KAMARAJ COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)

S.P.G.Chidambara Nadar - C.Nagammal Campus

S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.TECH. ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REGULATIONS – 2021

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM

III TO IV SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Computer Science and Engineering of this Institution the unique of its kind in the field of Research and Development activities in this part of world.

MISSION:

To impart highly innovative and technical knowledge to the urban and unreachable rural student folks in Computer Science and Engineering through "Total Quality Education".

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Apply the basic engineering skills and domain knowledge for developing effective computing solutions to address various social issues.

PEO 2: Able to have successful career in technical / managerial roles in multi-disciplinary environment.

PEO 3: To confront the evolving technical challenges and problems in the areas of computing.

PROGRAM OUTCOMES:

After going through the four years of study, the Artificial Intelligence and Data Science graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/Development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : **Professional Skills:** To apply learned skills to build optimized solutions pertaining to Data Processing, Artificial Intelligence and Machine Learning.

PSO2 : **Problem - Solving Skills:** To analyze data using domain knowledge to get insights and develop appropriate solutions.

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REGULATIONS - 2021

CHOICE BASED CREDIT SYSTEM

B.TECH. ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

CURRICULUM AND SYLLABI FOR SEMESTER III TO IV

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA2201	Linear Algebra and Boundary Value Problems	BS	4	3	1	0	4
2	EC2201	Digital System Design and Microprocessors	ES	4	3	1	0	4
3	AI2201	Artificial Intelligence	PC	3	3	0	0	3
4	AI2202	Data Structures and Algorithms	PC	3	3	0	0	3
5	CS2202	Object Oriented Programming using Java[#]	PC	4	2	0	2	3
6	CS2203	System Software and Operating Systems	PC	3	3	0	0	3
7		Audit Course	AU	2	2	0	0	0
PRACTICALS								
8	AI2203	Data Structures and Algorithms Laboratory	PC	4	0	0	4	2
9	EC2202	Digital System Design and Microprocessors Laboratory	PC	4	0	0	4	2
			TOTAL	**31**	**19**	**2**	**10**	**24**

[#] Theory cum Laboratory Course

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA2253	Probability and Statistics	BS	4	3	1	0	4
2	CS2251	Database Management Systems	PC	3	3	0	0	3
3	AI2251	Foundations of Data Science and Machine Learning[#]	PC	5	3	0	2	4
4	AI2252	Introduction to Internet of Things	PC	3	3	0	0	3
5	GE2201	Design Thinking	ES	3	3	0	0	3
6	GE2251	Quantitative Aptitude	EM	1	1	0	0	1
7	AUD110	Tamils and Technology	AU	1	1	0	0	0
PRACTICALS								
8	CS2254	Database Management Systems Laboratory	PC	4	0	0	4	2
9	CS2255	Mobile Application Development Laboratory	PC	4	0	0	4	2
10	AI2253	Internet of Things Laboratory	PC	4	0	0	4	2
TOTAL				**32**	**18**	**1**	**16**	**24**

[#] Theory cum Laboratory Course

Course Code	Course Name	L	T	P	C
MA2201	LINEAR ALGEBRA AND BOUNDARY VALUE PROBLEMS	3	1	0	4

Category: Foundation Courses (Basic Science Courses)

a. Preamble

The operations of addition and scalar multiplication are used in many diverse contexts in mathematics. The general theory of mathematical systems involving addition and scalar multiplication has the applications to many areas of Engineering. Mathematical systems of this form are called vector spaces or linear spaces. Subject to certain given conditions, called boundary conditions, solving partial differential equation is known as solving a boundary value problem. It is also applied in many Engineering field.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Test the given system of equation is linearly dependent or independent.	K3
CO2	Apply the concept of Eigen values and Eigen vectors for diagonalization of a matrix.	K3
CO3	Apply the inner product techniques for finding the orthonormal vector and minimal solution to the system of linear equation.	K3
CO4	Apply the Fourier series techniques in solving wave and heat flow equations.	K3
CO5	Solve Initial and Boundary value problems numerically.	K3

c. Course Syllabus **Total : 60 Periods**

VECTOR SPACES **12**

Vector spaces - Subspaces - Linear combinations of vectors - Linear Span - Linear independence and linear dependence – Bases and dimensions.

LINEAR TRANSFORMATION AND DIAGONALIZATION **12**

Linear transformation - Null space and range space - Dimension theorem (proof excluded) - Matrix representation of a linear transformation - Eigen values and eigen vectors - Diagonalization of linear transformation – Applications.

INNER PRODUCT SPACES **12**

Inner products spaces - Orthogonal vectors - Gram Schmidt orthogonalization process (proof excluded) - Orthogonal complement - Least square approximation - Minimal solution to system of linear equations.

FOURIER SERIES AND BOUNDARY VALUE PROBLEMS **12**

Dirichlet's conditions - General Fourier series - Half range sine series - Half range cosine series - Classification of Partial differential equations - Fourier Series Solutions of one dimensional wave equation - One dimensional equation of heat conduction.

NUMERICAL SOLUTION OF BOUNDARY VALUE PROBLEMS **12**

Difference operators - Finite difference solution of second order ordinary differential equation - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain - Numerical solution of Parabolic: Crank Nicholson and Bender Schmidt method.

d. Activities

Students shall be exposed to MATLAB programming to solve simple problems in Diagonalization.

e. Learning Resources

Text Books

1. Friedberg, A.H, Insel, A, J, & Spence, L, *Linear Algebra*, Prentice Hall of India, New Delhi, 2004.
2. Grewal, B.S, *Higher Engineering Mathematics*, Khanna Publishers, Forty Fourth Edition New Delhi, 2020.
3. Grewal, B.S, and Grewal, J.S, *Numerical Methods in Engineering and Science*, Khanna Publishers, Tenth Edition, New Delhi, 2016.

