# COURSES OF STUDIES

**FOR**

**2yr. M.Sc.**

**In**

# Applied Mathematics


## Biju Patnaik University of Technology, Odisha

# Course Structure for 2yr M.Sc. in Applied Mathematics (2015-16)

| 1st Semester | | | | 2nd Semester | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | **Contact Hours** | | **Theory** | | **Contact Hours** | |
| **Code** | **Subject** | **L-T-P** | **Credit** | **Code** | **Subject** | **L-T-P** | **Credit** |
| 15 MMCC101 | Real analysis | **3-1-0** | **4** | 15 MMCC201 | Topology | **3-1-0** | 4 |
| 15 MMCC103 | Discrete Mathematics | **3-1-0** | **4** | 15 MMCC203 | Complex Analysis | **3-1-0** | 4 |
| 15 MAMC102 | Ordinary Differential Equation | **3-0-0** | **3** | 15 MMCC202 | Numerical Analysis | **3-0-0** | 3 |
| 15 MMCF107 | Data Structure with C++ | **3-0-0** | **3** | 15 MAMC204 | Partial Differential Equation | **3-0-0** | 3 |
| 15 MMCC104 | Abstract Algebra | **3-0-0** | ***3*** | 15 MAMC205 | Continuum Mechanics | **3-1-0** | *4* |
| 15 MAMC105 | Linear Algebra | **3-1-0** | **4** | 15 MAMF206 | RDBMS | **3-0-0** | 3 |
| | | **Total** | **21** | | | **Total** | **21** |
| **Practical/Sessional** | | | | **Practical/Sessional** | | | |
| **Code** | **Subject** | **L-T-P** | **Credit** | **Code** | **Subject** | **L-T-P** | **Credit** |
| | | | | | | | |
| 15 MMCF151 | Data Structure using C++ Lab | **0-0-3** | **2** | 15 MMCC251 | Lab on Numerical Analysis | **0-0-3** | **2** |
| 15 MAMC152 | Seminar | **0-0-3** | **2** | 15 MAMF252 | RDBMS Lab | **0-0-3** | **2** |
| 15 MAMC153 | Ethics & Human Values | | | | | | |
| | | **Total** | **4** | | | **Total** | **4** |
| | | **Total** | **21+4=25** | | | **Total** | **21+4=25** |

Syllabus for 2 Year M.Sc. (Applied Mathematics)- Admission Batch 2015-16

| 3rd Semester | | | | 4th Semester | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | **Contact Hours** | | **Theory** | | **Contact Hours** | |
| **Code** | **Subject** | **L-T-P** | **Credit** | **Code** | **Subject** | **L-T-P** | **Credit** |
| 15 MMCC304 | **Optimization Techniques** | **3-0-0** | **3** | 15 MAMC402 | Design Analysis and Algorithm | **3-1-0** | **4** |
| 15 MMCC301 | **Functional Analysis** | **3-1-0** | **4** | 15 MMCC401 | **Differential Geometry** | **3-0-0** | **3** |
| 15 MAMC302 | **Probabilities & Stochastic Process** | **3-1-0** | **4** | 15 MAMC403 | Matrix Computation | **3-0-0** | **3** |
| | **Elect -I** | **3-1-0** | **4** | | **Elective III** | **3-0-0** | **3** |
| | **Elect -II** | **3-1-0** | **4** | | | | |
| | | **Total** | **19** | | | **Total** | **13** |
| **Practical/Sessional** | | | | **Practical/Sessional** | | | |
| **Code** | **Subject** | **L-T-P** | **Credit** | **Code** | **Subject** | **L-T-P** | **Credit** |
| 15 MMCC351 | **Optimization Lab** | **0-0-3** | **2** | 15 MAMC451 | **LAB - DAA** | | **2** |
| 15 MMCC352 | MAT lab | **0-0-3** | **2** | 15 MAMC452 | LAB - Matrix Computation | | **2** |
| 15 MAMC353 | **Industry Orient SEMINAR** | | **2** | 15 MAMC453 | **PROJECT** | | **8** |
| | | **Total** | **6** | | | **Total** | **12** |
| | | **Total** | **19+6=25** | | | **Total** | **13+12=25** |

**ELECTIVE-I**

| Sl No | CODE | |
|---|---|---|
| 1 | 15 MAME301 | Fluid Dynamics |
| 2 | 15 MAME302 | Computational Finance |
| 3 | 15 MAME303 | Convex Analysis and optimization |
| 4 | 15 MAME304 | Parallel and Distributive Computing |
| 5 | 15 MAME305 | Number Theory and Cryptography |
| 6 | 15 MAME306 | Advanced Operating System |
| 7 | 15 MAME307 | Computer Architecture |

**ELECTIVE-II**

| | | |
|---|---|---|
| 1 | 15 MAME308 | Numerical Solution of Differential Equation |
| 2 | 15 MAME309 | Advanced Statistics |
| 3 | 15 MAME310 | Computational Biology |
| 4 | 15 MAME311 | Graph Theory |
| 5 | 15 MAME312 | Fourier Analysis |
| 6 | 15 MAME313 | Theory of Computation |
| 7 | 15 MAME314 | Finite Element Method |

**ELECTIVE-III**

| | | |
|---|---|---|
| 1 | 15 MAME401 | Computational Fluid Dynamics |
| 2 | 15 MAME402 | Distribution Theory and Sobolev spaces |
| 3 | 15 MAME403 | Artificial Intelligence |
| 4 | 15 MAME404 | Machine learning |
| 5 | 15 MAME405 | Hydrostatics |
| 6 | 15 MAME406 | Fuzzy and Rough set theory |
| 7 | 15 MAME407 | Numerical Optimization |

# DETAILED SYLLABUS OF SEMESTER-I

# 15 MMCC 101 REAL ANALYSIS (3-1-0)

**Module – I : (14 Hours)**

Introduction to Metric spaces, compact set, connected set, Weistrass Approximation Theorem, Sequence and series of function, Uniform convergence.Lebesgue measure: Introduction, outer measure, measurable sets and Lebesgue measure, A non measurable set, measurable function.The Lebesgue Integral: The Rimann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a non negative function, The general Lebesgue integral.

**Module –II : (14 Hours)**

Measure and Integration: measure spaces, measureable functions, Integration, General convergence theorem, Signed measures, The Random-Nikodyn theorem, The $L^p$ spaces.

