PROPOSED

COURSE STRUCTURE

OF

5 -YEAR INTEGRATED COURSE

IN

MATHEMATICS AND COMPUTING

(With exit option after 3 year with Mathematics (Hons) degree)

DEPARTMENT OF MATHEMATICS

SCHOOL OF SCIENCE

SESSION: 2018-23

ADAMAS UNIVERSITY
PURSUE EXCELLENCE

Course Structure of 5-Year Integrated Course in Mathematics and Computing

Programme Objectives:

After successfully completing this programme, a student must have:

- Understanding of foundational topics in Mathematics.
- Understanding of theoretical foundations and limits of computing and different levels of abstraction including architecture and operating systems, algorithms, and applications.
- Ability to design and implement algorithms and data structures for efficiently solving new problems.
- Ability to use and apply mathematical and statistical techniques and tools to solve problems.
- Ability to abstract and rigorously model and analyze a variety of problems using appropriate mathematical or computational concepts.

Career opportunities:

- This programme will provide training in the tools and techniques of mathematical modelling and scientific computing, and will provide students with skills for problem solving using modern techniques of applied mathematics.
- Advanced mathematics and computer simulations are present within several important fields, their use having increased dramatically by the rapid development in computer software and hardware. Financial mathematics, medicine and biology are prevalent areas, but students will be able to bring the usage of mathematics and simulations into a multitude of applications.
- The graduates of this programme will have in high demand on the co-corporate market as well as in academia. A successfully graduate of this programme may get opportunity to work in many national as well as multinational companies such as Google, Infosys, Tata Consultancy Service (TCS), Cognizant Technology Service (CTS), IBM, Wipro, Ericsson, Citibank and many others.

Distribution of Papers Semester-wise:

ADAMAS UNIVERSITY								
SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS 5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING SEMESTER - I								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Engineering Mathematics I		4	3	1	0	4
Theory		Engineering Physics		3	3	0	0	3
Theory		Computer Programing		3	3	0	0	3
Theory		HSS–I		3	3	0	0	3
Theory		HSS-II (Economics for Engineers)		3	3	0	0	3
Practical		Engineering Physics I - Lab		3	0	0	3	2
Practical		Computer Programing		3	0	0	3	2
Practical		Engineering Drawing and CAD		3	0	0	3	2
Total				**25**	**15**	**1**	**9**	**22**

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Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY								
SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS								
5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING								
SEMESTER - II								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Engineering Mathematics II		3	3	0	0	3
Theory		Engineering Chemistry		3	3	0	0	3
Theory		Engineering Mechanics		3	3	0	0	3
Theory		HSS –III		3	3	0	0	3
Theory		Electrical and Electronics Technology		3	3	0	0	3
Theory		Life Sciences		3	3	0	0	3
Practical		Engineering Chemistry Lab		3	0	0	3	2
Practical		Electrical and Electronics Technology Lab		3	0	0	3	2
Practical		Engineering Workshop		3	0	0	3	2
Practical		Computing Lab		3	0	0	3	2
Total				**28**	**18**	**1**	**9**	**26**

Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY								
SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS								
5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING								
SEMESTER - III								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Algebra-I		4	3	1	0	4
Theory		Analysis -I		4	3	1	0	4
Theory		Object Oriented Programming		3	3	0	0	3
Theory		Elective Physics		3	3	0	0	3
Theory		Elective Chemistry		3	3	0	0	3
Practical		Object Oriented Programming Lab		3	0	0	3	2
Practical		Elective Physics Lab		3	0	0	3	2
Practical		Elective Chemistry Lab		3	0	0	3	2
Total				**26**	**15**	**2**	**9**	**23**

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Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY

SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS

5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING

SEMESTER - IV

Type of the Paper	Paper Code	Theory / Practical	Brief Contents	Contact Hour Per Week	L	T	P	Credit
Theory		Algebra-II		4	3	1	0	4
Theory		Differential Equation		4	3	1	0	4
Theory		Analysis -II		4	3	1	0	4
Theory		Analytical Geometry		4	3	1	0	4
Theory		Computer Organization and Architecture		4	3	1	0	4
Theory		Design and analysis of Algorithm		3	3	0	0	3
Practical		Design and analysis of Algorithm Lab		3	0	0	3	2
Total				**26**	**18**	**5**	**3**	**25**

Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY								
SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS								
5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING								
SEMESTER - V								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Theory of Probability and Statistics		4	3	1	0	4
Theory		Computer Graphics		3	3	0	0	3
Theory		Vector and Tensor Calculus		4	3	1	0	4
Theory		Mechanics-I		4	3	1	0	4
Theory		Numerical Analysis		3	3	0	0	0
Practical		Numerical Analysis Lab		3	0	0	3	2
Practical		Computer Graphics Lab		3	0	0	3	2
6CORE		Summer Internship			0	0	0	2
Total				**25**	**10**	**4**	**6**	**24**

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Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS 5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING SEMESTER - VI								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Integral Equations and Variational Principles		4	3	1	0	4
Theory		Operating Systems		3	3	0	0	3
Theory		Discrete Mathematics and Graph Theory		4	3	1	0	4
Theory		Operations Research		4	3	1	0	4
Practical		Operating Systems Lab		3	0	0	3	2
		Project-I		9	0	0	9	6
		Presentation on Project-I and Viva-Voce			0	0	0	2
Total				**27**	**12**	**3**	**12**	**25**

Total Credits: 22+26+23+25+24+25=145

Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE, DEPARTMENT OF MATHEMATICS **5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING** **SEMESTER - VII**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Functional Analysis		4	3	1	0	4
Theory		Number Theory		4	3	1	0	4
Theory		Complex Analysis		4	3	1	0	4
Theory		Integral transformations and boundary value problems		4	3	1	0	4
Theory		Machine Learning		4	3	1	0	4
Theory		System programming		3	3	0	0	3
Practical		System programming Lab		3	0	0	3	2
Total				**26**	**18**	**5**	**3**	**25**

Course Structure of 5-Year Integrated Course in Mathematics and Computing

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE, DEPARTMENT OF MATHEMATICS **5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING** **SEMESTER - VIII**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Distribution Theory and Generalized Functions		4	3	1	0	4
Theory		Topology and Measure Theory		4	3	1	0	4
Theory		Stochastic Process		4	3	1	0	4
Theory		Compiler Design		3	3	0	0	3
Theory		File organization & Database systems		3	3	0	0	3
Theory		Optional- I		4	3	1	0	4
Practical		Compiler Design Lab		3	0	0	3	2
Practical		File organization & Data base systems Lab		3	0	0	3	2
Total				**28**	**18**	**4**	**6**	**26**

Course Structure of 5-Year Integrated Course in Mathematics and Computing

FACULTY OF SCIENCE, DEPARTMENT OF MATHEMATICS 5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING SEMESTER - IX								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
Theory		Data communication & Computer Networks		4	3	1	0	4
Theory		Artificial Intelligence (AI)		3	3	0	0	3
Theory		Information and Coding Theory		4	3	1	0	4
Theory		Queuing Theory		4	3	1	0	4
Theory		Optional- II		4	3	1	0	4
Practical		Artificial Intelligence (AI) Lab		3	0	0	3	2
		Minor Project		4	0	0	3	2
		Summer Internship						2
Total				**25**	**15**	**4**	**6**	**25**

ADAMAS UNIVERSITY
FACULTY OF SCIENCE, DEPARTMENT OF MATHEMATICS 5 -YEAR INTEGRATED COURSE IN MATHEMATICS AND COMPUTING SEMESTER - X

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Course Structure of 5-Year Integrated Course in Mathematics and Computing

Type of the Paper	Paper Code	Theory / Practical	Brief Contents	Contact Hour Per week	L	T	P	Credit
Theory		Software Engineering		3	3	0	0	3
Theory		Image Processing		4	3	1	0	4
Theory		Fuzzy Set Theory		3	3	0	0	3
Theory		Optional -III		4	3	1	0	4
Practical		Software Engineering Lab		3	0	0	3	2
		Project/ Dissertation		9	0	0	9	6
		Seminar on Project and Viva-Voce			0	0	0	2
Total				**26**	**12**	**2**	**12**	**24**

List of Optional papers		
Optional I	**Optional II**	**Optional III**
Mechanics-II[**SMA52108]**	Pattern Recognition and Scene Analysis	Mathematical & Statistical Methods in Climate System
Operator Theory [**SMA52110]**	Formal Language Automata Theory [**ECS52101]**	Cryptography and Cyber Security **[ECS53102]**
Fluid Dynamics[**SMA52112]**	Mathematical Modeling	Financial Mathematics
Wavelet: Theory and Applications [**SMA52114]**	Cloud Computing	Time Series and Forecasting Methods

***Offering of subjects will vary from year to year subject as per choice of Students**

SEMESTER I & II – SAME AS PHYSICS

SEMESTER III

Core Courses of 5yr integrated course in Mathematics & computing

Algebra-I

Course Structure of 5-Year Integrated Course in Mathematics and Computing

Paper Code: SMA31101 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Short review of complex numbers, De Moivre's theorem and its applications, direct and inverse circular and hyperbolic functions, logarithm of a complex number, expansion of trigonometric functions, Gregory's series.

Unit II

Relation between the roots and coefficients of general polynomial equation of one variable, fundamental theorem of classical algebra and its consequences, nature of roots of an equation (surds or complex roots occur in pairs), statements of Descartes rule of signs and of Sturm's theorem and their applications, transformation of equations, multiple roots, symmetric functions of roots, reciprocal equations, special roots, solutions of cubic equations (Cardan's method) and biquadratic equation (Ferrari's method).

Cauchy-Schwarz inequality, inequality involving A.M. (including weighted), G.M., H.M. and their applications, m^{th}power theorem.

Unit III

Integers: Statements of well-ordering principle and principle of mathematical induction, second principle of mathematical induction, proof of some simple mathematical results by induction, divisibility of integers, division algorithm, the greatest common divisor (gcd) of integers a, b, existence and uniqueness of (gcd) of two integers, prime integers, Euclid's first and second theorems, congruence's, Euler's function, Fermat's theorem.

Text Books:

1. S. K. Mapa, Classical algebra, Sarat book house.
2. S. K. Mapa, Higher algebra, Sarat Book House.

Reference Books:

1. Burnside and Panton, The theory of equations, Vol. 1, Hodges Figgisand company.
2. A. Kurosh, Higher algebra, Mir publishers.
3. Ghosh and Chakroborty, Higher algebra, U N Dhur& Sons.
4. Barnard and Child, Higher algebra, Mac Millan.

5. John B Fraleigh, First course in abstract algebra, Pearson.
6. I N Hernstein, Topics in algebra, Wiley India Pvt Ltd.
7. Sen, Ghosh and Mukhopadhyay, Topics in abstract algebra, University press.

Analysis-I

[**Sets in *R*, sequence and series of real numbers**]

Paper Code: SMA32103 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Real number system: Intuitive idea of numbers, mathematical operations revisited with their properties (closure, commutative, associative, identity, inverse, distributive).

Sets and functions: definition and properties (union, intersection, complementation, injection, surjection, bijection).

Field Axioms: concept of ordered field, bounded set, l.u.b. (supremum) and g.l.b. (infimum) of a set, properties of l.u.b. and g.l.b. of sum of two sets and scalar multiple of a set, least upper bound axiom or completeness axiom.

Characterization of IR as a complete ordered field, definition of an Archimedean ordered field, Archimedean property of IR, Q is Archimedean ordered field but not ordered complete.

Unit-II

Intervals, neighbourhood of a point, interior point, open set, union, intersection of open sets, every open set can be expressed as disjoint union of open intervals, limit point and isolated point of a set, criteria for l.u.b. and g.l.b. of a bounded set to be limit point of the set, Bolzano-Weierstrass theorem on limit point.

Unit-III

Definition of derived set, closed set, complement of open set and closed set, union and intersection of closed sets as a consequence, no nonempty proper subset of IR is both open and

Closed, dense set in IR as a set having non-empty intersection with every open Interval, Q and IR - Q are dense in IR.

Unit-IV

Sequences of real numbers: Definition of a sequence as function from IN to IR, bounded sequence, convergence (formalization of the concept of limit as an operation in IR) and non-convergence, examples, every

convergent sequence is bounded and limit is unique, algebra of limits, relation between the limit point of a set and the limit of a convergent sequence of distinct elements, monotone sequences and their convergence, sandwich rule, nested interval theorem.

Text Books:

1. S.K. Mapa, Introduction to Real Analysis, 7th Edition, Sarat Publishers, India.

Reference Books:

2. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
3. S.C. Malik and S Arora, Mathematical Analysis, New Age International Private Limited, Paperback– 1 Jan 2017.
4. R.K. Ghosh and K.C Maity, An Introduction to Analysis: Differential Calculus: Part I.

