Annexure-I

Programme

Master of Technology in Mathematics and Computing

(M. Tech., Mathematics and Computing)

Department of Applied Sciences (Division of Mathematics)

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

राष्ट्रीय प्रौद्योगिकी संस्थान दिल्ली

Vision

To emerge as a center of excellence and eminence by imparting futuristic technical education with solid mathematical background in keeping with global standards, making our students technologically and mathematically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind.

Mission

- To achieve academic excellence through innovative teaching and learning practices.
- To improve the research competence to address social needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviors for a harmonious and prosperous society.
- Strive to make students to understand, appreciate and gain mathematical skills and develop logic, so that they are able to contribute intelligently in decision making which characterizes our scientific and technological age.

Program Objective

- M.Tech. (Mathematics & Computing) or Master of Technology in Mathematics & Computing is a two-year postgraduate program based on Mathematics and Computer Sciences. The course is designed to provide students with an in-depth theoretical background and practical training in computer science, numerical computing, and mathematical finance.

PO1: To prepare graduates with a solid foundation in Engineering, Mathematical Science and technology for a successful career in Mathematics & Computing/ Finance/Computer Engineering fields.

PO2: To prepare graduates to become effective collaborators/ innovators, who could ably address tomorrow's social, technical and engineering challenges.

PO3: To enrich graduates with integrity and ethical values so that they become responsible engineers.

PO4: To apply mathematics, numerical computation, and applications of systems-oriented ideas to the physical, biological, social, and behavioral sciences,

PO5: To develop the computational approachs on new algorithms, their analysis, and numerical results.

M.Tech. (Mathematics & Computing) Eligibility

- Candidates should have passed a B.E/ B.Tech or M.Sc. (Mathematics/Applied Mathematics/Computer Sciences) or equivalent degree from a recognized University.
- Must possess at least 60% aggregate marks or equivalent at Graduation level
- Candidate must have qualified valid GATE score
- Admission thorough CCMT

M.Tech. (Mathematics & Computing) Course Suitability

- The course is suitable to acquire knowledge and understanding of financial mathematics and computational techniques for finance.
- They should be able to formulate problems from finance in mathematical terms, select and develop an appropriate numerical method, write a computer program to

numerically approximate the problem, and present and interpret these results for a potential client.

How is M.Tech. (Mathematics & Computing) Course Beneficial?

- The course is beneficial for those who want a bit of exposure to everything-maths, computer science, programming, etc.
- It will give you many varied options afterward. It provides a broad range of employment opportunities in mathematics, computing, operations research, and secondary teaching.

Semester wise structure

SN	Courses	Credits				Total
		1st sem	2nd sem	3rd sem	4th sem	
	Program Core	14	14	-	-	28
	Program Electives	6	6	-	-	12
	Seminars/Independent Study	--	--	4	4	8
	Project work (Thesis)	--	--	16	16	32
	total	20	20	20	20	80

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M.Tech. (Mathematics & Computing) Syllabus

Syllabus of **M.Tech.** (Mathematics & Computing) are prescribed as

M.Tech. (Mathematics & Computing) Semester-I			**Credits hours**			
Sr. No.	**Course Name**	**Course code**	**L**	**T**	**P**	**Credit**
1	Discrete Mathematical Structures	MACM501	3	1	0	4
2	Numerical Methods and Computation	MACM502	3	1	0	4
3	Probability and Statistics	MACM503	3	1	0	4
4	Elective- I (bouquet I)	MACM5XX	3	0	0	3
5.	Elective-II (bouquet II)	MACM5XX	3	0	0	3
6	Programming Languages Laboratory	MACM504	0	0	4	2
Total Credits hours (Semester-I)			**15**	**3**	**4**	**20**
M.Tech. (Mathematics & Computing) Semester-II						
1	Data Structures and Algorithms	MACM551	3	0	2	4
2	Computational Methods for	MACM552	3	1	0	4

	Differential Equations					
3	Numerical Optimization	MACM553	3	1	0	4
4	Elective-III (Bouquet I)	MACM5XX	3	0	0	3
5	Elective-IV (Bouquet II)	MACM5XX	3	0	0	3
6	Computational Simulation Lab	MACM554	0	0	4	2
Total credit hours (Semester-II)			**15**	**2**	**6**	**20**
M.Tech. (Mathematics & Computing) Semester-III						
1	Seminar- I	MACM6XX	0	0	8	4
2	Dissertation-Part 1	MACM70X	0	0	32	16
Total			**0**	**0**	**40**	**20**
M.Tech. (Mathematics & Computing) Semester-IV						
1	Seminar-II	MACM6XX	0	0	8	4
2	Dissertation-Part II	MACM7XX	0	0	32	16
Total					**40**	**20**

*Students need to take 2 electives in Bouquet-I and 2 electives in Bouquet-II.

Bouquet-I

List of Electives

SN	Course Name	Course Code	Credits (L-T-P)
1	Introduction to Cyber Security	MACM531	3-0-0
2	Introduction to Machine Learning	MACM532	3-0-0
3	Graph Theory and Combinatorics	MACM533	3-0-0
4	Randomized Algorithms	MACM534	3-0-0
5	Parallel Algorithms	MACM535	3-0-0
6	Computer Networks	MACM536	3-0-0
7	Pattern Recognition and Rule Based Computing	MACM537	3-0-0
8	Big Data Analysis	MACM538	3-0-0
9	Data Mining	MACM539	3-0-0

Bouquet-II (add PG Mathematics courses)

SN	Course Name	Course Code	Credits
1	Mathematical Modeling and Simulation	MAC521	3-0-0
2	Computational Method for Partial Differential Equations	MAC522	3-0-0
3	Applied Regression Analysis	MAC523	3-0-0

4	Financial Mathematics	MAC524	3-0-0
5	Stochastic of Finance	MAC525	3-0-0
6	Boundary Elements Methods with Computer Implementation	MAC526	3-0-0
7	Boundary Value Problems	MAC527	3-0-0
8	Finite Element Method and Applications	MAC528	3-0-0
9	Computational Linear Algebra	MAC529	3-0-0

M.Tech (Mathematics & Computing) Employment Areas

Fields such as **finance, software, IT sector, telecom, pharmaceutical, consulting engineering, and even in public sectors**.

