DIRECTORATE OF DISTANCE EDUCATION

SYLLABUS

M.Sc. Course in Mathematics

VIDYASAGAR UNIVERSITY
MIDNAPORE - 721102

M.Sc. Syllabus in Applied Mathematics and Occanology and Computer Programming

VIDYASAGAR UNIVERSITY

M.Sc. Part - I

M.Sc.Part - I Course : 500 marks

First Paper:	Group- A	Real Analysis (40 marks)
	Group- B:	Functions of Complex Variables (30 marks)
	Group- C:	Ordinary Differentail Equations (30 marks)
Second Paper:	Group- A:	Algebra (50 marks)
	Group - B:	Functional Analysis (50 marks)
Third Paper:	Group - A:	Probability and Statistics (30 marks)
	Group- B:	Numerical Analysis (40 marks)
	Group- C:	Introduction to computing (30 marks)
Fourth Paper:	Group- A:	Prindciple of Mechanics (50 marks)
	Group-B :	Partial Differential Equation (50 marks)
Fifth Paper:	Group- A:	Mechanics of Continuous Media (50 marks)
	Group- B:	Practical (50 marks)

M.Sc Part - II Course : 500 marks.

Sixth Paper:	Group A:	Computer Science II (50 marks).
	Group B:	Computer Science. Parctical (50 marks)
Seventh Paper:	Group A :	Electromagnetic Theory (25 marks)

Group B: Any one of the following subjections: Gas dynamics Quantum Mechanics, Fuzzy sets and its application in R.Computer

Science - III, wave dynamics,

Conspectional.....Applicant Statistics

(25 marks each.)

Group C: Flecid Mechanics (30 marks)

Group D: Magneto hydro-dynamics(20 marks)

Eighth paper : Group A: Mathematical Method (50 marks)

Group B: Elements of Optimization and O.R(50 marks) for students with or as special paper/Dynamical Oceanography and Meterology (50 marks) for students with or as special paper.

Ninth and Tenth Paper: (100 marks each): Any one of the following of subjects:

(a) Operations Reserach: (OR)

Ninth paper - Advance optimization and O.R.- I

Tenth Paper- Advance oplimization and O.R - II

(b) Oceanography and Meterology : (OM)

Ninth Paper - Dynamical Oceanography

Tenth Paper - Group A: Dynamical Meterology (75 marks)

Group B: Dynamical Meterology Practical (25 marks)

Subjects to be offered in any particular year will be decided by the department .

(VIII) Group - A: 50

Group - B: OR (50)

OM (50)

(IX) OR & OM

(100) (100)

(X) OR & OM

(100) (75)

M.Sc. Syllabus in Applied Mathematics with Oceanology and Computer Programming

Vidyasagar University

PAPER - 1

Group - A

Real Analysis **(Marks - 40)**

1. Functions of bounded variation & its simple properties. Total variation & its additive property. Variation function & its properties. Necessary & sufficient conditions for a function to be bounded variation.

2. Riemann stieltjes intedgrals: Definition as limit of a sum. Its properties. R-S integrals with monotonic integrators. First and second mean value theorems. R-S integrals with function of bounded variation as integrator. Reduction of R-S integrals to a Riemann integral. R-S integral with step function as integrator. Euler's summation formula. Differentiation under the integral sign. Multiple integral. Interchanging the order of integration.

3. Measurable sets. Concept of Lebesgue measure. Inner & outer measure Its simple properties. Set of measure zero. Cantor set. N.P Measurable function: Definition. Modulus of measurable function is measurable. Every continuous function is measurable. Sum, difference, product and quotient of measurable functions are measurable. Statements of Lusin and Egoroff's theorems. Lebesgue integral: Definition. Basic simple properties Relation between Lebesgue integral and Riemann integral. Lebsegue integral of a bounded function over a set A of finite measure. Simple properties. Lebesgue integral for unbounded functions: Bounded convergence theorem for a sequence of functions. Fatou's lemma. Classical Lebesgue.

GROUP - B

(PAPER - 1)

Functions of Complex Variables

(Marks - 30)

1. Complex numbers. The complex plane. Functions of a complex variable Limit. Continuity. Differentiability. The definition of an analytic function. Cauchy-Riemann differential equation. Construction of analytic function.

2. Complex integration. Jordan arc, Contour. Rectifiable arcs. The absolute value of a complex integral. Cauchy's theorem. Cauchy's integral formula. The derivatives of an analytic function. Cauchy's inequalities. Morera's theorem. Liouville's theorem. Taylor's and Laurent's series. Maximum modulus principle.

3. Singularities: Zero of an analytic function. Different types of singularties. Poles. Isolated, Removal and Essential singularities.

4. Residues: Residue at pole. Residue at infinity. Cauchy residue theorem. Number of poles and zeros of an analytic function. Rouche's theorem.

5. Contour integration: Evaluation of integrals using contour integration.

6. Conformal representation: Conformal transformation. Mobius transformation or Bilinear transformation. Mapping properties of important functions.

GROUP - C (PAPER - 1)

Ordinary Differential Equations

(Marks - 30)

1. Differential equation. Homogeneous linear differential equations. Fundamental system of integrals. Singularity of a linear differential equation. Solution in the neighbourhood of a singularity. Regular

integral, Equation of Fuchsian.