Measure and Outer measure: Outer measure and measurability, The extension theorem, The Lebesgue-Stieltjes integral, Product measures, Integral operators, Inner measure, Extension by sets measure zero.

**Module –III : (12 Hours)**

Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

The Riemann Stieltjes Integrals: Introduction, Notation, The definition of Riemann Stieltjes Integral, Linear operators, Integration by parts, Change of variable in Riemann StetiItjes integrals, Reduction to a Riemann Integral, Euler's summation formula, Monotonically increasing integrals.

**Text Book :**

1. Real Analysis by H.L Royden($3^{rd}$ edition)
Chapter 3(3.1 to 3.5), Chapter(4.1 to 4.4), Chapter(11), Chapter(12.1 to 12.7).
2. Mathematical analysis by Tom M.Apostol,$2^{nd}$ Edition,Addison-Wesley publication company Inc. Newyork,1974.
Chapter6(6.1 to 6.8), Chapter7(7.1 to 7.11)

**Reference Book :**

1. Bartle, R.G. Real Analysis, John Wiley and Sons Inc., 1976.
2. Rudin,W. Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.
3. Malik,S.C. and Savita Arora. Mathematical Anslysis, Wiley Eastern Limited.New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
5. Gelbaum, B.R. and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964.

6. A.L.Gupta and N.R.Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003.
7.Measure theory and integration by G. De. Barra (willey estern ltd)

## 15 MMCC 103 DISCRETE MATHEMATICS (3-1-0)

**Module-I : (13 Hours)**
Propositional logic operations, First order logic, basic logical Operations Propositional Equivalence, Predicates and Universal & Existential Quantifiers, Nested Quantifiers,
Rules of Inference, Proof methods and Strategies, Sequences and Summations, Mathematical Induction, Recursive definition and structural induction, Program Correction
Recurrence relation, Solution to recurrence relation, Generating functions, Principle of Inclusion and exclusion, Application of Inclusion and Exclusion Principle,
Set Theory, Relation and their properties, Partitions, Closure of Relations, Warshall,s Algorithm, Equivalence relations, Partial orderings, .

**Module-II : (14 Hours)**
Introduction to graph theory, Graph terminology, Representation of graphs, Isomorphism, Connectivity, Euler and Hamiltonian paths, Shortest path problems, Planar graph, Graph coloring,
Introduction to trees, Application of trees, Tree Traversal, Minimum Spanning tree.

**Module-III : (13 Hours)**
Matrix representation of a graph: Basic ideas of Incidence matrix, sub matrix, circuit matrix fundamental circuit matrix, cut set matrix, path matrix and adjacency matrix, Coloring :Chromatic number, chromatic partitioning ,chromatic polynomial,matching ,covering
Algebraic systems, Lattices, Distributive and Complemented Lattices, Boolean Lattices and
Boolean Algrebra, Boolean Functions and Boolean Expressions.

**Text Books:**
1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Sixth Edition, 2008, Tata McGraw Hill Education , New Delhi.
Chapters: 1, 2(2.4), 4, 6(6.1, 6.2, 6.4-6.6), 7, 8, 9
2. C. L. Liu and D. Mohapatra, "Elements of Discrete Mathematics", Third Edition, 2008, Tata McGraw Hill Education, New Delhi
Chapters: 10 (10.1- 10.10), 11(11.1 – 11.7)

**Reference:**
1. J. L. Mott, A. Kandel, T. P. Baker, "Discrete mathematics for Computer Scientists & Mathematicians", Second Edition, PHI.
Chapters : 1,2,3,4(4.1-4.5), 5, 6(6.1-6.5)
Chapters: 10 (10.1- 10.10), 11(11.1 – 11.7)

# 15 MAMC102 ORDINARY DIFFERENTIAL EQUATION(3-0-0)

**Module-I(8 hours)**

Existence and uniqueness of Solution: Lipchitz condition, Gronwall inequality, Successive approximations, Picard's theorem, Second order linear equations, Separation and comparison theorems, Solutions in series, Legendre and Bessel functions

**Module-II(10 hours)**

Systems of differential equations: Existence and uniqueness of solution of systems, Systems of linear Differential equations, nth order equations of a first order system, Fundamental matrix, Non- homogeneous linear systems, linear systems with constant coefficients ,Eigen values and Eigen vectors

**Module-III(12 hours)**

Boundary value problems for Ordinary differential equations:, Green's functions, Construction of Green's functions, Non-homogenous boundary conditions. Self-Adjoint Eigenvalue Problems: Sturm-Liouville Systems, Eigen values and Eigen functions, expansion in Eigen functions. Stability: Stability of linear and non linear systems, Asymptotically stability, Critical points, Autonomous Systems, , Lyapunov stability.

Books Recommended:

**Text book:**

Tyn Myint-U: Ordinary Differential Equations, New York, Chapters:2,3(3.1-3.5),4(4.1-4.4)5(5.1-5.6),6(6.1-6.4),7(7.1-7.3),8(8.1-8.5)

Reference Books:

1. S.D.Deo, V. Lakshmikantham and V. Raghavendra: Text book of Ordinary differential equations, 2nd edition, TMH

2. Boyce,W., and R. Diprima. Elementary Differential Equations and Boundary Value Problems. New York;Wiley.

# 15 MMCF 107 DATA STRUCTURE using C++ (3-0-0)

**Module – I [10 hours]** Introduction to data structures: storage structure for arrays, sparse matrices, Stacks and Queues: representation and application. Linked lists: Single linked lists, linked list representation of stacks and Queues. Operations on polynomials, Double linked list, circular list.

**Module – II [10 Hours]** Dynamic storage management-garbage collection and compaction, infix to post fix conversion, postfix expression evaluation. Trees: Tree terminology, Binary tree, Binary search tree, General tree, B+ tree, AVL Tree, Complete Binary Tree representation, Tree traversals, operation on Binary tree-expression Manipulation.

**Module –III [10 Hours**] Graphs: Graph terminology, Representation of graphs, path matrix, BFS (breadth first search), DFS (depth first search), topological sorting, Warshall's algorithm (shortest path algorithm.) Sorting and Searching techniques – Bubble sort, selection sort, Insertion sort, Quick sort, merge sort, Heap sort, Radix sort. Linear and binary search methods, Hashing techniques and hash functions.

**Text Books**: 1. Gilberg and Forouzan: "Data Structure- A Pseudo code approach with C++" by Thomson publication

2. "Data structure in C++" by Y. Kanetkar TMH publication.