Reference Books

1. Kolman, B, & Hill, D.R, *Introductory Linear Algebra*, Pearson Education, New Delhi, First Reprint, 2009.
2. Strang, G, *Linear Algebra and its applications*, Fourth Edition, Cengage learning India pvt. Ltd, 2012.
3. Glyn James, *Advanced Modern Engineering Mathematics*, Pearson Education, Fourth Edition, New Delhi, 2011.
4. Peter ,V, O'Neil, *Advanced Engineering Mathematics*, Cengage Learning India Pvt., Ltd., Seventh Edition, New Delhi, 2012.

5. Kandasamy, P, Thilagavathy, K, & Gunavathy, K, *Numerical Methods*, Third Edition Reprint, S. Chand & Co. Ltd., New Delhi, 2014.

Course Code	Course Name	L	T	P	C
EC2201	DIGITAL SYSTEM DESIGN AND MICROPROCESSORS	3	1	0	4

Category: Engineering Science Course

a. Preamble

This course promotes students to understand the basic concept of combinational and sequential circuits in digital system design. This course focuses on introducing programmable devices, microprocessors and its applications.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the concepts of Boolean functions and minimization techniques.	K2
CO2	Illustrate the combinational circuits used to perform basic digital operations	K2
CO3	Develop synchronous/asynchronous counters and shift registers using sequential logic.	K3
CO4	Design combinational circuits using programmable logic devices and Memory Devices.	K3
CO5	Explain the 8086 microprocessor and its I/O interfacing concepts	K2

c. Course Syllabus **Total : 60 Periods**

DIGITAL FUNDAMENTALS **12**

Review of Number systems, Logic gates, Boolean algebra - Boolean postulates and laws - Simplification using Boolean algebra, Canonical forms - Sum of product and Product of sum - Minimization using Karnaugh map - NAND and NOR Implementation

COMBINATIONAL CIRCUITS **12**

Realization of combinational logic using gates, Design of combinational circuits : Adder , Subtractor, Parallel adder / Subtractor, Magnitude Comparator, Code Converters, Parity generator and checker, Encoder, Decoder, Multiplexer, Demultiplexer - Function realization using Multiplexer, Decoder

SYNCHRONOUS SEQUENTIAL CIRCUITS **12**

Latches, Flip-Flops - SR, JK, D & T - Master Slave Flip Flops - Shift Registers - SISO, SIPO, PISO, PIPO, Design of synchronous counters - Modulo N counters, Random Sequence counters, Johnson counter, Ring counter.

MEMORY AND PROGRAMMABLE LOGIC DEVICES **12**

Random Access Memory - Read Only Memory - Types, Error Detection and Correction, Programmable Logic Devices - Programmable Logic Array (PLA) - Programmable Array Logic (PAL) - Implementation of combinational logic circuits using PLA / PAL, Sequential Programmable Devices.

THE 8086 MICROPROCESSOR AND I/O INTERFACING **12**

Introduction to 8086 - Microprocessor architecture - Addressing modes - Instruction set - Assembly language programming - I/O Interfacing - Parallel communication interface - Case studies: Traffic Light control, LED display

d. Activities

Students shall be given exposure to understand the combinational and sequential digital circuits and to develop an application by using digital logic.

e. Learning Resources

Text Books

1. M. Morris Mano, Michael D. Ciletti, 2017, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog*, 6th Edition, Pearson Education.and Synthesis, McGraw Hill
2. Nagoor Kani, A, 2017, *Microprocessors and Microcontrollers*, McGraw Hill.

Reference Books

1. Charles H.Roth. 2013, *Fundamentals of Logic Design*, 6th Edition, Thomson Learning.
2. Mulammad Ali Mazidi and Janice Gillispie Mazidi, 2003, *The 80x86 IBM PC and compatible computers - Assembly Language, Design and Interfacing*, Fourth Edition, Pearson Education, International Edition.
3. D.D. Givone, 2003, *Digital Principles and Design*, Tata Mc-Graw Hill, New Delhi.
4. Thomas L.Floyd, 2011, *Digital Fundamentals*, 10th Edition, Pearson Education Inc.
5. Stephen Brown and ZvonkoVranesic, 2013, *Fundamentals of Digital Logic with Verilog Design*, Third Edition, McGraw-Hill Higher Education, New Delhi, India.

Course Code	Course Name	L	T	P	C
AI2201	ARTIFICIAL INTELLIGENCE	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand the various characteristics of Intelligent agents and different search strategies. This course familiar with represent knowledge in solving Artificial Intelligence problems and agent communication. This course emphasis on various applications of Artificial Intelligence.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the various characteristics of intelligent agents.	K2
CO2	Interpret appropriate search algorithms for Artificial Intelligence problem.	K2
CO3	Illustrate a Knowledge Representation using first order logic.	K2
CO4	Infer different ways of the agent communication and Trust and Reputation in Multi-agent systems.	K2
CO5	Summarize the applications of AI.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Introduction - Definition - The Foundations of Artificial Intelligence - Characteristics of Intelligent Agents - Turing test - Agents and Environments - Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents; Problem Solving Approach to Typical AI problems.

PROBLEM SOLVING USING SEARCHING **9**

Problem-Solving Agents, Formulating problems, searching for Solutions, Uninformed Search Strategies, Breadth-first search, Depth-first search, searching with Partial Information, Informed Search Strategies, Greedy best-first search, A* Search-IDA*-Heuristic Functions, Local Search Algorithms and Optimization Problems - Constraint Satisfaction Problems - Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games - Alpha - Beta Pruning.

LOGIC AND INFERENCES **9**

Propositional Logic - First Order Logic - Forward Chaining-Backward Chaining - Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories.

AGENT COMMUNICATION **9**

Architecture for Intelligent Agents - Agent communication - Agents and Objects - Negotiation and Bargaining - Argumentation among Agents - Trust and Reputation in Multi-agent systems.

