B.Sc with Mathematics and Computer Applications

Department of Applied Science
Maulana Abul Kalam Azad University of Technology, West Bengal

"B.Sc in Mathematics and Computing" is an undergraduate non-AICTE course to be offered by Maulana Abul Kalam Azad University of Technology, West Bengal, from this year 2019. This programme blends relevant mathematics and computer science courses covering theoretical, computational and practical aspects. When the core mathematics courses are aimed at building a stron g foundation in the subject, then this laboratory based course give s the exposure and training in application-oriented practical subjects. Students are exposed to advanced research topics through electives and a mandatory two -semester project work.

Eligibility

Duration : 3 years
Qualification: The applicant having passed / appeared /due-to- appear in 2019 at the Higher Secondary Examination in the General or Vocational Stream under the West Bengal Council of Higher Secondary Education or its equivalent examination / Undergraduate Courses as prescribed from a recognized Board / University, respectively are eligible to apply. Candidates should have English, Physics, and Chemistry along with Mathematics at 10+2 level.

Admission

Candidates who seek for admission in this course have to appear in "Common Entrance Test (CET)". Total intake is 30.

Program Objective

The objective of this profram is to prepare the students to

- work alongside engineering, medical, ICT professionals and scientists to assist them in scientific problem solving
- act as administrators in public, private and government organisations or business administrator or entrepreneur with further training and education
- pursue masters and doctoral research degrees to work in colleges, universities as professors or as scientists in research establishments

Program Outcome

On successful completion of this course, student should be able to

- Apply discrete mathematics concept to practical applications such as those in computer science.
- Use concept and tools of diffrential and integral calculus in solving real-life problems.
- Create and develop software applications using systematic approach; to apply general principle of modern programming languages and examing emerging computer and software

technologies within dynamic environments.

- Pursue further studies in advanced computer science and computational mathematics.
- Find jobs in Banking & Finance, Audit Departments, Stock Exchanges, Transport Units Marketing Companies and IT Companies.

Proposed Course Structure

Semester 1:

Serial No.	Category	Subject	Contact Hours /Week			Credit Points
			L	T	P	
1	Core Course-C1	Algebra	3	1	0	4
2	Core Course-C2	Differential Equations	3	1	0	4
3	Core Course-C3	Programming for Problem Solving	4		0	4
4	Generic Elective-GE-1	Physics	2	0	2	2
Sessional						
5	AECC-1	English	2	0	0	2
Practical						
7	Laboratory-1	Programming for Problem Solving Lab	0	0	2	2
8	Laboratory-2	Physics Lab	0	0	2	2
Total Credit = 20						

Semester 2:

Serial No.	Category	Subject	Contact Hours /Week			Credit Points
			L	T	P	
1	Core Course: C4	Real Analysis	3	1	0	4
2	Core Course: C5	Numerical Analysis	3	1	0	4
3	Core Course:C6	Discrete Mathematics	3	1	0	4
4	Generic Elective-GE-3	Chemistry	2	0	0	2
Sessional						
5	AECC	Environmental Science	2	0	0	2
Practical						
7	Laboratory-3	Numerical Lab	0	0	2	2
8	Laboratory-4	Chemistry Lab	0	0	2	2
Total Credit = 20						

Semester 3:

Serial No.	Category	Subject	Contact Hours /Week			Credit Points
			L	T	P	
1	Core Course-C7	Data Structure and Algorithms	4	0	0	4
2	Core Course- C-8	Optimization theory	4	0	0	4
3	Core Course- C-9	Theory of Probability and Statistics	4	0	0	4
4	Elective:Discipline Specific DSE-1	Special Paper 1	4	0	0	4

Practical						
5	Laboratory-5	Data Structure Lab	0	0	4	4
Total Credit = 20						

Semester 4:

Serial No.	Category	Subject	Contact Hours /Week			Credit Points
			L	T	P	
1	Core Course- C-10	Database Management System	4	0	0	4
2	Core Course-C-11	Mathematical Modelling	4	0	0	4
3	Core Course- C-12	Financial Mathematics	4	0	0	4
4	Elective:Discipline Specific DSE-2	Special Paper 2	4	0	0	4
Practical						
5	Laboratory-6	DBMS Lab	0	0	4	4
Total Credit = 20						

Semester 5:

Serial No.	Category	Subject	Contact Hours /Week			Credit Points
			L	T	P	
1	Core Course- C-13	Fundamentals of Soft Computing/ ML	4	0	0	4
3	Core Course- C-14	Formal Language and theory of Automata	4	0	0	4
4	Elective:Discipline Specific DSE-3	Special Paper-3	4	0	0	4
Practical						
	Laboratory-7	Soft Computing Lab	0	0	4	4
Project (Part-I)						4
Total Credit = 20						

Semester 6:

Serial No.	Subject	Contact Hours /Week			Credit Points
		L	T	P	
1	Project (Part-II)				8
2	Internship				6
3	Seminar and viva				6
Total Credit = 20					

Total Credit point = 120

In addition to 120 credit points another 16 credit points have to be attained though online courses (MOOCS) distributed over three years in the following way:
First Year : 8 credits
Second Year : 4 credits
Third Year : 4 credits

Mooc for First Year

Student of first year has to cover courses from at least three skills:
1. Computer Programing
2. Softskill
3. Ethics

Module	**Course**	**Provider**	**Duration (Weeks)**	**Credit**	**Name of University/ Institute**	**Status**
Programming Skills	Introduction to Programming with MATLAB	Coursera	8	3	Vanderbilt University	Active
	Introduction to Computer Science and Programming Using Python	edX	Self Paced	4	MIT, USA	Active
	Statistics and R	edX	Self Paced	4	Harvard University	Active
Ethics	A Life of Happiness and Fulfillment	Coursera	6 weeks	2	Indian School of Business	Active
	Ethics and Law in Data and Analytics	edX	Self Paced	4	Microsoft	Active
Soft Skill	Technical Writing	Coursera	5	1	Moscow Institute of Physics and Technology	Active
	Communication in the 21st Century Workplace	Coursera	4	1	University of California	Active

Mathematics	Mathematics for Boundary Value Problem	NPTEL	4	2	IIT Kharagpur	Active
	Matrix Analysis with Application	NPTEL	8	4	IIT Roorkee	Active

List of Electives : Discipline Specific (DSE)

DSE-1 (Choose one)

i. Mathematical logic
ii. Coding Theory
iii. Cryptography
iv. Electrodynamics

DSE-2 (Choose one)

i. Algebraic Graph Theory
ii. Artificial Intelligence
iii. Functional Analysis
iv. Topology
v. Computer Graphics

DSE-3 (Choose one)

i. Thermodynamics and Statistical Physics
ii. Advanced Statistics
iii. Quantum mechanics
iv. Relativity and Gravitation
v. Bio-informatics

Detailed Syllabus

First Semester

Algebra

Course Objective:

- understanding basic concepts of linear algebra (systems of linear equations , matrix calculus , vectors and basic vector operations)
- solving computational problems of linear algebra

Unit 1: Polar representation of complex numbers, n-th roots of unity, De Moivre's theorem for rational indices and its applications.

Theory of equations: Relation between roots and coefficients, Transformation of equation, Descartes rule of signs, Cubic and biquadratic equations, reciprocal equation, separation of the roots of equations, Strum's theorem.

Inequality: The inequality involving AM≥GM≥HM, Cauchy-Schwartz inequality.

Unit 2: Equivalence relations and partitions, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set. Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm. Congruence relation between integers.Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit 3: Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Unit 4: Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Vector spaces, Subspaces of Rn , dimension of subspaces of Rn , rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Course Outcome

On successful completion of this course, student should be able to

- Define basic terms and concepts of matrices , vectors and complex numbers
- comprehense the use of various forms of complex numbers to solve numerical problems
- apply the matrix calculus in solving a system of linear algebraic equations

Books Recommended:

(1) TituAndreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
(2) Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
(3) David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
(4) K.B. Dutta, Matrix and linear algebra.
(5) K. Hoffman, R. Kunze, Linear algebra.
(6) W.S. Burnstine and A.W. Panton, Theory of equations.

Differential Equations

Course Objective

- Evaluate first order differential equations including separable, homogeneous, exact, and linear.
- Show existence and uniqueness of solutions.
- Solve second order and higher order linear differential equations.
- Create and analyze mathematical models using higher order differential equations to
- solve application problems such as harmonic oscillator and circuits.
- Solve differential equations using variation of parameters
- Solve linear systems of ordinary differential equations

Unit 1: Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Unit 2: Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

Unit 3: Equilibrium points, Interpretation of the phase plane, Power series solution of a differential equation about an ordinary point, solution about a regular singular point.