**Reference Books:** 1. Pai: "Data Structures & Algorithms; Concepts, Techniques & Algorithms "Tata McGraw Hill.

2. "Fundamentals of data structure in C" Horowitz, Sahani & Freed, Computer Science Press.

3. "Fundamental of Data Structure" ( Schaums Series) Tata-McGraw-Hill. 22 BE

# 15 MMCC-104 ABSTRACT ALGEBRA (3-1-0)

**Module-I (14 hours)**

Normal subgroup, Isomorphism theorem, Automorphisms, Permutation group: Cyclic decomposition and Alternating group $A_n$. Structure theorems for groups: Direct Product, finitely generated abelian group. Structure theorem for groups: Invariants of a finite abelian group, Sylows theorem. Unique factorization domain, Principal ideal domain, Euclidean domains, polynomial rings over UFD.

**Module-II(13 hours)**

Algebraic extension of fields: Irreducible polynomials and Einstein criterion, Adjunction of roots, Algebraic extension. Algebraically closed fields, Normal separable extensions: splitting fields, normal extensions. Normal separable extension: Multiple roots, Finite fields, Separable extensions.

**Module-III (13hours)**

Galois Theory: Automorphism groups and fixed field s, Fundamental theorem of Galois theory. Application of Galois theory to classical problems: Roots of unity and Cyclotomic polynomials, Cyclic extensions, Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions.

**Text Book**

**P.B. Bhattacharya, S.K Jain and S.R.Nagpaul:** Basic Abstact Algebra, Cambridge University Press. Chapter : 5 (Art 2,3), 7(Art 1,2), 8( Art 1-4), 11 (Art 1-4), 15(Art 1-3), 16( Art 1,2), 18(1-5).

**Reference Books:**

1. **Vivek Sahai and Vikas Bist :** Algebra (Narosa publication House).

2. **I.S. Luthar and I.B.S. Passi :** Algebra Vol. 1 Groups (Narosa publication House).

3**. I.N. Herstein :** Topics in Algebra (Wiley Eastern Ltd.).

4. **Surjit Singh and Quazi Zameeruddin :** Modern Algebra (Vikas Publishing House).

5. **S.K. Jain & S.R. Nagpal :** Basic Abstract Algebra (Cambridge University Press 1995).

# 15 MAMC 105 LINEAR ALGEBRA (3-1-0)

**Module-I (14-hours)**

Geometric interpretation of solution of system of equations in two and three variables; matrix notation; solution by elimination and back substitution; interpretation in terms of matrices, elimination using matrices; elementary matrices, properties of operations on matrices. Definition and uniqueness; non-existence in general: singular matrices; calculation of inverse using Gauss-Jordan elimination; existence of one sided inverse implies invertibility ; decomposition of a matrix as product of upper and lower triangular matrices. Vector spaces and Subspaces, Solving Ax=0 and Ax=b, Linear Independence, Basis and Dimension, The four fundamental Subspaces, graph and networks, Linear Transformations.

**Module-II (13-hours)**

Orthogonal Vectors and Subspaces, Cosines and Projections onto Lines, Projections and Least Squares, orthogonal Bases and Gram-Schmidt, The Faster Fourier Transform, Properties of the determinant, formulas for the determinant, Expansion of determinant of a matrix in Cofactors, Applications of Determinants.

**Module-III (13-hours)**

Eigen values and eigenvectors, Diagonalisation of a Matrix, Difference equations and powers $A^k$, Markov Matrices, Differential equations and $e^{At}$, stability of differential equation, complex Matrices, unitary Matrices, similarity transformations, Jordan Form, minima , maxima and saddle points, tests for positive definiteness, Test for positive definiteness, singular value decomposition, minimum principles.

**Text BooK:**

1. Strang, Introduction to Linear Algebra, 4$^{th}$ ed., Wellesley Cambridge Press. Chapters-1-5, 6.1,6.2,6.3,6.4.

## 15 MMCF 151 DATA STRUCTURE LAB (0-0-3)

(Minimum 10 experiments to be done)

**Experiment No.1** Write a C++ program to perform matrix multiplication using array. **Experiment No.2** (a) Write a C program to create a stack using an array and perform (i) push operation (ii) pop operation (b) Write a C program to create a queue and perform i) Push ii) pop iii) Traversal

**Experiment No. 3** Write a C++ program that uses Stack operations to perform the following: i) Converting infix expression into postfix expression ii) Evaluating the postfix expression

**Experiment No. 4** Write a C++ program that uses functions to perform the following operations on Single linked list: i) Creation ii) Insertion iii) Deletion iv) Traversal in both ways

**Experiment No. 5** Write a C++ program that uses functions to perform the following operations on Double linked list: i) Creation ii) Insertion iii) Deletion

**Experiment No. 6** Write a C++ program that uses functions to perform the following operations on Binary Tree: i) Creation ii) Insertion iii) Deletion

**Experiment No. 7** Write C++ programs that use both recursive and non recursive functions to perform the Linear search operation for a Key value in a given list of integers: i) Linear search

**Experiment No. 8** Write C++ program that use both recursive and non recursive functions to perform the Binary search operation for a Key value in a given list of integers:

**Experiment No.9** Write a C++ program that implement Bubble Sort method to sort a given list of integers in descending order.

**Experiment No.10** Write a C++ program that implement Quick Sort method to sort a given list of integers in ascending order:

# DETAILED SYLLABUS OF SEMESTER-II

# 15 MMCC 201 Topology (3-1-0)

**Module –I : (14 Hours)**

Countable and uncountable set, Infinite sets and the Axiom of choice, Well-ordered sets. Topological spaces, Basis and sub basis for a topology, The order, product and subspace topology, closed sets and limit points. Continues function and homeomorphism, Metric topology, Connected spaces, connected subspaces of the real line, Components and local connectedness.

**Module –II : (14 Hours)**

Compact spaces, Basic properties of compactness, Compactness and finite intersection property, Compact subspaces of the real line, Compactness in metric spaces, Limit point compactness, Sequential compactness and their equivalence in metric spaces, Local compactness and one point compactification.

**Module –III : (12 Hours)**

First and second countable spaces, Lindelo''f space, Separable spaces, separable axioms, Hausdorff, Regular and normal spaces. The Urysohn lemma, completely regular spaces, The Urysohn metrization theorem, Imbedding theorem, Tietn extension Theorem, Tychonoff theorem, Stone-Cech campactification.

**Text Book :**

1. Topology, J.R. Munkhres, 2e, Pearson Education, 2000.

Chapter: 1(7,9,10),2(excluding section 22), 3, 4 (excluding section 36), 5.