APPLICATIONS **9**

AI applications - Language Models - Information Retrieval - Information Extraction - Natural Language Processing - Machine Translation - Speech Recognition - Robot - Hardware - Perception - Planning - Moving.

d. Activities

Students shall be exposed to basic Artificial Intelligence concepts and applications.

e. Learning Resources

Text Book

1. Russell, S & Norvig, P, 2020, *Artificial Intelligence: A Modern Approach*, 4th ed, Prentice Hall.

Reference Books

1. Elaine Rich & Kevin Knight, 2008, *Artificial Intelligence*, 3rd ed, Tata McGraw-Hill.
2. Tim Jones, M, 2008, *Artificial Intelligence: A Systems Approach (Computer Science)*, 1st ed, Jones and Bartlett Publishers, Inc.
3. Nils J Nilsson, 2009, *The Quest for Artificial Intelligence*, Cambridge University Press.
4. Gerhard Weiss, 2013, *Multi Agent Systems*, 2nd ed, MIT Press.
5. David L Poole & Alan K Mackworth, 2010, *Artificial Intelligence: Foundations of Computational Agents*, Cambridge University Press.

Course Code	Course Name	L	T	P	C
AI2202	DATA STRUCTURES AND ALGORITHMS	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand different data structures and how to use them effectively for solving problems. It also enables the students to select an appropriate data structure and develop the real world applications.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Illustrate the basic concepts of List ADT.	K2
CO2	Explain Stack and Queue ADTs	K2
CO3	Summarize the concepts of non-linear data structures, Trees.	K2
CO4	Outline the concepts of non-linear data structures, Graphs.	K2
CO5	Apply appropriate sorting and searching techniques for problem solving.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO ALGORITHMS AND ADTs **9**

Time and space complexity - Big O, Omega, Theta notation – List ADT – array based implementation, linked list implementation, singly linked lists, circularly linked lists, doubly linked lists, applications of lists.

STACK AND QUEUE **9**

Stack ADT – Operations, Applications, Evaluating arithmetic expressions, Conversion of Infix to postfix expression - Queue ADT - Operations, Circular Queue, Priority Queue, dequeue, applications of queues.

TREES **9**

Tree ADT - tree traversals - Binary Tree ADT - expression trees, applications of trees - binary search tree ADT-AVL Tree - B-Tree - Heap- Binary heap - Applications of heap.

GRAPHS **9**

Definition, Representation of Graph, Types of graph, Breadth-first traversal, Depth-first traversal - Topological Sort - Bi-connectivity - Cut vertex - Euler circuits - Applications of graphs.

SEARCHING, SORTING AND HASHING TECHNIQUES **9**

Searching - Linear Search, Binary Search - Sorting - Bubble sort, Selection sort, Insertion sort, Shell sort, Radix sort - Hashing - Hash Functions, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing.

d. Activities

Students shall be given exposure to understand the nature of a given problem and to explore solutions to real-life problems.

e. Learning Resources

Text Books

1. Weiss, M.A., 1997, *Data Structures and Algorithm Analysis in C*, 2/e. Pearson Education India.
2. Reema Thareja, 2011, *Data Structures Using C*, Second Edition, Oxford University Press.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest & Clifford Stein, 2002. *Introduction to Algorithms*, Second Edition, Mcgraw Hill.
2. Aho, Hopcroft & Ullman, 1983, *Data Structures and Algorithms*, Pearson Education.
3. Kochan, S.G., 2015, *Programming in C*. Pearson education.
4. Ellis Horowitz, SartajSahni, Susan & Anderson-Freed, 2008, *Fundamentals of Data Structures in C*, Second Edition, University Press

Course Code	Course Name	L	T	P	C
CS2202	OBJECT ORIENTED PROGRAMMING USING JAVA	2	0	2	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand the importance of coding using object oriented concepts to solve the real-time challenges by computer. This course enriches the logical skills of the students to instruct the computer for solving the problems. This course focuses on problem solving using Object Oriented programming language using Java.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the basic Object Oriented Programming concepts and Java Fundaments.	K3
CO2	Demonstrate Java applications with Inheritance and Interfaces.	K3
CO3	Infer the use of Exceptions and I/O Streams in Java applications.	K2
CO4	Build applications using Threads and Generic Classes.	K3
CO5	Construct interactive Java applications using swings.	K2

c. Course Syllabus **Total : 60 Periods**

INTRODUCTION TO OOPS AND JAVA FUNDAMENTALS **6**

Object Oriented Programming Concepts - Fundamental Programming Structures in Java - Data Types, Variables, Operators, Control Flow & Array, Defining classes in Java - constructors, methods and Fields - Packages.

INHERITANCE AND INTERFACES **6**

Inheritance - Super classes & Sub classes, types of Inheritance, Abstract classes and methods - Final Classes and methods - Interfaces - Inner classes - String.

EXCEPTION HANDLING AND I/O **6**

Exceptions - Exception hierarchy, Throwing & Catching exceptions, Built-in Exceptions and Creating own exceptions, Input / Output Streams Basics - Byte streams and Character streams - Reading and Writing Console - Reading and Writing Files.

MULTITHREADING AND GENERIC PROGRAMMING **6**

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, Generic Programming - Generic classes - generic methods, Type inference with var and datetime and Collection API.

EVENT DRIVEN PROGRAMMING **6**

Introduction to Swing - layout management, Swing Components, Working with 2D shapes - Using color, fonts, and images - Basics of event handling - AWT event hierarchy, adapter classes & mouse events - Solid pattern in Java and JDBC.