Object Oriented Programming

Paper code- ECS42106 L-T-P 3-1-0 3 credits

Module 1:

OOP concept: Data abstraction, encapsulation, inheritance, polymorphism, classes and objects; Properties of OOP, Procedural and object oriented programming paradigms.

Introduction to C++ / Java / Python, data types, variables, constants, scope and validity of variables, various operators, operator hierarchy, expressions, data type conversion and casting, enumerated types, control flow and scope of blocks, conditional statements, loops, break and continue statements, stand-alone java programs, arrays, console input-output, formatting output, constructors, methods, parameter passing, static fields and methods, access control, this reference, method overloading and overriding, recursion, garbage collection, building and exploring string class.

Module 2:

Inheritance: Inheritance hierarchy, sub and super classes, Member accessing rules, super keyword, preventing inheritance: using final classes and methods, the Object class and its methods.

Polymorphism: dynamic binding, method overriding, abstract classes and methods.

Interfaces: Interfaces and Abstract classes, definition and implementation of interfaces, accessing through interface references, extending interfaces.

Inner classes: uses of inner classes, Various inner classes: local inner class, anonymous inner class, static inner class.

Packages: Definition, Creation and Access of a Package, Understanding "classpath", importing packages.

Module 3:

Exception handling: errors/exceptions occur in OOP, Benefits of exception handling, the classification of exceptions- exception hierarchy, checked exceptions and unchecked exceptions; usage of try-catch block, throw, throws and finally, re-throwing exceptions, exception specification, built in exceptions, user defined exceptions.

Multithreading: multiple processes vs. multiple threads, states of a thread, creating threads, interrupting threads, thread priorities, thread synchronization, inter-thread communication, producer-consumer pattern.

Module 4:

Collection Framework: Introduction to Collections, Overview of Collection frame work, Generics, Basic Collection classes: Array List, Vector, Hash table, Stack, Enumeration, Iterator, String Tokenizer, Random, Scanner, calendar.

Files: streams- byte streams, character streams, text input/output, binary input/output, random access file operations, File management.

Connecting to Database: JDBC / ODBC Type 1 to 4 drives, database connectivity, database query and result processing, data updation with JDBC.

Module 5:

GUI Programming: AWT class hierarchy, Fundamentals of Swing, Swing vs. AWT, Hierarchy of Swing components, Containers - JFrame, JApplet, JDialog, JPanel; Overview of swing components - Jbutton, JLabel, JTextField, JTextArea; Applications of swing, Layout management - Layout manager types - border, grid and flow.

Event handling: Events, Event sources, Event classes, Event Listeners, Relationship between Event sources and Listeners, Delegation of event model, handling of a button click, handling of mouse events, Adapter classes.

Applets: Basics, Inheritance hierarchy for applets, applets vs. applications, life cycle of an applet, passing parameters to applets, security issues.

Text Books:

1. Java Fundamentals - A comprehensive Introduction", Illustrated Edition by DaleSkrien, Herbert Schildt, McGraw-Hill Education.

Reference Books:

1. "Java for Programmers", 2nd Edition by Paul Deitel and Harvey Deitel, Pearson Education.
2. "Thinking in Java", Low Price Edition by Bruce Eckel, Pearson Education.

Algebra-II

[Set and Group theory]

Paper Code: SMA31102 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Set, relation, mapping and algebraic structure: Basic properties of sets, set operations, De Morgan's laws, cartesian product of sets, relation, equivalence relation, relation between equivalence relation and partition, congruence of integers, congruence classes. Mapping: Injection, surjection, bijection, identity and inverse mappings, composition of mappings and its associativity. Binary operations: Definitions and examples, commutative and associative binary operations, identity and inverse element. Algebraic structure: Concept of algebraic structure, definition (only) of groupoid, semi-group, monoid.

Unit-II

Group, Abelian group, examples of groups from number system, root of unity, matrices, symmetries of squares, triangles etc., groups of congruence classes, Klein's 4 group, properties deducible from definition of group including solvability of equations like $ax = b$, $ya = b$, any finite semi-group having both cancellation laws is a group, integral power of elements and laws of indices in a group, order of an element of a group, order of a group.

Unit-III

Subgroups, necessary and sufficient condition for a subset of group to be a subgroup, intersection and union of subgroups, necessary and sufficient condition for union of two subgroups to a subgroup, permutation groups and quaternion groups, properties of cyclic groups, classification of subgroups of cyclic groups.

Unit-IV

Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Text Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
4. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Analysis-II

Paper Code: SMA51102 **L: T: P=2:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Real number system and set theory: Completeness property, Archimedean property, Denseness of rationals and irrationals, Countable and uncountable, Cardinality, Zorn's lemma, Axiom of choice.

Unit-II

Metric spaces: Open sets, closed sets, Continuous functions, Completeness, Cantor intersection theorem, Baire category theorem, Compactness, Totally boundedness, Finite intersection property.

Unit-III

Riemann-Stieltjes integral: Definition and existence of the integral, Properties of the integral, Differentiation and integration.

Unit-IV

Sequence and Series of functions: Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Equicontinuity, Ascoli's Theorem.

Recommended Books:

1. W. Rudin, Principal of Mathematical Analysis, Mcgraw-Hill, 1976.
2. C.C. Pugh, Real Mathematical Analysis, Springer, 2002.
3. T.M. Apostol, Mathematical Analysis, Addison-Wesley, 1974.
4. G.F. Simmons, Topolgy and Modern analysis, Kreiger 2004.

Ordinary Differential Equation- I

[First order linear and nonlinear and 2nd order differential equations with constant coefficients]

Paper Code: SMA31105 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Motivation and importance, order and degree of a differential equation, differences between linear and nonlinear equations, general, particular, explicit, implicit and singular solutions of a differential equation, formation of differential equation by eliminating arbitrary constants, general solution and geometrical significance of differential equation.

Unit II

First Order Linear Equations: Existence and uniqueness of solution of ordinary differential equations, separable equations, exact differential equations and integrating factors, equations reducible to this form, linear equation and Bernoulli's equations, special integrating factors and transformations, application of first order differential equations to acceleration-velocity model, growth and decay model.

Unit-III

Second Order Linear Equations: Homogeneous Equations with Constant Coefficients, 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, and method of undetermined coefficients, method of variation of parameters.

Higher Order Linear Equations: General theory of *n*th order linear equations, homogeneous equations with constant coefficients, method of undetermined coefficients, method of variation of parameters.

Text Books:

1. H.T.H. Piaggio, Differential Equations, G.Bell & Sons Ltd. 1921
2. S. L. Ross, Differential Equations, John Wiley and Sons, India, 2004.

Reference Books:

1. William E. Boyce and Richard C. Di-Prima, Elementary Differential Equations and Boundary Value Problems, 7th edition, John Wiley & Sons, Inc.

2. C. H. Edwards and D. E. Penny, Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, India, 2005.
3. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple, Taylor and Francis, London and New York, 2002.
4. H.T.H. Piaggio, An elementary treatise on differential equations, G. Bell and sons limited.

Ordinary Differential Equation II

[2nd order differential equation with variable coefficients and series solutions]

Paper Code: SMA31106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Existence and uniqueness of solutions: Lipschitz condition, non-local existence of solutions, uniqueness of solutions, existence and uniqueness theorem for first order equations, statement of existence and uniqueness theorem for the solutions of ordinary differential equation of order *n*.

Unit-II

Differential equation of first order but not first degree, solvable for *p, y, x,* Clairaut's equation, singular solutions, Geometric meaning, application of first order differential equation, orthogonal trajectories and related problems. Basic theory of systems of first order linear equations, homogeneous linear systems with constant coefficients, non-homogeneous linear systems, predator-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Unit-III

Application of ODE: Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

Unit IV

Series solution: Introduction, ordinary point, singular point and regular singular point, power series solution about an ordinary point, solutions about singular points, Frobenius method.

Legendre's equation and Legendre's polynomials, Rodrigue's formula, Bessel's equation, Bessel's function and its application.

Text Books:

1. Shepley L Ross, Introduction to ordinary differential equation, John Wiley & Sons.
2. M.D.Raisinghania: Ordinary and Partial Differential equations, S.Chand.
3. M.D.Raisinghania: Advanced Differential equations, S.Chand.

Reference Books:

4. H.T.H. Piaggio, An elementary treatise on differential equations, G. Bell and sons limited.
5. Iaan Sneddon, Elements of partial differential, McGraw-Hill book.
6. A. R. Forsyth, A treatise on differential equations, Macmillan.

Analytical Geometry

Paper Code: SMA32106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Coordinate Geometry: Transformation of rectangular axes. Invariants associated with the coefficients of general degree equation, necessary and sufficient conditions for the general second degree equation to represent a pair of straight lines, reduction of the general second degree equation to canonical form, classification of conics, and pair of straight lines.

Unit-II

Conjugate diameters of conics, pole and polar with respect to a non -singular conic, asymptotes, coaxial systems of circles, polar equations of straight lines, circle and conics (with a focus as pole) and tangent, normal, chord of contact.

Unit-III

Three- dimensional Geometry: Rectangular Cartesian coordinates in space, direction cosines and direction ratios of a directed line, projection, angle between two lines, equations to a plane in intercept, normal and

general forms, the sides of a plane, bisectors of the angles between two planes, parallelism and perpendicularity of two planes, straight lines in the space, skew lines.

Unit-IV

Sphere, cone, cylinder, surfaces of revolution, ruled surface, transformation of rectangular axes in the space, reduction of the general second degree equation in three variables to canonical form, classification of quadrics, standard equations and shapes of ellipsoid, hyperboloid and paraboloid.

Text Books:

1. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.

Reference Books:

2. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, Mc Millan India Ltd., 1994.

Computer Organization & Architecture

ECS32102 **3-1-0** **3 Credit**

Module 1:

Basic computer Organization: CPU, memory, input-output subsystems, control unit. Instruction set architecture, registers, Machine cycle, RTL interpretation of instructions, instruction format, addressing modes, instruction set. Case study – instruction sets of some common CPUs.

Data representation: signed number, fixed and floating point and character representation. Computer arithmetic: integer addition and subtraction, multiplication using shift-and-add, Booth multiplier, carry.

Module 2:

Introduction To x86 architecture.

CPU Design: hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU. Memory hierarchy, Access method, Main memory, associative memory, cache memory, virtual memory, memory organization.

Peripheral devices: I/O interface and I/O driver, device interface, I/O transfers: program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions.

Module 3:

Pipelining: Basic Concept of pipelining, throughput and speedup, pipeline hazards.

Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Module 4:

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Text Books:

1. "Computer Organization And Design: The Hardware/Software Interface", 5th Edition By David A. Patterson And John L. Hennessy, Elsevier.
2. "Computer Organization And Design: The Hardware/Software Interface", 5th Edition By David A. Patterson And John L. Hennessy, Elsevier

Reference Books:

1. "Computer Architecture And Organization", 3rd Edition By John P. Hayes, WCB/Mcgraw-Hill.
2. "Computer Organization And Architecture: Designing For Performance", 10th Edition By William Stallings, Pearson Education.
3. "Computer System Design And Architecture", 2nd Edition By Vincent P. Heuring And Harry F. Jordan, Pearson Education

Design and Analysis Of Algorithms

Paper code - ECS51105 L-T-P - 3-1-0 3 Credits

Module 1:

Introduction: Fundamentals. Asymptotic Analysis Of Complexity – Best, Average And Worst-Case. Empirical Measurements Of Performance, Time And Space Trade-Offs In Algorithms. Recurrence Relations For Recursive Algorithms.

Module 2:

Fundamental Algorithmic Strategies: Illustrations Of Brute-Force, Greedy, Branch-And-Bound, Backtracking And Dynamic Programming Methodologies. Heuristics – Characteristics And Their Applicability. Algorithms For String/Text Matching Problems, Huffman Code And Data Compression Problems, Subset-Sum And Knapsack Problems.

Module 3:

Graph And Tree Algorithms: Depth- And Breadth- First Traversals. Shortest Path Algorithms, Transitive Closure, Minimum Spanning Tree, Topological Sort, Network Flow Problems.

Module 4:

Tractable And Intractable Problems: Computability. The Halting Problem. Computability Classes – P, NP, NP-Complete And NP-Hard. Cook's Theorem. Standard NP-Complete Problems And Reduction Techniques.

Module 5:

Advanced Topics: Approximation Algorithms, Randomized Algorithms, Class Of Problems Beyond NP – PSPACE.

Text Books:

1. Introduction To Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest And Clifford Stein, MIT Press/Mcgraw-Hill.
2. Fundamentals Of Algorithms – E. Horowitz Et Al.