- Asset Allocation Companies
- Colleges / Universities
- Financial Risk Management Firms
- Hedging Firms
- Investment Management Companies
- Modeling and Forecasting Financial Markets

M.**Tech (Mathematics & Computing) Job Types**

- Actuary
- Banker
- Business Data Analyst
- Commodities or Futures Trader
- Computational Engineer
- Consultant

- Data Analyst
- Economic Researcher
- Financial Analyst
- Internet Commerce Worker
- Meteorologist
- Statistician
- Telecommunications Analyst
- Information and Communications Technologist
- Computer Scientist
- Computer Programmer
- Database Coordinator
- Systems Analyst

Core Course Contents

1. **Course name: Discrete Mathematical Structures**

   CO1: Understanding the concepts of discrete mathematical structures.

   CO2: Solving problems on discrete structures.

   CO3: Analyzing the discrete mathematical structures.

   CO4: Creating discrete mathematical structures.

   Course code: MACM501

   Credits(L-T-P): 3 -1-0

   Relations, recursion, recurrence relations, linear homogeneous recurrence relations, solution of recurrence relations. Partially ordered sets, different types of lattices, Boolean algebra, Boolean expressions, logic, networks, Karnaugh maps, application of Boolean algebra to switching theory. Directed graphs, undirected

graphs, matrices, relations and graphs, paths and circuits, Eulerian and Hamiltonian graphs, planar, connected graphs. Trees, properties of trees, rooted trees, spanning trees, minimum spanning trees, binary tree, tree traversals. Linear codes, error detection and correction, hamming distance and hamming weights, maximum-likelihood decoding, syndrome decoding, perfect code, the sphere packing bound, cyclic codes.

Reference Books:

i. K A Ross and G R Wright, "Discrete Mathematics", Prentice Hall of India, 2003.

ii. C L Liu," Elements of Discrete Mathematics", McGraw Hill Publishing Co, 1985.

iii. Narsingh Deo, "Graph theory with applications to Engineering & Computer Science", Prentice Hall of India, 1994.

2. Course name : Numerical Methods and Computations

CO1: Understanding the concepts of numerical methods.

CO2: Solving problems by numerical methods and computation.

CO3: Deriving the numerical techniques.

CO4: Implementation of the numerical techniques.

Course code : MACM502

Credits (L-T-P) : 3 -1-0

Numerical Algorithms and errors, Floating point systems, Roundoff error accumulations. Interpolation: Lagrange Interpolation Newton's divided difference interpolation. Finite differences. Hermite Interpolation. Cubic splines. Numerical differentiation. Numerical Integration: Newton cotes formulas, Gaussian Quadrature composite quadrature formulas

Approximation: Least squares approximation, minimum maximum error techniques. Legendre and Chebyshev polynomials. Solution of Nonlinear equations: Fixed point iteration, bisection, Secant, Regula-Falsi, Newton-Raphson methods. Solution of linear systems: Direct methods, Gauss elimination, LU and Cholesky factorizations. Iterative methods – Jacobi, Gauss- Seidel and SOR methods. System of nonlinear equation, Eigen-Value problems: Power and Inverse power method. Numerical Solution of ODE. Taylor series, Euler and Runge-Kutta methods.

References Books:

i. Gerald & Wheatlay, Applied Numerical Analysis, Pearson, 2004.

ii. M. K. Jain, S.R.K Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age Int., New Delhi, 2010.

iii. D. Kincaid and W Cheney, Numerical Analysis: Mathematics of Scientific Computing (3e), Thomoson Brook/ Cole, 2002.

iv. S.D. Conte & Carl De Boor, Elementary Numerical Analysis, McGraw Hill, 2005.

v. Naseem Ahmad, Fundamentals Numerical Analysis with error estimation, Anamaya Publishers, 2010.

vi. J Stoer and R. Bullirsce, An introduction to Numerical Analysis (2e), Academic Press, 1996.

3. Course name: Probability and Statistics

Course code: MACM503

Credits(L-T-P): 3 -1-0

Course outcomes:

CO1: Understanding the concepts of probability and statistics.

CO2: Solving problems using concepts of probability theory and statistics.

CO3: Analyzing the concept probability on real life problems.

CO4: Creating models based on probability and statistics.

Probability definition, conditional probability, Bayes theorem, random variables, expectation and variance, specific discrete and continuous distributions, e.g. uniform, Binomial, Poisson, geometric, Pascal, hypergeometric, exponential, normal, gamma, beta, moment generating function, Poisson process, Chebyshev's inequality, bivariate and multivariate distributions, joint, marginal and conditional distributions, order statistics, law of large numbers, central limit theorem, sampling distributions - Chi-sq, Student's t-test, F-distribution, theory of estimation, maximum likelihood test, testing of hypothesis, nonparametric analysis, test of goodness of fit.

Reference Books:

i. Hogg, R.V., McKean, J.W. and Craig, A.T., Introduction to Mathematical Statistics. 7th Edition, Pearson, Boston, 2013.

ii. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics (A Modern Approach) 10th Edition, Sultan Chand & Sons, 2002

iii. Sheldon M. Ross, First Course in Probability, A, 9th Edition, Pearson, Boston, 2014.

iv. V.K. Rohatgi and A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, John Wiley & Sons, 3rd Edition, 201

4. Course name : Programming Languages Laboratory

CO1: Understanding the basic programing language.

CO2: Solving problems using programming languages.

CO3: Developing programs based on high level languages.

CO4: Application of programming languages in real problems.

Course code : MACM504

Credits (L-T-P) : 0 -0-4

Introduction to Computers - CPU, ALU, I/O devices, Introduction to C Programming - Data types, Looping Statements, Arrays, Structure, Functions (Both simple and Recursive function), Call by Value and Call by reference, Pointers, File Handling in C

Introduction to C++ Programming, Looping Statements, arrays and Structures in C++, Functions in C++, Basic Python programming

Reference Books:

i. M. Morris Mano, Computer System Architecture, Prentice Hall of India, 1982.

ii. William Stalling, Computer Organization and Architecture, Pearson Education, 2015.

iii. P. K. Sinha & Sinha, Priti, Computer Fundamentals, BPB, 2007.

iv. V., Rajaraman, Fundamentals of Computers, PHI, 2010.

v. S. Lipshutz, Data Structures, Schaum outline series, McGraw-Hill, 2011.

vi. Cay Horstmann, Computing Concepts with Java Essentials, 2 nd Edition, Wiley India, 2006.