Unit 4: Partial Differential Equations – Basic concepts and Definitions. Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.

Unit 5: Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear

Equations to canonical forms.

Learning Outcome

On successful completion of this course

- Student will be able to solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- Student will be able to find the complete solution of a nonhomogeneous differential equation as a linear combination of the complementary function and a particular solution.
- Student will be introduced to the complete solution of a nonhomogeneous differential equation with constant coefficients by the method of undetermined coefficients.
- Student will be able to find the complete solution of a differential equation with constant coefficients by variation of parameters.
- Student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.

Books Recommended:

(1) Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
(2) C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and□ Modeling, Pearson Education India, 2005.
(3) S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.

(4) Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

(5) Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.

(6) Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.

(7) TynMyint-U and LokenathDebnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.

(8) Miller, F. H., Partial Differential Equations, John Wiley and Sons.

Programming for Problem Solving

Unit 1: Introduction to Programming.

1) Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.
2) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.
3) From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Unit 2: Arithmetic expressions and precedence

Unit 3: Conditional Branching and Loops.

1) Writing and evaluation of conditionals and consequent branching .
2) Iteration and loops

Unit 4: Arrays
Arrays (1-D, 2-D), Character arrays and Strings

Unit 5: Basic Algorithms
Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit 6: Function
Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.

Unit 7: Recursion
Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Unit 8: Structure
Structures, Defining structures and Array of Structures

Unit 9: Pointers
Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Unit 10: File handling (only if time is available, otherwise should be done as part of the lab)

Books Recommended:

1) R. S. Salaria, Computer Concepts and Programming in C, Khanna Publishers
2) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Physics

Mechanics : Problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Potential energy function F = -grad V, equipotential surfaces and meaning of gradient. Conservative and non-conservative forces. Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonic oscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D. Angular velocity vector. Moment of inertia.

Optics :

1) Distinction between interference and diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits (only the expressions for max;min, & intensity and qualitative discussion of fringes); diffraction grating(resolution formulac only), characteristics of diffration grating and its applications.
2) Polarisation : Introduction, polarisation by reflection, polarisation by double reflection, scattering of light, circular and elliptical polarisation, optical activity.
3) Lasers : Principles and working of laser : population inversion, pumping, various modes, threshold population inversion with examples .

Electromagnetism and Dielectric Magnetic Properties of Materials:

1) Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielecrrics, internal fields in a solid, Clausius- Mossotti equation(expression only), applications of dielectrics.
2) Magnetisation , permeability and susceptibility, classificationof magnetic materials, ferromagnetism,

magnetic domains and hysteresis, applications.

Quantum Mechanics: Introduction to quantum physics, black body radiation, explanation using the photon concept, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

Statistical Mechanics : Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Books Recommended:

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley
3. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
4. Engineering Mechanics (In SI Units) (SIE), S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati , McGraw Hill Education
5. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education
6. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education
7. Principles of mechanics, John L. Synge and Byron A. Griffith, New York, McGraw-Hill
8. Mechanics (Dover Books on Physics) , J. P. Den Hartog , Dover Publications Inc.
9. Engineering Mechanics: Dynamics, L.G. Kraige J.L. Meriam, Wiley

10. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley.
11. Introduction to Quantum Mechanics, J. Griffiths David , Pearson Education
12. Optics , Hecht, Pearson Education
13. Optics, Ghatak, McGraw Hill Education India Private Limited
14. Fundamentals of Statistical and Thermal Physics, Reif, Sarat Book Distributors
15. Statistical Mechanics , Pathria , Elsevier

English

Vocabulary Building : The concept of Word Formation: Compounding, Backformation, Clipping, Blending; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms, and standard abbreviations: Acronyms .

Basic Writing Skills : Sentence Structures & Types: Simple, Compound, Complex; Use of phrases and clauses in sentences: Transformation of sentences, active, passive, narration ; Importance of proper punctuation ; Creating coherence: Arranging paragraphs & Sentences in logical order ; Creating Cohesion: Organizing principles of paragraphs in documents; Techniques for writing precisely .