2. Hypergeometric equations. Hypergeometric functions. Series solution near zero. one and infinity. Integral formula for the hypergeometric function. Differentiation of hypergeometric function. The confluent hypergeometric function. Integral represention of the confluent hypergeometric function.

3. Legendre equation: Legerdre functions. Generating function. Legendre functions of the first kind and second kinds. Laplace integral. Orthogonal properties of Legendre polynomials. Rodrigue's formula. Schlaefli's integral.

4. Bessel equation: Bessel function. Series solution of Bessel equation. Contour integral solutions. Integrals representations of Bessel functions. Hankel functions. Recurrence relations. Asymptotic expansion of Bessel functions.

PAPER - II

GROUP - A

Algebra

(50- Marks)

Groups. Morphism of groups Quotient groups. Fundamental theorem on homorphism of groups. Isomorphism theorems. Automorphism. Solvable groups and theorems on them. Direct product. Conjugacy, Conjugate classes. Class equation. Theorems on finite groups-Cauchy's theorem. Sylow's theorem

Rings. Integral domian. Fields. Skew fields. Quotient rings. Morphism of rings. Ideals (Prime and maxiaml). Isomorphism theorem. Euclidean domain. Principal Ideal domain. Unique Factorisation domain. Polynomial Rings.

Partially and totally ordered set. Lattice. Complete Lattice.

Distributive Lattice. Complements.

Elements of Graph Theory. Eularian and Hamiltonian Graphs. Trees. Planar Graphs. Distance and Centre. Duals. cut sets and cut vertices. Bipartite Graphs. Colouring and matching. four colour theorem (statement only). Directed Graphs and weighted Graphs. Matrix representation of graphs. Important algorithms Shortest spanning. treeprime's algorithm. Shortest path problem. Dijkstra's algorithm.

Group - B (Paper - II)

Functional Analysis

(50-Marks)

Metric space. Open and closed sets. Convergence limits. Cauchy-sequence. Complete metric spaces. The Bolzano-Weirstrass theorem. The Cantor Intersection theorem. The Heine-Borel covering theorem. Completion of metric space. Nested sphere theorem. Barie's theorem. Compact metric spaces. Total boundedness, Equi-continuous family of functions. Arzela's theorem. Contraction mapping. Banach fixed point theorem. Its application to find solution of a system of algebraic linear, differential and integral equation. Definition of topological spaces. Hausdorffspace Seperable space. Example of separable and non separable space.

Linear metric space, Examples. Normed linear spaces. Examples. Norm is continuous operator. ANLS is complete if every absolutely convergent series is convergent.

Bounded linear transformation. Set of all bounded linear transformation B(X,Y) from NLS X into NLS. Y is a NLSB. (X,Y) is a Banach space if Y is a Banch space. Statement of Hahn-Banach theorem. Theorems obtained as application of Hahn-Banach theorem. Open mapping theorem. Closed Graph Theorem. Banach Steinhaus

theorem.

Inner product space and Hilbert space. projection theorem. Cauchy-schwarz inequality. Inner product is a continuous operator. Relation between IPS and NLS. Definition of uniformuly convex space. Every IPS is uniformly convex. Pythogorian theorem for n vectors. Gram-schmidt orthogonalisation process. Bessels inequality. Parseval's identity. Reisz representation theorem for bounded linear functional on a Hibert space. Definition of adjoint operator. Simple theorems. Definition of Normal. Unitary and positive operators. Related simple theorems.

PAPER - III

GROUP - A

Probability and Statistics

(Marks - 30)

Stochastic Process:

Markov chains with finite and countable state space. Classification of states. Limiting behaviour of n state transition probabilities.

Stationary distribution. Branching process. nodonwalk. Gambler's ruin.

Markov processes in continuous time. Poisson's process. Partial correlation. Multiple correlation. Advanced theory of Linear Estimation.

GROUP - B

Numerical Analysis

Error propagation in a finite difference table. Symbolic operations and their relations. Central difference formulae of Stirling, Bessel and Everett. Inverse interpolation, Cubic spline interpolation. Numerical differentiation Numerical integration by Simpson 3/ 8

rule, Rombergrule, Gauss - Legendre, and Gauss - Tchebyshev quadrature. Techebyshev polynomials, Minimax property. Curve fitting by least squares. Use of orthogonal polynomial. Solution of system of equations: Direct and iterative methods, Newton - Raphson method of solving a system of non-linear algebraic equations and criterion of convergence, Convergence and rate of convergence of iterative schemes. Matrix iteration. Eigen-value problem. Power method. Jacobi's method. Jacobi-seidel method.

Ordinary Differential Equations:-

Runge _ kutta methods. Predictor corrector method with error term. stability. Solution of boundary value problem for linear second order equations.

Finite difference scheme for the linear equations with first order partial derivatives. Mixed problem for the heat equation. The wave equation. Finite element method and its illustration by a simple example.

GROUP - C
(PAPER III)
Introducing to Computing

(30 marks)

Prerequisite/Recapitualation: Different number system - Decimal, Binary, Octal, Hexa-decimal number. Decimal to Binary, Octal, Hexa-decidml and Binary to Decidml, Octal, Hexa-decimal Conversion. Addition and subtraction of binary numbers. Postulates of Boolean Algebra. Basic theorems. Boolean Functions and truth tables. Canonical Forms of Boolean functions. Algorithm and Fow-chart.

