Semester III

DISCIPLINE SPECIFIC CORE COURSE -7 (DSC-7): Modeling continuous changes through ordinary differential equations

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
DSC-7 Modeling continuous changes through ordinary differential equations	**4**	**3**	**0**	**1**	**Class XII with Mathematics**	**NIL**

Learning Objectives

Differential equations have the remarkable ability to translate the real-world problems in mathematical language. This course enables students to study many engineering systems, population dynamics in ecology and biology, mechanics of particles in physics, planetary models etc. involving differential equations. The main objective of the paper is to first analyze and understand the real-world problem through a mathematical lens and then develop the corresponding mathematical model with differential equations in the most realistic sense. Once governing equations are obtained, students should be able to solve them analytically and analyze the solution in physical situations. Students will use MATHEMATICA software for the purpose of simulation.

Learning outcomes

After completing this course, student will be able to:

- explain the fundamental concepts of ordinary differential equations (ODEs).
- use MATHEMATICA software to solve problems and applications of ordinary differential equations (ODEs) and complex analysis.
- formulate real life problems as ODEs.
- use concepts of ordinary differential equations to solve physical models such as mass spring, pendulum, alternating current circuits, etc.

- Use knowledge of ODEs, the general and particular structure of solutions and different methods for solutions.

SYLLABUS

Unit I: First Order Differential Equations
Review of first order differential equations - Variable separable, homogeneous, linear, exact differential equation - Integrating factors - Existence and uniqueness of solution [12 hours]
Unit II: Second and Higher Order Differential Equations
General solutions of second order differential equation - Homogeneous and non-homogeneous differential equations with constant coefficients - Method of variation of parameters - Method of undetermined coefficients, higher order differential equations with constant coefficients [12 hours]
Unit III: Planar Autonomous Systems
Planar autonomous linear systems with graphical representation - Determination of stability and classification of equilibrium of a planar nonlinear system by linearization [9 hours]
Unit IV: Power Series Solutions
Power series solution about a regular point of an analytic ordinary differential equation - Power series solution of Legendre and Bessel's equation - Laplace transform and its application to differential equations [12 hours]

Practical component – [30 hours]
The following explorations would be carried out on matrix based numerical mathematics software:

- Plotting of slope fields and solution curves of first order and higher order differential equations
- Graphical analysis of solution of Population model, Pollution Model, Acceleration – Velocity Models
- Projectile motion, Mechanical Vibrations – Motion of Simple Pendulum, Free undamped and damped motion, Forced undamped and damped motion
- Plotting of phase plane diagrams for predator – prey model, competing species, epidemic model and their analysis
- Innovation project

Essential/recommended readings

- Elementary differential equations and boundary value problems, W. E. Boyce and R. DiPrima, John Wiley, 2009.
- Differential equations and boundary value problems: Computing and modeling, C.H. Edwards and D.E. Penny, Pearson education (Singapore), Pte. Ltd., 2008.
- Advanced engineering mathematics, E. Kreyszig, John Wiley, 2015.

DISCIPLINE SPECIFIC CORE COURSE -8 (DSC-8): Operating Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-8 Operating Systems	4	3	0	1	Class XII pass	Programming languages

Learning Objectives

The objective is to introduce students with basic concepts of Operating System, its functions and services and to familiarize the students with various views and management policies adopted by O.S. as pertaining with processes, Deadlock, memory, File and I/O operations. To brief the students about the functionality of various OS like Unix, Linux and Windows XP as pertaining to resource management and to provide the knowledge of basic concepts towards process synchronization and related issues.

Learning outcomes

After completing this course, student will be able to;

- Understand the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system.
- Conceptualize the components involved in designing a contemporary OS.
- Analyze the structure of OS and basic architectural components involved in OS design.
- Analyze and design the applications to run in parallel either using process or thread models of different OS.
- Analyze the various device and resource management techniques for timesharing and distributed systems.

SYLLABUS

Unit I: Introduction

Overview: Operating systems – structure, operations, components, types, services, user interfaces. System calls, system programs, system boot. [12 hours]

Unit II: Process management

Processes: concept, scheduling, operations on processes, inter-process communications. Threads – single - and multi-threaded processes. CPU scheduling – criteria, algorithms, multiple-processor scheduling. [12 hours]

Unit III: Process synchronization

Critical-section problem, semaphores, classic synchronization problems, monitors. Deadlocks – characterization, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock. [12 hours]

Unit IV: Memory management

Main memory – memory allocation schemes. [9 hours]

Practical component: [30 hours]

- Write a program for implementation of Priority scheduling algorithms, Round Robin scheduling algorithms, FCFS scheduling algorithms, SJF scheduling algorithms.
- Write a program to implement the producer – consumer problem using semaphores, IPC using shared memory, banker's algorithm for deadlock avoidance, Threading and Synchronization Applications.
- Write a simple Unix commands.
- Innovation Projects

Essential/recommended readings

- Operating System Concepts, 10th Edition, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons, 2018.
- Manish Kumar Singh, Sachin Kumar, Saibal Kumar Pal, Operating Systems: Concept Building & Problem Solving Approach, Cengage Publication, 2022.
- John. Lions' Commentary on UNIX® 6th Edition with Source Code. John Lion, San Jose, CA: Peer-to-Peer Communications, 1996.
- Exokernel: An Operating System Architecture for Application-Level Resource Management., Engler, Dawson R., M. Frans Kaashoek, and James O'Toole Jr., ACM Press, 1995.

DISCIPLINE SPECIFIC CORE COURSE -9 (DSC-9): Computer Systems Architecture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-9 Computer Systems Architecture	4	3	0	1	Class XII with Mathematics	NIL

Learning Objectives

The objective is to introduce students with the basic concepts of Computer and the principles underlying systems organization, issues in computer system design, and contrasting implementations of modern systems and to familiarize the students with a fundamental knowledge of computer hardware and computer systems, with an emphasis on system design and performance.

Learning outcomes

After completing this course, student will be able to;

- understand Computing Systems, Models & Logic, Organization & Architecture of Memory
- develop an understanding of CPU, I/O Devices, Distributed Computing, Parallel Architecture, Mobile Systems Architecture
- understand about Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)
- get hands-on experience with Arduino/ARM Interface, Programming & interfacing with Sensors and Parallel Programming using OPENMP, OpenMPI & CUDA.

SYLLABUS

Unit I: Computer arithmetic:

Fixed point and floating-point representation and arithmetic, numbers conversion. Digitals circuits: Boolean algebra, logic gates, logical synthesis by minimization of Boolean functions [12 hours]

Unit II: Input-Output Organisation

Combinational circuits, sequential circuits (synchronous and asynchronous). Construction of the computer: Von Neumann Architecture [12 hours]

Unit III: Memory Organisation

Organization and architecture of memory systems, input/output systems [12 hours]

Unit IV: Construction of the simple processor. [9 hours]

Practical component: [30 hours]

- Logic Gate Designs
- Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)
- Hands on experiments with Arduino/ARM Interface
- Programming in Assembler: memory addressing, interrupts, operations on numbers bits and tables, conditional instructions, loops, input/output

Essential/recommended readings

- Computer System Architecture, Morris Mano, Pearson Education, 2008
- Computer Systems Architecture: a Networking Approach, Rob Williams, Pearson Education, 2011
- Advanced Computer Architecture: Parallelism, Scalability, Programmability, K. Hwang, McGraw Hill, 2017.