Applied Mathematics

Specific objectives	Contents
• Understand and apply function of complex variables, Calculus of functions of complex variables and their applications in Engineering problems.	**Unit I: Complex Analysis (17 hrs.)** **1.1 Complex numbers and functions (5 hrs.)** 1.1.1 Review on Complex number, their geometric representation, Polar form, power and roots**.** 1.1.2 Sets and functions in complex plane, Limits Continuity and derivatives of function of complex variables. (Definition and concepts only) 1.1.3 Analytic functions, Cauchy-Riemann(C-R) equations as necessary conditions for functions to be analytic, C-R equations as sufficient condition for analyticity (without proof), Polar form of C-R equations (No derivation). 1.1.4 Laplace equation, harmonic functions and harmonic conjugate 1.1.5 Related problems
	1.2 Integrals in complex plane (4 hrs.) 1.2.1 Line integrals in the complex plane, Evaluation of basic line integrals in complex plane 1.2.2 Cauchy's Integral theorem, Cauchy's integral formula and Cauchy integral formula of higher order (for analytic functions) without proof. 1.2.3 Related problems.
	1.3 Taylor and Laurent series for functions of complex variables. (6 hrs.) 1.3.1 Taylor series and Laurent series (Without Proof) and Related Problems 1.3.2 Singularities and zeros, Residues and integration, Cauchy Residue theorem (Without proof) and related Problems.
	1.4 Conformal mapping (2 hrs.): Special Linear fractional transformation (Bilinear fractional transformation) only.
• Understand and apply discrete transforms and solve difference equations.	**Unit II: Z-Transform and its Applications (10 hrs.)** 2.1 Z-transform, Z-transform of elementary functions, Properties of Z-transforms, Shifting theorems, initial value theorem, final value theorem. 2.2 Inverse z-transforms using division method, expansion method, Partial fraction method and residue method. 2.3 Application: Difference equations and solution by using Z-transform.

• Understand and apply higher dimensional systems and describe them by partial differential equations with solution techniques and interpretation of solutions.	**Unit III: Partial Differential Equations (12 hrs.)** 3.1 Partial differential equations and solutions by variable separation method. 3.2 One dimensional wave equation and its solutions and related problems. 3.3 One dimensional heat equation and it's solutions and related problems. 3.4 Two dimensional heat equation, Laplace equation (steady state heat equation) and its solution for rectangular boundaries. Laplace equation in polar form and its solution for circular boundaries, related problems.
• Evaluate Fourier integrals and Transforms.	**Unit IV Fourier integral and Transform (6 hrs.)** 4.1 Fourier integral, Fourier sine and cosine integrals and related problems. 4.2 Fourier integral in complex form and Fourier transform and inverse transform, Fourier sine and cosine transforms and their inverse transforms, Convolution theorem, Parseval's identity and related problems.

Numerical Method:

Specific Objectives	**Contents**
Solve non-linear equations by different numerical methods.	Unit 1: **Solution of Non-linear equations (5 hrs)** 1.1. Introduction, Importance of Numerical Methods 1.2. Approximation and Errors in computation 1.3. Bisection Method 1.4. Secant method 1.5. Newton Raphson method 1.6. Fixed point iterative method
Visualize and solve mathematical relationships of practical observations.	Unit 2: **Interpolation and approximation (5hrs)** 2.1. Lagrange interpolation 2.2. Finite differences (forward, backward, and divided difference) 2.3. Newton's Interpolation (forward, backward) 2.4. Least square method of fitting linear and nonlinear curve for discrete data and continuous function 2.5. Cubic Spline Interpolation
Calculate definite integration and differentiation numerically.	Unit 3: **Numerical Differentiation and Integration (4 hours)** 3.1. Numerical Differentiation formulae 3.2. Trapezoidal, Simpson's 1/3, 3/8 rule 3.3. Romberg integration
	3.4. Gaussian integration (2- point and 3- point formula)