(a) Computer Fundamentals: Bit, Byte Nibble, Basic structure of computer - I/O Unit, ALU, CU, Memory Unit. Peripheral devices.

Different types of I/O unite. Line Printer. Dot Matrix Printer. Desk-Jet Laser. Floopy-disk. CTD. Winchester Disk. Memory Devices-ROM & RAM.

(b) Digital Technique:

(i) Data representation: Binary Coded Decimal Numbers. Hamming Code for Error correction. Alphanumderic Codes.

(ii) Arithmetic Operation: Complement representation of Numbers. Addition /Subtraction in One's and Two's complement Notation. Binary Multiplication Multiplication of signed numbers. Binary Division. Arithmetic with BCD numbers. Floating point Representation of Numbers. Floating point Addition/Subtraction.

(iii) Algebra for Digital System: Logic gates. Simplifying Boolean expressions by Veitch Karnaugh Map method.

(iv) Combinatorial circuit design procedure and implementation by Binary operators and logic gates.

(c) Programming in C: Introduction, Basic structures. Character set. Keywords. Identifiers. Constants Variable-type declaration Execution of some sample C programes. Operation: Arithmetic Relational. Logical and assignment. Increment and decrement. Conditional.

Operator precedence and associativity. Arithmetic expression. Evaluation and type conversion. Character reading and writing. Formated input and output. Decision making (branching and looping) Simple and nested IF; IF - ELSE: WHILE - DO; FOR, Arrays one and two dimension. String handling with arrays-reading and writing; Concatenation: Comparision: String handling functions, User defined funcdtions-need; simple examples; call-by-value and call-by-reference function & their uses; Return values and their types: Nesting of functions; Recursion.

Pointers-Declaration and initialisation. Accessing variables through pointer arithmetic. Pointers and arrays. Strings. Functions and structures.

PAPER - IV

GROUP - A

PRINCIPLES OF MECHANICS

(Marks - 50)

System of particles

System of particles:-

Linear momentum. Angular momentum. Conservative forces. Conservation of Linear momentum. Angular momentum and total energy. Virial theorem.

Orientation and displacement of rigid body. Angular velocity. Eulerain angles, Infinitesimal rotations. Coriolis acceleration. Moving axes. Motion relative to roating Earth. A breif review of orbital mechanics with special reference to satellite mechanics. Faucault's pendulum. Inertial tensor and moment of inertia. Angular momentum and Kinetic energy. Euler's dynamical equations and torque free motion of rigid body about a fixed point on it.

Generalized co-ordinates. Constraints. Holonomic and nonholonomic system. Principle of virtual work. D'Alembert's principle. Lagrange's equations for holonomic (conservative and non-conservative forces) and non-holonomic system. Generalized momenta Cyclic co-ordinates. Routh's procedure. Hamilton's cannonical equations. Motions of a symetrical top with one point fixed.

Variational principle. Brachistocrone problem. Hamilton's principle. Principle of least action. Deduction of Lagrange and Hamilton equation from Hamilton's principle. Legendre transformation. Canonical transformation. Hamilton-Jacobi equation for Hamilton's

principle function. Solution of harmonic oscillator problem by Hamilton-Jacobi method. Liouville's theorem. Poisson brackets.

Small oscillation about equilibriudm. Lagrange's method. Normal co-ordinates. Oscillations under constraint. Stationary character of a normal mode. Small osicllation about the state of steady motion Vibration of strings.

Special theory of relativity in Classical mechanics

Special theory of relativity in classical Mechanics:-

Postulates of special theory of relativity. Lorentz transformation. Force and energy equations in relativistic mechanics. Instead of deducing from usual D Alembert's principle the following approach may be followed.

First order autonomous system-basic theory, rotation, natural boundaries, simple examples.

Second order autonomous systems-Systems of ordern, tied points equilibrium & stability, sepration of variables.

Hamiltonian systems, generalized co-ordinate conservation Linear conservative systems, standard examples (the cubic potential the general potential etc) Lagrangians. etc.

GROUP - B (PAPER -IV)

Partial Differential Equation

(Marks - 50)

Partial Differential Equation

The existence theorem of Cauchy an Kowaleswsky. Methods of solving first order linear and non-linear equations and higher order linear equations with constant coefficients.

Equations of second order:

Reduction to canonical forms of linear and quasi-linear

equations of second order in two independent variables and classification of equations, characteristics curves. Adjoint equation. Self-adjoint equations, canonical forms and classification of second order linear equations in many independent variables.

Linear partial differential equations with constant coefficients: Green's Function construction with the help of delta function.

Hyperbolic equations:

The equation of vibration of a string. Formulation of the mixed initial and boundary value problem. Existence, uniqueness and continuous dependence of the solution on the initial conditions. D'Alembert's formula for the vibration of an infinite string. The domain of dependence, the doman of influence, Method of separation of variables, Investigation of the conditions under which the series converges and represent the solution. Riemann Volterra method of solution, Goursat's problem for one-dimensional wave equation.

