition.

Math 4.1: Number Theory

Block I: Primes and their distribution, Fermat's theorem.

1. The fundamental theorem of Arithmetic, the Euclid's theorem.
2. The prime number theorem, the Goldbach conjecture.
3. Fermat's factorization method, the Fermat's little theorem.
4. Euler's theorem and Wilson's theorem.

Block II: Number theoretic functions and their applications.

1. The multiplicative functions, The functions τ and σ, the Möbius function, Möbius inversion formula.
2. The greatest integer function, Euler's φ – function and its properties.
3. Applications to cryptography.
4. The Dirichlet product of arithmetical functions, averages of arithmetical functions.

Block III: Primitive roots and the quadratic reciprocity law.

1. The order of an integer modulo n, primitive roots for primes.
2. Composite numbers having primitive roots, the theory of indices.
3. The Euler's criterion, the Legendre symbol and its properties.
4. Quadratic reciprocity law, Quadratic congruences with composite moduli.

Block IV: Representation of integers, Fibonacci numbers and Continued fractions.

1. Sums of two squares, sums more than two squares.
2. The Fibonacci sequences, identities involving Fibonacci numbers.
3. Finite continued fractions, convergent of a continued fraction, simple continued fractions.
4. Infinite continued fractions, periodic continued fractions, Pell's equation.

References:

1. David M. Burton – Elementary number theorem, Universal Book Stall, 1999, 2nd Edition.
2. G. H. Hardy and E. M. Wright – An Introduction to the Theory of Numbers, Oxford University Press, 1979, 5th Edition.
3. T. M. Apostol – Introduction to Analytic number theory, Narosa Publishing House, New Delhi.

Math 4.2: Graph Theory and Algorithms

Block I: BASICS

1. Graphs. degree of vertex, sub graphs, varieties of graphs.
2. Walk and connectedness, isomorphic graphs, complements, self-complementary graphs.
3. Distance, eccentricity, radius and diameter.
4. Operations on graphs, the adjacency matrix and incidency matrix

Block II: TREES AND CONNECTIVITY

1. Bipartite graphs, Characterizations of bipartite graphs.
2. Trees, spanning trees with some properties.
3. Cut vertices and bridges with some properties.
4. Connectivity, edge connectivity, Menger's theorem.

Block III: ALGORITHMS

1. Algorithms, Introduction to Algorithms, Breadth-first Search Algorithm
2. Dijkstra's algorithm
3. Prim's Algorithm
4. Kruskal's Algorithm

Block IV: PARTITIONS

1. Degree sequences, Graphical sequences
2. Havel and Hakimi Theorem
3. Erdos and Gallai theorem
4. Algorithm for construction of a graph

References:

1. J.A.Bondy and U.S.R. Murthy, Graph Theory with applications, Macmillan Co.1976.
2. D.B.West, Introduction to Graph Theory, Prentice Hall of India, 2001.
3. F.Harary, Graph Theory, Addison-Wesley Reading Mass, 1969.
4. G.Chartrand and L.Lesniak, Graphs and Digraphs, 2nd edition., Wordsworth, Inc.Belmont, California 1986.

Math 4.3: Fluid Mechanics

Block I: VISCOUS FLUID DYNAMICS.

1. Basic concepts: Fluid, Continuum hypothesis. Viscosity, General motion of a fluid element,
2. Rate of Strain quadric, stress at a point, Symmetry of stress matrix, Stress quadric, stress in a fluid at rest, stress in a fluid in motion,
3. Relation between stress and strain components (Stokes law of friction)
4. Thermal conductivity, Generalised law of heat conduction.

Block II: FUNDAMENTAL EQUATIONS OF THE FLOW OF VISCOUS FLUIDS.

1. Introduction, Equation of state, Equation of continuity: conservation of mass,
2. Equation of motion: conservation of momentum,
3. Equation of energy: conservation of energy,
4. Vorticity and circulation in a viscous incompressible fluid motion: (a) Vorticity transport equation (b) circulation.

Block III: DYNAMICAL SIMILARITY AND INSPECTION AND DIMENSIONAL ANALYSIS.

1. Introduction: dynamical similarity (Reynolds Law),
2. Inspection analysis, dimensional analysis, Buckingham pai-theorem,
3. Physical importance of non-dimensional parameters,
4. Important non-dimensional co efficient in the dynamics of viscous fluids.

Block IV: EXACT SOLUTIONS OF THE NAVIER STOKES EQUATIONS.

1. Introduction: Flow between parallel plates: velocity and Temperature distribution,
2. Flow in a circular pipe: velocity and Temperature distribution. Flow in a circular pipe: velocity and Temperature distribution.

3. Flow between two concentric rotating cylinders: velocity and Temperature distribution.
4. Flow due to a rotating disc: steady incompressible flow with variable viscosity, variable viscosity in plane coutte flow, variable viscosity in plane poiseuille flow.

References:

1. F. M. White: Viscous fluid flow Mcgraw Hill Series in Mechanical Engineering,3rd Edition, 2005.:
2. H. Schlichting: Boundary layer theory, Springer 8th Edition, 2000.
3. J.L.Bansal: viscous fluid Dynamics, Oxford Publishing Co.Pvt.Ltd., New Delhi, 1995.

Math 4.4: Mathematical Statistics

Block I: Probability, Conditional Probability and Moments.

1. Sample space, class of events; Classical and Axiomatic definitions of Probability, their consequences.
2. Conditional Probability, Independence, Bayes' theorem and applications.
3. Random Variables, Distributions Functions, Probability Mass functions, Probability Density functions.
4. Expectations, Moment generating function, Probability generating function, Chebyshev's and Jensen's inequalities and applications.

Block II: Distributions.

1. Standard discrete distributions and their properties – Bernoulli, Binomial, Geometric, Negative Binomial, Poisson.
2. Standard continuous distributions and their properties – Uniform, Exponential, Normal, Beta, Gamma.
3. Functions of random variables – transformation technique and applications,
4. Sampling distributions – t, Chi-square, F and their properties.

Block III: Convergence of Random Sequences and Statistical Inference.

1. Sequences of random variables – convergence in distribution and in probability, Chebyshev's Weak law of large numbers.
2. Central limit theorem (statement only) and applications.
3. Point estimation – sufficiency, unbiasedness, method of moments, maximum likelihood estimation.
4. Testing of hypotheses – Basic concepts, Neyman-Pearson lemma (statement only), UMP test.

Block IV: Statistical Tests and Anova.

1. Likelihood ratio tests, t, Chi-square, F tests and their applications.
2. Nonparametric tests and their applications – Sign, Run, Wilcoxon.
3. Confidence Intervals - for population mean based on small and large samples, for difference of means.
4. One way Anova, Simple Linear Regression.

References:

1. Dudewiscz and Mishra, S.N. – Modern Mathematical Statistics, John Wiley.
2. Freund, J.F. - Mathematical Statistics, Prentice Hall of India.
3. Hogg, R.V. And Craig, A.T. - Introduction to Mathematical Statistics, McMillan and Co.
4. Mukhopadhyaya, P. – Modern Mathematical Statistics.
5. Rohatgi, V.K. And Saleh, A.K. - An Introduction to Probability and Statistics, John Wiley.

Math 4.5: Dissertation

ಆದೇಶ ಸಂಖ್ಯೆ : ಕರಾಮುವಿ/ಸಿಪಾವಿ /2-1311/2010-2011 ದಿನಾಂಕ : 21-10-2010
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