Reference Books:

1. Algorithm Design, 1ST Edition, Jon Kleinberg And Évatardos, Pearson.
2. Algorithm Design: Foundations, Analysis, And Internet Examples,Second Edition,Michael T Goodrich And Roberto Tamassia, Wiley.
3. Algorithms -- A Creative Approach, 3RD Edition, Udimanber, Addison-Wesley, Reading, MA

SEMESTER IV

Algebra-II

[Set and Group theory]

Paper Code: SMA31102 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Set, relation, mapping and algebraic structure: Basic properties of sets, set operations, De Morgan's laws, cartesian product of sets, relation, equivalence relation, relation between equivalence relation and partition, congruence of integers, congruence classes. Mapping: Injection, surjection, bijection, identity and inverse mappings, composition of mappings and its associativity. Binary operations: Definitions and examples, commutative and associative binary operations, identity and inverse element. Algebraic structure: Concept of algebraic structure, definition (only) of groupoid, semi-group, monoid.

Unit-II

Group, Abelian group, examples of groups from number system, root of unity, matrices, symmetries of squares, triangles etc., groups of congruence classes, Klein's 4 group, properties deducible from definition of group including solvability of equations like $ax = b$, $ya = b$, any finite semi-group having both cancellation laws is a group, integral power of elements and laws of indices in a group, order of an element of a group, order of a group.

Unit-III

Subgroups, necessary and sufficient condition for a subset of group to be a subgroup, intersection and union of subgroups, necessary and sufficient condition for union of two subgroups to a subgroup, permutation groups and quaternion groups, properties of cyclic groups, classification of subgroups of cyclic groups.

Unit-IV

Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Text Books:

2. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002

Reference Books:

5. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi.
6. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
7. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
8. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Analysis-II

Paper Code: SMA51102 **L: T: P=2:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Real number system and set theory: Completeness property, Archimedean property, Denseness of rationals and irrationals, Countable and uncountable, Cardinality, Zorn's lemma, Axiom of choice.

Unit-II

Metric spaces: Open sets, closed sets, Continuous functions, Completeness, Cantor intersection theorem, Baire category theorem, Compactness, Totally boundedness, Finite intersection property.

Unit-III

Riemann-Stieltjes integral: Definition and existence of the integral, Properties of the integral, Differentiation and integration.

Unit-IV

Sequence and Series of functions: Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Equicontinuity, Ascoli's Theorem.

Recommended Books:

5. W. Rudin, Principal of Mathematical Analysis, Mcgraw-Hill, 1976.
6. C.C. Pugh, Real Mathematical Analysis, Springer, 2002.
7. T.M. Apostol, Mathematical Analysis, Addison-Wesley, 1974.
8. G.F. Simmons, Topolgy and Modern analysis, Kreiger 2004.

Ordinary Differential Equation

Paper Code: SMA31105 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Motivation and importance, order and degree of a differential equation, differences between linear and nonlinear equations, general, particular, explicit, implicit and singular solutions of a differential equation, formation of differential equation by eliminating arbitrary constants, general solution and geometrical significance of differential equation.

Unit II

First Order Linear Equations: Existence and uniqueness of solution of ordinary differential equations, separable equations, exact differential equations and integrating factors, equations reducible to this form, linear equation and Bernoulli's equations, special integrating factors and transformations, application of first order differential equations to acceleration-velocity model, growth and decay model.

Unit-III

Second Order Linear Equations: Homogeneous Equations with Constant Coefficients, 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, and method of undetermined coefficients, method of variation of parameters.

Higher Order Linear Equations: General theory of *n*th order linear equations, homogeneous equations with constant coefficients, method of undetermined coefficients, method of variation of parameters.

Unit-IV

Existence and uniqueness of solutions: Lipschitz condition, non-local existence of solutions, uniqueness of solutions, existence and uniqueness theorem for first order equations, statement of existence and uniqueness theorem for the solutions of ordinary differential equation of order *n*.

Unit-V

Differential equation of first order but not first degree, solvable for *p, y, x,* Clairaut's equation, singular solutions, Geometric meaning, application of first order differential equation, orthogonal trajectories and related problems. Basic theory of systems of first order linear equations, homogeneous linear systems with constant coefficients, non-homogeneous linear systems, predator-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Unit-VI

Application of ODE: Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

Unit-VII

Series solution: Introduction, ordinary point, singular point and regular singular point, power series solution about an ordinary point, solutions about singular points, Frobenius method.

Legendre's equation and Legendre's polynomials, Rodrigue's formula, Bessel's equation, Bessel's function and its application.

Text Books:

3. H.T.H. Piaggio, Differential Equations, G.Bell & Sons Ltd. 1921
4. S. L. Ross, Differential Equations, John Wiley and Sons, India, 2004.
5. Shepley L Ross, Introduction to ordinary differential equation, John Wiley & Sons.
6. M.D.Raisinghania: Ordinary and Partial Differential equations, S.Chand.
7. M.D.Raisinghania: Advanced Differential equations, S.Chand.

Reference Books:

5. William E. Boyce and Richard C. Di-Prima, Elementary Differential Equations and Boundary Value Problems, 7th edition, John Wiley & Sons, Inc.
6. C. H. Edwards and D. E. Penny, Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, India, 2005.
7. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple, Taylor and Francis, London and New York, 2002.
8. H.T.H. Piaggio, An elementary treatise on differential equations, G. Bell and sons limited.

Reference Books:

7. H.T.H. Piaggio, An elementary treatise on differential equations, G. Bell and sons limited.
8. Iaan Sneddon, Elements of partial differential, McGraw-Hill book.
9. A. R. Forsyth, A treatise on differential equations, Macmillan.

Analytical Geometry

Paper Code: SMA32106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Coordinate Geometry: Transformation of rectangular axes. Invariants associated with the coefficients of general degree equation, necessary and sufficient conditions for the general second degree equation to represent a pair of straight lines, reduction of the general second degree equation to canonical form, classification of conics, and pair of straight lines.

Unit-II

Conjugate diameters of conics, pole and polar with respect to a non -singular conic, asymptotes, coaxial systems of circles, polar equations of straight lines, circle and conics (with a focus as pole) and tangent, normal, chord of contact.

Unit-III

Three- dimensional Geometry: Rectangular Cartesian coordinates in space, direction cosines and direction ratios of a directed line, projection, angle between two lines, equations to a plane in intercept, normal and general forms, the sides of a plane, bisectors of the angles between two planes, parallelism and perpendicularity of two planes, straight lines in the space, skew lines.

Unit-IV

Sphere, cone, cylinder, surfaces of revolution, ruled surface, transformation of rectangular axes in the space, reduction of the general second degree equation in three variables to canonical form, classification of quadrics, standard equations and shapes of ellipsoid, hyperboloid and paraboloid.

Text Books:

3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.

Reference Books:

4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, Mc Millan India Ltd., 1994.

Computer Organization & Architecture

ECS32102 **3-1-0** **3 Credit**

Module 1:

Basic computer Organization: CPU, memory, input-output subsystems, control unit. Instruction set architecture, registers, Machine cycle, RTL interpretation of instructions, instruction format, addressing modes, instruction set. Case study – instruction sets of some common CPUs.

Data representation: signed number, fixed and floating point and character representation. Computer arithmetic: integer addition and subtraction, multiplication using shift-and-add, Booth multiplier, carry.

Module 2:

Introduction To x86 architecture.

CPU Design: hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU. Memory hierarchy, Access method, Main memory, associative memory, cache memory, virtual memory, memory organization.

Peripheral devices: I/O interface and I/O driver, device interface, I/O transfers: program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions.

Module 3:

Pipelining: Basic Concept of pipelining, throughput and speedup, pipeline hazards.

Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Module 4:

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Text Books:

3. "Computer Organization And Design: The Hardware/Software Interface", 5th Edition By David A. Patterson And John L. Hennessy, Elsevier.
4. "Computer Organization And Design: The Hardware/Software Interface", 5th Edition By David A. Patterson And John L. Hennessy, Elsevier

Reference Books:

4. "Computer Architecture And Organization", 3rd Edition By John P. Hayes, WCB/Mcgraw-Hill.
5. "Computer Organization And Architecture: Designing For Performance", 10th Edition By William Stallings, Pearson Education.
6. "Computer System Design And Architecture", 2nd Edition By Vincent P. Heuring And Harry F. Jordan, Pearson Education

Design and Analysis Of Algorithms

Paper code - ECS51105 L-T-P - 3-1-0 3 Credits

Module 1:

Introduction: Fundamentals. Asymptotic Analysis Of Complexity – Best, Average And Worst-Case. Empirical Measurements Of Performance, Time And Space Trade-Offs In Algorithms. Recurrence Relations For Recursive Algorithms.

Module 2:

Fundamental Algorithmic Strategies: Illustrations Of Brute-Force, Greedy, Branch-And-Bound, Backtracking And Dynamic Programming Methodologies. Heuristics – Characteristics And Their Applicability. Algorithms For String/Text Matching Problems, Huffman Code And Data Compression Problems, Subset-Sum And Knapsack Problems.

Module 3:

Graph And Tree Algorithms: Depth- And Breadth- First Traversals. Shortest Path Algorithms, Transitive Closure, Minimum Spanning Tree, Topological Sort, Network Flow Problems.

Module 4:

Tractable And Intractable Problems: Computability. The Halting Problem. Computability Classes – P, NP, NP-Complete And NP-Hard. Cook's Theorem. Standard NP-Complete Problems And Reduction Techniques.

Module 5:

Advanced Topics: Approximation Algorithms, Randomized Algorithms, Class Of Problems Beyond NP – PSPACE.

Text Books:

3. Introduction To Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest And Clifford Stein, MIT Press/Mcgraw-Hill.
4. Fundamentals Of Algorithms – E. Horowitz Et Al.

Reference Books:

4. Algorithm Design, 1ST Edition, Jon Kleinberg And Évatardos, Pearson.
5. Algorithm Design: Foundations, Analysis, And Internet Examples,Second Edition,Michael T Goodrich And Roberto Tamassia, Wiley.
6. Algorithms -- A Creative Approach, 3RD Edition, Udimanber, Addison-Wesley, Reading, MA

SEMESTER V

Theory of Probability and Statistics

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Review of Probability concepts, condition probability, Bayes' theorem and its applications, random variables and its types, discrete distribution function, probability density function, various measures of central tendency, Moment generating function and its limitations, Discrete probability distributions: Binomial, Poisson, negative binomial, geometric and hyper-geometric distributions and their moment generating functions and properties, Continuous probability distributions: Triangular, gamma, exponential, Weibul, normal distribution, their moment generating functions and applications.

Unit-II

Sampling theory: Introduction, types of sampling, parameter and statistics, test of significance, procedure for testing of hypothesis, tests of significance for large samples, sampling of attributes, sampling of variables, χ^2 – distribution, some theorem on Chi-Square distribution, linear transformation, applications of Chi-Square distribution, Student's 't' distribution and F-distribution and its applications, relations between t & F distribution and F & χ^2 – distributions.

Unit-III

Correlation and Regression Analysis: Correlation analysis, measure of simple correlation,Spearman's rank correlation, regression analysis, two regression equations, logistic regression, estimation of multiple regression equation and calculation of multiple correlation coefficients, forecast with a regression equation, correlation matrix, dummy variable, partial correlation and regression coefficients, Beta coefficients, cross sectional and time series correlation, regression model with more than two independent variables.

Unit-IV

Time series analysis and forecasting methods: Introduction and analysis of a time series, trend method, time series method, correlation regression method, End–Use method, exponential smoothing method, Delphi method, demand forecasting for industrial products.

Text Books:

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical Statistics, S Chand & Sons.
2. Vijay K. Rohatgi, A.K. Md. EhsanesSaleh, An Introduction to Probability and Statistics, Second edition, Wiley.
3. T N Srivastava and ShailagaRego, Statistics for Management, McGraw Hill Education.

Reference Books:

1. DipakChatterjee, Elements of Statistics, Scitech publications.
2. R VHogg, J Mckean and A T Craig, Introduction to Mathematical Statistics, 7e, Pearson Education India.

ADAMAS UNIVERSITY
PURSUE EXCELLENCE

Course Structure of 5-Year Integrated Course in Mathematics and Computing

Data Structures

Paper Code: **L: T: P=2:1:0**

Credits- 3 **Contact hours per week -3**

Unit-I

Introduction: BasicTerminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic Notations, Time-Space Trade-Off, Abstract Data Type (ADT).

Unit-II

Array: Definition, 1D and Multi-Dimensional Arrays, Representation of Arrays, Row Major and Column Major Order, Applications, Sparse Matrices and their Representation.

Stacks and Queues: ADT Stack, Array Implementation of Multiple Stack, Application of Stacks: Conversion from Infix To Postfix, Evaluation of Postfix and Prefix Notation Etc. ADT Queue, Linear Queue, Circular Queue.