Solve the system of linear equations by different techniques.	Unit 4: **Solution of system of linear algebraic equations (6 hours)** 4.1. Gauss elimination method and concept of pivoting 4.2. Ill-conditioned system of linear equations 4. 3. LU Factorization method (Dolittle, Crout's, Cholesky's) 4.4. Iterative methods (Jacobi method, Gauss-Seidel method) 4.5. Eigen value and Eigen vector using Power method
Solve the ordinary differential equations which may exist in the field of engineering.	Unit 5: **Solution of ordinary differential equations (6 hours)** 5.1. Review of ordinary differential equations 5.2. Runge-Kutta methods (first, second and fourth) for first and second order differential equations 5.3. Solution of boundary value problem by shooting method
Solve numerically the partial differential equations which exist in the field of engineering.	Unit 6: **Numerical solution of Partial differential Equation (4 hours)** 6.1. Classification of partial differential equation (elliptic, parabolic and hyperbolic) 6.2. Solution of Laplace equation (standard 5-point formula with iterative methods) 6.3. Solution of Poisson equation (finite difference approximation method) 6.4. Solution of one-dimensional Heat equation by Schmidt method

Advanced Programming with Java:

Specific Objectives	Contents
The chapter intends to provide a brief introduction of programming in JAVA and familiarize students with concepts of basics of Programming. It intends to enhance the understanding of the programming with respect to JAVA along with concepts of Access Modifiers and Java Collections.	**Unit 1: Basics of Programming in Java (7 hrs)** 1.1 Java Architecture, Class paths, Sample Program 1.2 Classes, Objects, Constructors 1.3 Packages and Data Types 1.4 Conditional Statements 1.5 Access Modifiers 1.6 Exception Handling 1.7 Java Collections
Students will learn about object-oriented principles in JAVA. Students will be able to implement the concepts of inheritance, abstraction, polymorphism. This chapter helps students learn how object-oriented concepts are implemented in JAVA.	**Unit 2: Object Oriented Principles in Java (6hrs)** 2.1 Review of object-oriented principles 2.2 Super class, sub class, inheritance, and member access 2.3 Types of inheritance 2.4 Extends and super keyword 2.5 Overriding/Overloading 2.6 Final classes and methods 2.7 Abstract classes and methods 2.8 Upcasting vs Down casting 2.9 Interfaces and Implementations
This chapter intends to provide students' knowledge on how UI components like Swing, AWT and JavaFX is used to create desktop applications along with elements, layouts and controls.	**Unit 3: Building Components using Swing and JavaFX (6 hrs.)** 3.1 Introduction to AWT and Swing: Concept, Applets, Swing Class Hierarchy, Components/Containers 3.2 Layout Management 3.3 GUI Controls 3.4 Menu Elements and Tooltips 3.5 Dialogs and Frames 3.6. Event handling and Listener Interfaces 3.7. Handling Action Events 3.8 JavaFX vs Swing 3.9 JavaFX Layouts 3.10 JavaFX UI Controls
This chapter intends to provide students basic of networking and how JAVA programming can be used to perform basic to advanced network programming. This also intends to cover the basics of Email Handling along with advanced concepts like RMI, IDL and CORBA.	**Unit 4: Distributed Network Programming (8 Hrs.)** 4.1 TCP, UDP, IP Address and Ports 4.2 Socket Programming using TCP and UDP 4.3 Working with URLs and URL Connection Class 4.4 Email Handling using Java Mail API 4.5 Architecture of RMI 4.6. Creating and Executing RMI Applications 4.7. Architecture of CORBA 4.8. RMI vs CORBA 4.9. IDL and Simple CORBA Program

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This chapter intends to provide information on how Database connectivity is handled in JAVA along with the architecture, drivers, and basics of database.	**Unit 5: Database Connectivity with JAVA (5 hrs)** 5.1 JDBC Architecture 5.2 JDBC Driver Types and Configuration 5.3 Managing Connections and Statements 5.4 Result Sets and Exception Handling 5.5 DDL and DML Operations 5.6. SQL Injection and Prepared Statements 5.7. Row Sets and Transactions 5.8. SQL Escapes
This chapter intends to provide students' knowledge on how web programming is achieved in JAVA with the help of Servlets and JSP.	**Unit 6: Servlets and JSP (6 hrs.)** 6.1 Overview of Web Application 6.2 HTTP Methods and Responses 6.3 Life Cycle of Web Servlets 6.4 Writing Servlet programs with Servlet APIs 6.5 Reading and Processing Forms 6.6. Handling GET/POST Requests 6.7. Database connectivity through servlets 6.8. Cookies and Sessions
In this chapter, students will get to know advanced topics like ORM, Frameworks, concurrency, multithreading and how it can be used in JAVA. Along with these, students will also learn basics of design patterns.	**Unit 7: Advanced Topics in JAVA (7 Hrs)** 7.1 Overview of ORM 7.2 Hibernate 7.3 Web Framework Introduction 7.4. Basics of Spring Boot 7.5. Concurrency and Multithreading in JAVA 7.6. Design Patterns: Singleton, Factory and Abstract Factory