Elliptic equations :

Occurence of Laplacic equation, the fundamental solutions of Laplace's equations in two three independent variables. Harmonic functions. regularity, characterization of harmonic functions by their mean value property. Uniqueness, continuous dependence and existence of solutions, Method of separation of variables for the solutions of Laplacic equations in twoand three dimensions, the Dirichlet's and Naumann's problems. Dirichlet's principles, Green's functions or the Laplace's equations in two and three dimension, solution of Dirichlet's and Naumann's problem for a disc half-space and a sphere The potentials due to a volume distribution a single layer and to a double layer. Representation of a harmonic function by potentials of simple and double layers. Poisson's general solution.

Parabolic equations :

Diffusion equation. Conduction of heat in a bounded strip (First boundary value problem) Uniqueness, continuous dependence and existence of solution, conduction of heat in an infinite strip (Cauchy problem). Method of separation of variables.

PAPER -V

Group - A

(Marks - 50)

Mechanics of Continuous Media :

1. Strees : Body force. Surface forces. Cauchy's stress principle. Stress vector. State of stress at a point. Strees tensor. The stress vector-strees tensor relationship. Force and Moment equilibrium. Stress tensor symmetry strees quadric of Cauchy. Stress transformation laws. Principal stress. Stress invariant. Stress ellipsoid.

2. Strain: Deformation Gradients, Displacement Gradient Deformation tensor. Finite strain tensors. Small deformation theory - in-finitesimal strain tensor. Relative displacement. Linear rotation tensor. Interpretation of the linear strain tensors. Strength ratio. Finite strain interpretation. Principle strains. Strain invariant Cubical dilatation. Compatibility equation for linear strain. Strain energy function, Hook's law Saint-

3. Perfect fluid Kinematic of fluids, Lagrangian method Eularian method. Acceleration, Equation of continuity. The boundary surface. Stream lines and path lines. Irrotational motion and its physical interpretetation. Velocity potential. Eulerian equations of motion of an inviscid fluid. Cauchy's integral. Bernoulli's equation Integration of Euler's equation.

Impulsive motion of fluid. Energy equation Motion in two

dimensions. The stream functions. Complex potential. Source. sinks and doublets and their image. Milne-Thompson circle theorem and its application, Vorticity, Flow and circulation. Kelving's circulation theorem. Kelvin's minimum energy theorem.

Paper - V

Group - B

(Marks - 50)

Practical

(a) DOS, UNIX and WINDOWS 95/98

(b) Identification of PC components and Assemble of some components.

(c) Spread Sheet-LOTUS.

(d) Word processing-Page maker/ MS-WORD/LATEX.

(e) Numerical and Statistical problems in FORTRAN-77 and C:Problems on FORTRAN-77 & C:

Numerical Problems:

1. Solution of Equations By Bisection, Iteration, Regular False. Newton Raphson method. Roots of Polynomial equations.
2. Solution of System of Equations By Gauss's elemination, Seidal iteration. Matrix Invesion methods. Solution of tridiagonal equation.
3. Interpolation: Difference table. Lagrange Newton Forward and Backward interpolation. Spline interpolation.
4. Integration: Trapezoidal Simpson 1/3 & 3/8 rule. Weddles rules. Gauss quadrature.

Double integration.

5. Solution of ODE: Eulers and modified Eulers method. Rungakutta method. Predictor and corrector method. Euler

method for a pair of equations-higher degree.

6. Solution of PDE By Finite difference method.
7. Eigen value of matrix By Power method Jacobi's method for Symmetric matrix.

Statistical Problems:

1. Preparation of Frequency table his stogram.
2. Problems on simple frequency distribution: mean, median, quartile, mode, standard deviation, moments, skewness, Kurtosis beta and gamma coefficient.
3. Preparation of Poisson, binomial and normal probability istribution table. Problems on group frequency distribution mean, s.d. median, mode, quartile, percentiles.
4. On Bivariate distribution-correlation coefficient regression lines curve fitting.

Searching and Sorting:

1. Linear and binary search.
2. Sorting: Bubble insertion, quick heap and marge sort.

String manipulation (c only):

1. No. of occurence of a letter in a given string.
2. Palindrome of string.
3. Rewrite the name with surname first.
4. Print a string in a reverse order.
5. String searching.
6. Sorting of names in alphabetic order.
7. Find and replace a given letter or word in a given string.
8. Combinations of letters of a word.
9. Conversion of name into abbreviation form.
10. Pattern matching.

Misc. Problems.

1. Generation of randon numbers.
2. Generation of prime numbers.
3. Graph plotting.
4. Multiple choice test.
5. Multiplication of polynomials.
6. Preparation of calender.
7. Fibonacci no.

Paper - VI

Group - A, Marks - 50

Computer Science

Computer Organisation : 10

Basic of computer organisation, Computer structures, Component of CPU Registers, Adders, ALU, Control unit, Basic concepts, Memory, Characteristics-primary & Secondary Storage, Hierachy of memory, Cache memory, Virtual memory, Basic concept of I/O, Standard I/O Interrupts. Direct memory access, Concepts of parallelism in computing systems.

Data structure: 15

Definition, Concepts of data types, Elementary structures. Arrays: types, Memory representation, Addressed translation function. Linked structures: Single and double link list (circular and non Circular), Simple example, Polynomials using linked representations.