Unit-III

Linked List: Static and Dynamic Implementation of Singly Linked List, Doubly Linked List, Circular Linked List and Linked List Operations, Insertion, Deletion, Traversal, Polynomial representation and addition, Generalized Linked List.

Trees: Basic Terminology, Binary Trees and their Representation: Static and Dynamic, Complete and Extended Binary Trees, Algebraic Expressions, Array and Linked Representation, Tree Traversal Algorithms, Threaded Binary Trees, Traversing of Threaded Binary Trees, Huffman Algorithm.

Unit-IV

Graphs: Terminology, Sequential and Linked Representation of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi-List, Graph Traversal: Depth First Search and Breath First Search, Connected Component, Spanning Trees, Minimum Cost Spanning Trees: Prims and Kruskal Algorithm. Transitive Closure and Shortest Path Algorithms: Warshal Algorithm and Dijkstra Algorithm, Introduction of Activity Networks.

Unit-V

Searching And Sorting: SequentialSearch, Binary Search, Comparison andAnalysis of Internal Sorting: Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Two-Way Merge Sort, Heap

Sort, Radix Sort. Search Trees: Binary Search Trees (BST), Insertion and Deletion, Complexity, AVL Trees, M-Way Search Trees, B-Trees and B+ Trees.Hashing.

Text books:

1. Data Structures Using C", 7th Edition, A. M. Tenenbaum, YedidyahLangsam And Moshe J. Augenstein, PHI Learning Private Limited, Delhi, India.

2. Data Structures and Algorithms In C++", 2nd Edition, M. T. Goodrich, Roberto Tamassia, David M. Mount, John Wiley & Sons.

Reference Books:

1. Fundamentals Of Data Structures", Illustrated Edition By Ellis Horowitz, SartazSahani, Computer Science Press.

2. Data Structures:Schaum's Outline Series", Lischutz, Tata Mcgraw-Hill Education Pvt. Ltd.

Vector and Tensor Calculus

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week -4**

Unit-I

Basics (addition, negation, right-hand coordinates, length, unit vector), Dot Product, Cross Product, Triple Products.

Integration: Line Integrals, Surface Integrals, Volume Integrals.

Unit-II

Differential Operators: Diveregence, curl, Laplacian & their properties.

Unit-III

Suffix, Index, Tensor Notation, Special Tensors (Kronecker Delta, Alternating Tensor), Differential Operators in Index Notation (definitions, combinations, product rules).

Unit-IV

Green's Theorems (General Form), Divergence Theorem (Gauss's Theorem), Stokes's Theorem (Curl Theorem).

Unit-V

Cartesian Tensors and Rotation: Coordinate Transforms, Rotation Transform Rules for Tensors, Symmetric/Antisymmetric Tensors, Isotropic Tensors.

Text Books:

1. Murray Spiegel and Seymour Lipschutz, Vector Analysis, Schaum's outlines
2. Barry Spain, Tensor Calculus: A Concise Course,Dover Books.

Reference Books:

1. J.G. Chakravorty, P.R. Ghosh, Vector Analysis, U. N. Dhar& sons Pvt. Ltd.
2. J E Marsden and A Tromba, Vector Calculus by, 6th edition, Freeman.
3. David C. Kay, Schaums Outline of Tensor Calculus, Schaums' Outline Series, McGraw-Hill Education.

Numerical Analysis

Paper Code: SMA33103 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit – I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Regular Falsi method, Newton's Raphsan method, Secant method, Rate of convergence of these methods, fixed point of a function, fixed point iteration method, numerical solution system of non-linear equation by Newton-Raphson method.

Unit – II

System of linear algebraic equations: Gaussian Elimination, pivoting, Gauss Jordan methods, LU-Decomposition methods,ill condition system and its solution,Gauss Jacobi method, Gauss Seidel methodand their convergence analysis, eigen value and eigen vector problems, power method.

Unit – III

Interpolation: Finite difference operators and its properties and relation between finite difference operators, Newton's forward and backward difference formula, numerical differentiation.

Interpolation with unequal intervals: Lagrange's interpolation formula and Newton's divided difference interpolation formula.

Unit – IV

Numerical Integration: Trapezoidal rule, Simpsons 1/3rd rule, Simpsons 3/8th rule, Midpoint rule, Composite Trapezoidal rule, Composite Simpsons, Guass Quadrature 2 point & 3 point rule.

Ordinary Differential Equations: Taylor's method,Picard's Methods, Euler's method, Modified Euler's method,Runge-Kutta methods of orders two and four.

Text Books:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition, 2007

Reference Books:

1. T. Veerarajan, T. Ramachandran , Numerical Methods with Programs in C , Tata McGraw-Hill Publications
2. S. Dey, S. Gupta , Numerical Methods, McGraw Hill Education
3. B.S. Grewal , Numerical Methods in Engineering & Science with Programs in C & C++, Khanna Publications

Mechanics-I

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I:

Applications of Newton's laws to elementary problems of simple harmonic motion, inverse square law and composition of two simple harmonic motions, center of mass.

Basic kinematic quantities: momentum, angular momentum and kinetic energy, principle of energy and momentum, work and poser, simple examples on their applications.

Impact of elastic bodies, direct and oblique impact of elastic spheres, losses of kinetic energy, angle of deflection.

Unit II:

Tangent and normal accelerations, circular motion, radial and cross-radial accelerations, damped harmonic oscillator, motion under gravity with resistance proportional to some integral power of velocity, terminal velocity, simple cases of a constrained motion of a particle,

motion of a particle in a plane under different laws of resistance, motion of a projectile in a resisting medium in which the resistance varies as the velocity, trajectories in a resisting medium where resistance varies as some integral power of the velocity.

Unit III:

Central forces and central orbits, typical features of central orbits, stability of nearly circular orbits, planetary motion and Kepler's laws, time of describing an arc of the orbit, orbital energy, relationship between period and semi-major axis, motion of an artificial satellite, motion of a smooth cure under resistance, motion of a rough curve under gravity e.g., circle, parabola, ellipse, cycloid etc.

Momental ellipsoid, equimomental system, principal axis, D'Alembert's principle, D'Alembert's equations of motion, principles of moments, principles of conservations of linear and angular momentum, independence of the motion of centre of inertia and the motion relative to the centre of inertia, principle of energy, principle of conservation of energy.

Unit IV:

Equation of motion of a rigid body about a fixed axis, expression for kinetic energy and moment of momentum of a rigid body moving about a fixed axis, compound pendulum, interchangeability of the points of a suspension and centre of oscillation, minimum time of oscillation, equations of motion of a rigid body moving in two dimensions, expression for kinetic energy and angular momentum about the origin of rigid body moving in two dimensions, necessary and sufficient condition for pure rolling, two dimensional motion of a solid of revolution moving on a rough horizontal plane.

Unit V:

Equations of motion under impulsive forces, equation of motion about a fixed axis under impulsive forces, to show that (i) of there is a definite straight line such that the sum of the moments of the external impulses acting on a system of particles about it vanishes, then the total angular momentum of the system about that line remains unaltered (ii) the change of K.E. of a system of particles moving in any manner under the application of impulsive forces is equal to the work done by the impulsive forces.

Text Books:

1. Dynamics of Particle and of Rigid Bodies – S. L. Loney.

Reference Books:

2. Anil Rao,Dynamics of Particles and Rigid Bodies: A Systematic Approach.
3. E. T. Whittaker,A Treatise on the Analytical Dynamics of Particles and Rigid Bodies.

SEMESTER VI

Integral Equations and Variational Principles

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit-I

Integral Equations: Basic concepts, Fredholm integral equations, Volterra integral equations, conversion of ODE into integral equations, Relationship between linear differential equations and Volterra and Fredholm integral equations, Solutions of homogeneous Fredholm integral equations of 2nd kind with degenerate kernels, Resolvent kernel, Solutions of Fredholm integral equations of 2nd kind with degenerate kernels and related examples, Method of successive approximations, Convolution type equations, Volterra equation of first kind, Abel's integral equation.

Unit-II

Fredholm integral equations, Fredholm equations of the second kind, the method of Fredholm determinants, Iterated kernels, Integral equations with degenerate kernels, Eigen values and eigen functions of a Fredholm alternative, Construction of Green's function for BVP, Singular integral equations.

Unit-III

Variational Principles : Functionals, Euler's equations, Isoperimetric problems, Functional involving higher order derivatives, Variational problems with fixed and moving boundary, Rayleigh-Ritz method, Galerkin's method, Hamilton's principle, Lagrange's equations, Reflection and Refraction of extremals, Diffraction of light rays.

Text Books:

1. A. S. Gupta: Calculus of Variations with Applications, PHI.
2. Robert Weinstock: Calculus of Variations: With Applications to Physics and Engineering, Dover Publications Inc.
3. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications, Chapman and Hall/CRC publishers.

Reference Books:

4. Babu V R Ranganatham S, Fourier Series and Integral Transforms, S Chand & Company-New Delhi
5. Swarup and Singh, Integral Equations & Boundary Value Problems, Krishna publications.

Operating Systems

Course Structure of 5-Year Integrated Course in Mathematics and Computing

Paper Code: **L: T: P=3:0:0**

Credits- 3 **Contact hours per week – 3**

Unit-I

Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.

Unit- II

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads.

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Types and performance evaluation.

Unit- III

Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation , Peterson's Solution, The Producer Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Unit- IV

Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: banker's algorithm, Deadlock detection and Recovery.

Unit- V

Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition – Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging.

First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

Unit- VI

I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms.

File Management: Concept of File, Access methods, File types, File operation, Directory structure, File system structure,

Disk Management: Disk structure, Disk scheduling- FCFS, SSTF, SCAN, C-SCAN, DISK reliability, Disk formatting, Boot- block, Bad blocks.

Text Books:

1. Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.

Reference Books:

3. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing.
4. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison-Wesley.
5. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India.
6. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates.

ADAMAS UNIVERSITY
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Course Structure of 5-Year Integrated Course in Mathematics and Computing

Discrete Mathematics and Graph theory

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit-I

Sets, Relation and Function: Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem.

Principles of Mathematical Induction: The Well-Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

Unit-II

Introduction to Counting: Basic Counting Techniques, Inclusion, Exclusion, Pigeon-Hole Principle, Permutation and Combination, Summation.

Recurrence Relation and Generating Function: Recurrence Relation, The First-Order Linear Recurrence Relation, The Second-Order Linear Homogeneous Recurrence Relation with Constant Coefficients, The Nonhomogeneous Recurrence Relation, The Method of Generating Function, Divide-and Conquer Algorithms, Generating Function, an Introductory Example, calculation Techniques, Partitions of Integers, the Exponential Generating Function, and the Summation Operator.

Unit-III

Algebraic Structures and Morphism: Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Substructures, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields, Boolean Algebra, Boolean Expression and Boolean Function, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Sum-of-Product, Functional Completeness, Switching Function: Disjunctive and Conjunctive Normal Form, Logic Gates, Minimization of Circuits,

Boolean Ring.

Unit-IV

Basic Concepts: Graphs and digraphs, loop, isolated vertex, pendent vertex, complete graph, regular graphs, cycles, wheels, platonic graphs, sub-graphs, graphs isomorphism, operations on graphs, connected and disconnected graphs, rank and nullity of a graph, walks, paths, circuits, Eulerian graph, Eulerian path, Eulerian circuit, Hamiltonian graphs, Matrix representation of a graph, Incidence and adjacency matrices, Planar graphs, Kuratowski's graphs, bipartite graphs, Euler's formula, Kuratowski's theorem, dual of a planar graph, double dual of a graph.

Unit-V

Trees: Equivalent definitions of trees and forests, Cayley's formula, the Matrix-Tree theorem, minimum spanning trees;

Connectivity: Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger's theorem;

Paths and Cycles: Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy and Chvatal, girth, circumference, the Chinese Postman Problem, the Travelling Salesman problem, diameter and maximum degree, shortest paths;

Unit-VI

Matchings: Berge's Theorem, perfect matchings, Hall's theorem, Tutte's theorem, Konig's theorem, Petersen's theorem, algorithms for matching and weighted matching (in both bipartitieand general graphs), factors of graphs (decompositions of the complete graph), Tutte's f-factor theorem;

Extremal problems: Independent sets and covering numbers, Turan's theorem, Ramsey theorems;

Colorings: Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizing's theorem;

Unit-VII

Directed graphs: Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, Branching's;

Networks and flows: Flow cuts, Max flow min cut theorems, perfect square; Selected topics: Dominating sets, the reconstruction problem, intersection graphs, perfect graphs, random graphs.

Text Books:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw - Hill.
2. V Somasundaram, Discrete Mathematics with Graph Theory and Combinatory, Tata McGraw- Hill.
3. Schum's Outlines Series, Seymour Lipchitz, Marc Lipson, Discrete Mathematics, Tata McGraw - Hill.
4. C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw – Hill.
5. Graph Theory By Narsing Deo, Prentice Hall.