**Reference Book :**

1. Introduction to general Topology, by K.D.Joshi, Wiley Eastern Ltd., 1983.
2. Foundation of General Topology, by W.J. Pervin, Academic Press, 1964.

General Topology, by S.Nanda and S.Nanda, Macmillan India.

# 15 MMCC 202 Numerical Analysis (3-0-0)

**Module –I (10 Hours)**

Solution of equations in one and two variables: Mullers method, for two variables; fixed pt iteration, Newton's method.

Interpolation; Hermite, cubic spline and piecewise interpolation .,Natural cubic splines, B. Splines

Numerical differentiation; first order derivative, higher order derivative, Richardson Extrapolation.

**Module -II :(10 Hours)**

Numerical integration; Romberg integration, Gaussian Quadrature (2-pt,3-pt,4-pt),asymptotic error formula and their applications , Newton- Cotes rules..

Numerical solution to ODE; Taylor's series methods ,Adaptive Runge - Kutta method, predictor- corrector method, convergence and stability theory for multistep methods,

**Module -III: (10 Hours)**

Matrix eigen value problem; power method ,shifted power method, inverse power ,RQ-method, error and stability results.

Numerical solution to partial differential equations; parabolic ,elliptic ,Hyperbolic equations using finite difference method.

**Text Book :**:

1. Numerical Analysis: Richard L. Burden.(chapter – 3,4,5,6,7)
2. An introduction to Numerical Analysis : by Kendall E. Atkinson

**Reference Books :**

1. Advanced numerical methods ,L.V. Fusset

2. Numerical methods for Scientific and Engineering Computation , M.k.Jain,S.R.K.Iyengar.

3. Numerical methods for Engineers by Chapra & Canale , TMH

# 15 MMCC 203 Complex Analysis (3-1-0)

**Module-I (14 Hours)**

The complex number system: The real numbers, The field of complex numbers, the complex plane, polar representation and roots of complex numbers, Line and half planes in the complex plane. Power series and radius of convergence, analytic function ,Power series representation of analytic functions, Cauchy- Riemann equation , analytic function as mapping and its Mobius transformation.

**Module-II (14 Hours)**

Complex integration: Zeros of analytic function, entire function, Liouville's theorem, fundamental theorem of algebra, , maximum modulus theorem, Index of a closed curve, Cauchy's theorem and Cauchy's integral formula, Morera's theorem.

**Module-III (12Hours)**

Classification of singularity, Poles ,absolute convergence, Laurent series development ,Residue theorems, evaluation of integrals by using residue theorem, Argument principle, Rouche's theorem, Maximum Modulus theorem, Schwarz's Lemma.

**Text Book :**

1. Functions of one Complex variable- J. B. Conway ( springer Verlag , International student edition , Narosa Publishing house,

Chapter-1(1.1-1.5),Chapter-3(3.1- 3.3),Chapter-4(4.2 - 4.5),Chapter-5(5.1-5.3) , Chapter-6(6.1 - 6.2).

**Reference Books:**

1. A Text book of Complex variable: by M.L Khanna (Meerut Publication)
2. Complex Analysis by Alhfors, TMH

# 15 MAMC 204 Partial Differential Equations (3-0-0)

**Module-I (10 Hours)**

PARTIAL DIFFERENTIAL EQUATIONS OF 1ST ORDER: Formation and solution of PDE-Integral surfaces- Cauchy problem for 1st order equation-orthogonal surfaces-First order non linear-characteristics compatible system-Charpits Method. Classification of second order PDE-Canonical forms- Adjoint operators-Riemann's method.

**Module-II (10 Hours)**

ELLIPTIC DIFFERENTIAL EQUATIONS: Derivation of Laplace & Poisson equation-BVP-Separation of variables-Dirichlets and Newmann problem for a rectangle-Solution of Laplace equation in Cylindrical and spherical coordinates-Examples.

PARABOLIC DIFFERENTIAL EQUATIONS: Formation and solution of Diffusion equation-Dirac-Delta function- Separation of variables method-Solution of Diffusion equation in Cylindrical and spherical coordinates-Examples.

**Module-III (10 Hours)**

HYPERABOLIC DIFFERENTIAL EQUATIONS: Formation and solution of one dimensional wave equation-Canonical reduction-D'Alembert's solution-IVP and BVP for two dimensional wave equation-Periodic solution of one dimensional equation in Cylindrical and spherical coordinates-Uniqueness of the solution for the wave equation-Duhamel's Principle-Examples.

TEXT BOOK:

K.Sankar Rao, Introduction to Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi,2005

Chapters:0(0.4-0.11,(omit 0.11.1)),1(1.1-1.5),2(2.1,2.2,2.5-2.7,2.10-2.13),3(3.1-3.7,3.9),4(4.1-4.12 omit (4.5,4.6 & 4.10)).

Reference Books

1. R.C.McOwen, Partial Differential Equations, 2nd Edition, Pearson Education, New Delhi, 2005.

2. I.N.sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.

3. R.Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.

4. M.D.Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd, New Delhi.2001

# 15 MAMC 205 Continuum Mechanics (3-1-0)

**Module-I (14 Hours)**

Vector calculus: Derivative of a Scalar Function of a Vector ,The del Operator ,Divergence and Curl of a Vector ,Cylindrical and Spherical Coordinate Systems ,Gradient, Divergence, and Curl Theorems ,Tensor calculus, Eigen values & Eigen vectors of Tensors. Kinematics of Continua: Descriptions of Motion: Configurations of a Continuous Medium ,Material Description, Spatial Description, Displacement Field ,Analysis of Deformation :Deformation Gradient Tensor ,Isochoric, Homogeneous, and Inhomogeneous Deformations , Change of Volume and Surface, Strain Measures: Cauchy–Green Strain Tensors

**Module-II (14 Hours)**

Conservation of Mass, Momenta, and Energy: Conservation of Mass: Material Time Derivative, Continuity Equation in Spatial and Material Description, Conservation of Momenta : Principle of Conservation of Linear Momentum ,Equation of Motion in Cylindrical and Spherical Coordinates ,Principle of Conservation of Angular Momentum, Thermodynamic Principles :The First Law of Thermodynamics: Energy Equation ,Energy Equation for One-Dimensional Flows ,The Second Law of Thermodynamics