THEORY:30 Periods

d. LIST OF LABORATORY EXPERIMENTS

1. Develop a Java application to generate Electricity bill.
2. Develop a java application to implement the User Defined Packages.
3. Write a program to perform string operations using ArrayList.
4. Develop a java application with Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club fund. Generate pay slips for the employees with their gross and net salary
5. Design a Java interface for ADT Stack/Queue. Implement this interface using array. Provide necessary exception handling in both the implementations
6. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method print Area () that prints the area of the given shape.
7. Write a Java program that reads the file information and display it in console by Byte/Character Stream Classes.
8. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number.

9. Write a java program to find the maximum value from the given type of elements using a generic function
10. Design a calculator using event-driven programming paradigm of Java.
11. Write a java program to connect MySQL/Oracle using JDBC.

PRACTICAL : 30 Periods

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Java (JDK Latest Version), NetBeans IDE / Eclipse IDE or equivalent	Open source

e. Activities

Students shall be exposed to object oriented programming concepts and to solve simple problems using Java.

f. Learning Resources

Text Books

1. Herbert Schildt, 2019, *Java The complete reference*, 11th ed, McGraw Hill Education.
2. Cay S Horstmann & Gary cornell, 2013, *Core Java Volume – I Fundamentals*, 9th ed, Prentice Hall.

Reference Books

1. Paul Deitel & Harvey Deitel, 2015, *Java SE 8 for programmers*, 3rd ed, Pearson.
2. Steven Holzner, 2011, *Java 2 Black book*, Dreamtech press.
3. Timothy Budd, 2000, *Understanding Object-oriented programming with Java*, Updated Edition, Pearson Education.

Course Code	Course Name	L	T	P	C
CS2203	SYSTEM SOFTWARE AND OPERATING SYSTEMS	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand the basic concepts about system software, processes and threads. The students get familiarized with the scheduling algorithms and deadlock handling mechanisms. This course focuses on various memory management schemes and file systems.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain different types of system software and its use	K2
CO2	Illustrate the concepts of process, threads and CPU scheduling algorithms	K2
CO3	Explain the algorithms used for concurrency and deadlock handling	K2
CO4	Make use of various memory management schemes	K3
CO5	Demonstrate the concept of file systems.	K2

c. Course Syllabus **Total : 45 Periods**

SYSTEM SOFTWARE **9**

System Software versus Application Software - Basic System Software: Assembler: Two pass assembler, Loader: Absolute and Bootstrap loader; Key terms: Relocation, linking, Macro Processor, Text Editor, Debugger, Device Driver, Compiler, and Interpreter. Operating system objectives and functions - Operating System Structure - System Calls, System Programs, OS Generation and System Boot.

PROCESS MANAGEMENT **9**

Processes - Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication; CPU Scheduling - Scheduling criteria, Scheduling algorithms, Multiple-processor scheduling, Real time scheduling; Threads - Overview, Multithreading models, Threading issues.

PROCESS SYNCHRONIZATION **9**

Process Synchronization - The critical-section problem, Synchronization hardware, Mutex locks, Semaphores, Classic problems of synchronization, Critical regions, Monitors; Deadlock - System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.

STORAGE MANAGEMENT **9**

Main Memory - Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging, 32 and 64 bit architecture Examples; Virtual Memory - Background, Demand Paging, Page Replacement, Allocation, Thrashing; Allocating Kernel Memory.

FILE SYSTEMS **9**

Mass Storage system - Overview of Mass Storage Structure, Disk Structure, Disk Scheduling and Management, swap space management. File-System Interface - File concept, Access methods, Directory Structure, Directory organization, File system mounting, File Sharing and Protection; File System Implementation- File System Structure, Directory implementation, Allocation Methods, Free Space Management, Efficiency and Performance, Recovery. I/O Systems - I/O Hardware, Application I/O interface - Kernel I/O subsystem, Streams, Performance.

d. Activities

Students shall be exposed to the core concepts of operating systems using case study.

e. Learning Resources

Text Books

1. Leland L Beck, 1997, *System Software: An Introduction to Systems Programming*, 3rd ed, Pearson Education Asia.
2. Abraham Silberschatz, Peter Baer Galvin & Greg Gagne, 2018, *Operating System Concepts*, 9th ed, John Wiley and Sons Inc.

Reference Books

1. Andrew S Tanenbaum, 2004, *Modern Operating Systems*, 2nd ed, Pearson Education.
2. Elmasri, R, Carrick, A & Levine, D, 2010, *Operating Systems – A Spiral Approach*, Tata McGraw Hill Edition.

3. Achyut S Godbole & Atul Kahate, 2016, *Operating Systems*, McGraw Hill Education.
4. Gary Nutt, 2004, *Operating Systems*, 3rd ed, Pearson Education.
5. Harvey M Deitel, 2004, *Operating Systems*, 3rd ed, Pearson Education.
6. Daniel P Bovet & Marco Cesati, 2005, *Understanding the Linux kernel*, 3rd ed, O'Reilly.
7. Neil Smyth, 2011, *iPhone iOS 4 Development Essentials – Xcode*, 4th ed, Payload media.