Stack and queues: Definitions, Representation, Post fix conversion and evaluation. Binary trees, Tree traversal algorithm. Asymtotic notations. Analysis of algorithm. Searching : Linear and binary search. Sorting. Terminology, performance evolution, complexsity, advantages

and disadvantages, Bubble, Insertion, Selection, Heap, Marge and quick sort.

Graph algorithm: Representation of graph, DFS and BFS algorithm, shortest path algorithm, Dijsktra algorithm.

Computer Network: 10

Concept of centralised and distributed computing. Advantage of Networking LAN, WAN, Internet and Its applications.

Operating System: 15

What is OS? History, Concept Process, Files, Shell, System Call, Structures-monolithic, layered virtual, client-server model.

Processor management: Concept of inter process communication (race, mulual, exclusion, semaphore, massage passing) Scheduling: round-robin, priority-queue.

Device management : Device and device Controllers, interrupt handlers and device drivers RAM dish Floppy disk terminal.

Memory management : Single allocation technique, partition technique paging technique, multiprogramming, Virtual memory.

File System: Files and directories, File serves, Security and protection.

Group B : Practical Marks -50

(a) Programming in C++

(b) Programming in Visual C++Basic.

(c) Computer Network (including e-mail)

(d) DBMS-Foxpro/ Oracle/ Sybase/ Power Builder/ Excel/ Developer 2000

(e) Practical Note Book + VIVA

Paper - VII

Group - A, Marks - 25

Electromagnetic Theory

1. Concepts of potentials and conservative force. Potential due to a distribution fields. Potential due to dipole, dipole-dipole interaction. Boundary value problems in electrostatics, method of images. Complex potential, electrostatic field energy, Maxwell stresses.

2. Field Equations and Conservation laws : Equation of continuity displacement current, Maxwell's equations, energy in electromagnetic field, Poynthing vector, electromagnetic potentials, non-uniqueness of electromagnetic potential and concept of gauge Lorentz gauge, Coulumb gauge Field equations in terms of differential forms,

3. Field of Moving charges and radiation

Retarded potentials, Licniard Wiechert Potentials, field produced by an arbitary miving charges particle, the field of a uniformly moving charged particle, radiation from an accelerated charged particle at low velocity, radiation from an accelerated charged particle at high velocity.

4. Plane electromagnetic waves and their Propagation

Electromagnetic waves in vacum, dielectries, Conducting media, skin effect reflecation & refraction of eletrmagnetic wave. Fresnel formulas.

Paper - VI

Group - B, Marks - 25

Quantum Mechanics

Experimental Background Inadequacy of Classical Mechanics

Wave and particle aspects of login. De Broglie's theory Heisenbergs uncertainty principle, Schrodinger equation (in one and three

dimensions) Eigen vector and eigen values, basic vectors. Expected values of operators. Elementary ideas on the representation of linear operators, Simple one dimensional problems the potentials well. the potential barrier (tunneling). Harmonic oscillator, Matrix theory, Application to Harmonic Oscillator Problem, Hydrogen atom problem.

OR

Paper-VII, Group-B, Marks-25

Gas Dynamics

Basic concept of thermodynamics. First Law of thermodynamics. Internal energy. Specific heats of gas Entropy. Second Law of thermodyamics. Maxwell's thermodynamics relations. Wave motion. Wave motion in two and three dimensions, Progressive and stationary waves, Speed of sound in gas. Equations of motion of a gas. Subsonic, Sonic, supersonic flow, isentropic gas flow. Shock waves, Formation of shock waves Elementary analysis of normal oblique shock waves. The method of characteristics for two dimensional, Homentropic irrotational gas flow.

OR

Paper-VII, Group-B, Marks-25

Fuzzy Sets and its application in O.R.

Definition of Fuzzy sets, Alpha-set. Normally Extension Priniciple, Basic Operations like inclusion completion union and intersection, Difference.

Fuzzy number Addition, Subtraction Multiplication & Division. Triangular & trapezoid fuzzy numbers.

Linear Programming Problems with fuzzy resources:

(i) Vendegay's approach

(ii) Werner's approach

L.P.P. with fuzzy resources and objective: Zimmermann's approach.

L.P.P. with fuzzy parameters in the objective function. Definition of Fuzzy multiobjective linear programming problem. A brief survey of the methodology of solving fuzzy M.O.L.P & fuzzy goal programming.

Paper-VII: Group-B

Wave dynamic (25 marks)

Gravity waves Airy's wave theory : Free surface conditions, velocity potentials. Dispersion relation. Surface tension effect. Orbital motion Group velocity, dynamical significance of group velocity, dynamical significance of group velocity. Wave energy standing wave. Wave forces and Morison's equation. Long waves and waves in a canal. Tides waves in shallow water. Shoaling, refraction and diffraction.

Nonlinear waves-stocks finite amplitude waves.

Paper - VII : Group - B

Comptational fluid dynamics (25 marks)

Conservation principles of fluid dynamics, basic equations for viscous and non viscous flow boundary conditions.

Finite difference method: Schemes for Pecybuiir Hyperbolic and Elliplic type equations Splitting.

Stability analysis Convergence and consistency: Finite volume method: ADI method and multigrid methods. Basic idea of finite element method with simple applications.