**Module-III (12 Hours)**

Constitutive Equations: Elastic Solids: Generalized Hooke's Law ,Material Symmetry, Monoclinic , Orthotropic and Isotropic Materials ,Transformation of Stress and Strain Components, Constitutive Equations for Fluids: Ideal Fluids, Non-Newtonian Fluids, Heat Transfer: Fourier's Heat Conduction Law ,Newton's Law of Cooling,

**TEXT BOOKS**

J. N. Reddy, An Introduction to Continuum Mechanics with Applications, Cambridge University Press, 2008.

Chapters 2(2.4,2.5.4,2.5.5),3(3.2,3.3,3.4.1),5(5.2.2-5.2.4,5.3.1-5.3.3,5.4.2,5.4.4,5.4.5),6(6.2.2-6.2.7,6.3.2-6.3.4,6.4.2-6.4.3)

M. Gurtin, An Introduction to Continuum Mechanics, Academic press, 1981.

REFERENCES

O. Gonzalez and A. M. Stuart, A First Course in Continuum mechanics,

Cambridge University Press, 2008.

J. N. Reddy, Principles of Continuum Mechanics: A Study of Conservation Principles with Applications, Cambridge University Press, 2010.

Y. R. Talpaert, Tensor analysis and Continuum Mechanics, Springer, 2003.

R. Temam and A. Miranville, Mathematical Modelling in Continuum

Mechanics, Cambridge University Press, 2005.

# 15 MAMF206 Relational Database Management System

## (3-0-0)

**Module I : (10 hours)**

Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages. Data models - Entity Relationship(ER), Mapping ER Model to Relational Model, Network .Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

**Module II : (10 hours)**

Relation Query Languages, Relational Algebra and Relational Calculus, SQL.

Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.

Query Processing Strategy.

**Module III: (10 hours)**

Transaction processing: Recovery and Concurrency Control. Locking and Timestamp based Schedulers.

Database Recovery System: Types of Data Base failure & Types of Database Recovery, Recovery techniques

**Text Books:**

1. Database System Concepts by Sudarshan, Korth (McGraw-Hill Education )
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

**References Books:**

(1) An introduction to Database System – Bipin Desai, Galgotia Publications
(2) Database System: concept, Design & Application by S.K.Singh (Pearson Education)
(3) Database management system by leon &leon (Vikas publishing House).
(4) Fundamentals of Database Management System – Gillenson, Wiley India
(5) Database Modeling and Design: Logical Design by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, “”, 4th Edition, 2005, Elsevier India Publications, New Delhi

## 15 MCC 251 NUMERICAL ANALYSIS LAB(0-0-3)

1. Write a computer oriented algorithm & the corresponding C Program to fit a st. line of the form y = a x + b, for a given data, using the method of least square.
2. Write a computer oriented algorithm & the corresponding C Program to fit a nth degree polynomial of the form $y = \sum_{i=0}^{n} c_i x^i$ for a given data by the method of least square.
3. Write a computer oriented algorithm & the corresponding C Program to find the smallest positive root using fixed point iteration method.
4. Write a computer oriented algorithm & the corresponding C Program to find the smallest positive root using Newton- Raphson method.
5. Write a computer oriented algorithm & the corresponding C Program to find the solution of the system of linear equations using Gauss Seidel Method.
6. Write a computer oriented algorithm & the corresponding C Program to interpolate y using the given pair of values of x and y by Lagrange's interpolation.
7. Write a computer oriented algorithm & the corresponding C Program to find the derivative at the initial point using Newton 's Forward Difference Method.
8. Write a computer oriented algorithm & the corresponding C Program to find the derivative at the final point using Newton 's Backward Difference Method.
9. Write a computer oriented algorithm & the corresponding C Program to integrate Numerically using Trapezoidal & Simpson's Rule.
10. Write a computer oriented algorithm & the corresponding C Program to integrate Numerically using Gauss Quadrature Rule.
11. Write a computer oriented algorithm & the corresponding C Program to solve the Differential Equation. $\frac{dy}{dx} = f(x, y),\ y(x_0) = y_0$ at the specified pivotal points by using the Runge-Kutta Method of $4^{th}$ order.

## 15 MACF252 Relational Database Managements System Lab (0-0-3)

1. Use of SQL syntax: insertion, deletion, join, updation using SQL. (1 class)

2. Programs on join statements and SQL queries including where clause. (1 class)

3. Programs on procedures and functions. (1 class)

4. Programs on database triggers. (1 class)

5. Programs on packages. (1 class)

6. Programs on data recovery using check point technique. (1 class)

7. Concurrency control problem using lock operations. (1 class)

8. Programs on ODBC using either VB or VC++. (1 class)

9. Programs on JDBC. (1 class)

10. Programs on embedded SQL using C / C++ as host language. (1 class)

# DETAILED SYLLABUS OF SEMESTER-III

# 15 MMCC –304 OPTIMIZATION TECHNIQUES (3-0-0)

**Module-I (10 Hours**)

**Linear programming:** Formulation of LPP, Graphical solution, Simplex method, Big M method, Two Phase method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming

**Transportation problems:** Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method.

**Assignment problems:** Hungarian method for solution of Assignment problems.

**Module -II (10 Hours)**

**Integer Programming**: Integer programming problem, Importance and application of Integer programming problem, Gromory cutting plane method and fractional cut method Branch and Bound algorithm for solution of integer Programming Problems .Zero one programming problem.

**Game theory :** Pay off, types of games, maxima minima principle ,without saddle point ,2x2 and 2xn dominance principle

**Dynamic programming :** Decision tree Belmain principle of optimality characteristics of DPP DPP algorithm

**Simulation and Modeling :** Introduction to simulation and modeling,random variable ,monte carlo techinque and monte carlo, Simulation ,generation of random variables.

**Sequencing :** Principle assumption n jobs through two machine,N jobs with tree machine, N jobs and k machine , 2 jobs through k machine,Decision theory making process making environment under conditions of certainty

**Module -III (10 Hours)**

**Goal programming:** Goal programming model formulation, Goal programming algorithm and modified simplex method of Goal programming.

**Non-linear programming:** Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Constrained optimization with inequality constraint: Kuhn-Tucker condition.