Identifying Common Errors in Writing : Subject-verb agreement ; Noun-pronoun agreement Misplaced modifiers ; Articles ; Prepositions ; Redundancies ; Clichés.

Nature and Style of sensible Writing : Describing; Defining ; Classifying; Providing examples or evidence ; Writing introduction and conclusion.

Writing Practices : Comprehension ; Précis Writing; Essay Writing; Business Letter, Cover Letter & CV; E-mail .

Books Recommended:

1) Kulbushan Kumar, R S Salaria,Effective Communication Skills, Khanna Publishing House, Delhi.
2) Practical English Usage. Michael Swan. OUP. 1995.
3) Remedial English Grammar. F.T. Wood. Macmillan.2007
4) On Writing Well. William Zinsser. Harper Resource Book. 2001
5) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
7) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
8) Universal English Prof. Prasad Kataria Publications, 2019.
9) "Communication Skills for Professionals"-Nira Konar, Prentice Hall of India 2nd edition, New Delhi, 2011 .
10) Gajendra Singh Chauhan, Smita Kashiramka and L. Thimmesha. Functional English. Cengage , 2019.

Programming for Problem Solving

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions.

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures.

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling:
Lab 12: File operations.

Physics Lab

Experiments in Optics:

1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton's ring
3. Determination of wavelength of a monochromatic light by Fresnel's bi-prism
4. Determination of wavelength of the given laser source by diffraction method

Electricity & Magnetism experiments

1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.

5. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.
6. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
7. Determination of unknown resistance using Carey Foster's bridge
8. Study of Transient Response in LR, RC and LCR circuits using expeyes
9. Generating sound from electrical energy using expeyes .

Experiments in Quantum Physics

1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

Miscellaneous experiments

1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure
2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5. To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseulle's capillary flow method .

Second Semester

Real Analysis

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence. Sequences and series of functions, Pointwise and uniform convergence. M_{n}-test, M-test, Statements of the results about uniform converg ence and integrability and differentiability

of functions, Power series and radius of convergence.

Integral Calculus: Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations. Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Double and Triple integrals.

Books Recommended :

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005. .
2. H. Anton, I. Bivens and S. Davis, *Calculus* , John Wiley and Sons (Asia) P. Ltd. 2002.
3. T.M. Apostol, Calculus (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
4. R.G. Bartle and D. R Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia) P. Ltd., 2000.
5. Fischer, Intermediate Real Analysis , Springer Verlag, 1983.
6. K.A. Ross, Elementary Analysis- The Theory of Calculus Series-Undergraduate Texts in Mathematics, Springer Verlag, 2003

Numerical Analysis

Solution to Transcendental and Polynomial Equations: Iterative methods, bisection method, secant method, Newton-Raphson method, fixed point iteration, methods for finding complex roots. Matrices and Linear System of Equations: LU decomposition method for solving systems of equations, Symmetric positive definite matrices and least square approximation, iterative algorithms for linear equations.

Interpolation: Polynomial interpolation, Newton-Gregory, Stirling's, Bessel's and Lagrange's interpolation formula, Newton's divided differences interpolation formulae. Curve fitting: B-spline and Approximation: Fitting linear and non-linear curves, weighted least square approximation, method of least square for continuous functions.
Numerical Differentiation and Integration: Numerical differentiation and errors in numerical differentiation, Newton-Cotes formulae, trapezoidal rule, Simpson's rule, Gaussian integration.
Numerical Solutions of Ordinary Differential Equations: Picard's and Taylor's series, Euler's and Runge-Kutta (RK) methods. Finite Element Method: Boundary value problems, Rayleigh and Galerkin methods of approximation, applications.

Books Recommended :

1. K.E. Atkinson, W. Han, Elementary Numerical Analysis , 3rd Ed., Wiley, 2003.
2. C. Xavier, S.S. Iyengar, Introduction to Parallel Algorithms , Wiley-Interscience, 1998.
3. A. Kharab, R.B. Guenther, An Introduction to Numerical Methods: A MATLAB Approach, 1st
4. Ed., Chapman and Hall/CRC, 2001.
5. B. Bradie, A Friendly Introduction to Numerical Analysis , Pearson Education, 2007.
6. S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in
7. MATLAB , Springer, 2005.
8. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering

9. Computation , 7th Ed., New Age International Publishers, 2007.

Discrete Mathematics

Logic and Sets: opositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.
Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.
Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Number Theory : Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues.
Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius inversion formula, the greatest integer function, Euler's phi-function.