Paper-VII: Group - B

Applied Statistics (25-marks)

Analysis of variance: Introduction, different sources of variation, techniques in oneway and Two-way classified data and their

computations.

Time series: Introduction, Components of time series, adjustment to time series date, secular trend, Measurement of trend, monthly trend from annual data, Seasonal variation, Measurement of seasonal variation. Cyclical fluctuation, Business forecasting, Exponential smoothing.

Index Numbers: Introduction, Methods of construction of Index numbers, Tests of Index numbers, chain base method, cost of Living Index, numbers, Bias in Laspeyres and Paasche's formula for C.L.I., Base shifting. Splicing and Deflation, Errors in Index numbers.

Statistical Quality control: Introduction, chance and assignable causes, control chart for variables and attributes, Formulae for central lane and control limits. Sampling Inspection, Single and Double Sampling Inspection Plans.

OR

Paper-VII, Group-B, Marks-25

Computer Science - III

Computer Graphics:

Overview of graphics system: Video display devices, Cathode-Ray tube, Rasterscan displays, Graphics software.
Points & lines, line drawing algorithms, Circle generation.

2D transformations: Translation, rotation, scaling, reflection, matrix representation, Clipping: Point & line.

3D transformation: Scaling, rotation, reflection, translation & projection, equation of plane.
What is AI? AI technique.
Heuristic search techniques: Hill climbing, Best-first search, OR graphs, A* algorithm. Problem reduction: AND-OR graphs.
Knowledge representations and mappings, approaches to Knowledge

representations.

Using predicate Calculus: Syntax & semanties, abstract represetation, representing Isa relationships, Matching.

References:

1. Techniques for Computer Graphics, by D.F. Rogers and R.A. Earnshaw, Springerverlag.

2. Mathematical Elements for Computer Graphics, by D.F. Rogers & J.A. Adams, McGraw Hill.

3. Computer Graphics, by D. Hean & M.P. Baker (2e) PHI.

Paper-VII, Group-C, Marks-30

Fluid Mechanics

1. Irrotational Motion in Two Dimensions :

General motion of a cylinder in two dimensions. Motion of a cylinder in a uniform stream. Liquid streaming past a fixed circular cylinder. Equations of motion of a circular cylinder. Circulation about a moving cylinder. Conjugatefunction. Elliptic cylinder Liquid streaming past a fixed elliptic cylinder. Elliptic cylinder rotating in an infinite mass of liquid at rest at infinity Circulation about an elliptic cylinder. Kinetic energy. Blasius theorem and its application Kutta and Joukowski theorem, D.Alemberts paradox, Application of conformal mapping.

Vortex Motion

Vortex line, Vortex tube: Properties of the vortex, Strength of the vortex, Rectilinear vortices, Velocity component, centre of vortices. A case of two vortex filaments, cortexpair Vortex double Image of vortex filament with respect to a plane. An infinite single row of parallel rectilinear vortices of same strength. Two infinite row of parallen rectilinear vortices. Karman's vortex sheet. Rectilinear vortex with circular section. Rankline's combine vortex, Rectilinear vortices

with elliptic section.

Viscous Flow :

Navier-Stokes equations, Vorticity and circulation in viscous fluids. Reynolds number. Boundary conditions. Flow of a viscous fluid with free surface on an inclined plane. Flow between parallel plates. Flow through pipes of circular, elliptic section under constant pressure gradient. Laminar flow between concentric rotating cyclinder Steadymotion of a viscous fluid due to a slowly rotating sphere.Unsteady motion of a flat plate. Pulsatile flow between parallel surfaces. Prandtl's concept of boundary layer. Boundary layer flow along a flat plate. Momentum and energy integral equation for the boundary layer. Von Karman Pohlhousen method. Turbulence, Calculation of Turbulent BL.

Paper-VII, Group-D, Marks-20

Magnetohydro Dynamics

Magnetohydro Dynamics

Maxwell's electromagnetic field equations when medium in motion. Lorentz' s force. The equations of motion of a conducting fluid. Basic equations. Simplification of the electromagnetic field equation. Magnetic Reynolds number. Alfven theorem. Magnetic body force. Ferraro's law of isorotation. Laminar Flow of a viscous conducting liquid between parallel walls in transverse magnetic fields. M.H.D. Flow Past a porous flat plate. MHD Conette Flow, Magnetohydro dynamics waves.

Paper - VIII, Group - A, Marks-50

Mathematical Methods

Laplace transform, Properties of Laplace transform, Inversion formula, Convolution Application to ordinary and partial differential equation.

Fourier transform, Properties of Fourier transform, Inversion formula, Convolution, Parseval's equality, Fourier transform of generalized functions. Hankel transform Bassel's inequality Application of transform of heat, Wave and Laplace equations.

Formulation of integral equations, Integral equations of Fredholm and Volterra type solution by successive substitution and successive approximation. Integral equations with degenerate Kernels. Abel's integral equation.

Paper-VII, Group-B, Marks-50

Either

Elements of optimization and operation research

Revised simplex method (with and without artificial variables), Post optimality analysis: Change in the objective function, change in the require

Non-linear Programming : Quadratic Programming: Wolfs modified simplex method and Beale's method.