Reference Books:

6. Introduction to Graph theory By Douglus B. West, Prentice Hall.
7. Introduction to Graph theory By Gary Chartrand, Dover Publications.

Operations Research

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Introduction to Operations Research: basics definition, scope, objectives, phases, models and limitations of Operations Research, Linear Programming Problem – Formulation, Graphical solution, Simplex method, Big-M method, Two-phase method, infeasible alternate optimum, degeneracy and unbound solutions.

Unit-II

Extension of Linear Programming Problem: Revised Simplex method, Duality theorems, Dual simplex method, Post optimal analysis, Changes in objective function coefficients, Changes in b_i and a_{ij} values, Integer linear programming, Pure and mixed integer programming, Gomory's constraints, Branch and bound method.

Unit-III

Dynamic programming: Characteristics of dynamic programming, Dynamic programming approach for priority management employment smoothening, Capital budgeting, Ctage coach/shortest path, Cargo loading and reliability problems.

Network Analysis: Project management by PERT and CPM: A brief introduction to PERT and CPM, Components of PERT/CPM network and precedence relationships, critical path analysis, PERT analysis in controlling project.

Unit-IV

Replacement Models: Replacement of Items that deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, Group replacement policy.

Inventory models: Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.

Text Books:

1. J K Sharma, "Operations Research Theory & Applications, 3e", Macmillan India Ltd, 2007.
2. A M Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education, 2005.

Reference Books:

3. P. K. Gupta and D. S. Hira, "Operations Research", S. Chand & co., 2007.
4. N.V.S. Raju, "Operations Research", SMS Education.
5. H. A. Taha, Operations Research, 9th edition, Pearson.

6. S. D. Sharma, Operations Research: Theory and Applications,4th edition, Laxmi Publications
7. Frederick. S. Hillier and G. J. Lieberman, Introduction to Operations Research, McGraw-Hill Science.
8. S. S. Rao, Optimization: Theory and Applications, Wiley Eastern.
9. P. SankaraIyer, Operations Research, Tata McGraw-Hill, 2008.

SEMESTER VII

Functional Analysis

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Review of Normed spaces, Banach spaces and examples, incomplete normed spaces, completion of normed linear spaces, some properties of Banach spaces, Open and Closed spheres in normed spaces, Quotient spaces of normed linear spaces and its completion, best approximation theorem, Inner product space and projection theorem, Bessel's inequality, Riesz-Fischer theorem.

Unit-II

Characterization of finite dimensional spaces, Banach spaces, Bounded linear maps on a normed linear spaces: Examples, linear map on finite dimensional spaces, finite dimensional spaces are isomorphic, operator norm.

Unit-III

Hahn-Banach theorems: Geometric and extension forms and their applications, Three main theorems on Banach spaces: Uniform boundedness principle, divergence of Fourier series, closed graph theorem, projection, open mapping theorem, comparable norms.

Unit-IV

Bounded linear operators and bounded linear functions and their norms andproperties, Dual spaces and their examples, Reflexive normed spaces, Properties ofreflexive normed spaces, weak convergence and strong convergence, Geometric properties of normed spaces, Invertibility of an operator, Spectrum of an operator.

Text Books:

1. B.V. Limaye, Functional Analysis, New Age International, 1996.
2. E. Krezyisz, Introduction to Functional Analysis with Application, Wiley, 1989.

Reference Books:

1. M.T. Nair, Functional Analysis-a first course, Prentice Hall of India, 2010.
2. G.F. Simmons, Topology and Modern analysis, Kreiger, 2004.

Number Theory

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.

Unit-II

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, Euler's theorem, reduced set of residues, some properties of Euler's phi-function,

Unit-III

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.

Unit-IV

Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last theorem.

Text Books:

1. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.

Reference Books:

2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

ADAMAS UNIVERSITY
PURSUE EXCELLENCE

Course Structure of 5-Year Integrated Course in Mathematics and Computing

Complex Analysis

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit - I

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings, Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Unit – II

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions, contours, Contour integrals and its examples, upper bounds for moduli of contour integrals, Cauchy- Goursat theorem, Cauchy integral formula.

Unit – III

Liouville's theorem and the fundamental theorem of algebra, Convergence of sequences and series, Taylor series and its examples, Laurent series and its examples, absolute and uniform convergence of power series.

Unit – IV

Classification of singularities: Isolated and non-isolated singularities, removable singularities, poles, isolated singularities at infinity, Meromorphic functions, essential singularities, residues at a finite point, residues at the point at infinity, Cauchy's residue theorem, Rouche's theorem and evaluation of integrals.

Unit-V

Bilinear transformations their properties and classifications, principle of conformal mapping, bilinear of fractional transformations, Schwartz-Christoffel transformation, mapping. Analytic continuation, uniqueness of analytic continuation along a curve, power series method of analytic continuation and Schwartz's reflection principle.

Text Books:

1. Murray. R. Spiegel, Theory and Problems of Complex Variables, Schaum outline series.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Pub. House.

Reference Books:

3. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill International Edition, 2009.
4. H K Kasana, Complex Variables: Theory and Applications: Second Edition, Prentice Hall India Learning Private Limited.
5. P. Duraipandianand K. Pachaiyappa, Complex Analysis, S. Chand Publishing.
6. J. B. Conway, Functions of one Complex variable. Springer,Verlag.

Integral Transformations

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs and PDEs. Finite Laplace Transform: Definition and properties, Shifting and scaling theorem.

Unit-II

Fourier series: Trigonometric Fourier series and its convergence.Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval`s identity, Complex form of Fourier series.

Unit-III

Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems.

Unit-IV

Z-Transform: Z–transform and inverse Z-transform of elementary functions, Shifting theorems, Convolution theorem, Initial and final value theorem, Application of Z-transforms to solve difference equations.

Text Books:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2011.

Reference Books:

1. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, Narosa Publishing House.
2. F. B. Hildebrand, Methods of Applied Mathematics, Courier Dover Publications, 1992.
3. L. Debanth and D. Bhatta, Integral Transforms and Their Applications, Taylor and Francis Group, 2007.

Machine Learning

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit 1:
Introduction: Overview of machine learning, related areas, applications, software tools, course objectives.
Parametric regression: linear regression, polynomial regression, locally weighted regression, numerical optimization, gradient descent, kernel methods.

Unit 2:
Generative learning: Gaussian parameter estimation, maximum likelihood estimation, MAP estimation, Bayesian estimation, bias and variance of estimators, missing and noisy features, nonparametric density estimation, Gaussian discriminant analysis, naive Bayes.

Unit 3:
Discriminative learning: linear discrimination, logistic regression, logit and logistic functions, generalized linear models, softmax regression.
Neural networks: the perceptron algorithm, multilayer perceptrons, back-propagation, nonlinear regression, multiclass discrimination, training procedures, localized network structure, dimensionality reduction interpretation.

Unit 4:
Support vector machines: functional and geometric margins, optimum margin classifier, constrained optimization, Lagrange multipliers, primal/dual problems, KKT conditions, dual of the optimum margin classifier, soft margins, kernels, quadratic programming, SMO algorithm.

Unit 5:
Graphical and sequential models: Bayesian networks, conditional independence, Markov random fields, inference in graphical models, belief propagation, Markov models, hidden Markov models, decoding states from observations, learning HMM parameters.

Unit 6:
Unsupervised learning: K-means clustering, expectation maximization, Gaussian mixture density estimation, mixture of naive Bayes, model selection.

Unit 7:

Dimensionality reduction: feature selection, principal component analysis, linear discriminant analysis, factor analysis, independent component analysis, multidimensional scaling, manifold learning

Text Books:

1"Elements of Statistical Learning", T. Hastie, R. Tibshirani and J. Friedman, Springer, 2001.
2"Machine Learning", E. Alpaydin, MIT Press, 2010.

Reference Books:

1 "Pattern Recognition and Machine Learning", C. Bishop, Springer, 2006.
2 "Pattern Classification", R. Duda, E. Hart, and D. Stork, Willey-Interscience, 2000.

System Programming

Paper Code: **L: T: P=3:0:0**

Credits- 3 **Contact hours per week - 3**

Unit-I

Basics of C Programming: Characters, Identifiers, Keywords, Data type and sizes, Constant and variables, Various operators and expressions, Standard input and output, Formatted input and output Printf(), Flow of control and Exit() Function.

Unit-II

Functions and Pointers: Definition, Declaration of Function, Various Types of Functions, Call-By-Value, Call-By-Reference, Recursion, Tail Recursion, Pointer, Functions with Pointer.

Unit-III

Arrays and String: Definition, Declaration, Initialization of an Array, Dimensionality, Sorting and Searching Algorithms, String: Definition, Declaration, Initialization, String Functions.

Unit-IV

Structures and Unions: Definition, Declaration, Initialization, Operators used in Structure, Structure within Structures, Union, Difference between a Structure and Union.

Files: Types of File, File Processing, Handling Characters, Handling Integers, Random File Accessing, Errors during File processing.

Unit-V

Interpreters & Debuggers: Benefits of Interpretation, Overview of Interpretation, The Java Language Environment, Java Virtual Machine, Types of Errors, Debugging Procedures, Classification of Debuggers, Dynamic/Interactive Debugger

Text Book:

1. Herbert Schildt, The Complete Reference, 4th Edition, Tata Mcgraw Hill Education.

Reference Books:

1. Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, 2nd Edition, PHI.
2. Byron S. Gottfried, Schaum's Outline of Programming with C", 2nd Edition, Mcgraw Hill Education.

System Programming Lab

Paper Code: **L: T: P=3:0:0**

Credits- 3 **Contact hours per week - 3**

Experiments should include but not limited to:

Introduction to DOS and UNIX Operating System Development of Computer Program using C language- Roots of quadratic and Cubic equations; Summation of n Natural numbers; Arranging numbers in ascending and descending orders; Separation of odd and even numbers, problems on recursion, Arrays, Pointers, and File handling, 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

Binary files of various types: structure and processing:
Maintaining data structures in files (e.g. Linux directories), Object and executable files (demonstrated through ELF files), Linking and Loading, Dynamic Loading.

Using operating systems services (system calls):
Process control: creating and terminating processes, process control, signals.
System-level Input/Output: read, write files, file metadata, sharing files.

Issues in program development:
Debugging programs, and the effect of compound bugs (e.g. various types of memory leaks, compiler bugs). Patching and hacking.

ADAMAS UNIVERSITY
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Course Structure of 5-Year Integrated Course in Mathematics and Computing

SEMESTER VIII

Distribution theory & Generalized functions

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week -4**

Unit I

Quick review of basic concepts in distribution theory:- generating functions and properties, pgf, mgf, cumulant generating function and characteristic functions, factorial moments and recurrence relation, Discrete Distributions:- Power series, Binomial, Geometric, Poisson, Negative binomial and Hyper geometric.

Continuous Distributions:- Rectangular, Exponential, Weibull, Beta, Gamma, Pareto, Normal, Lognormal, Cauchy, Laplace, Logistic.

Unit II

Functions of Random variables and their distributions using transformations of variables techniques. Distributions of sums, products and ratios of independent r.v.s, compound, truncated and mixture distributions.

Sampling distributions:- Chi-square, t and F distributions (central only) Order statistics and their distributions:- joint and marginal distributions of sample median, range and mid – range (Exponential, Uniform, Logistic).

Unit III

Dirac delta-function and delta-sequences, definition of generalized functions and their basic properties, the space of generalized functions, regular generalized function, Sokhotski formulas, differentiation of generalized functions, direct product of generalized functions, convolution of generalized functions.

Unit IV

Integrals and derivatives of high orders, the Poisson summation formula, Fourier Transform of generalized functions, Laplace transform of generalized functions, some elements of the Sobolev spaces theory.

Text Books:

1. Hogg R.V and Craig A.T (1989) Introduction to Mathematical Statistics, Macmillian publishing company.
2. Arnold B.C, Balakrishnan N and Nagaraja H.N (1992) A first Course in Order Statistics.
3. Gupta S.C and Kapoor V.K (2000) Fundamentals of Mathematical Statistics, S. Chand & Co, New Delhi.
4. Kanwal R., *Generalized functions. Theory and applications*, 3d ed., Springer Science + Business Media, LLC, 2004.
5. Gelfand I. and Shilov G., *Generalized functions, vol. I*, Academic press, New York and London, 1964.
6. Vladimirov V., *Equations of mathematical physics,* Marcel Dekker, inc., New York, 1971.