Graph Theory : Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi- partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd- Warshall algorithm.

Boolean Algebra : Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices , products and homomorphisms.
Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Books Recommended :

1. B A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
4. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2005
5. David M. Burton, Elementary Number Theory , 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
6. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with

Maple, CRC Press, Boca Raton, 2000.
7. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics , Pearson Education, 1998.
8. P.R. Halmos, Naive Set Theory , Springer, 1974.

Chemistry

i) Atomic and molecular structure :
Schrodinger equation. Particle in a box solutions and their applications for simple sample. Molecular orbitals of diatomic molecules (e.g.H2). Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

ii) Spectroscopic techniques and applications :
Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering.

iii)Intermolecular forces and potential energy surfaces :
Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena.

iv)Use of free energy in chemical equilibria :
First and second laws of thermodynamics and thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

v) Periodic properties :
Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

vi) **Stereochemistry :**
Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

vii) Organic reactions and synthesis of a drug molecule :
Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Books Recommended:

1. Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi.
2. University chemistry, by B. H. Mahan.
3. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
5. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
6. Physical Chemistry, by P. W. Atkins
7. Spectroscopy of Organic Compounds, by P.S.Kalsi, New Age International Pvt Ltd Publishers 8. Physical Chemistry, P. C. Rakshit, Sarat Book House.
8. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp.

Environmental Science

Numerical Lab

1. Assignments on Newton forward /backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
3. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
4. Assignments on ordinary differential equation: Euler's and Runga-Kutta methods.
5. Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica/Statistica/Sigmaplot.

Chemistry Lab

Choose 10 experiments from the following:

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
3. Determination of dissolved oxygen present in a given water sample.
4. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

5. Determination of surface tension and viscosity
6. Thin layer chromatography
7. Ion exchange column for removal of hardness of water
8. Determination of the rate constant of a reaction
9. Determination of cell constant and conductance of solutions
10. Potentiometry - determination of redox potentials and emfs
11. Saponification/acid value of an oil
12. Chemical analysis of a salt
13. Determination of the partition coefficient of a substance between two immiscible liquids
14. Adsorption of acetic acid by charcoal
15. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg

Third Semester

Introduction to Statics and Dynamics

Data Structure and Algorithms

Linear Data Structures - Sequential representations - Arrays and Lists, Stacks, Queues and Dequeues, strings, Application. Linear Data Structures, Link Representation - Linear linked lists, circularly linked lists. Doubly linked lists, application. Recursion - Design of recursive algorithms, Tail Recursion, When not to use recursion, Removal of recursion.

Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B+ -trees, Application of trees; Graphs - Representations, Breadth-first and Depth-first Search.

Hashing - Hashing Functions, collision Resolution Techniques.

File Structures - Sequential and Direct Access. Relative Files, Indexed Files - B+ tree as index. Multi-indexed Files, Inverted Files, Hashed Files.

Books Recommended:

1. 1.Heileman:data structure algorithims&Oop Tata McGraw Hill
2. Data Structures Using C – M.Radhakrishnan and V.Srinivasan, ISTE/EXCEL BOOKS
3. Weiss Mark Allen, “Algorithms, Data Structures, and Problem Solving with C++”, Addison Wesley.
4. Horowitz Ellis &SartajSahni, “Fundamentals of Data Structures”, Galgotria Pub.
5. Tanenbaum A. S. , “Data Structures using ‘C’ ”

6. Ajay Agarwal: Data structure Through C.Cybertech

Optimization theory

Linear programming problem and its formulation, convex sets and their properties, Graphical method, Simplex method, Duality in linear programming, Revised simplex method, Integer programming, Transportation problems, Assignment problems, Games and strategies, Two-person (non) zero sum games, Introduction to non-linear programming and techniques.

Books Recommended:

1. J. K. Strayer, "Linear Programming and its Applications", Undergraduate Texts in Mathematics, Springer-Verlag, 1989.
2. P. R. Thie, G. E. Keough, "An Introduction to Linear Programming and Game Theory", John Wiley & Sons, 2008.
3. L. Brickman, "Mathematical Introduction to Linear Programming and Game Theory", Undergraduate Texts in Mathematics, Springer-Verlag, 1989.
4. D. G. Luenberger, Y. Ye, "Linear and Nonlinear Programming", International Series in Operations Research & Management Science 116, Springer, 2008.