Convex programming Dynamic programming. Integer programming Gemory's cutting plane algorithm, (Gemory's mixed integer progarm algorithm) A branch and bound algorithm, inventory model (deterministic)

OR

Paper-VIII, Group-B, Marks-50

Dynamical Occanography and Meteorolgy

Dynamical Occanography :

Navier-Stokes equations of motion for viscous fluid. Thermodynamics of sea-water inequilibrium state. Salinity. Basic thermodynamics. Gibb's general therodynamics relation for sea-water Governing equatoous of motion of sea water. Boundary conditions at the free occan surface. Linearised equation of small amplitude

occanian wave motion on a rotating earth. Boussines approximation. The beta plane approximation. Equation of conservartion of energy for linearised wave motion.

Dynamical Meteorology :

Heat balance of the atmosphere, Basic thermodynamics of the atmosphere: Potential temperature and stability of dry air.

Energy in a compressible atmosphere, change in potential energy due to adiabatic interchage of small parcels, dissipation of energy.

General circulation, its schematic description and theory (in out line).

Rate of change of circulation. Geostrophic and thermal wind. The geostrophic balance, the geodynamical paradox, Surface of discontinuity. Classification of fronts. Fromation of cyclones. Aerological diagrams, its purpose and use.

SPECIAL PAPER

Paper-IX, Marks-100

Advanced Optimization And Operations Research-1

Optimization:

The nature of optimization and scope of the theory. The optimality criterian of Linear programming. An application of Farka's Theorem. Existence Theorem for Linear systems. Theorems of the alternatives. Simplex Theorems on the Variants of convexity.

Optimality in the absence of differentiability, Slater's constraint qualification, Karlin's constraint qualification, Kuhn-Tucker's saddle point necessary optimality Theorem.

Optimality criterian with differentiability and Convexit, Kuhn-Tucker's Sufficient optimality theorem. Duality in non-linear programming Weak duality theorem, Wolf's duality theorem, Duality for quadratic

programming.

Revised simple method (with and without artificial variable) Bounded variable Technique Dual Simplex mothod Modified dual simplex method.

Parametric and post-optimal analysis:

Change in the objective function Change in the requirement vector, Addition of a constrain, Change in the coefficient matrix, Parametric analysis of cost and requirement vector.

Large scale linear programming:

Decomposition principle of Dantzig and Wolfe, Composite simplex algorithm.

Non-linear programming.

Quadratic Programming:

Wolfe's modified simplex method, Beale's method. Convex Programming.

Unconstrained optimization:

Search Methods: Fibonacci and golden section method.

Gradient Method:

Method of conjagate directions for quadratic function, Streepest descent and Davodon-Fletcher-Powell method.

Constrained Optimization:

Methods of feasible direction and cutting hyperplane method.

Integer Programming:

Gemory's cutting plane algorithm, Gemory's mixed integer problem algonthm, A branch and bound algorithm.

Goal Programming:

Introduction, Difference between LP and GP approach. Concept of Goal Programming, Graphical solution-method of Goal Programming, Modified simplex method of Goal Programming.

SPECIAL PAPER

Paper-IX, Marks-100

Dynamical Oceanography

Thermodynamics of Equilibrium State:

Gibb's relation, Thermodynamic potentials, Definition of Salinity, Sea water as two component mixtures. Entropy Internal energy and Chemical potential of sea water, Adiabatic gradient of temperature and coefficient of compressibility of sea water, equilibrium conditions of sea water.

Thermodynamics of Irreversible Processes:

Fluxes of heat and salt, conservation equations for heat, salt and mass, Navier-Stocks quations in an inertial frame and the corresponding equation in a uniformly rotating frame. Potential Vorticity, Geostrophic flow, Taylor-Proudman theorem. The-plane approximation.

Basic concept of turbulence, Reynold's stresses, equation of turbulent energy, Coefficient of turbulent exchange Closer of the system of average equation for the large scale flow, Boundary conditions, Geostophic motion, Ekman layer on a free surface, Vertical shear layers.

Homogencous Midels of the wind-driven steady oceanic circulation: Derivation of the wind-driven steady oceanic circulaiton, Derivation of the Vorticity equation in terms of geostrophic stream function and the relevant boundary conditions. The Svendrup relation, Meridional boundary layers, Bottom friction layer, intertial boundary layer theory. Inertial currents in the presence of friction dissipation integrals for steady circulation, Ekman upwelling circulation.

Quasigeostrophic motion of a stratified fluid on a sphere: equations of motion in a spherical coordinates, Scaling geostrophic approximation for synoptic scales. The concept of static stability quasigeostrophic potential vorticity equation for occanic synoptic scales and relevent boundary conditions. Rossby Wave normal modes. The vertical structure equation. Topographic waves in a stratified ocean, Geostrophic approximation for large scale. The thermocline problems. Barotropic and Baroclinic Rossby waves. Boussinesq approximation, Internal waves in a rotating nondissipative stratified fluid, Internal wave Poincare and Kelvin waves.