5. Course name : Data Structures and Algorithms

CO1: Understanding the concepts of data structures.

CO2: Solving problems using data structures.

CO3: Analyzing problems based on data structures.

CO4: Creating algorithms based on data structures.

Course code : MACM551

Credits(L-T-P) : 3 -0-2

Preliminaries: Growth of functions, recurrence relation, generating functions, solution of difference equations, Master's theorem (without proof).

Sorting and Order Statistics: Bubblesort, mergesort, heapsort, quicksort, sorting in linear time, median and order statistics.

Elementary Data Structures: Stacks, queues, linked lists, implementing pointers, rooted trees, direct-address tables, hash tables, open addressing, perfect hashing, binary search trees, red-black trees, dynamic programming, optimal binary search trees, greedy algorithms.

Graph Algorithms: Breadth-first search, depth-first search, topological sort, Minimum spanning trees, Krushkal's and Prim's algorithms, shortest path, Bellman-Ford algorithm, Dijkstra's algorithm, Floyd-Warshall algorithm, Johnson's algorithm, Maximum flow, Ford-Fulkerson method, maximum bipartite matching.

Reference Books:

i. Elmasri, Navathe, Fundamentals of Database Systems, Pearson Education, 2008.

ii. Henry F. Korth, Abraham Silberschatz, S. Sudurshan, Database System Concepts, McGraw-Hill, 2005.

iii. C. J. Date, An Introduction to Database Systems, Pearson, 2006.

iv. Ramakrishna, Gehrke, Database Management Systems, Mcgraw-Hill, 2014.

v. S.K. Singh, Database Systems Concepts, Design and Applications, Pearson, 2011. 6. Jeffrey D. Ullman, Jennifer Widom, A first course in Database Systems, Pearson, 2014.

6. Course name: Computational Methods for Differential Equation

CO1: Understanding the concepts of differential equations.

CO2: Solving problems on differential equations.

CO3: Analyzing the computational methods for differential equations.

CO4: Implementing computational methods on differential equations.

Course code: MACM552

Credits(L-T-P): 3 -1-0

Numerical methods for solving IVPs for ODEs: Difference equations, Routh-Hurwitz criterion, Test Equation. Single step methods: Taylor series method, explicit Runge-Kutta methods, convergence, order, relative and absolute stability. Multistep methods: Development of linear multistep method using interpolation and undetermined parameter approach, convergence, order, relative and absolute stability, Predictor Corrector methods. Solution of initial value problems of systems of ODES. BVP: Finite difference methods for second order ODEs, Eigenvalue problems.

Reference Books:

i. Earl A. Coddington, An Introduction to Ordinary Differential Equation, Dover Publications, INC., 2012.

ii. Henrice, P., Discrete variable methods in ordinary differential equation, wiley New York 1962.

iii. Atkinsen, K.E. Han, W. Stewark, D.E., numerical solution of ordinary differential equation, wiley, John Wiley and Sons, 2009.

iv. Boyce and Diprime, Elementary Differential Equations and Boundary Value Problems, Wiley, 2008.

v. H. F. Weinberger, A First Course in Partial Differential Equations: with Complex Variables and Transform Methods (Dover Books on Mathematics), Dover Publications, 1995.

7. Course name: Numerical Optimization

CO1: Understanding the concepts of optimization.

CO2: Solving problems using numerical optimization.

CO3: Analyzing the numerical techniques of optimization.

CO4: Implementing the optimization techniques on real applications.

Course code: MACM553

Credits(L-T-P): 3 -1-0

Introduction, Background and Classification of optimization problems, Unconstrained optimization, Line Search methods, Trust region methods, Gradient descent, Exact and Quasi-Newton Methods, Non-linear least squares, Nonlinear equations, Constrained optimization, Linear programming: Simplex method, Nonlinear constrained optimization, Farkas' lemma, Karushâ“Kuhnâ“Tucker (KKT) conditions, Quadratic programming, Penalty, Barrier and Augmented Lagrangian methods, Sequential Quadratic Programming, Large scale optimization: Algorithms and Softwares.

Reference Books:

i. P. E. Gill, W. Murray and M. H. Wright, Numerical Methods for Linear Algebra and Optimization: Volume 1, Addison-Wesley.

ii. P. E. Gill and W. Murray, Numerical Methods for Constrained Optimization, Academic Press. 3. P. E. Gill, W. Murray, and M. H. Wright, Practical Optimization, Academic Press.

8. Course name: Computational Simulation Lab

CO1: Understanding the simulation techniques.

CO2: Solving problems using simulation methods.

CO3: Developing computational programs.

CO4: Implementing the simulation programs on real problems.

Course code: MACM554

Credits(L-T-P): 0-0-4

Numerical Optimization, Linear programming: Simplex method, Nonlinear constrained optimization, Quadratic programming, Large scale optimization: Algorithms and Softwares, Errors - Rounding off error - Solution of Algebraic and Transcendental equations - Bisection method - Regula-Falsi Method - Newton-Rephson's Method - Muller's Method - Interpolation formulae using differences - Difference Schemes - Lagrange's interpolation formula. Taylor's series method for linear ODE, 2^{nd} and

4^{th} order Runge Kutta (RK) method, Multistep method.

Reference Books:

i. Gerald & Wheatley, Applied Numerical Analysis, Pearson, 2004.

ii. G.D. Smith, Numerical Solutions of Partial Differential Equations, Clarendon Press Oxford, 1985.

iii. S.D. Conte & Carl De Boor, Elementary Numerical Analysis, McGraw Hill, 2005.

iv. Naseem Ahmad, Fundamentals Numerical Analysis with error estimation, Anamaya Publishers, 2010.

Bouquet-I

1. Course name: Information Security

CO1: Understanding Information Security.

CO2: Solving problems using Cybersecurity.

CO3: Developing computational programs for Cybersecurity.

CO4: Implementing the real network systems.

Course code: MACM531

Credits(L-T-P): 3 -0-0

Introduction to Cybersecurity, Network Security, Key distribution, Transport layer security, Internet protocol security, Wireless security, Email security, Network monitoring, Intrusion detection system, Virtual private network and firewall.