Theory of Probability and Statistics

Important Concepts in Probability: Definition of probability - classical and relative frequency approach to probability, Richard Von Mises, Cramer and Kolmogorov's approaches to probability, merits and demerits of these approaches only general ideas to be given)

Random Experiment: Trial, sample point and sample space, definition of an event, operation of events, mutually exclusive and exhaustive events. Discrete sample space, properties of probability based on axiomatic approach, conditional probability, independence of events, Bayes' theorem and its applications.
Random Variables: Definition of discrete random variables, probability mass function, idea of continuous random variable, probability density function, illustrations of random variables and its properties, expectation of a random variable and its properties -moments, measures of location, dispersion, skewness and kurtosis, probability generating function (if it exists), their properties and uses.

Standard univariate discrete distributions and their properties: Discrete Uniform, Binomial, Poisson, Hypergeometric, and Negative Binomial distributions.

Continuous univariate distributions- uniform, normal, Cauchy, Laplace, Exponential, ChiSquare, Gamma and Bea distributions.Bivariate normal distribution (including marginal and conditional distributions).

Chebyshev's inequality and applications, statements and applications of weak law of large numbers and central limit theorems.

Types of Data: Concepts of a statistical population and sample from a population; qualitative and quantitative data; nominal and ordinal data; cross sectional and time series data; discrete and continuous data; frequency and non- frequency data. Different types of scales - nominal, ordinal, ratio and interval.

Collection and Scrutiny of Data: Primary data - designing a questionnaire and a schedule; checking their consistency. Secondary data - its major sources including some government publications. Complete enumeration, controlled experiments, observational studies and sample surveys. Scrutiny of data for internal consistency and detection of errors of recording.Ideas of cross-validation.

Presentation of Data: Construction of tables with one or more factors of classification. Diagrammatic and graphical representation of grouped data.Frequency distributions, cumulative frequency distributions and their graphical representation, histogram, frequency polygon and ogives. Stem and leaf chart. Box plot.

Analysis of Quantitative Data: Univariate data-Concepts of central tendency or location, dispersion and relative dispersion, skewness and kurtosis, and their measures including those based on quantiles and moments. Sheppard's corrections for moments for grouped data (without derivation).

Bivariate Data: Scatter diagram. Product moment correlation coefficient and its properties.Coefficient of determination.Correlation ratio.Concepts of error in regression.Principle of least squares.Fitting of linear regression and related results.Fitting of curves reducible to polynomials by transformation.Rank correlation — Spearman's and Kendall's measures.

Multivariate data: Multiple regression, multiple correlation and partial correlation in three variables. Their measures and related results.

Analysis of Categorical Data: Consistency of categorical data. Independence and association of attributes.Various measures of association for two -waand three-way classified data.Odds ratio.

Books Recommended:

i. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997):Statistics: A Beginner's Text, Vol. II, New Age International (P) Ltd.

ii. Edward P.J., Ford J.S.and Lin (1974): Probability for Statistical Decision-Making, Prentice Hall.

iii. Goon A.M., Gupta M.K., Das Gupta.B. (1999): Fundamentals of Statistics,

Vol.II, World Press, Calcutta.

iv. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.

v. Bhat B.R, Srivenkatramana T and Rao Madhava K.S.(1996): Statistics: A Beginner's Text, Vol. I, New Age International(P) Ltd. Croxton

vi. F.E, Cowden D.J and Kelin S (1973): Applied General Statistics, Prentice Hall of India.

vii. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics, Vol.I, World Press, Calcutta.

Data Structure Lab

Experiments should include but not limited to :

- Implementation of array operations:
- Stacks and Queues: adding, deleting elements Circular Queue: Adding & deleting elements Merging Problem:
- Evaluation of expressions operations on Multiple stacks & queues :
- Implementation of linked lists: inserting, deleting, inverting a linked list. Implementation of stacks& queues using linked lists.
- Polynomial addition, Polynomial multiplication
- Sparse Matrices : Multiplication, addition.
- Recursive and Nonrecursive traversal of Trees
- Threaded binary tree traversal. AVL tree implementation
- Application of Trees. Application of sorting and searching algorithms
- Hash tables implementation: searching, inserting and deleting, searching & sorting techniques.