Course Code	Course Name	L	T	P	C
AI2203	DATA STRUCTURES AND ALGORITHMS LABORATORY	0	0	4	2

Category: Foundation Core Course

a. Preamble

This course promotes students to bring together the data elements in a logical way which facilitates storing data on computers for efficient use. The course also explores the algorithms that are used to accurately and efficiently execute tasks.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Make use of linear Data structures Array, List, Stack and Queue to solve problems.	K3
CO2	Apply non-linear Data Structures - Trees for problem solving.	K3
CO3	Make use of non-linear Data Structures - Graph for problem solving	K3
CO4	Utilize various sorting and searching algorithms to solve problems.	K3
CO5	Apply appropriate hash functions in a Hash ADT for collision free data storage and retrieval	K3

c. Course Syllabus **Total : 60 Periods**

1. Implementation of List ADT using array and Linked list.
2. Implementation of Stack ADT using array and linked list.
3. Application of Stack - Conversion of infix expression into postfix expression.
4. Implementation of Queue ADT using array and linked list.
5. Implementation of Binary Search Tree ADT.
6. Implementation of Graph ADT using adjacency matrix and Graph traversal algorithms.
7. Implementation of Linear search and binary search algorithms.
8. Implementation of Bubble sort and Insertion sort Algorithms.
9. Implementation of collision techniques in hashing.

d. Activities

Students shall be given exposure to build data structures and use them in implementations of Abstract data types. The ability of the students is strengthened by making them to apply various data structures and related algorithms to solve real world problems.

e. Learning Resources

Text Books

1. Weiss, M.A., 1997, *Data Structures and Algorithm Analysis in C*, 2/e. Pearson Education India.
2. Reema Thareja, 2011, *Data Structures Using C*, Second Edition, Oxford University Press.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest & Clifford Stein, 2002, *Introduction to Algorithms*, Second Edition, Mcgraw Hill.
2. Aho, Hopcroft & Ullman, 1983, *Data Structures and Algorithms*, Pearson Education.

LIST OF LAB EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Anaconda IDE	30
4.	Interpreter: Python3	30 users

Course Code	Course Name	L	T	P	C
EC2202	DIGITAL SYSTEM DESIGN AND MICROPROCESSOR LABORATORY	0	0	4	2

Category: Engineering Science Course

a. Preamble

This course promotes students to design circuits for different digital systems and to interface I/O devices with microprocessors for various applications.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Experiment with the basics of gates	K3
CO2	Build different combinational circuits	K3
CO3	Construct various sequential circuits	K3
CO4	Experiment with 8086 microprocessor based programs	K3
CO5	Build different I/Os with 8086 microprocessor	K3

c. Course Syllabus **Total : 60 Periods**

List of Experiments

Digital Experiments

1. Verification of Boolean Theorems using basic gates
2. Design and implementation of combinational circuits using basic gates for arbitrary functions
3. Design and implementation of Half/Full Adder and Subtractor
4. Design and implementation of Encoder, Decoder, Multiplexer and Demultiplexer using logic gates
5. Design and implementation of
    a. BCD to Excess 3 Code Converter & Vice Versa
    b. Binary to Gray Code Converter & Vice Versa
6. Design and implementation of Shift register using Flip flops
7. Design and implementation of 2 bit Synchronous counters

Microprocessor Experiments

8086 Programs using kits and MASM

1. Basic arithmetic and Logical operations
2. Move a data block without overlap

Peripherals and Interfacing Experiments

1. Traffic light control
2. Keyboard and Display Interface

d. Activities

Students shall be given exposure to design a circuit and analyze its performance through hardware components. Based on the gained knowledge, they can do mini projects.

e. Learning Resources

Text Books

1. M. Morris Mano and Michael D. Ciletti, 2014, *Digital Design*, 5th Edition, Pearson.
2. Mulammad Ali Mazidi and Janice Gillispie Mazidi, 2003, *The 80x86 IBM PC and compatible computers - Assembly Language, Design and Interfacing*, Fourth Edition, Pearson Education, International Edition.

Reference Books

1. Charles H.Roth, 2013, *Fundamentals of Logic Design*, 6th Edition, Thomson Learning.
2. Thomas L. Floyd, 2011, *Digital Fundamentals*, 10th Edition, Pearson Education Inc.
3. S.Salivahanan and S.Arivazhagan, 2012, *Digital Electronics*, 1st Edition, Vikas Publishing House pvt Ltd.
4. Anil K.Maini, 2014, *Digital Electronics*, Wiley.

LIST OF LAB EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Digital trainer kits	15
2.	Digital ICs	50
3.	8086 Microprocessor trainer kit with power supply	15
4.	Traffic light control interfacing card compatible with 8086	5
5.	Stepper motor control interfacing compatible with 8086 Kits	5
6.	Keyboard & Display interface board compatible with 8086 kits	5

Course Code	Course Name	L	T	P	C
MA2253	PROBABILITY AND STATISTICS	3	1	0	4

Category: Foundation Courses (Basic Science Courses)

a. Preamble

This course introduces the basic concepts and techniques of random variables, some standard distributions, two-dimensional random variables, testing of hypothesis for small and large samples, basic principles in the design of simple experiments, statistical quality control and highlights their applications in various fields such as Engineering and Technology.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply the concepts of probability distributions to solve engineering problems.	K3
CO2	Compute the correlation between two random variables and linear regression equation for a given set of data.	K3
CO3	Apply the concepts of testing of hypothesis for small and large samples in real life problems.	K3
CO4	Apply the basic concepts of classifications of design of experiments in Engineering.	K3
CO5	Apply the techniques of statistical quality control in industrial Engineering problems.	K3

c. Course Syllabus **Total : 60 Periods**

PROBABILITY AND RANDOM VARIABLES **12**

Probability - Conditional probability - Baye's theorem - Random variables - Mathematical expectations - Moments - Moment generating functions - Distributions: Binomial, Poisson, Geometric, Uniform, Exponential and Normal distribution.

CORRELATION AND REGRESSION **12**

Joint distributions - Marginal and conditional distributions - Covariance - Correlation - Karl Pearson's correlation coefficient - Rank correlation - Spearman's rank correlation coefficient - Kendall's rank correlation coefficient - linear regression.

TESTING OF HYPOTHESIS **12**

Sampling distributions - Statistical Hypothesis - Type I and Type II errors - Tests single mean and difference of means of large samples (z-test) and small samples (t-test) - F-test for variance - chi-square test for goodness of fit - independence of attributes

DESIGN OF EXPERIMENTS **12**

Basic Principles of experimental design - Completely randomized design - Randomized block design - Latin square design - 22 factorial design.