SPECIAL PAPER

Paper-X, Marks-100

Dynamical Meteorology

Thermodynamics of Red Atmosphere:

Basic laws of themodynamics, potential temperature, Lapserate Atmoshperic water vapour. Equation of state for Dry and Moist air, Dry weather, virtual Temperature, Adiabatic changes in unsaturated Moist Air and in saturated Moist Air, Pseudoadiabaitc change, Equivalent Temperature and Equivalent Potental Temperature, Saturated adiabatic Lapse Rate, Stability in saturated adiabatic changes, conditional Instability, Isobaric Cooling, Condensations by Isobaric cooling.

Aerological Diagrams:

Purpose and use of Aerological Diagrams, Clapeyron and Refsdal and Stuve diagrams, Tephigram, Emagum, Area equivalence, Composition and structure of the Atmosphere Solar and Terristrial radiations. Derivation of the complete of thermo Hydrodynamical equation w.r.t the Rotating Earth Energy and Angular Momentum, Circulation and voticity, Rate of change of circulation, The geostrophic

gradient, Thermal and cyclostrophic winds. The geodynamical Paradox, Steady motion along a circular Isobar, accelerated motion and a changing pressure field. Divergence, Convergence and pressure variation. Pressure distribution in a moving cyclone. Pressure endency equation. The atmospheric energy equation. The dissipation of energy. Available potential energy.

The general circulation and monsoon meteorology Atmosphic wave. Numerical wave prediction.

Froats, Cyclones and Anticyclones:

Surface of discontinuty, Pressure distribution near Fronts, Temperature and wind distribution at Fronts, Classification of Fronts. The geostrophic Fronts. The motion of Fronts, Tropical Cyclones, CISK, The wave theory of cyclones, Storm Surges.

Atmosphere Turbulence:

Praudlts theory of momentum transfer, the vertical variation of the wind in an above the surface layer, Vertical Mixing Air Masses.

Practicals (20+5)=Marks

1. Surface temperature, pressure, humidity, Wind speed and direction measurements.
2. Rainfall and rain measurements.
3. TD charts-analysis.
4. T-Q diagram:
   i) Geopotential height by isotherm/adiabatic method.
   ii) To find dry bulb and wet bulb temperature, potential, virtual, equivalent potential, dew point temperatures and mixing ratio.
5. Numerical method and computer techniques related to Meterological problems. Handling and analysis of Meteorogical data.

6. Field work & Lab Visit-5 marks (compulsory): Students should go at least for few days to one of the University /Institute/ Organisation laboratory (preferably in the Laboratory of IMDIISc. IITM, NPL IIT etc) to understand experiments set-ups in Meteorolgy (such as Annular experiment for existence of general circulation and Rossby wave, experiement for demonstrating Helmholtz instability, Aerosot measurements. Facrimile recorder for receiving weather charts etc).

SPECIAL PAPER

Paper-X, Marks-100

Advanced Optimization And Operations Research-II

Dynamic Programming:

Natural of dynamic programming, Daterministic processes, Non-Sequential discrete optimization, Allocation problems, Assortment problems, Sequential discrete optimization, Long-term panning problem, Multi-stage decision process. Application of Dynamic Programming in production scheduling and routing problems.

Sochastic Programming: Chance Constraint programming technique.

Optimal Control:

Performace indices. Mathods of calculus of variations, Transversality Conditions, Simple octimal problems of mechanics. Pontryagin's principle (with proof assuming smooth conditon), Linear regulator. Application of dynamic programming in proving pontryagin's principle.

Sequencing:

Problems within jobs two machines, n-jobs three machines and n-jobs, m-machines.

Theory of Games: Continuous Games, Convex games Separable

Games.

Inventory control:

Inventory control deterministic (including price breaks), probabilistic (with and without lead time) fuzzy and dynamic in ventory models.

Queuing Theory:

Poisson and Non-Poisson (M/G/I, G/M/I. M/D/C, Machine-Maintenance etc.) queues steady state.

Geometric Programming:

Geometric Programming (both unconstrained and constrained)

Raliability :

Concept System Reliability. System Failure rate Reliability of the Systems connected in series on and parallel.

Network : PERT and CPM

Introduction, Basic difference between PERT and CPM. Steps of PERT/CPM Techniques, PERT/CPM Network componentand precedence relationships, Critical path analysis. Probability in PERT analysis Project Time-Cost, Trade-off, Updating of the project, Resource allocation resource smoothing and resource leveling.

Replacement and Maintenane Models:

Introduction Failure Mechanism of items, Replacement of items deterio rates with time, Replacement policy for equipments when value of money changes with constant rate during the period. Replacement of items that fail completely-individual replacement policy and group replacement policy, Other replacement problems-staffing problem, equipment renewal problem.

Simulation:

Introduction Steps of simulation process, Advantages and disadvantages of simulation, Stochastic simulation and random

numbers Monte carlo simulation. Random number Generation, Simulation of Inventory Problems, Simulation of Queueing problems. Role of computers in Simulation Applications of Simulations.

Information Theory:

Introduction Communication Processes-memory less channel. the matrix, Probability relation in a channel, noiseless channel.

A Mersure of information Properties of Entropy function, Measure of Other information quantities-marginal and joint entropies, conditional entropies, expected mutual information, Axion for an Entropy function properties of Entropy function.

Chemel capacity efficient and redundancy.

Encoding - Objectives of Encoding.

Shannon-Cano Encoding Procedure, Necessary and sufficient Condition for Noiseless Encoding.

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