4th Semester

Database Management System

Introduction

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Entity-Relationship Model

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Relational Model

Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.

SQL and Integrity Constraints

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Relational Database Design

Functional Dependency, Different anamolies in designing a Database., Normalization using funtional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Nomalization using multi-valued depedencies, 4NF, 5NF

Internals of RDBMS

Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lockbase protocols, two phase locking. File Organization & Index Structures

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

Books Recommended:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.Graw Hill.
2. ElmasriRamez and NovatheShamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing.Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, “Transaction Processing : Concepts and Techniques”, Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., “Introduction to Database Management”, Vol. I, II, III, Addison Wesley.
7. Ullman JD., “Principles of Database Systems”, Galgottia Publication

Mathematical Modelling

Perturbation methods: Introduction to modelling concepts, dimensional analysis, perturbation

techniques, applications of techniques of nonlinear dynamics

Queuing Models: Birth and death model (Earlang model) M|M|1 (|FCFS), (N|FCFS), Harbor system, morning rush hour.

Modelling of Social Dynamics: Mathematical theories of war, Richardson's theory of conflict, Lancaster's combat models, modeling of terrorism, modeling of environmental related phenomena. Modeling of intoxicants.

Modelling of Electrical Circuits: Oscillations in RLC circuits, response of RLC circuits to sinusoidal square, pulse, ramp and burst.

Models for inventory controls: Inventor, Demand, Holding cost, shortage cost, Setup cost, Lead time, Deterioration, models for cost minimization and profit maximization.

Introduction to Stochastic Analysis: Brownian motion, hitting problems, stochastic differential equations.

Monte Carlo Simulation Modeling: Simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence,

Books Recommended:

1. W. Meyer, Concepts of Mathematical Modeling, McGraw Hill, New York, 1994.
2. Hinch, Perturbation methods, Cambridge Texts in Applied Mathematics.
3. Kevorkian & Cole, Perturbation methods in applied mathematics, Applied Mathematical Sciences,
Springer.
4. Bender & Orszag, Advanced mathematical methods for scientists and engineers, Asymptotic Methods and Perturbation Theory: v.1, Springer.
5. I. Karatzas and S. Shreve, Brownian motion and Stochastic Calculus, Graduate texts in Mathematics, Springer.
6. G. Hadeley and T.M. Whitin, Analysis of Inventory Systems, Prentice Hall, 1963.

Financial Mathematics

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance

and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

Books Recommended:

1. David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
2. John C. Hull, Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
3. Sheldon Ross, An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.

DBMS Lab

Structured Query Language

- Creating Database
- Creating a Database
- Creating a Table
- Specifying Relational Data Types
- Specifying Constraints
- Creating Indexes

Table and Record Handling

- INSERT statement
- Using SELECT and INSERT together
- DELETE, UPDATE, TRUNCATE statements
- DROP, ALTER statements

Retrieving Data from a Database

- The SELECT statement
- Using the WHERE clause
- Using Logical Operators in the WHERE clause
- Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING
- Clause
- Using Aggregate Functions
- Combining Tables Using JOINS
- Subqueries

Database Management

- Creating Views

- Creating Column Aliases
- Creating Database Users
- Using GRANT and REVOKE

5th Semester

Fundamentals of Soft Computing/ ML

Module-I

Introduction: Introduction to soft computing; introduction to fuzzy sets and fuzzy logic systems; introduction to biological and artificial neural network; introduction to Genetic Algorithm.

Module-II

Fuzzy sets and Fuzzy logic systems:

Classical Sets and Fuzzy Sets and Fuzzy relations : Operations on Classical sets, properties of classical sets, Fuzzy set operations, properties of fuzzy sets, cardinality, operations, and properties of fuzzy relations.

Membership functions: Features of membership functions, standard forms and boundaries, different fuzzification methods.

Fuzzy to Crisp conversions: Lambda Cuts for fuzzy sets, fuzzy Relations, Defuzzification methods.