Systems Security, Malware, Program analysis, Penetration testing, Embedded system and hardware security, Mobile security, Secure storage management.

Evolving Security Techniques, IoT security, Cyber-physical system security, Adversarial ML, Block chains. Cyber Forensics & Incident Management

Reference Books:

i. Kevin Clark · Narrated by Jim D Johnston, Cybersecurity for Beginners: Learn the Fundamentals of Cybersecurity in an Easy, Step-by-Step Guide,2022

ii. Ajay Singh, Introduction to Cyber Security Concepts Principles Technologies and Practices, Universities Press (India) Pvt. Ltd.

2. Course name: Introduction to Machine Learning

CO1: Understanding the basic concept of machine learning.

CO2: Apply search strategies to solve AI problems.

CO3: Developing algorithms based on machine learning.

CO4: Implementing the machine learning concept on real world problems.

Course code: MACM532

Credits(L-T-P): 3 -0-0

Algorithmic models of learning. Learning classifiers, functions, relations, grammars, probabilistic models, value functions, behaviors and programs from experience. Bayesian, maximum a posteriori, and minimum description length frameworks, Parameter estimation, sufficient statistics, decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, probabilistic relational models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers, Computational learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning, accuracy and confidence boosting. Dimensionality reduction, feature selection and visualization. Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering, Introduction to Deep Learning, Deep Learning for Computer Vision and NLP (natural language processing)

Reference Books:

i. Bishop, C., Pattern Recognition and Machine Learning, Berlin: Springer-Verlag, 2006.

ii. Tom Mitchell, Machine Learning, McGraw Hill, 1997.

iii. Hastie, Tibshirani, Friedman, The Elements of Statistical Learning, Springer, 2001.

iv. Sergios Theodoridis, Konstantinos Koutroumbas, Pattern Recognition, Academic Press, 2009.

3. Course name: Graph Theory and Combinatorics

CO1: Understanding the basic concept graph theory.

CO2: Apply strategies to solve problems using combinatorics.

CO3: Developing the graph based on real problems.

CO4: Characterization of different types of graphs.

Course code: MACM533

Credits(L-T-P): 3 -0-0

Definitions, pictorial representation of a graph, isomorphic graphs, sub graphs, matrix representations of graphs, degree of a vertex, special graphs, complements, larger graphs from smaller graphs, connected graphs and shortest paths, walks, trails, paths, cycles, connected graphs, cut-vertices and cut-edges, blocks, connectivity, weighted graphs and shortest paths, weighted graphs, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.

Trees, Definitions and characterizations, number of trees, Cayley's formula, minimum spanning trees, Kruskal's algorithm, Prim's algorithm, bipartite graphs, Eulerian graphs, Fleury's algorithm, Chinese Postman problem.

Hamilton Graphs, necessary conditions and sufficient conditions, independent sets, coverings and matchings, matchings in bipartite graphs, Hall's theorem, Konig's theorem, perfect matching's in graphs, vertex Colorings, basic definitions, cliques and chromatic number, greedy coloring algorithm.

Edge colorings, Gupta-Vizing theorem, class-1 and class-2 graphs, edge-coloring of bipartite, graphs, planar graphs, basic concepts, Euler's formula and its consequences, characterizations of planar graphs, 5-color-theorem, directed graphs, directed walks, paths and cycles, Eulerian and Hamilton digraphs.

Planarity (duality, Euler's formula, characterization, 4-color theorem); Advanced topics (perfect graphs, matroids, Ramsay theory, extremal graphs, random graphs); Applications.

Reference Books:

i. D. B. West, Introduction to Graph Theory, 2 nd edition, Prentice Hall, 2000.

ii. R. Diestel, Graph Theory (Graduate Texts in Mathematics), 2nd edition, Springer Verlag, 2000.

iii. J.A. Bondy and U.S.R. Murty, Graph Theory (Graduate Texts in Mathematics), Springer, 2011.

iv. R. P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5 th edition, Pearson Education, Asia, 2003.

v. N. Alon and J. Spenser, The Probabilistic Method, 3 rd edition, John Wiley y and Sons, 2008.

4. Course name: Randomized Algorithms

CO1: Understanding the basic concept of Randomized algorithms

CO2: Determine the different types of algorithms

CO3: Developing randomized algorithms based on probability theory

CO4: Implementing the algorithms for solving real world problems.

Course code: MACM534

Credits(L-T-P): 3 -0-0

The concept of probability, The axioms of probability, Some important theorems on Probability, Conditional Probability, Theorems on conditional probability, Independent Event’s, Bayes’Theorem.

Random Variables Random variables, discrete probability distributions, Distribution functions for Discrete random variables, Continuous probability distribution, Distributions for Continuous random variables, joint distributions, Independent random variables. Mathematical Expectation Definition, Functions of random variables, some theorems on Expectation, The variance and Standard Deviation, Moments, Moment Generating Functions, Covariance, Correlation Coefficient.

Special Probability Distributions The Binomial Distribution, The Normal Distribution, The Poisson Distribution, Relations between different distributions, Central limit theorem, Uniform distribution, Chi square Distribution, Exponential distribution. Sampling Theory Population and Sample, Sampling with and without replacement, the sample mean, Sampling distribution of means, proportions, differences and sums, the sample variance, the sample distribution of variances.

Tests of Hypotheses and Significance Statistical Decisions, Statistical hypotheses, Null Hypotheses, Tests of hypotheses and significance, Type I and Type II errors, level of significance, Tests involving the Normal distribution, One Tailed and Two tailed tests, Special tests of significance for large and small samples.

Reference Books:

iii. Robert V Hogg, Joseph McKean, Allen T Craig, Introduction to Mathematical Statistics, Pearson Edition 7th Edition

iv. Sheldon M Ross, Introduction to Probability and Statistics for Engineers and Scientists, Publisher Elsevier, 5th Edition.

5. Course name: Parallel Algorithms

CO1: Understanding the basic concepts of parallel algorithms

CO2: Apply Parallel Algorithms on high end processors

CO3: Developing parallel algorithms based different types of models

CO4: Implementing the parallel algorithms on real applications

Course code: MACM535

Credits(L-T-P): 3 -0-0

Need for Parallel Processing - Data and Temporal Parallelism - Models of Computation - RAM and PRAM Model – Shared Memory and Message Passing Models- Processor Organisations - PRAM Algorithm – Analysis of PRAM Algorithms- Parallel Programming Languages.