Computer Architecture

Specific objectives	Contents
● Understand the concepts of computer architectures, functional units and components of computer systems and various addressing modes.	**Unit 1 Introduction to Architecture [4 Hrs]** 1.1. Brief overview of Computer organization and Architecture 1.2. Hierarchy structure of computer system 1.3. Computer evolution and generations 1.4. Computer Components and Functions 1.5. Future Trends in Computer 1.6. Review of Instruction sets, Addressing Modes and Instruction format

● Understand the VHDL Programming for simple operations.	**Unit -2: Register Transfer Language and Micro operations [4Hrs]** 2.1 Register Transfer and RTL 2.2.Micro Operation 2.3 Data Transfer Micro Operations 2.4 Arithmetic and Logical Operations 2.5 Shift Micro operations 2.6 Introduction to HDL and VHDL 2.7 VHDL programming for Adder, Mux, ALU
● Understand the functional units of CPU and their organization.	**Unit -3: Processor Organization [5 Hrs]** 3.1 CPU Organization/Structure 3.2 Register Organization and Data paths 3.3 Instruction Cycle(T states) 3.4 Arithmetic and Logical Unit 3.5 Design Principles for Modern Systems
● Understand the design of Hardwired and microprogrammed control units.	**UNIT 4 Control Unit [5 Hrs]** 4.1 Control of the processor 4.2 Hardwired Control Unit(Control unit inputs/logic) 4.3 Microinstruction Format 4.4 Micro Programmed Control Unit 4.5 Architecture of Microprogrammed Control Unit 4.6 Microinstruction Sequencing and Execution 4.7 Application of Hardwired and Micro programmed Control Units 4.8 RISC and CISC Architecture
● Understand the representation of binary numbers in signed and unsigned notation along with the algorithms used for the basic arithmetic operations.	**UNIT 5 Computer Arithmetic [7 Hrs.**] 5.1 Integer Representation 5.2 Integer Arithmetic 5.3 Unsigned Binary Addition and Subtraction 5.4 Unsigned Binary Multiplication Algorithm 5.5 Booth Multiplication Algorithm 5.6 Unsigned Binary Division Algorithm 5.7 Floating Point Representation
● Understand the concepts of pipelining for better performance.	**Unit 6: Pipelining [4 hrs]** 6.1 Pipelining 6.2 Arithmetic Pipeline 6.3 Instruction Pipeline 6.4 Conflicts in Instruction Pipelining and their solutions 6.5 RISC pipeline 6.6 Register Windowing and Register Renaming

• Review memory Hierarchy of computer systems and understand the principles of cache memory to increase the performance of CPU	**UNIT 7 Memory Organization [4 Hrs.]** 7.1 Memory Hierarchy 7.2 Main Memory and Auxiliary Memory 7.3 Associative Memory and Cache Memory 7.4 Cache mapping techniques- Direct,Associative and Set Associative Mapping 7.5 Cache Write Policy. 7.6 Cache Replacement algorithm (FIFO, LRU, LFU)
• Familiarize with IO interfaces and introduce various methods for improving I/O performances.	**Unit 8: Input-Output Processing [4 Hrs**] 8.1 Peripheral Devices 8.2 I/O Modules 8.3 I/O Interface and Techniques 8.4 Modes of Transfer: Programmed,Interrupt-Driven and DMA 8.5 I/O Processor and IO channel 8.6 GPU and TPU 8.7 External Interfaces: FireWire and Infiniband 244
• Understand the concept of parallel processing and multi thread architecture in modern processors.	**Unit 9: Parallel \Processing [4 Hrs]** 9.1 Parallel Processing 9.2 Parallelism In Uniprocessor system 9.3 Multiprocessor System and their characteristics 9.4 Flynn Classification 9.5 Interconnection structures in Multiprocessors 9.6 Vector processing and Array processing 9.7 Introduction to Multithreaded Architecture
• Prevalent new development in computer architecture: the use of multiple processors on a single chip	**Unit 10:Multi-core computer (4Hrs)** **10.1** Hardware performance issues 10.2 Software Performance Issues 10.3 Multicore Organization 10.4 Dual Core, Quad Core and Octa Core 10.5 Power Efficient Processor