Classical Logic and Fuzzy Logic: Classical predicate logic, Fuzzy Logic, Approximate reasoning and Fuzzy

Implication Fuzzy Rule based Systems: Linguistic Hedges, Fuzzy Rule based system – Aggregation of fuzzy Rules,

Fuzzy Inference System- Mamdani Fuzzy Models – Sugeno Fuzzy Models.

Applications of Fuzzy Logic: How Fuzzy Logic is applied in Home Appliances, General Fuzzy Logic controllers, Basic Medical Diagnostic systems and Weather forecasting

Module-III

Neural Network

Introduction to Neural Networks: Advent of Modern Neuroscience, Classical AI and Neural Networks,

Biological Neurons and Artificial neural network; model of artificial neuron.

Learning Methods :Hebbian, competitive, Boltzman etc.,

Neural Network models: Perceptron, Adaline and Madaline networks; single layer network; Backpropagation and multi layer networks.

Competitive learning networks: Kohonenself organizing networks, Hebbian learning; Hopfield Networks.

Neuo-Fuzzy modelling:

Applications of Neural Networks: Pattern Recognition and classification

Module-IV

Genetic Algorithms: Simple GA, crossover and mutation, Multi-objective Genetic Algorithm

(MOGA).
Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering
Algorithm, Image processing and pattern Recognition

Module-V
Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO),
Particle Swarm Optimization (PSO).

Books Recommended:

1. Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley and Sons.
2. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI
3. Principles of Soft Computing , S N Sivanandam, S. Sumathi, John Wiley & Sons
4. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg
5. Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, PHI
6. Neural Networks: A Classroom Approach,1/e by Kumar Satish, TMH,
7. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg, Pearson/PHI
8. A beginners approach to Soft Computing, Samir Roy &Udit Chakraborty, Pearson

Formal Language and Automata Theory

Prerequisites of Formal Language & Automata Theory:
Elementary discrete mathematics including the notion of set,function,relation,product,partial order,equivalence relation,graph& tree. They should have a thorough understanding of the principle of mathematical induction.
Module-1: Fundamentals: Basic definition of sequential circuit, block diagram, mathematical representation, concept of transition table and transition diagram (Relating of Automata concept to sequential circuit concept) Design of sequence detector, Introduction to finite state model.
Finite state machine: Definitions, capability & state equivalent, kth- equivalent concept
. Merger graph, Merger table, Compatibility graph
Finite memory definiteness, testing table & testing graph.
Deterministic finite automaton and non deterministic finite automaton.
Transition diagrams and Language recognizers.
Finite Automata: NFA with Î transitions - Significance, acceptance of languages.
Conversions and Equivalence: Equivalence between NFA with and without Î transitions. NFA to DFA conversion.
Minimization of FSM, Equivalence between two FSM's , Limitations of FSM .
Application of finite automata, Finite Automata with output- Moore & Melay machine.

Module-2: Regular Languages : Regular sets.
Regular expressions, identity rules. Arden's theorem state and prove .
Constructing finite Automata for a given regular expressions, Regular string accepted by NFA/DFA
.
Pumping lemma of regular sets. Closure properties of regular sets (proofs not required).
Grammar Formalism: Regular grammars-right linear and left linear grammars.
Equivalence between regular linear grammar and FA.
Inter conversion, Context free grammar.
Derivation trees, sentential forms. Right most and leftmost derivation of strings. (Concept only)

Module-3: Context Free Grammars, Ambiguity in context free grammars.
Minimization of Context Free Grammars.
Chomsky normal form and Greibach normal form.
Pumping Lemma for Context Free Languages.
Enumeration of properties of CFL (proofs omitted). Closure property of CFL, Ogden's lemma & its applications
Push Down Automata: Push down automata, definition.
Acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence.
Equivalence of CFL and PDA, interconversion. (Proofs not required).
Introduction to DCFL and DPDA.

Module-4: Turing Machine : Turing Machine, definition, model.
Design of TM, Computable functions .
Church's hypothesis, counter machine .
Types of Turing machines (proofs not required)
Universal Turing Machine, Halting problem .

Books recommended:

1. "Introduction to Automata Theory Language and Computation", Hopcroft H.E. and Ullman J. D., Pearson Education.
2. "Theory of Computer Science ", Automata Languages and computation", Mishra and Chandrashekaran, 2nd edition, PHI.
3. "Formal Languages and Automata Theory", C.K.Nagpal, Oxford