Parallel Algorithms for Reduction – Prefix Sum – List Ranking –Preorder Tree Traversal – Searching -Sorting - Merging Two Sorted Lists – Matrix Multiplication - Graph Coloring - Graph Searching.

2D Mesh SIMD Model - Parallel Algorithms for Reduction - Prefix Computation - Selection - Odd-Even Merge Sorting - Matrix Multiplication

Hypercube SIMD Model - Parallel Algorithms for Selection- Odd-Even Merge Sort- Bitonic Sort- Matrix Multiplication Shuffle Exchange SIMD Model - Parallel Algorithms for Reduction -Bitonic Merge Sort - Matrix Multiplication - Minimum Cost Spanning Tree.

UMA Multiprocessor Model -Parallel Summing on Multiprocessor- Matrix Multiplication on Multiprocessors and Multicomputer - Parallel Quick Sort - Mapping Data to Processors.

Reference Books:

i. Michael J. Quinn, "Parallel Computing: Theory & Practice", Tata McGraw Hill Edition, Second edition, 2017.

ii. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", University press, Second edition, 2011.

iii. V Rajaraman, C Siva Ram Murthy, "Parallel computers- Architecture and Programming ", PHI learning, 2016.

iv. Ananth Grame, George Karpis, Vipin Kumar and Anshul Gupta, "Introduction to Parallel Computing", 2nd Edition, Addison Wesley, 2003.

v. M Sasikumar, Dinesh Shikhare and P Ravi Prakash, " Introduction to Parallel Processing", PHI learning , 2013.

vi. S.G.Akl, "The Design and Analysis of Parallel Algorithms", PHI, 1989.

6. Course name: Computer Networks

CO1: Understanding the basic concept of computer network.

CO2: Apply computer network on different types of complex problems.

CO3: Developing algorithms-based computer networks.

CO4: Implementing the Computer network on social platforms.

Course code: MACM536

Credits(L-T-P): 3 -0-0

Introduction: history and development of computer networks, Basic Network Architectures: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit switched, packet switched, message switched, extranet, intranet, Internet, wired, wireless)

Physical layer: line encoding, block encoding, scrambling, modulation demodulation (both analog and digital),errors in transmission, multiplexing (FDM, TDM, WDM, OFDM, DSSS), Different types of transmission media. Data Link Layer services: framing, error control, flow control, medium access control. Error & Flow control mechanisms: stop and wait, Go back N and selective repeat. MAC

protocols: Aloha, slotted aloha, CSMA, CSMA/CD, CSMA/CA, polling, token passing, scheduling.

Local Area Network Technology: Token Ring. Error detection (Parity, CRC), Ethernet, Fast Ethernet, Gigabit Ethernet, Personal Area Network: Bluetooth and Wireless Communications Standard: Wi-Fi (802.11) and WiMAX

Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Supernetting, Classless addressing, Network Address Translation

Transport layer: UDP, TCP. Connection establishment and termination, sliding window, flow and congestion control, timers, retransmission, TCP extensions, Queuing theory, Single and multiple server queuing models, Little's formula. Application Layer. Network Application services and protocols including e-mail, www, DNS, SMTP, IMAP, FTP, TFTP, Telnet, BOOTP, HTTP, IPSec, Firewalls.

Reference Books:

i. Computer Networks, AS Tanenbaum, DJ Wetherall, Prentice-Hall, 5th Edition, 2010

ii. Computer Networks: A Systems Approach, LL Peterson, BS Davie, Morgan-Kauffman, 5th Edition, 2011

iii. Computer Networking: A Top-Down Approach 81, JF Kurose, KW Ross, Addison-Wesley, 5th Edition, 2009

7. Course Name: Computer Vision and Pattern Recognition

CO1: Apply mathematical modeling methods for low, intermediate, and high-level image processing tasks (L3).
CO2: Design a new algorithm to solve a recent of the art computer vision problem.
CO3: Perform software experiments on the computer vision problems and compare their performance with the state of the art.
CO4: Build a complete system to solve a computer vision problem.

Course code: MACM537

Credits(L-T-P): 3 -0-0

Course content

Human vision, Image formation: Geometric primitives and transformations , Photometric image formation , The digital camera, How machine sees and recognizes things , Applications , Mathematical foundations

Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches. Statistical Pattern Recognition : Bayesian Decision Theory, Classifiers, Normal density and discriminant functions, Dimension reduction methods – Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation maximization (EM)

Object detection and segmentation e.g. Edge, texture, region, detection of sliding windows : Feature extraction, e.g. linear binary pattern, principal component analysis, Gabor filters, bags of features , Matching and recognition e.g. Bayesian classifier, support vector machine, fusion , Image alignment and stitching,

Photometric calibration , High dynamic range imaging, Super-resolution, denoising, and blur removal, Image matting and compositing, Texture analysis

and synthesis

Key components and basic architecture of deep neural network , Convolution neural network, Object detection using R-CNN, Segmentation using image-to-image neural network, Temporal processing and recurrent neural network.

Reference Books:

Duda, Richard O., Peter E. Hart, and David G. Stork. *Pattern Classification*. New

York, NY: John Wiley & Sons, 2000. ISBN: 9780471056690.

8. Course name: Soft Computing

CO1: Define the basic concepts of soft computing.
CO2: Explain applications & operations of Fuzzy Logic in real life Problems.
CO3: Apply different FIS models to solve optimization problems. Analyse and examine Evolutionary and swarm algorithms in solving real world multi-Objective optimization problems (L2, L3, L4).
CO4: Choose of different optimization algorithms to solve real-life multi objective problems and Discuss applications of Soft Computing and solve Problems in Varieties of Application Domains (L5, L6).

Course code: MACM538

Credits(L-T-P) : 3 -0-0

Basic mathematics of soft computing, Learning and statistical approach to regression and classification.