Reference Books:

1. Johnson N.L, Kotz S and Kemp A.W (1992) Univariate discrete distributions, John Wiley.
2. Johnson N.L, Kotz S and Balakrishnan N (1991) Continuous Univariate distributions I & II, John Wiley.
3. Kotz S, Balakrishnan N and Johnson N.L (2000) Continuous Multivariate distributions, John Wiley and sons.
4. Rohatgi V.K (1988) An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
5. Mukhopadhaya P (1996) Mathematical Statistics, The New Central Book Agency.

Topology and Measure Theory

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week -4**

Unit-I

Topological spaces, Definition of topology through open set axioms, Basis for a topology, The order topology, Subspace topology, Closed sets, Countability axioms, Limit points, Convergence of nets in topological spaces, Continuous functions and homeomorphism, The product topology, topology of metric spaces, Quotient topology.

Unit-II

Connected spaces, Connected sets in R, totally disconnected spaces, Intermediate value theorem, path connected, Components, Path components, Locally connected spaces, Locally path connected spaces, Totally disconnected spaces, Continuous functions and connected sets.

Unit-III

Compact sets and their properties,Compact spaces,Compactness in metric spaces, Local compactness, Finite intersection property, Bolzano Weierstrass property, Continuous functions and compactness, Sequential compactness, countable compactness and their comparison, one point compactification.

Unit-IV

Separation axioms, T_o, T_1, T_2, regular, T_3, normal and T_4 spaces, their comparison and examples, hereditary and topological invariant characters, Uryshon's lemma, Uryshon'smetrization theorem, Tietz extension theorem, the Tychonoff theorem, completely regular spaces, Stone –Czech compactification.

Unit-V

Lebesgue Integral, Semi-algebra, Algebra, Monotone class, Sigma-algebra, Monotone class theorem. Measure spaces.Extension of measures from algebras to the generated sigma-algebras: Measurable sets; Lebesgue Measure and its properties, Measurable functions and their properties; Integration and Convergence theorems, Lebesgue integral, Fundamental Theorem of Calculus for Lebesgue Integrals (an outline), Product measure spaces, Fubini's theorem.

Text Books:

1. J.R.Munkres, Topology, Pearson Education India, 2001.

2. K.D. Joshi, Introduction to General Topology, New Age International, 2002
3. P.R. Halmos, Measure Theory, Graduate Text in Mathematics, Springer-Verlag, 1979.
4. H.L. Royden, Real Analysis, 3rd ed., Macmillan, 1988.

References Books:

1. G.F. Simmons,Topolgy and Modern analysis, Kreiger 2004.
2. J.V. Deshpande, Introduction to Topology, Tata Mcgraw-hill, 1998.

Stochastic Process

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit-I

Probability and random variables: Probability Concepts, Random variables, Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Erlang, Weibull and Normal distributions, Function of a Random variable, Moments, Moment generating function.

Unit-II

Two dimensional random variables: Joint distributions, Transformation of random variables and their distributions, Conditional expectation, Computing probabilities and expectations by conditioning,Correlation and Regression.

Unit-III

Limit Theorems: Modes of convergence, Markov, Chebyshev's and Jensen's inequalities, Weak law of large numbers, Strong law of large numbers, Kolmogorov's inequality, Central limit theorem (iid case).

Unit-IV

Markov Chains: Stochastic processes, Classification, Markov chain, Chapman Kolmogorov equations, Transition probability Matrix, Classification of states, First passage times, Stationary distribution, Mean time spent in a transient state.

Unit-V

Markov Processes: Markov process, Poisson process, pure birth process, pure death process, Birth and death process, Limiting probabilities, Non-homogeneous Poisson process, Compound Poisson process.

Text Books:

1. J. Medhi, Stochastic Processes, New Age International (P) Ltd., New Delhi,2nd Edition, 2001.
2. S.M. Ross, Introduction to Probability Models, Academic Press Inc., 9th Edition, 2007.

Reference Books:

1. V.K. Rohatgi and A.K.MD. EhsanesSaleh, An introduction to Probability and Statistics, Wiley Eastern Ltd., 2nd Edition, 2001
2. J. N. Kapur and H.C. Saxena, Mathematical Statistics, S. Chand and Company Ltd., New Delhi, 2003.

Compiler Design

Paper Code: **L: T: P=2:1:0**

Credits- 3 **Contact hours per week – 3**

Unit-I

Introduction: Phases Of Compilation And Overview.

Lexical Analysis (Scanner): Regular Language, Finite Automata, Regular Expression, From Regular Expression To Finite Automata, Scanner Generator (Lex,Flex).

Unit-II

Syntax Analysis (Parser): Context-Free Language And Grammar, Push-Down Automata, LL(1) Grammar And Top-Down Parsing, Operator Grammar, LR(O), SLR(1), LR(1), LALR(1) Grammars And Bottom-Up Parsing, Ambiguity And LR Parsing, LALR(1) Parser Generator (Yacc,Bison).

Unit-III

Semantic Analysis: Attribute Grammar, Syntax Directed Definition, Evaluation And Flow Of Attribute In A Syntax Tree.

Symbol Table: Its Structure, Symbol Attributes And Management.

Unit-IV

Run-Time Environment: Procedure Activation, Parameter Passing, Value Return, Memory Allocation, And Scope.
Intermediate Code Generation: Translation Of Different Language Features, Different Types Of Intermediate Forms.
Code Improvement (Optimization): Analysis: Control-Flow, Data-Flow Dependence Etc.; Code Improvement Local Optimization, Global Optimization, Loop Optimization, Peep-Hole Optimization Etc. Architecture Dependent Code Improvement: Instruction Scheduling (For Pipeline), Loop Optimization (For Cache Memory) Etc.

Unit-V

Register Allocation and Target Code Generation.

Advanced Topics: Type Systems, Data Abstraction, Compilation Of Object Oriented Features And Non-Imperative Programming Languages.

Text Books:

1. Compilers: Principles, Techniques And Tools, 2nd Edition, Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Addison-Wesley.

Reference Books:

2. Modern Compiler Implementation In Java, 2nd Edition, Andrew W. Appel , Cambridge University Press.
3. Compiler Design In C, Allen I. Holub , Prentice-Hall.
4. Optimizing Compilers For Modern Architectures, 1st Edition, Randy Allen And Ken Kennedy, Elsevier.

File organization & Database systems

Paper Code: **L: T: P=2:1:0**

Credits- 3 **Contact hours per week – 3**

Unit-I

Database System Architecture: Data Abstraction, Data Independence, DDL And DML.
Data Models: Entity-Relationship, Network, Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Unit-II

Relational Query Languages: Relational Algebra, Tuple And Domain Relational Calculus, SQL3, DDL And DML Constructs, Open Source And Commercial DBMS: MYSQL, ORACLE, DB2, SQL Server.

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

Query Processing And Query Optimization: Relational Algebra Expressions Evaluation, Query Equivalence, Joins Strategies, Query Optimization Algorithms.

Unit-III

Storage Strategies: Indices, B-Trees, Hashing.

Transaction Processing: Concurrency Control, ACID Property And Serializability Of Scheduling, Locking And Timestamp Based Schedulers, Multi-Version And Optimistic Concurrency Control Schemes, Database Recovery.

Unit-IV

Database Security: Authentication, Authorization And Access Control, DAC, MAC And RBAC Models, Intrusion Detection, SQL Injection.

Unit-V

Advanced Topics: OO Model, Object Relational, Logical, Web, And Distributed Databases, Data Warehousing And Data Mining.

Text Books:

1. "Database System Concepts", 6th Edition By Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Mcgraw-Hill.

Reference Books:

2. "Principles Of Database And Knowledge – Base Systems", Vol 1 By J. D. Ullman, Computer Science Press.
3. "Fundamentals Of Database Systems", 5th Edition By R. Elmasri And S. Navathe, Pearson Education

SEMESTER-IX

Data communication & Computer Networks

Credits- 4 **Contact hours per week - 4** **L: T: P=3:1:0**

Unit-I

Data Transmission Basic Concepts and Terminology :
Data Communication Model, Communication Tasks, Parallel & Serial Transmission, Transmission Models, Transmission Channel, Data Rate, Bandwidth Signal Encoding Schemes, Data Compression.

Unit-II

Computer network :
Network Topology, Network Classification, advantages & disadvantages of Network, Transmission Media (guided and unguided), Network Architecture, OSI Reference Model, and TCP/IP.

Unit-III

Physical Layer :
Guided Transmission, Media, Wireless Transmission Medium, Circuit Switching and Telephone Network, High Speed Digital Access.

Unit-IV

Data Link Layer:
Stop and Wait Protocols: Noise free and Noisy channels, performance and efficiency, Sliding Window protocols: Go Back and Selective Repeat ARQS, performance and efficiency, verification of protocol. HDLC data link protocol.

Unit-V

Network and Transport Layer :
Network Layer: Network Layer Design Issues, Routing Algorithms (Optimality principle, Static Routing Algorithms, Shortest Path, Flooding, Dynamic routing Algorithms, Distance Vector, Link State routing.), Congestion control Algorithms (Principles, Policies, Algorithms), Network Layer Protocols (IP Addressing, IP layer protocols: ICMP, ARP, RARP, DHCP, BOOTP, IPv6)
Transport Layer: Transport Layer Service, Elements of Transport protocols, Internet protocols (UDP and TCP)

Unit-VI

Application Layer :

DNS, Electronic Mail, The World Wide Web (Architectural Overview only), Multimedia.

Unit-VII

Local Area Network & Medium Access Layer :
LAN topologies, Layered architecture of LAN, MAC, IEEE standard. Ethernet LAN, Multiple Access: CSMA, CSMA/ CD CSMA/CA.

Unit-VIII

Network Security :
Introduction to Cryptography, Data Encryption standard, RSA Algorithm, Digital signature, Public keys, IPSec, Firewalls.

Unit-IX

Advance Networks:
Introduction to Mobile Communication and Networks - their types and basic principles; ISDN and B-ISDN; ATM- Header structure, Protocol stack, Signaling and Service category, Virtual Private Networks (VPN), MPLS support for VPN.

Artificial Intelligence

Credits- 3 **Contact hours per week - 3** **L: T: P=3:0:0**

Unit-I

Introduction – Agents – Problem Formulation – Uninformed Search Strategie – Heuristics – Informed Search Strategies – Constraint Satisfaction

Unit-II

Logical Agents – Propositional Logic – Inferences – First-Order Logic – Forward Chaining – Backward Chaining – Unification – Resolution

Unit-III

Planning With State-Space Search – Partial-Order Planning – Planning Graphs – Planning And Acting In The Real World .

Unit-IV

Uncertainty Revision Of Probability - Probabilistic Reasoning – Bayesian Networks –Inferences In Bayesian Networks – Temporal Models – Hidden Markov Models.

Unit-V

Learning From Observation - Inductive Learning – Decision Trees – Explanation Based Learning – Statistical Learning Methods - Reinforcement Learning.

Text Books:

1. Artificial Intelligence – A Modern Approach, Second Edition, S. Russel And P. Norvig Pearson Education, 2003.

Reference Books:

1 Computational Intelligence : A Logical Approach", David Poole, Alan Mackworth, Randy Goebel, Firstedition;Oxforduniversitypress, 2004.

2 Artificial Intelligence: Structures And Strategies For Complex Problem Solving", Fourth Edition, G. Luger , Pearson Education, 2002.

Queing theory

Credits- 4 **Contact hours per week - 4** **L: T: P=3:1:0**

Unit-I

Introduction, Markov Chains and Markov Processes, Birth-Death Processes, Simple Queueing Models (M/M/-/-Queues), Queues with Batch Arrivals, M/G/1 Queue with Residual Life and Imbedded Markov Chain Approach, Queues with Vacations, Bulk Arrivals and Priorities, Discrete Time Queues, Delay Analysis of Queues.

Unit-II

Fundamentals of Queueing Networks, Open and Closed Queueing Networks, Open Networks of M/M/m type queues and Jackson's Theorem, MVA and Convolution Algorithm for Closed Networks, Approximate Models for Open and Closed Queueing Networks, Queueing System Applications, Simulation Modeling of Queueing Systems.

Unit-III

Poisson Process, Random Sampling, PASTA, Equivalent Models for Tree Networks, Halfin-Whitt (or Quality-Efficiency-Driven) regime, Non-Degenerate Slowdown regime, Special Topics: Supermarket model (power of d choices), Light and heavy-traffic, light-tailed and heavy-tailed asymptotics, other approximations and bounds.

REFERENCES

1. Donald Gross, James M. Thompson, John F. Shortle and Carl W. Harris, Fundamentalsof Queueing Thoery, Wiley 2008.
2. Sanjay K. Bose, An Introduction to Queueing Systems, Springer 2002.

RELATED LINKS

1. http://www.iitg.ernet.in/skbose/qbook/qbook.html.