**Ttext books**

1. A. Ravindran, D. T. Philips, J. Solberg, *" Operations Research- Principle and Practice*", Second edition, Wiley India Pvt Ltd
2. Kalyanmoy Deb, " *Optimization for Engineering Design*", PHI Learning Pvt Ltd

**Reference books:**

1. **S**tephen G. Nash, A. Sofer, *" Linear and Non-linear Programming*", McGraw Hill
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis," *Engineering Optimization*", Second edition, Wiley India Pvt. Ltd
3. H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, "*Operations Research*", Eighth Edition, Pearson Education
4. F.S.Hiller, G.J.Lieberman, *" Operations Research*", Eighth Edition, Tata McDraw Hill
5. P.K.Gupta, D.S.Hira, "*Operations Research*", S.Chand and Company Ltd.
6. Kanti Swarup, P. K. Gupta, Man Mohan, "*Operations Research*", Sultan Chand and Sons.

# 15 MMCC – 301 FUNCTIONAL ANALYSES (3-1-0)

## MODULE-I (14 Hours)

Normed spaces, continuity of linear maps, Hahn-Banach theorems, Banach spaces.

Uniform bounded principle, Application-Divergencce of Fourier Series of Continuous Functions, closed graph theorem, open mapping theorem, bounded inverse theorem, Spectrum bounded Operator.

## MODULE-II (13 Hours)

Duals and transposes, duals of $L^p[a,b]$ and $C[a,b]$.

Inner product spaces, orthonormal sets, approximation and optimization, projections, Riesz representation theorem.

## MODULE-III (13 Hours)

Bounded operators and adjoints on a Hilbert space, normal, unitary and self adjoint operators.

**Text book :**

1. B. V. Limaye : Functional Analysis (2nd Edition)- New Age International Limited.

Chapter-2 (5-8), chapter-3 (9-12), chapter-4 (13,14), chapter-6 (21-24), chapter-7 (25,26)

2. G. *BACHMAN*, L. *NARICI*, *Functional Analysis*, Academic Press

**Reference book :**

1) Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons (Asia), pvt.ltd., 2006.
2) John B. Conway, A course in Functional Analysis, 2nd edition, Springer verlag, 2006

# ELECTIVE – I (3-0-0)

## PARALLEL AND DISTRIBUTED COMPUTING (3-0-0)

**Module - I (12 Hrs.) .**

Introduction to parallel computing. Parallel programming platforms: Trends in microprocessor Architectures, Limitations of memory system performance, Dichotomy of parallel computing platforms, physical organization of parallel platforms, communication costs in parallel machines, Routing mechanisms for interconnection network, Impact of process processors mapping and mapping techniques

**Module –II (12 Hrs)**

Principles of parallel algorithm design: Preliminaries, Decomposition techniques, Characteristics of tasks and interactions, Mapping techniques for load balancing, Methods for containing. Interactions overheads, Parallel algorithm models. Basic communication operations: One-to-All Broadcast and All-to-One Reduction, All-to-All broadcast and reduction All-Reduce and prefix sum operations, scatter and gather, All-to-All personalized communication, circular shift, Improving the speed of some communication operation

**Module – III (16 Hrs)**

Analytical modeling of parallel programs: Performance metrics for parallel systems, Effect of granularity of performance, scalability of parallel system, Minimum execution time and minimum cost-optimal execution time, Asymptotic analysis of parallel programs, other scalability metrics. Programming using the message passing paradigm:

Principle of message – Passing programming, Send and receive operations, The message passing interface, Topologies and embedding, Overlapping communication with computation, collective communication and computation operations, Groups and communicators.

Dense matrix algorithm:

Matrix-vector multiplication, Matrix-matrix algorithm, Solving a s.

**Text Book:**

1. Introduction to Parallel Computing, Second Edition, Ananth Gram, Anshul Gupta, George Karypis, Vipin Kumar Person Education.
2. Parallel computing Theory and Practice, Second Edition, Michael J. Quinn, TMH.
3. Advanced Computer Architecture: Parallelism, Scalability, Programmability, Kai **Hwang**, McGraw-Hill.

**Reference Books :**

1. Distributed Computing: Principles and Applications ,Mei-Ling **Liu**, 2004, Pearson Education, Inc. New Delhi.
2. Introduction to Distributed Algorithms ,Gerard **Tel**, Second edition, 2002, Cambridge University Press / Foundation Books India, New Delhi.

# ELECTIVE – I (3-0-0)

# COMPUTATIONAL FINANCE (3-0-0)

**Module-I (14 Hrs)**

Stochastic process: Markov process, Wiener process, Geometric Brownian Motion, Ito Integral, Ito's Lemma.

Basic concepts of financial- Stock options, Forward and Futures, Speculation, Hedging, put-call parity, Principle of non-arbitrage pricing, Computation of volatility.

**Module-II(14 Hrs)**

Derivation of black- scholes differential equation and Black-scholes Option Pricing formula, Greeks and Hedging strategies.

**Module-III(12 Hrs)**

Finite difference methods for partial differential equations-finite difference approximation to derivatives, Explicit and implicit and methods for parabolic equations, Iterative methods for solution of a system of linear algebraioc equations, Two dimensional Parabolic equations-alternating –directimplicit method, Convergence, Stability and Consistency of finite difference schemes.

## Text Book:

1 .J. BAX and G. Chacko-Financial Derivatives : Pricing, Application and Mathematics-Cambridge Univ. Press, 2004.

2. G. D. Smith : Numerical Solution of Partial Differential Equations, Oxford University Press.

## References Book :

1. P. Wilmott : Qualitative Finance-John Wiley, 2000.

2. P. Copinsui and T. Zastawrian : Mathematics for Finance-an Introduction to Financial Engineering, Springer Verlag.

3. J. C. Hull : Options, Futures and others Derivatives-PHI, 2003

# ELECTIVE-I

# Fluid Dynamics

# CODE-MAME301

**Unit – I**

Basic Concepts.

**Unit – II**

Fundamental Equations of the flow of viscous fluids. Dynamical similarity, inspection and Dimensional Analysis.

**Unit – III**

Exact solutions of Navier - Stokes Equations.

**Unit – IV**

Theory of Laminar Boundary Layers.

**Unit – V**

Integral methods for the approximate solution of laminar boundary layer equations, thermal boundary layers in Two – Dimensional Flow.

**Book Prescribed:**

Viscous Fluid Dynamics – J. L .Bansal, Oxford 7 IBH Publishing Co.

Chapter (2.1-2.6), 3 (3.1-3.4, 3.8, 3.9), (4.1-4.6).

Chapter 4(4.8-4.13), 6(6.1-6.4), 7(7.1-7.4), 8(8.1,8.2).