Single layer perceptron, ADALINE, LMS algorithm, Multi layer perceptron, Radial basis function, Associative Memory Networks, Hopfield Network, Principal component analysis, RNN, MATLAB Programming. Introduction to SVM, Binary classification, Regression by SVM: linear & nonlinear, Decomposing multiclass classification into binary classification. SVM MATLAB Applications
Introduction to Fuzzy logic, Probability vs Possibility Theory, Classical set andfuzzy set, fuzzy set operations, Criteria for Selecting appropriate aggregation Operators. Fuzzy relation, Fuzzy composition, Fuzzy Inference system, Fuzzification, rule based , Defuzzification, Fuzzy Arithmetic, Fuzzy logic application

Introduction, Models of Neuro-fuzzy system (NFS), Interpretation of NFSlayers, Adaptive N-F Inference system (ANFIS) Architecture, T-S Fuzzy system, Mamdani Fuzzy System, ANFIS MATLAB Applications

Introduction to Optimization, Genetic algorithms, Procedure and working of GA, Particle swarm optimization, Matlab programming

Reference Books:

i. Timothy J. Ross, Fuzzy logic with engineering applications, John Wiley & sons, 3rd ed , 2009

ii. S.V. Kartalopoulos, Understanding Neural Networks and Fuzzy Logic: Basic Concepts andApplications, IEEE press, PHI, 2014

9. Course name: Data Mining

CO1: Understanding the basic concept of data mining.

CO2: Apply the data mining on distributed systems.

CO3: Developing algorithms based on data mining.

CO4: Implementing the data mining on real work applications.

Course code: MACM539

Credits(L-T-P) : 3 -0-0

Data Mining Concepts, Input, Instances, Attributes and Output, Knowledge Representation & Review of Graph Theory, Lattices, Probability &Statistics. Machine learning concepts and approaches Supervised Learning Framework, concepts & hypothesis, Training & Learning, Boolean functions and formulae, Monomials, Disjunctive Normal Form & Conjunctive Normal Form, A learning algorithm for monomials.

Data Preparation Data Cleaning, Data Integration & Transformation, Data Reduction. Mining Association Rules Associations, Maximal Frequent & Closed Frequent item sets, Covering Algorithms & Association Rules, Linear Models & Instance Based Learning, Mining Association Rules from Transactional databases, and Mining Association Rules from Relational databases & Warehouses, Correlation analysis & Constraint based Association Mining.

Classification and Prediction Issues regarding Classification & Prediction, Classification by Decision Tree induction, Bayesian classification, Classification by Back Propagation, k Nearest Neighbour Classifiers, Genetic algorithms, Rough Set & Fuzzy Set approaches.

Cluster Analysis Types of data in Clustering Analysis, Categorization of Major Clustering methods, Hierarchical methods, Density based methods, Grid based methods, Model based Clustering methods. Mining Complex Types of Data Annexure VIII 295

Multidimensional analysis & Descriptive mining of Complex data objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time series & Sequence data, Mining Text databases, Mining World Wide Web. Data Mining Applications and Trends in Data Mining Massive Datasets/Text mining, Agent Based Mining. Variance

Analysis and MLE F test, Techniques of Analysis of Variance, Analysis of Variance in two-way Classification Model.

Reference Books:

i. Cristianini N. and Shawe Taylor J., An Introduction to Support Vector Machines and Other Kernel based Learning Methods,2000.

ii. Larose D.T., Discovering knowledge in data: an introduction to data mining, Wiley Interscience, 2005.

iii. Tan P. N., Steinbach M. and Kumar V. Publisher, Introduction to Data Mining, Wesley, 2006.

10. Data Mining and Warehousing

CO1: Explain the concept and significance of Data Mining.
CO2: Explore Recent Trends in Data Mining such as Web Mining, Spatial-Temporal Mining .
CO3: Analyze different mining algorithms and clustering techniques for Data Analytics .
CO4: Design and Develop a Data Warehouse for an organization.

Course code: MACM540
Credits(L-T-P) : 3 -0-0

Course content:

Design Guidelines for Data Warehouse Implementation, Multidimensional Models, OLAP – Introduction, Characteristics, Architecture, Multidimensional view, Efficient Processing of OLAP Queries, OLAP Server Architecture, ROLAP versus MOLAP Versus HOLAP and Data Cube, Data Cube Operations, Data Cube Computation. Motivation for data mining, Introduction to data mining system, Data mining functionalities, KDD, Data object and attribute types, Statistical description of data, Issuesand Applications

Supervised Learning Framework, Concepts & Hypothesis, Training & Learning, Boolean Functions and Formulae, Monomials, Disjunctive Normal Form & Conjunctive Normal Form, A Learning Algorithm for Monomials.

Data cleaning, Data integration and transformation, Data reduction, Data discretization and Concept Hierarchy Generation, Data mining primitives. Frequent patterns, Market basket analysis, Frequent itemsets, closed itemsets, association rules, Types of association rule (Single dimensional, multidimensional, multilevel, quantitative), Finding frequent itemset (Apriori algorithm, FP growth), Generating association rules from frequent itemset, Limitation and improving Apriori, From Association Mining to Correlation Analysis, Lift.

Issues regarding Classification & Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back Propagation, k-Nearest Neighbour Classifiers, Genetic Algorithms, Rough Set & Fuzzy Set Approaches.

Types of Data in Clustering Analysis, Categorization of Major Clustering Methods, Hierarchical Methods, Density-based methods, Grid-based methods, Grid-based methods, Model-based Clustering Method

Reference Book:

i. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Morgan Kaufmann, 2011

ii. Eibe Frank and Ian H. Witten , Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 3rd ed., 2011.

iii. Abraham Sibertschatz, Henry F. Korth and S. Sudarshan, Database Concepts, McGraw Hill, 7th Edition, 2019.

11. Game Theory

CO1: To introduce students to the novel concepts of Game Theory with special emphasis on its applications in diverse fields and current research.
CO2: To analyze the possible outcomes of situations ranging from card games and sports to strategic price fixing, negotiation, group cooperation.
CO3: To understand the possible advantage of moving first, the credibility of threats, the strategic importance of having a last encounter, and the mechanisms to maintain cooperation alive.
CO4: To recognize strategic environments and to use Game Theory to gain a better understanding of interactions and outcomes within them.