STATISTICAL QUALITY CONTROL **12**

Control charts for measurements ($\bar{X}$ and R charts for continuous data) - control charts for attributes (p, c, np and u charts for discrete data) - tolerance limits

d. Activities

Students shall be exposed to Microsoft Excel for Design of Experiments and Statistical Quality control.

e. Learning Resources

Text Books

1. Devore, J.L, *Probability and Statistics for Engineering and the Sciences*, Cengage Learning, Nineth Edition, Boston, 2017.
2. Johnson, R.A, & Gupta, C.B, *Miller and Freund's Probability and Statistics for Engineers*, Pearson India Education, Asia, Nineth Edition, New Delhi, 2017.

Reference Books

1. Milton, J.S & Arnold, J.C, *Introduction to Probability and Statistics*, Tata McGraw Hill, Fourth Edition, New Delhi, 2014.
2. Ross, S.M, *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier, Fifth Edition, New Delhi, 2014.
3. Spiegel, M.R, Schiller, J, Srinivasan, R.A & Goswami, D, *Schaum's Outline of Theory and Problems for Probability and Statistics*, McGraw Hill Education, Third Edition, New Delhi, 2017.
4. Walpole, R.E, Myers, R.H, Myers, S.L, & Ye, K, *Probability and Statistics for Engineers and Scientists*, Nineth Edition, Pearson Education, Asia, 2012.
5. Gupta, S.C, & Kapoor, V.K, *Fundamentals of Mathematical Statistics*, Twelth Edition Reprint, Sultan Chand & Sons, 2020.

Course Code	Course Name	L	T	P	C
CS2251	DATABASE MANAGEMENT SYSTEMS	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to learn the fundamentals of data models and to represent a database system using ER diagrams and study SQL and relational database design. This course enriches the knowledge in the internal storage structures using different file and indexing techniques which will help in physical database design. This course enables the students to understand the fundamental concepts of transaction processing- concurrency control techniques and recovery procedures and learn about file organization and query processing

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Infer the basic concepts of database system and model ER diagram for real time applications	K3
CO2	Use appropriate SQL commands to store and access data from Relational Database.	K3
CO3	Construct normalized database for real world scenario using functional dependencies	K3
CO4	Illustrate the importance of concurrency control in transaction to maintain consistency in a database	K3
CO5	Interpret the mechanisms incorporated in file organization and Query	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO DATABASE & ER MODEL **9**

Introduction to Databases - File System Vs Database System - Database System Architecture - Database Users and Administrator - Data Models - Entity Relationship Model - E-R Diagrams - Design Issues - Extended E-R Features - Introduction to Relational Model - ER to Relational Schema Mapping.

RELATIONAL MODEL & SQL **9**

Structure of Relational Databases - Relational Query Languages - Relational Algebra - SQL: DDL, DML, DCL, TCL - Simple Queries, Complex Nested Queries, Correlated Nested Queries, Joins, Aggregate Functions, Grouping - PL/SQL : Functions, Procedures, Triggers, Views -Embedded SQL - Dynamic SQL.

NORMALIZATION **9**

Pitfalls in Bad Relational database design - Functional Dependencies (Closure of Functional dependencies) - Closure of Attributes - Normal Forms : First, Second, Third, Boyce Codd Normal Form, Multivalued Dependencies : Fourth Normal Form, Join Dependencies : Fifth Normal Form –Domain Key Normal Form.

TRANSACTION AND CONCURRENCY CONTROL **9**

Transaction processing concepts - Need for concurrency control and recovery - Recoverability - Transaction Recovery - Serializability : Conflict Serializability, View Serializability, Testing for Serializability - Concurrency Control : Lock Based Protocols (Two phase locking Techniques, Strict Two Phase Locking, Deadlocks, Multiple Granularity) Timestamp Based protocol, Validation Based protocol.

FILE ORGANIZATION & QUERY PROCESSING **9**

File Organization : Organization of Records in Files, Indexing and Hashing, Ordered Indices - Query Processing: Measures of Query Cost (Selection, Sorting and Join Operation), Query Tuning, Query Optimization (Transformation of Relational Expressions, Choice of Evaluation Plans, Materialized Views) – No SQL – Mongo DB.

d. Activities

Students shall be involved in various activities to improve conceptual learning:

i. Chart preparation

ii. Quiz

e. Learning Resources

Text Books

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, *Database System Concepts*, 6th edition, Tata McGraw Hill. 2017.
2. Ramez Elmasri, Shamkant B. Navathe, *Fundamentals of Database Systems*, 6th edition, Pearson Education, 2011.

Reference Books

1. C.J. Date, A. Kannan & S. Swamynathan, *An Introduction to Database Systems*, 8th edition, Pearson Education, 2006.
2. Raghu Ramakrishnan, *Database Management Systems*, 4th edition, McGraw-Hill College Publications, 2015.
3. G.K.Gupta, *Database Management Systems*, Tata McGraw Hill, 2011.

Course Code	Course Name	L	T	P	C
AI2251	FOUNDATIONS OF DATA SCIENCE AND MACHINE LEARNING	3	0	2	4

Category: Professional Core Course

a. Preamble

This course enables the students to understand the basics of data analysis. This course focuses on the study of machine learning fundamentals with python programming language.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of machine learning	K2
CO2	Apply suitable regression algorithms for an application	K3
CO3	Apply suitable classification algorithms for an application	K3
CO4	Apply ensemble learning for the real world applications	K3
CO5	Apply clustering algorithms for different types of applications	K3

c. Course Syllabus **Total : 75 Periods**

DATA SCIENCE FUNDAMENTALS **9**

Types of Machine learning: Supervised learning- Unsupervised learning-Reinforcement Learning- Machine Learning Process-Terminologies: Weight Space, Curse of Dimensionality, Overfitting, Training, Testing, Validation Sets- Performance Measures: Confusion Matrix, Accuracy Metrics, Receiver Operator Characteristic (ROC) Curve, Measurement PrecisionModel selection-No free lunch theorem- Bias-Variance Tradeoff.