# ELECTIVE-II
# GRAPHY THEORY
# CODE: MAME311

**UNIT-I**

Definition of a Graph, Paths and Circuits: Isomorphism,Sub graphs,walks,andcircuits, Connected graphs,disconnected Graphs and components,Euler Graphs,Operations on Graphs,more on Euler Graphs,Hamiltonian Paths and circuits,the Traveling salesman Problem,the Degree of Vertex, Sub graphs, Degree Sequences, Cut-Vertices and Bridges, Special Graphs, Digraphs, Properties of Trees, Depth FirstSearch and Breadth First Search.

**UNIT-II**

Eulerian Graphs and their characterization,HamiltonianProperties of Planar Graphs,Vertex- Colouring and Chromatic Polynomial.Trees: definition and properties, rooted trees, tree traversals- preorder, inorder,postorder, binary trees,labeled trees, spanning trees, cut sets, Graph traversals-BFS And DFS, minimum cost spanning trees-Prim and Kruskal's algorithm,shortest paths in weighted graphs-
Dijkstra's algorithm

**UNIT-III**

Vector spaces of a Graph:sets with one operation,sets with two operations,Modular Arithmetic and Galois Fields, vectors and vector spaces,vector space Associated with a Graph,Basis vectors of a Graph,circuit and cut-set subspaces,orthogonal vectors and spaces,intersection and join of W and $W^S$ .Matrix Representation of Graphs:Incidence Matrix, submatricesA (G), circuit Matrix,fundamental circuit Matrix and Rank,cut-set Matrix,Relationship among $A_f$ ,$B_f$ and $C_f$,path Matrix

**Text Book:**

1. GRAPH THEORY with applications to Engineering and Computer Science BY NARSINGH DEO

## 15 MMCC 351 Optimization Lab (0-0-3)

1. Introduction to linear programming problem, solving lpp by mat lab(Introduction)

2. Solve various simplex problem using mat lab Function

3. Solve Transportation and assignment problem using ,Any suitable simulator

4. Compare between Transportation, Assignment problem by using mat lab

5. Explore queuing theory for scheduling, resource allocation, and traffic flow applications using mat lab

6. Elementary concept of Modelling and Simulation using Mat-lab

7. Solve Various Decision Problem Using mat lab

8. Introduction to Non linear Programming by any suitable simulator

9. Iterative method for optimization problem by any suitable simulator

10. Application of non linear programming using Mat lab

## 15 MMCC 352 MatLab (0-0-3)

1. Introduction to statistical problem by mat lab.
2. Finding Correlation, Regression by the use of mat lab.
3. T- test , Chi square test by using mat lab.
4. Testing of hypothesis, confidence interval by using mat lab.
5. Statistical validation of various types of data by using mat lab.
6. Design and modeling of Binomial and Poisson distribution by mat lab.
7. Generation of random numbers, by any simulator.
8. Simple integration by random numbers, mat lab implementation.
9. Finding $1^{st}$,$2^{nd}$ moments by using mat lab.
10. General statistical application in validation of medical related data.

# DETAILED SYLLABUS OF SEMESTER-IV

# 15 MCC 401 DIFFERENTIAL GEOMETRY (3-1-0)

**Module – I : (14 Hours)Tensors**

Tensor and their transformation laws, Tensor algebra, Contraction,

Quotient law, Reciprocal tensors, Kronecker delta, Symmetric and skew- symmetric tensors, Metric tensor, Riemannian space, Christoffel symbols and their transformation laws, Covariant differentiation of a tensor, Riemannian curvature tensor and its properties, Bianchi identities, Ricci-tensor, Scalar curvature, Einstein space.

**Module – II : (12 Hours)Curves in Space**

Parametric representation of curves, Helix , Curvilinear coordinates in $E_3$. Tangent and first curvature vector, Frenet formulas for curves in space, Frenet formulas for curve in $E_{n.}$ Intrinsic differentiation, Parallel vector fields, Geodesic.

**Module – III : (14 Hours)Surfaces**

Parametric representation of a surface, Tangent and Normal vector field on a surface, The first and second fundamental tensor, Geodesic curvature of a surface curve, The third fundamental form, Gaussian curvature , Isometry of surfaces, Developable surfaces, Weingarten formula, Equation of Gauss and Codazzi , Principal curvature, Normal curvature, Meusnier's theorem.

**Text Book:**

1. Tensor Calculas and Application to Geometry and Mechanics :

   (Chapter-II and III) – I.S.SOKOLNIKOFF.

2. An Introduction to Differential Geometry:

   (Chapter – I,II,III,V and VI) - T.J. WILMORE.

**References Book :**


1. Vector and Tensor Analysis : Lass, H, Mc Graw Hill
2. Tensor Analysis : Shanti Narayan, Academic Publishers
3. Differential Geometry : Weather burn, C.E.
4. Tenser Calculus - BARY SPAIN, Dover Publication

# 15 MAMC 402 Design Analysis and Algorithms

**Module-I**

Basics of Algorithms and Mathematics: (2)

What is an algorithm?, Mathematics for Algorithmic Sets, Functions and Relations, Vectors and Matrices, Linear Inequalities and Linear Equations.

Analysis of Algorithm: (8)

The efficient algorithm, Average, Best and worst case analysis, Amortized analysis , Asymptotic Notations, Analyzing control statement, Loop invariant and the correctness of the algorithm, Sorting Algorithms and analysis: Bubble sort, Selection sort, Insertion sort, Shell sort Heap sort, Sorting in linear time : Bucket sort, Radix sort and Counting sort

**Module-II**

Divide and Conquer Algorithm: (6)

Introduction, Recurrence and different methods to solve recurrence, Multiplying large Integers Problem, Problem Solving using divide and conquer algorithm - Binary Search, Max-Min problem, Sorting (Merge Sort, Quick Sort), Matrix Multiplication, Exponential.

Dynamic Programming: (5)

Introduction, The Principle of Optimality, Problem Solving using Dynamic Programming – Calculating the Binomial Coefficient, Making Change Problem, Assembly Line-Scheduling, Knapsack problem, All Points Shortest path, Matrix chain multiplication, Longest Common Subsequence.

**Module-III**

Greedy Algorithm: (5)

General Characteristics of greedy algorithms, Problem solving using 05 20 Greedy Algorithm - Activity selection problem, Elements of Greedy Strategy, Minimum Spanning trees (Kruskal's algorithm, Prim's algorithm), Graphs: Shortest paths, The Knapsack Problem, Job Scheduling Problem, Huffman code.