Course code: MACM541
Credits(L-T-P) : 3 -0-0

What is game theory, The theory of rational Choice. Games with Perfect Information Strategic Games: Examples of strategic games, Nash Equilibrium and Existence, Best Response functions, Dominated actions, Cournot's model, Bertrand's model, Electoral Competition: Median Voter Theorem, Auctions: Definitions and The role of Knowledge Decision Making and Utility Theory, Mixed Strategy Equilibrium, Pure equilibria. Extensive Form Game with Perfect Information: Theory, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-T Bayesian Games, Cournot's Duopoly with Imperfect Information, Radio Spectrum, With Arbitrary Distribution of Valuations Extensive Games With Imperfect Information, Theory, Signalling Games.

Bargaining Model with Alternating Offers: Nash Bargaining Solution, Relation of Axiomatic and Strategic Model Two Illustrations: a. Trade in market b. Bargaining in Networks. Revenue Equivalence, Risk Averse Bidders, Asymmetries among Bidders, Mechanism, Optimal Mechanism, Auction and Mechanism Design with Applications - II, Efficient Mechanism. Supermodular Game and Potential Game, Wireless Networks: Resource Allocations, Admission Control, Routing in Sensor and Ad-Hoc Networks, Modeling Network Traffic and Strategic Network Formation. a. CDMA Power Control b. Network Admission Control

Reference books

i. Theory, Martin Osborne, Ariel Rubinstein PHI, 2016
ii. Game Theory for Wireless Engineers, Allan MacKenzie, Synthesis lectures on Communications. 2006
iii. Strategies and Games, (SG), Prajit Dutta, MIT Press

iv. Game Theory for Wireless Engineers, Allan MacKenzie, Synthesis lectures on Communications, 2006

Bouquet-II

1. Course name: Mathematical Modeling and Simulation

CO1: Understanding the concepts of modeling and simulation.

CO2: Solving problems using modeling and simulation.

CO3: Analyzing the models and using simulations for applications.

CO4: Developing mathematical models.

Course code: MACM521

Credits(L-T-P): 3 -0-0

Introduction to Mathematical Modeling Process: Concept; Objectives; Methods and tools Mathematics is the natural modeling language; Definition of mathematical models.

Modeling Continuous Systems: Modeling with Differential Equations: Population dynamic; Electrical Circuits; Mechanical Systems; Biological models (Lotka-Volterra systems, Predator-Prey systems).

Modeling with Partial Differential Equations: Linear Temperature Diffusion; One-dimensional Hydrodynamic model. Case Studies: Heat diffusion, Wave vibration, Laplace Equation.

Modeling Discrete Systems: Modeling with difference equations; Modeling with data; Discrete Velocity Models; Continuous Vs. Discrete Models.

Simulation: Block-Diagrams; State-Space Model; Transfer Functions, State-space Vs. transfer function. Stability and pole locations; Introduction to Matlab\Simulink

(Starting Simulink, Basic Elements, Building a System, Running Simulations); Simulation of some models (case study models) and Analysis of Simulation results.

Reference Books:

i. Mathematical Modeling and Simulation: Introduction for Scientists and Engineers, Kai Veltn, Wiley 2009.

ii. Introduction to Simulink® with Engineering Applications, Steven T. Karris, Orchard Publications, 2006.

iii. Simulation Modeling and Analysis with Expertfit Software, Averill Law, McGraw-Hill Science, 2007. 2. A Concrete Approach to Mathematical Modelling, M. M. Gibbons, Wiley-Interscience, 2007.

2. Course name: Computational Methods for Partial Differential Equations

CO1: Understanding the concepts of partial differential equations.

CO2: Solving problems on partial differential equations.

CO3: Analyzing the models of PDE and finding numerical solutions.

CO4: Implementation of numerical techniques on PDE's.

Course code: MACM522

Credits(L-T-P): 3-0-0

Two-point boundary value problem: Variational approach, Discretization and convergence of numerical schemes. Second order Elliptic boundary value problem, Variational formulation and Boundary conditions, Finite element Methods, Galerkin Discretization, Implementation, Finite difference and Finite volume methods, Convergence and Accuracy. Parabolic initial value problems, Heat

equations, variational formulation, Method of lines, Convergence. Wave Equations, Method of lines, Time stepping.

Reference Books:

i. Haberman R. Elementary applied partial differential equations: with Fourier series and boundary value problems: Prentice-Hall, Inc.; 1998.

ii. S.S. Rao, Finite Element Methods in Engineering, Butterworth-Heinemann, 1989.

iii. G.D. Smith, Numerical Solution of Partial Differential Equations: Finite Difference Method, Clarendon Press, Oxford , 1985.

iv. Lawrence C. Evans, Partial Differential Equations, American Mathematical Society

v. An Introduction to Partial Differential Equations, Renardy M., and Rogers R., Springe

3. Course name: Applied Regression Analysis

CO1: Understanding the concepts of regression analysis.

CO2: Solving problems using regression analysis.

CO3: Analyzing the real models using regression analysis.

CO4: Developing mathematical models using regression.

Course code: MACM523

Credits(L-T-P): 3 -0-0

Simple linear regression, multiple linear regression, model adequacy checking, transformations and weighting to correct model inadequacies. Polynomial regression models, orthogonal polynomials. dummy variables, variable selection

and model building, multicollinearity. Nonlinear regression. Generalized linear models, autocorrelation, measurement errors, calibration problem, bootstrapping.

Reference Books:

i. Draper, N. R., and Smith, H. (2003), Applied Regression Analysis, New York: Wiley.

ii. Sen, A. A. and Srivastava, M. (1990). Regression Analysis Theory, Methods & Applications, Springer-Verlag, Berlin.

iii. Bowerman, B. L. and O'Connell, R. T. (1990). Linear Statistical Models: An Applied Approach, PWS-KENT Pub., Boston.

4. Course name: Financial Mathematics

CO1: Understanding the concepts of financial mathematics.

CO2: Solving problems using financial mathematics.

CO3: Analyzing the financial mathematical models.

CO4: Developing mathematical models.

Course code: MACM524

Credits(L-T-P): 3 -0-0

Financial markets, Interest computation, value, growth and discount factors, derivative products, basic option theory: single and multiperiod binomial pricing models, Cox-Ross-Rubinstein (CRR) model, volatility, Black-Scholes formula for option pricing as a limit of CRR model, Greeks and hedging, Mean-Variance portfolio theory: Markowitz model, Capital Asset Pricing Model (CAPM), factor models, interest rates and interest rate derivatives, Binomial tree models.