ADDITIONAL READINGS

1. T.G. Robertazzi, Computer Networks and Systems - Queueing Theory and Peformance Evaluation, Springer 2000.
   L. Kleinrock, Queueing Systems Volume 1 : Theory, Wiley 1975.

Information and Coding Theory

Credits- 4 **Contact hours per week - 4** **L: T: P=3:1:0**

Prerequisite: Discrete Mathematics, General concepts of coding theory, noise and error correcting codes, linear codes including the hamming, golary, Reed - Muller codes. Finite and number fields, algebraic function fields, algebraic curves and their applications, cyclic codes (including the BCH, Reed-Solomon, Justesen, Goppa, and quadratic residue codes). Decoding techniques for some these codes. Applications to information processing.

ADAMAS UNIVERSITY
PURSUE EXCELLENCE

Course Structure of 5-Year Integrated Course in Mathematics and Computing

SEMESTER-X

Subject Code:SMA_____

Subject: Fuzzy Set Theory

L-T-P: 3-0-0 **Credit:3**

Abstract: The main objective of **Fuzzy Set Theory** is to Provide an understanding of the basic mathematical elements of the theory of fuzzy sets that are widely used in science and engineering. This course Provides an emphasis on the differences and similarities between fuzzy sets and classical sets theories. It covers fuzzy logic inference with emphasis on their use in the design of intelligent or humanistic systems. Also this course introduces brief introduction to fuzzy arithmetic concepts and provide an insight into fuzzy inference applications in the area of engineering

Prerequisites: Concept of Algebra Mathematical reasoning (Discrete Mathematics).

Course Outcomes:

The students will

- be able to distinguish between the crisp set and fuzzy set concepts through the learned differences between the crisp set characteristic function and the fuzzy set membership function.
- be able to draw a parallelism between crisp set operations and fuzzy set operations through the use of characteristic and membership functions respectively.
- be able to define fuzzy sets using linguistic words and represent these sets by membership functions.
- know how to perform mapping of fuzzy sets by a function and also use the α-level sets in such instances.
- know fuzzy-set-related notions; such as α-level sets, convexity,normality, support, etc.

Modules	Topics	Course content	Hours
1.	**Fuzzy Sets and Operations on Fuzzy Sets**	Classical sets vs Fuzzy Sets, Need for fuzzy sets, Definition and Mathematical representations, Level Sets, Fuzzy functions, Zadeh's Extension Principle, Operations on [0,1], Fuzzy negation, triangular norms, t-conorms, fuzzy implications, Aggregation Operations.	**7**
2.	**Fuzzy Relations and Fuzzy Graphs**	Fuzzy Binary and n-ary relations, composition of fuzzy relations, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations, Fuzzy Relational Equations, Fuzzy graphs and connectivity.	**8**
3	**Possibility Theory**	Fuzzy Measures, Evidence Theory, Necessity and Belief Measures, Probability Measures vs Possibility Measures.	**3**
4	**Fuzzy Logic**	Introduction to Fuzzy logic. Multi-valued logic, Fuzzy propositions, fuzzy quantifiers, Linguistic hedges, Fuzzy inference	**6**
5	**Approximate Reasoning**	Fuzzy rule base, Fuzzy Implication relation and selection of Fuzzy Implications, Approximate Reasoning to discrete fuzzy sets , Approximate Reasoning to continuous fuzzy sets	**6**

		with graphical representation.	
6	**Fuzzy Logic Control and pattern recognition**	Introduction of fuzzy control, Typical fuzzy control system, classical to fuzzy PID controller, Architecture to Mamdani type Fuzzy control system, T-S fuzzy system, Fuzzy pattern recognition.	**6**
Total			**36**

Text/Reference Books:

1. George J Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic : Theory and Applications, Prentice Hall NJ,1995.
2. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, New Delhi, 1991.
3. John N. Mordeson and PremchandS.Nair : Fuzzy Mathematics-An Introduction for engineers and Scientists by, Springer Books.
4. Anastassiou George A :Fuzzy Mathematics-Approximation Theory.

Subject Code: ECS_____

Subject: Image Processing

L-T-P: 3-1-0 **Credit: 4**

UNIT I:

Introduction: Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system.. Digital Image Fundamentals: A simple image formation model, image sampling and quantization, basic relationships between pixels .

UNIT II:

Image enhancement in the spatial domain : Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods .

UNIT III:

Image restoration : A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function (p.nos 147-167, 220-243, 256-276).

UNIT IV:

Color Image Processing : Color fundamentals, color models, pseudo color image processing, basics of full–color image processing, color transforms, smoothing and sharpening, color segmentation**.**

UNIT V:

Image Compression : Fundamentals, image compression models, error-free compression, lossypredictive coding, image compressionstandards**.**

UNIT VI:

Morphological Image Processing : Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms**.**

UNIT VII:

Image Segmentation : Detection of discontinuous, edge linking and boundary detection, thresholding, region–based segmentation.

UNIT VIII:

Object Recognition : Patterns and patterns classes, recognition based on decision–theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching**.**

TEXT/REFERENCE BOOKS:

1.Digital Image Processing, RafealC.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI.
2. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning.
3. Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology
4. Computer Vision and Image Processing, Adrian Low, Second Edition, B.S.Publications
5. Digital Image Processing using Matlab, RafealC.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.

Subject Code: ECS_____

Subject: Software Engineering

L-T-P: 3-0-0 **Credit: 3**

Introduction to Software Engineering: Characteristics, Emergence of Software Engineering, Software Metrics & Models, Process & Product Metrics.

Software Life Cycle Models: Waterfall, Prototype and Spiral Models and their Comparison.

Software Project Management: Size Estimation- LOC and FP Metrics, Cost EstimationDelphi and Basic COCOMO, Introduction to Halstead's Software Science, Staffing Level Estimation- Putnam's Model.

Software Requirements Specification: SRS Documents, their Characteristics and Organization.

Software Design: Classification, Software Design Approaches, Function Oriented Software Design, Structured Analysis-Data flow Diagrams and Structured Design, Introduction to Object Oriented Design.

Coding and Testing of Software: Unit Testing, Block Box Testing, White Box Testing, Debugging, Program Analysis Tools, System Testing. Software Reliability and Quality Assurance: Reliability Metric- Musa's Basic Model.

Software Quality Assurance: ISO 9000 and SEI CMM and their Comparison.

Software Maintenance: Maintenance Process Models and Reverse Engineering, Estimation of Maintenance Costs.

Software Development Tools: Introduction to "Rational Rose".

Text/Reference Books:

1. Rajib Mall -Fundamentals of Software Engineering, Prentice Hall of India, New Delhi,2005
2. Pankaj Jalote- An Integrated Approach to Software Engineering, 3rd Edition, Narosa Publishing House, New Delhi,2005
3. Richard Fairley- Software Engineering Concepts, Tata McGraw Hill, New Delhi, 2006

Cryptography and Cyber Security

Paper Code: ECS53102 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Course Structure of 5-Year Integrated Course in Mathematics and Computing

Unit-I:

Symmetric Ciphers: Overview - Services, Mechanisms and Attacks, the OSI, Security Architecture, A Model Of Network Security.

Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography. Block Cipher and the Data Encryption Standard - Simplified DES, Block Cipher Principles, the DES, the Strength of DES, Differential and Linear Cryptanalysis, Symmetric Ciphers - Triple DES, Blowfish, Confidentiality Using Conventional Encryption - Placement of Encryption Function, Traffic Confidentiality, Key Distribution, Random Number Generation.

Unit-II:

Public Key Encryption, Digital Signatures Number Theory, Prime Numbers, Fermat's And Euler's Theorems, Testing for Primality, Public Key Cryptography And RSA - Principles Of Public Key Cryptosystems, The RSA Algorithms, Key Management, Diffie-Hellman Key Exchange.

Unit-III:

Authentication Protocols Message Authentication: Authentication Requirements, Authentication Functions, Message Authentication Codes, MD5 Message Digest Algorithms, Digital Signatures and Authentication Protocols: Digital Signatures, Authentication Protocols, Digital Signature Standards.

Unit-IV:

Network Security: Authentication Applications: Kerberos, X.509 Directory, Authentication Service. Electronic Mail Security: Pretty Good Privacy. IP Security: Overview, IP Security Architecture, Authentication Header, Encapsulation Security Payload.

Web Security: Web Security Requirements, Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction.

System Security: Intruders, Malicious Software, Viruses and Related Threats, Counter Measures, Firewalls and Its Design Principles.

Text Books:

1. William Stallings, Cryptography and Network Security, 4th Edition, Pearson Education/PHI, 2006.

Reference Books:

2. Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: Private Communication in Public World", 2nd Edition, Pearson Education, 2011.
3. Atul kahate, Cryptography and Network Security, TMH, 2003.

Cloud Computing

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit-I:

NEW COMPUTING PARADIGMS & SERVICES : Edge computing, Grid computing, Utility computing, Distributed computing, Cloud computing and its history and evolution.

Unit-II:

INTRODUCTION TO CLOUD COMPUTING : Cloud Computing Architectural Framework, Cloud Deployment Models, private, public and hybrid , Challenges in adapting a cloud in the context of i) Security issues ii) Bandwidth and iii) Integration issues, Virtualization in Cloud Computing, Parallelization in Cloud Computing, Security for Cloud Computing, Cloud Economics.

Unit III :

CLOUD SERVICE MODELS : Software as a Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Seven Business Models for cloud, five-layer cloud service stack, compute and storage cloud services case studies Jeff Bezos and Amazon.

Unit IV :

VIRTUALIZATION & SECURITY : Virtualization:Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization. Cloud computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control-Identity management, Access control, Autonomic Security

Cloud computing security challenges: Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud.

Unit V :

CLOUD COMPUTING PRACTICES : Cloud Computing Operating System, Creating Windows servers on the cloud, Creating Linux servers on the cloud, Deploying applications on the cloud, Major cloud solutions, Implementing real time application over cloud platform.

Text Books:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing Principles and Paradigms, Wiley, 2010
2. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, 2009.
3. Ronald Krutz and Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley Publishing, 2010.

Reference Books:

4. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach, McGraw Hill, 2010.
5. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Helper, Cloud Computing For Dummies, Wiley Publishing, 2010.
6. Nick Antonopoulos, Lee Gillam, Cloud Computing: Principles, Systems and Applications, Springer, 2010.

Financial Mathematics

Credits- 4 **Contact hours per week - 4** **L: T: P=3:1:0**

Prerequisite: voidIntroduction to Mathematical Finance: Stocks, bonds and financial markets, Options and forward contracts, Pricing by no-arbitrage considerations, One-period binomial model, The Fundamental Theorems of AssetPricing. The Binomial Asset Pricing Model: Pricing by replication in a multiperiod model, Basic probability, Martingales and European derivative securities, The risk-neutral probability measure, Derivative securities with random payment times, Computational issues. The Black-Scholes Formula: Scaling time and model parameters, Using the Central Limit Theorem to obtain a limit, The role of volatility. Brownian

motion: Limit of scaled random walks, Definition of Brownian motion, Quadratic variation of Brownian motion, The problem of integration with respect to Brownian motion. Stochastic calculus: Ito s integral, Ito s formula, Geometric Brownian motion. he Black-Scholes Formula Revisited: Evolution of a call option price, Evolution of a replicating portfolio, Matching evolutions to price the call. Optimal Consumption and Investment in the Binomial Model: Risk aversion, some decision theory and utility functions, Dynamic programming. Optimal Consumption and Investment in the Brownian Motion Model: The Merton problem, The optimal-control formulation and the Hamilton-Jacobi-Bellman (HJB) equation, Constant relative risk aversion (CRRA) utilities and proportional investment strategies, Further Topics in Optimal Consumption and Investment. The martingale method, Complete and incomplete markets.

Fluid Dynamics

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Physical properties of fluids, concept of fluids, continuum hypothesis, density, specific weight, specific volume, Kinematics, Equation of continuity: Eulerian and Lagrangian equations, velocity of a fluid particles, material, local and convective derivatives, equation of continuity in Cartesian, cylindrical and spherical coordinates, streamline, streak line, vortex line, rotational and Irrotational motion, Kinematics of vorticity and circulation.

Unit-II

Equations of Motions: Euler's equations of a motion in Cartesian, cylindrical and spherical coordinates, Lamb's hydrodynamical equations, Impulsive action, the energy equation, Lagrange equations and Helmholtz equation of motion, integration of Euler's of motion, Bernoulli's equation, Bernoulli's theorem for steady motion with no velocity potential and conservation field of force, Torricelli's theorem.

Unit-III

Motion in two dimensions: Stream function, Irrotational motion, Velocity and Complex potentials, Cauchy-Riemann's equations, Sources and Sinks, Doublets; Image system of a simple source and a doublet with respect to a plane and a circle, Milne-Thomson Circle Theorem, Blasius Theorem, Motion of circular cylinders and sphere, Vortex motion.