Exploring Graphs: (4)

An introduction using graphs and games, Undirected Graph, Directed Graph, Traversing Graphs, Depth First Search, Breath First Search, Topological sort, Connected components,

Backtracking and Branch and Bound: (3)

Introduction, The Eight queens problem , Knapsack problem, Travelling Salesman problem, Minimax principle

**Module-IV**

String Matching: (3)

Introduction, The naive string matching algorithm, The Rabin-Karp algorithm, String Matching with finite automata, The Knuth-Morris-Pratt algorithm.

Introduction to NP-Completeness: (5)

The class P and NP, Polynomial reduction, NP- Completeness Problem, NP-Hard Problems. Travelling Salesman problem, Hamiltonian problem, Approximation algorithms

**Reference Books:**

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, PHI.

2. Fundamental of Algorithms by Gills Brassard, Paul Bratley, PHI.

3. Introduction to Design and Analysis of Algorithms, Anany Levitin, Pearson.

4. Foundations of Algorithms, Shailesh R Sathe, Penram

5. Design and Analysis of Algorithms, Dave and Dave, Pearson.

## 15 MAMC403 MATRIX COMPUTATIONS

**MODULE-I(14)**

**Gaussian Elimination and its Variants:** Matrix Multiplication System of Linear Equations, Triangular systems, Positive Definite Systems; Cholesky Decomposition, Banded Positive Definite Systems, Sparse Positive Definite systems, Gaussian Elimination and the LU Decomposition, Gaussian Elimination with Pivoting, Sparse Gaussian Elimination
**Sensitivity of Linear Systems**: Vector and Matrix Norms, Condition Numbers.

**MODULE-II (13)**

**The Least Squares Problem**, The Discrete Least Squares Problem, Orthogonal Matrices, Rotators, and Reflectors, Solution of the Least Squares Problem, The Gram-Schmidt Process, Geometric Approach, Updating the QR Decomposition, **The Singular Value Decomposition**, Introduction, Some Basic Applications of Singular Values.

**MODULE-III (15)**

**Eigenvalues and Eigenvectors**, Systems of Differential Equations, Basic Facts, The Power Method and Some Simple Extensions, Similarity Transforms, Reduction to Hessenberg and Tridiagonal Forms, The QR Algorithm, Implementation of the QR algorithm, Use of the QR Algorithm to Calculate Eigenvectors, The SVD Revisited,

**Eigenvalues and Eigenvectors**, Eigenspaces and Invariant Subspaces, Subspace Iteration, Simultaneous Iteration, and the QR Algorithm, Eigenvalues of Large, Sparse Matrices, Eigenvalues of Large, Sparse Matrices, Sensitivity of Eigenvalues and Eigenvectors, Methods for the Symmetric Eigenvalue Problem, The Generalized Eigenvalue Problem.

**Text Book :**

1. Fundamentals of Matrix Computation by David S. Watkins,Wiley
   Ch 1.Ch 2.1,2.2,Ch 3,Ch 4.1,4.2,Ch 5,Ch 6.

**Reference Book :**

1. Matrix Computations by Gene H. Golub, Charles F.Van Loan The Johns Hopkins University Press, Baltimore.

# COMPUTATIONAL FLUID DYNAMICS (ELECTIVE-III)

## UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS (15)

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions. Mathematical behaviour of PDEs on CFD – Elliptic, Parabolic and Hyperbolic equations-well posed

problems.

## UNIT II BASIC ASPECTS OF DISCRETIZATION (13)

Introduction- Intrduction to Finite Differences- Difference equations-Explicit and Implicit approaches: Definition and contrasts-Errors and analysis of stability-Grids with the appropriate transformation –metrics and jacobians-Form of the governing equations suited for CFD revisited-stretched grids-Boundary fitted coordinate system-adaptive grids-some modern developments in grid generation.

## UNIT III SOME SIMPLE CFD TECHNIQUES (17)

Introduction-The Lax-Wendroff Technique-MacCormack's Technique-Viscous flows-Conservation-pace marching-The Relaxation Technique and its use with low speed inviscid flow-Aspects of numerical dissipation and dispersion-The Alternating Direction Implicit (ADI) Technique, The Pressure correction technique-application to incompressible Viscous flow.

**TEXT BOOKS:**

1. Anderson J.D., "Computational Fluid Dynamics: The Basics with Applications", McGraw-Hill Publishing Company Ltd.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition, 2007.
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.

**REFERENCES:**

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004. AULibrary.com 99
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
5. ProdipNiyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.

6. Anil W. Date “Introduction to Computational Fluid Dynamics” Cambridge University Press, 2005.

# DESIGN ANALYSIS AND ALGORITHM LAB (0-0-3)

# 15 MAMC451

1. Obtain the Topological ordering of vertices in a given digraph.
2. Compute the transitive closure of a given directed graph using Warshall's algorithm.
3. Implement 0/1 Knapsack problem using Dynamic Programming.
4. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
5. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.
6. Print all the nodes reachable from a given starting node in a digraph using BFS method.
7. Check whether a given graph is connected or not using DFS method.
8. Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s algorithm.
9. Implement N Queen's problem using Back Tracking.
10. Implement All-Pairs Shortest Paths Problem using Floyd's algorithm.

# Matrix Computation LAB (0-0-3)

# 15 MAMC452

1. Write a MATLAB program that performs matrix-vector multiplication using the built-in MATLAB command b = A* x.
2. Solve the System of linear equation using MATLAB?
3. Write a algorithm that implements column oriented forward substitutions.
4. Determine the positive definite of the any 3x3 matrix with the help of MATLAB.
5. Write a algorithm on cholesky's method(inner product form and outer product form).
6. Use MATLAB to generate a random 8x6 matrix with rank 4.
7. Use the MATLAB plot command to plot the five data points and your least squares straight line.
8. Solve the system using MATLAB to find the interpolant.

| | | | |
|---|---|---|---|
| t | 1 | 2 | 3 |
| y | 1.1 | 1.2 | 1.3 |

9. Using Mat lab compute the QR decomposition for complex matrices.
10. Use Mat lab to investigate the sensitivity of the eigen vectors of the normal matrix $A = \begin{bmatrix} 1+\gamma & 0 \\ 0 & 1-\gamma \end{bmatrix}$ for small $\gamma$.
11. Using MATLAB, apply the power method to the following matrix

$$A = \begin{bmatrix} 1 & 1 & 1 \\ -1 & 9 & 2 \\ 0 & -1 & 2 \end{bmatrix}$$