Reference Books:

i. Sheldon M. Ross, An elementary introduction to mathematical finance, 1999.

ii. Mark H. A. Davis, Mathematical Finance a Very short Introduction, Oxford,2019.

5. Course name: Stochastic of Finance

CO1: Understanding the concepts of Stochastic theory.

CO2: Solving problems using stochastic theory.

CO3: Analyzing the financial based models using stochastic theory.

CO4: Implementing the stochastic models in Finance.

Course code: MACM525

Credits(L-T-P): 3 -0-0

Stochastic Processes; Brownian and Geometric Brownian Motion; Levy Processes, Jump-Diffusion Processes; Conditional Expectations and Martingales; Ito Integrals, Ito's Formula; Stochastic Differential Equations; Change of Measure, Girsanov Theorem, Martingale Representation Theorem and Feymann-Kac Theorem; Applications of Stochastic Calculus in Finance, Option Pricing, Interest Rate Derivatives, Levy Processes in Credit Risk.

Reference Books:

i. Hans Föllmer, Alexander Schied, Stochastic Finance, 4th Edition, De Gruyter,2016.

ii. Nicolas Privault, Stochastic Finance: An Introduction with Market Examples**,** CRC Press,2013

6. Course name: Boundary Elements Methods with Computer Application

CO1: Understanding the concepts of boundary element methods.

CO2: Solving problems using boundary element methods.

CO3: Developing programs for solving boundary value problems.

CO4: Implementing the boundary value problems in real applications.

Course code: MACM526

Credits(L-T-P): 3 -0-0

Distributions and Sobolev spaces of fractional order. Elliptic boundary value problems on unbounded domains in IRn (n=2,3). Fundamental solution of elliptic equations.

Simple layer and double layer potentials Fredholm integral equations of first and second kinds. Singular and hypersingular kernels. Interior and exterior Dirichlet problems and integral representations of their solutions.

Variational formulation of problems defined on boundary. Solution of some model problems by boundary element methods, approximate integrations over boundary, solution methods of algebraic equations; computer implementation of boundary element methods for a model problem. Coupling of boundary element and finite element methods.

Some advanced topics of boundary integral methods integrals with hypersingular kernel, a method of elimination of singularity, Lagrange multiplier method.

Reference Books:

i. Gernot Beer , Ian M. Smith , Christian Duenser, The Boundary Element Method with Programming For Engineers and Scientists,2008.

ii. Prem K. Kythe, An Introduction to Boundary Element Methods,2020.

7. Course name: Boundary Value Problems

CO1: Understanding the concepts of boundary value problems.

CO2: Solving the boundary value problems.

CO3: Characterizing the boundary value problems.

CO4: Developing models based on boundary value problems.

Course code: MACM527

Credits(L-T-P): 3 -0-0

Sturm Liouville problem, Boundary Value Problems for nonhomogeneous ODEs, Green's Functions. Fourier Series and Integrals: Periodic Functions and Fourier Series, Arbitrary Period and Half-Range Expansions, Fourier Integral theorem and convergence of series Parabolic equations: Heat equation, Fourier series solution, Different Boundary Conditions, Generalities on the Heat Conduction Problems on bounded and unbounded domains and applications in Option pricing.

The Wave Equation: The Vibrating String, Solution of the Vibrating String Problem, d'Alembert's Solution, One-Dimensional Wave Equation

The Potential Equation: Potential Equation in a Rectangle, Fourier series method, Potential equation in Unbounded Regions, Fourier integral representations, Potential in a Disk and Limitations.

Higher Dimensions and Other Coordinates: Two-Dimensional Wave Equation: Derivation, Parabolic equation, Solution by Fourier series, Problems in Polar Coordinates, Temperature in a Cylinder, Vibrations of a Circular Membrane.

Finite dimensional approximations of solutions, piecewise linear polynomials and introduction to different methods like Galerkin and Petrov-Galerkin method.

Reference Books:

i. Anthony W. Knapp, introduction to Boundary-Value Problems,2017.

ii. David Powers, Boundary Value Problems and Partial Differential Equations, 6th Edition - July 24, 2009

8. Course name: Finite Element Method and applications

CO1: Understanding the concepts of finite element methods.

CO2: Solving problems using finite element methods.

CO3: Developing programs using finite element methods.

CO4: Implementing the FEM for real life problems.

Course code: MACM528

Credits(L-T-P): 3 -0-0

Introduction and basic concepts, Finite element spaces, Mathematical fundamentals and computer algorithms, Variations and weighted residual techniques, Abstract formulation of FEM for elliptic equations, Applications to Elastic stress analysis using linear elements, FEM for parabolic and hyperbolic equations, Unsteady heat flow analysis, Mixed-FEM, Nonlinear, Curved, Isoperimetric plate and shell elements, Fluid flow, Material nonlinearity including plasticity, Creeping viscous flow and Boundary element formulation for electrostatic problem, Adaptive mesh refinement and large problem solvers.

Reference Books:

i. Reddy, J. N., Introduction to the finite element method. McGraw-Hill Education,2019.

ii. S.C. Brenner, L.R. Scott, Mathematical Theory of Finite Element Method, Springer-Verlag, 1994.

iii. Madenci, E., & Guven, I., The finite element method and applications in engineering using ANSYS®. Springer,2015.

9. Course name: Computational Linear Algebra

CO1: Understanding the numerical methods.

CO2: Solving problems using numerical methods.

CO3: Creating programs based on advanced numerical techniques.

CO4: Implementing numerical techniques on real life problems.

Course code: MACM529

Credits(L-T-P): 3 -0-0

Vector and matrix norms. Direct method for linear system of equations: LU decomposition, Cholesky Factorization, QR factorization; Perturbation analysis of Linear systems of equation. Iterative methods for solving linear systems: Jacobi, Gauss-Seidel and SOR methods, Singular value decomposition of a matrix and its applications. Linear least squares problem. Computational methods for the matrix eigenvalue problems: power method and its variants, Householder method, the QR algorithm.

Reference Books:

i. G.D. Smith, Numerical Solutions of Partial Differential Equations, Clarendon Press Oxford, 1985.

ii. B. N. Dutta, Numerical linear algebra and Application, SIAM, Prentice Hall India, 2010.

iii. S.D. Conte & Carl De Boor, Elementary Numerical Analysis, McGraw Hill, 2005.