Unit-IV

Kinematics of Deformation: Newton's Law of viscosity, Newtonian and non-Newtonian fluids, Theory of stress and Rate of strain, Body and Surface forces, Navier-Stokes equations of motion of a viscous fluid and energy equations, Diffusion of vorticity and equation, Laminar flow of viscous incompressible fluid, Similarity of flows: Reynolds and other numbers, Boundary layer concept, 2-dimensional boundary layer equations, separation phenomena; boundary layer on a semi-infinite plane, Blasius solution, boundary layer thickness.

Text Books:

1. F. Charlton, Text book of Fluid Dynamics, CBS Publishers.
2. M D Raisinghania, Fluid Dynamics, S. Chand

Reference Books:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS Publishers.
2. P. K. Kundu, I M Cohen, Fluid Mechanics, Academic press, Elsevier.
3. E. Rathakrishnan, Fluid Mechanics An introduction, PHI Learning Private Limited, Delhi
4. R. K. Rathy, An introduction to fluid dynamics, Oxford and IBH Publishing Co. 1976.
5. L. N. Milne Thomson, Theoretical Hydrodynamics, Macmillan and Co. Ltd.
6. Z.U.A. Warsi, Fluid Dynamics, CRC Press, 1999.

Formal Language and Automata Theory

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit-I

Review of Discrete Structures: Sets, Relations and Functions, Morphisms; Posets and Lattices, Boolean algebra, Proof Techniques – Inductive And Deductive Reasoning, Proof By Contradiction; Recurrence Relations, Algebraic Structures – Semigroup, Monoid, Group, Ring And Field, Propositional and Predicate Calculus.

Unit-II

Automata and Languages:

a. Strings, Phrase Structured Grammar And Formal Languages -- Finite Automata And Regular Expressions, Closure Properties Of Regular Languages, Pumping Lemma And Non-Regular Languages.

b. Context Free Languages (CFL) And Pushdown Automata (PDA), Normal Forms Of Cfls, Closure Properties Of Cfls, Pumping Lemma And Non-Context Free Languages, Deterministic Pushdown Automata And Dcfls.

c. Chomsky Hierarchy Of Grammars And Corresponding Acceptors; Turing Machines, And Type 0 Languages, Recursive And Recursively Enumerable Languages, Turing Computable Functions, Primitive And Mu-Recursive Functions.

Unit-III

Computability: Church-Turing Thesis, Decision Problems, Decidability And Undecidability, Universal Turing Machine, Halting Problem Of Turing Machines, Problem Reduction (Turing And Mapping Reduction).

Unit-IV

Computational Complexity: Time and Space Complexity Measures; Class P and Class NP Problems, NP-Completeness, Time and Space-Bounded Turing Machines, Oracle Machines and The Polynomial Hierarchy, Randomized Computation, Parallel Computation.

Text Books:

1. Michael Sipser, Introduction to the Theory of Computation, 3rd Edition, Cengage Learning.
2. J. P. Trembley and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mcgraw Hill Book Co.

Reference Books:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, 3rd Edition, Pearson Education.
2. H. R. Lewis and C. H. Papadimitrou, Elements of the Theory of Computation", Prentice Hall, International Inc.

Mathematical & Statistical Methods in Climate System

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit-I

Boundary value problems: singular and regular Sturm-Liouville problems, nonhomogeneous problems, Green's function, meteorological fields in terms of orthogonal functions, series of orthogonal functions, normal modes

Unit-II

Fourier- Legendre transforms, FFT; Asymptotic expansions: regular and singular perturbation methods, WKB method, method of multiple scales.applied to atmospheric motions, Calculus of variations and Rayleigh-Ritz method;

Unit-III

Probability, random variables and distributions, properties of distributions, covariance and correlation, multivariate distributions and analysis, multivariate linear regression model, principal component analysis, factor and time series analysis.

Unit-IV

Application of Auto-correlation and auto regressive processes applied to monsoon rainfall data. Error Analysis, Sampling and Test of Hypothesis, Analysis of variance.

Unit-V

Numerical solution of Partial Differential Equations. Harmonic Analysis and Spectral Analysis, Numerical Integration schemes.

Unit-VI

Artificial neural network and its application in atmospheric science problems

Books:

1. Fourier series and Boundary Value Problems, R.V. Churchill, McGraw Hill, New York, 1963.
2. Elementary Differential Equations and Boundary value Problems, W.E.,Boyce and R.C. DiPrima, John Wiley & Sons, New York, 1997.
3. Mathematical Methods for Physics and Engineering, Riley K.F., M.P. Hobson and S.J. Bence, Cambridge University Press, 1999.
4. Statistical Concepts and Methods, G.K. Bhattacharyya, and R.A. Johnson, John Wiley, New York, 1977.
5. Statistical Methods in the Atmospheric Sciences, D.S. Wilkes Academic Press, 1995.

Mathematical Modelling

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Basic steps of mathematical modeling, its needs, types of models, limitations, elementary ideas of dynamical systems, autonomous dynamical systems in the plane-linear theory, equilibrium point, node, saddle point, focus, centre and limit-cycle ideas with simple illustrations and figures, linearization of non-linear plane autonomous systems, mathematical modeling in the biological environment.

Unit-II

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

system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis

Unit-III

Differential equation based models: Numerical solvers of systems of differential equations: stiff equations, delay differential equations, compartment models: population dynamics, infectious disease models

Unit-IV

Spatial Models: One species model with diffusion, two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population, Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting

Text Books:

1. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.

Reference Books:

2. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
3. Barnes B and Fulford GR, Mathematical Modeling with Case Studies. CRC Press
4. Mattheij RMM, Rienstra SW, ten ThijeBoonkamp JHM, Partial differential Equations, Modeling Analysis, Computation. SIAM (Dimensional analysis)
5. Yang X.S, An Introduction to Computational Engineering with Matlab. CISP (Cellular automata)

Operator Theory

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Dual spaces and adjoint of an operator: Duals of classical spaces, weak and weak* convergence, BanachAlaoglu theorem, adjoint of an operator.

Unit-II

Hilbert spaces: Inner product spaces, orthonormal set, Gram-Schmidt ortho-normalization, Bessel's inequality, Orthonormal basis, Separable Hilbert spaces.

Unit-III

Projection and Riesz representation theorem: Orthonormal complements, orthogonal projections, projection theorem, Riesz representation theorem.

Unit-IV

Bounded operators on Hilbert spaces: Adjoint, normal, unitary, self adjoint operators, compact operators, eigen values, eigen vectors, Banach algebras.

Unit-V

Spectral theorem: Spectral theorem for compact self adjoint operators, statement of spectral theorem for bounded self adjoint operators.

Text Books:

1. M.T. Nair, Functional Analysis-a first course, Prentice Hall of India, 2010.
2. B.V. Limaye, Functional Analysis, New Age International, 1996.

Reference Books:

1. G.F. Simmons, Topolgy and Modern analysis, Kreiger, 2004.
2. E. Krezyisz, Introduction to Functional Analysis with Application, Wiley, 1989.

Formal Language Automata Theory

Credits- 4 **Contact hours per week – 4** **L: T: P=3:1:0**

Unit-I

Grammars, Production systems, Chomskian Hierarchy, Right linear grammar and Finite state automata, Context free grammars, Normal forms, uvwxy theorem, Parikh mapping, Self embedding property, Subfamilies of CFL, Derivation trees and ambiguity.

Unit-II

Finite state Automata, Non deterministic and deterministic FSA, NFSA with ε- moves, Regular Expressions, Equivalence of regular expression and FSA.

Unit-III

Pumping lemma, closure properties and decidability, Myhill-Nerode theorem and minimization, Finite automata with output, Pushdown automata, Acceptance by empty store and final state, Equivalence between pushdown automata and context-free grammars, Closure properties of CFL, Deterministic pushdown automata.

Unit-IV

Turing Machines, Techniques for Turing machine construction, Generalized and restricted versions equivalent to the basic model, Godel numbering, Universal Turing Machine, Recursively enumerable sets and recursive sets, Computable functions, time space complexity measures, context sensitive languages and linear bound automata.

Unit-V

Decidability; Post's correspondence problem; Rice's theorem; decidability of membership, emptiness and equivalence problems of languages, Time and tape complexity measures of Turing machines; Random access machines; the classes P and NP; NP-Completeness; satisfiability and Cook's theorem; Polynomial reduction and some NP-complete problems.

Text Books:

1. K.Krithivasan and R.Rama; Introduction to Formal Languages, Automata Theory and Computation; Pearson Education, 2009.
2. J.E.Hopcroft, R.Motwani and J.D.Ullman , "Introduction to Automata Theory Languages and computation", Pearson Education Asia , 2001.

Mathematical Modeling

Credits- 4 **Contact hours per week – 4** **L: T: P=3:1:0**

Unit-I

Differential equation based models

Numerical solvers of systems of differential equations: stiff equations, delay differential equations, Compartment models: population dynamics, infectious disease models

Unit-II

Dimensional analysis

Model scaling, dimensionless forms and Π-numbers , Dynamical Sysyem, Chaos, Lyapunov exponent, Poincare section.

Unit-III

Stochastic models

Probability distribution, random draws from distributions, Central limit theorem, Noise: additive, white noise, Poisson noise, noise reduction, Markov models, Cellular automata, Random walks, diffusion model

Unit-IV

Partial differential equations

Advection, diffusion, Boundary conditions.

References:

• Lecture notes of Math 441

• Barnes B and Fulford GR (2009) *Mathematical Modeling with Case Studies.* CRC Press

• Mattheij RMM, Rienstra SW, ten Thije Boonkamp JHM (2005) *Partial differential Equations, Modeling Analysis, Computation.* SIAM (Dimensional analysis)

• Yang X-S (2006) *An Introduction to Computational Engineering with Matlab.* CISP (Cellular automata)

Cloud Computing

Credits- 4 **Contact hours per week – 4** **L: T: P=3:1:0**

Unit-I

Introduction: Shift from distributed computing to cloud computing; principles and characteristics of cloud computing- IaaS, PaaS, SaaS, service oriented computing and cloud environment.

Unit-II

Cloud Computing Technology: Client systems, Networks, server systems and security from services perspectives, Accessing the cloud with platforms and applications, cloud storage.

Unit-III

Working with Cloud- Infrastructure as a Service: conceptual model and working Platform as a Service: conceptual model and functionalities Software as a Service: conceptual model and working Technologies and Trends in Service provisioning with clouds.

Unit-IV

Using Cloud Services- Cloud collaborative applications and services – technology, applications and case studies with calendars, schedulers and event management; cloud applications in project management.

Text Books:

1 "Cloud Computing – A Practical Approach", Anthony T.Velte, Toby J. Velte and Robert E,

TMH , 2010.

Reference Books:

1 "Cloud Computing – Web based Applications", Michael Miller, Pearson Publishing, 2011.

Time Series & Forecasting Method

Credits- 4 **Contact hours per week - 4** **L: T: P=3:1:0**

Prerequisite: Probability and Statistics

Classical techniques of time series analysis, different smoothing techniques, general linear process, autoregressive processes AR(P), moving average process Ma(q), autocorrelation, partial autocorrelation and Spectrum, identification in time domain, forecasting, estimation of parameters, model diagnostic checks, use of time series techniques in engineering fields.

Wavelet Analysis and its Applications

Paper Code: **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Fourier analysis: Fourier and inverse Fourier transforms, Continuous time convolution and the delta function, Fourier transform of square integrable functions, Poisson's summation formula.

Unit-II

Wavelet Transforms and Time - Frequency Analysis: The Gabor transform, Basic Properties of Gabor Transforms, Short time Fourier transforms and the uncertainty principle, The integral wavelet transform, Diadic Wavelets and inversions, Frames.

Unit-III

Multi Resolution Analysis and Wavelets: The Haar wavelet construction, Multi resolution analysis, Riesz basis to orthonormal basis, Sealing function and scaling identity, Construction of waveletBasis, Daubechie's Wavelets andAlgorithms.

Unit-IV

Compactly Supported Wavelets and Applications: Vanishing moments property, Meyer's wavelets, Construction of a compactly supported wavelet, Smooth wavelets, Digital Filters, Discrete wavelet transforms and Multi resolution analysis, Filters for perfect reconstruction, Para unitary filters and orthonormal wavelets, Filter design for orthonormal wavelets, Bi-orthogonal filters.

Text Books:

1. C.K. Chui, “An introduction to Wavelets”, Academic Press, San Diego, CA, 1992.
2. P. Wojtaszczyk, “A mathematical introduction to Wavelets”, London Mathematical Society Student Texts 37, Cambridge University Press, 1997.
3. Y.T. Chan, “Wavelet Basics”, Kluwer Academic Publishers, 1995.