SUPERVISED LEARNING - REGRESSION AND TREE BASED MODELS **9**

Linear Regression - Multivariate Regression- Logistic Regression- Principal Component Regression- Decision Trees, Regression Trees.

SUPERVISED LEARNING – CLASSIFICATION **9**

Linear Classification- Probability and Bayes learning - Naive Bayes - Bayesian Network - Perceptron - Perceptron Learning - Neural Networks –– Back propagation- Support Vector Machines

ENSEMBLE LEARNING **9**

Ensemble Methods - Bagging, Committee Machines and Stacking, Boosting - Gradient Boosting, Adaptive Boosting, Random Forests-Multi-class Classification.

UNSUPERVISED LEARNING **9**

Introduction to Clustering- Partitional Clustering - Hierarchical Clustering - Birch AlgorithmCURE Algorithm - Density based Clustering- Expectation Maximization

THEORY:45 Periods

d. Activities

Students shall be exposed to python packages to solve simple problems

e. LIST OF LABORATORY EXPERIMENTS

1. Basic statistical measure
2. Regression Algorithms – Simple Linear, Multiple Linear and Logistics
3. Classification Algorithms for Tree based models– Decision Tree, Principal component regression
4. Linear Classification Algorithms – Naïve Bayes, Neural Networks, Support Vector Machine
5. Classification Algorithm for multiclass – Gradient boosting, Random forest
6. Clustering Algorithms – Partition clustering, Hierarchal clustering

PRACTICAL : 30 Periods

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, HDD 500 GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Python 3.6	Open source

f. Learning Resources

Text Books

1. Ethem Alpaydin, 2015, *Introduction to Machine Learning*, 3rd ed, Prentice Hall of India.
2. Stephen Marsland, 2015, *Machine Learning - An Algorithmic Perspective*, 2nd Edition, CRC Press.

Reference Books

1. Christopher Bishop, 2006, *Pattern Recognition and Machine Learning*, Springer
2. Kevin P. Murphy, 2012, *Machine Learning: A Probabilistic Perspective*, MIT Press
3. Stephen Marsland, 2014, *Machine Learning –An Algorithmic Perspective*, 2nd ed, CRC Press
4. Tom Mitchell, 2017, *Machine Learning*, McGraw-Hill

Course Code	Course Name	L	T	P	C
AI2252	INTRODUCTION TO INTERNET OF THINGS	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand the importance of Internet of Things and to solve the real-time challenges. This course enriches the logical skills and focuses on embedded projects

b. Course Outcomes

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the IoT architecture and sensor fundamentals.	K2
CO2	Summarize the data acquisition concepts and various sensors operation	K2
CO3	Outline the various protocols used in IoT applications.	K2
CO4	Build IoT Systems using Arduino and Raspberry PI.	K3
CO5	Construct real time smart IoT Application using embedded system.	K3

c. Course Syllabus **Total: 45 Periods**

INTRODUCTION TO IoT 9

Evolution of Internet of Things - IoT Enabling Technologies - IoT Levels - IoT Architectures - IoT and M2M – Sensors types, principle, requirement and advantages – Classification of Sensors, Actuators, Smart Objects and Connecting Smart Objects

SENSORS FUNDAMENTALS 9

Amplification Basics of Measurement – Classification of errors – Error analysis – Data Acquisition: Single channel and multi-channel data acquisition. Data logging – applications, Motion Sensors – Potentiometers, Accelerometer, GPS, Bluetooth, Ultrasonic Ranging, Strain Gauge, Load Cell, and Magnetic Sensors.

IoT PROTOCOLS 9

IoT access technologies: Physical and MAC Layers, Topology – Application transport methods: supervisory control and data acquisition – Application layer protocols: CoAP and MQTT. Design Methodology - Embedded Computing Logic - Microcontroller, System on Chips - IoT System Building Blocks.

BUILDING IoT WITH ARDUINO, RASPBERRY PI & JETSON 9

Arduino - Board Details, IDE Programming - Logical Design using Python, Raspberry Pi - Interfaces and Raspberry Pi with Python Programming, Introduction to Jetson controller and its applications.

CASE STUDIES AND REAL WORLD APPLICATIONS 9

IoT Cloud Storage Models & Communication APIs - Cloud for IoT – Smart Agriculture Power Utility Industry - Smart Grid - Smart and Connected Cities: Smart Lighting, Smart Parking, Smart Traffic Control and Commercial building automation.

d. Activity

Students shall be exposed to Internet of Things concepts and to solve simple problems using IoT

e. Learning Resources

TEXT BOOK

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton & Jerome Henry, 2017, "*IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*, Cisco Press.

REFERENCES

1. Arshdeep Bahga & Vijay Madisetti, 2015, *Internet of Things - A hands-on approach*, Universities Press.
2. Olivier Hersent, David Boswarthick & Omar Elloumi, 2012 (for Unit 2), *The Internet of Things - Key Applications and Protocols*, Wiley.
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos Stefan Avesand & David Boyle, 2014, *From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence*, Elsevier.
4. Dieter Uckelmann, Mark Harrison, Michahelles & Florian (Eds), 2011, *Architecting the Internet of Things*, Springer.
5. Michael Margolis & Arduino Cookbook, 2011, *Recipes to Begin, Expand, and Enhance Your Projects*, 2nd ed, O'Reilly Media.