Research Fundamentals

Specific Objectives	Contents
● Understand the basic concepts of research, purpose and outcomes of a research/project work.	**Unit 1: Introduction (4 hrs)** 1.1 What is research? 1.2 Research Aim and Objectives 1.3 Features of Research 1.4 Types of Research 1.5 The 6Ps of Research 1.6 Purpose of Research- reasons for doing research 1.7 Product of Research- outcomes of research 1.8 Research and Project
● Understand and implement the research process model to conduct a research/project work.	**Unit 2: Research Process Model (10hrs)** 2.1 Personal Experiences and Motivation 2.2 Literature Review 1. Purpose and objectives of a literature review 2. Literature resources 3. Conducting a literature review 4. Citation and its types 5. Bibliographic Detail and Referencing Systems 6. Plagiarism 2.3 Research Question 2.5 Conceptual framework 2.5 Strategies 1. Survey 2. Design and Creation 3. Experiment 4. Case Study 5. Action Research and 6. Ethnography 2.6 Data Generation Methods 1. Interview 2. Observations 3. Questionnaire 4. Documents 5. Types of triangulation in a research project 2.7 Data Analysis 1. Quantitative and 2. Qualitative data analysis
● Familiarize with the laws and ethics in research conduction.	**Unit 3: Participants and Research Ethics (4hrs)** 3.1 Participants 3.2 The law and Research 3.3 Rights of People Directly Involved 3.4 Responsibilities of an Ethical Researcher

● Familiarize with the research proposal and its components. ● Develop a research/project proposal.	**Unit 4: Proposal Writing (4hrs)** 4.1 What is a research proposal? 4.2 Need of a Research Proposal 4.3 Components of a Research Proposal 4.4 A case study on any research paper/project
● Familiarize with the research/project report and its components. ● Develop a research/project report.	**Unit 5: Report Writing (4hr)** 5.1 What is a research report? 5.2 Need of a Research Report 4.3 Components of a Research Report 4.4 A case study on any research paper/report

Theory of Computation

Specific Objectives	**Contents**
- Understand the concept of alphabet and language	**Unit 1: Introduction (4 hrs.)** 1.1 Review of set, relation and function 1.2 Proof techniques– proof by contradiction, pigeon hole principle, induction and diagonalization. 1.3 Alphabets and language 1.4 Chomsky's hierarchy?

- Design and implement the deterministic and non-deterministic finite automata. - Develop the equivalence of regular languages and finite automata	**Unit 2: Finite Automata and Regular Language (10 hrs)** 2.1 Deterministic Finite Automata, Non-Deterministic Finite Automata 2.2 Regular expressions and regular language, equivalence of regular language and finite automata 2.3 Properties of regular language 2.4 Pumping lemma for regular sets 2.5 Closure properties of regular sets 2.6 Decision algorithms for regular sets

- Explain the theory and design of context-free grammar and pushdown automata and their equivalence. - Explore the derivation trees, simplification and formal forms of context-free grammar.	**Unit 3: Context-Free Language and Pushdown Automata (13 hrs)** 3.1 Context-free grammar 3.2 Derivative trees and simplification of context-free grammar 3.3 Normal forms (CNF, GNF) 3.4 Pushdown automata (formal description and final state PDA design) 3.5 Equivalence of pushdown automata and context-free grammar 3.6 Properties of context-free languages (CFL) 3.7 Pumping lemma for CFL's 3.8 Closure properties of CFL's 3.9 Decision algorithms for CFL's
- Explain the theory and significance of Turing machines - Explain computing mechanism and extensions of Turing machines - Understand the computable languages, functions and unrestricted grammar	**Unit 4: Turing Machines (10 hrs)** 4.1 Introduction to Turing machine 4.2 Computing with Turing machine 4.3 Extensions of Turing machine 4.4 Unrestricted grammar 4.6 Recursively enumerable languages
- Use the idea of undecidability introducing Church-Turing thesis and the halting problem - Understand the universal Turing machines and undecidable problems of Turing machines	**Unit 5: Undecidability (4 hrs)** 5.1 The Church-Turing thesis 5.2 Halting Problem 5.3 Universal Turing machines 5.4 Undecidable problems about Turing machines 5.5 Properties of Recursive and Recursively enumerable languages.

- Understand the concept of computational complexity and different classes of problems	**Unit 6: Computational Complexity (4 hrs)** 6.1 Introduction to Complexity theory, tractable and intractable problems. 6.3 Class P and Class NP problems 6.4 NP-complete problems.