Course Code	Course Name	L	T	P	C
GE2201	DESIGN THINKING	3	0	0	3

Category: Engineering Science Course

a. Preamble

This course introduces the various principles of design thinking to achieve an effective design and to examine the implementation of the model or process for its successful operation.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the basic principles of design and various stages of design thinking for better conceiving of idea and refinement	K2
CO2	Elucidate the concepts of idea generation and refinement	K3
CO3	Apply various prototype models for solving complex problems	K3
CO4	Analyze real-time problems for effective design, implementation and operation	K3
CO5	Device idea/solution towards development of a prototype for a chosen problem of interest	K4

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO DESIGN THINKING **9**

Introduction - Product life cycle - Design Ethics - Design Process - Stages in design thinking: Immersion, Analysis and synthesis, Ideation, Prototyping.

IDEA GENERATION AND REFINEMENT **9**

Basic design - directions - Themes of thinking - Inspiration and references – Brainstorming - Value - Inclusion – Sketching - Presenting ideas - Thinking in images - Thinking in signs - Appropriation - Personification - Visual metaphors - Modification - Thinking in words - Words and language - Thinking in shapes - Thinking in proportions - Thinking in color - Outside the Box.

PROTOTYPING **9**

Developing designs - Types of prototype - Prototyping for Designing Complex Systems - The Efficacy of Prototyping under Time Constraints.

IMPLEMENTATION **9**

Format - Materials - Finishing - Media - Scale - Series/Continuity - Emerging Landscapes of Design - Real-Time Design Interaction Capture and Analysis - Enabling Efficient Collaboration in Digital Design - Spaces Across Time and Distance - Software used in Developing in Virtual Environments.

DESIGN THINKING IN VARIOUS SECTORS **9**

Design & Development of Prototypes for Wall Plastering, Rubber shredding, Separation of Corn seeds, Electric vehicles, Smart gates, Burglar alarm, Tyre pressure monitor, Development of Online Voting System, Online Proctoring System, Online Health Monitoring System, IoT based Home Automation and any other problem of interest in your domain.

d. Activities

Students shall be exposed to design thinking concepts and to design simple prototypes related to various sectors.

e. Learning Resources

Text Books

1. Binder, T., De Michelis, G., Ehn, P., Jacucci, G., Linde, P., and Wagner, I., 2011, *Design things*, MIT press.
2. Ambrose, G., and Harris, P., 2009, *Basics Design: Design thinking*, Bloomsbury Publishing

Reference Books

1. Meinel, C., and Leifer, L. (Eds.)., 2011, *Understanding Innovation*, Springer.
2. Plattner, H., Meinel, C., and Leifer, L. (Eds.)., 2010, *Design thinking: understand–improve–apply*,, Springer Science & Business Media
3. Moran, T. P., and Carroll, J. M., 1996, *Design Rationale: Concepts, Techniques, and Use*, L. Erlbaum Associates Inc.
4. Cross, N., 1984, *Developments in Design Methodology*, Chichester: Wiley.

Web Resources

1. https://www.designsociety.org/download-publication /39626/ Design prototyping of systems
2. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process

Video Lectures : https://nptel.ac.in/courses/110/106/110106124/#

Course Code	Course Name	L	T	P	C
GE2251	QUANTITATIVE APTITUDE	1	0	0	1

Category: Employability Enhancement Course

a. Preamble

To develop the thinking ability and problem solving skills of students to compete themselves in placement and competitive examinations.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply the concept of profit in real life problems	K3
CO2	Solve the problems by using proportion	K3
CO3	Compute accurate speed, time and distance	K3
CO4	Apply the concept of Time & Speed	K3
CO5	Calculate the work done based on various methods	K3

c. Course Syllabus **Total : 15 Periods**

PROFIT AND LOSS **3**

Profit and Loss - Cost Price, Selling Price, Profit and Loss %, Marked Price, Discount.

RATIO AND PROPORTION **3**

Ratio and Proportion - Ratio, Proportion, Comparison of Ratios, Duplicate, Triplcate Ratio.

TIME, SPEED AND DISTANCE **3**

Time, Speed and Distance - Concept of time, speed and distance, Conversion of units and proportionality, Avearge speed concept.

APPLICATIONS ON TIME, SPEED AND DISTANCE **3**

Problems on trains - Relative speed concept and application. Boats and Streams - Upstream speed, Downstream speed, Speed of stream, Speed of boat.

TIME AND WORK **3**

Time & work - Problems based on time and work, Formulae, Computation of work together, Wages based work problems. Pipes & Cisterns - Inlet-outlet, Part of tank filled, Time based problems.

d. Learning Resources

Text Book

1. Dinesh Khattar, *Quantitative Aptitude for Competitive Examinations*, Pearson India Education services Pvt Ltd, Fourth Edition, Uttar Pradesh, 2019.

Reference Books

1. TCY online, *Reasoning ability and Quantitative Aptitude*, Wiley India Pvt. Ltd, First Edition, New Delhi, 2016.
2. Agarwal.R.S, *Quantitative Aptitude for Competitive Examinations*, S.Chand Limited, 2011.
3. Abhijit Guha, *Quantitative Aptitude for Competitive Examinations*, Tata McGraw Hill, 3rd Edition, 2011.

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Course Code	Course Name	L	T	P	C
CS2254	DATABASE MANAGEMENT SYSTEMS LABORATORY	0	0	4	2

Category: Professional Core Course

a. Preamble

This course enables the students to learn the commands for creating and manipulating the databases. This course makes students to construct queries for retrieval of required data from database and understand views, sequences and synonyms concepts of SQL. This course enriches the knowledge in the concepts of the functions, procedures, triggers and exception handling in SQL. This course enables the students to develop GUI based application for storage and retrieval of data.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Choose appropriate DDL, DML, DCL and TCL commands for creating and manipulating the databases.	K3
CO2	Construct appropriate nested queries, sub queries and join queries for efficient retrieval of data.	K3
CO3	Organize database using views, sequences, and synonyms.	K3
CO4	Implement functions, procedures, triggers and exceptions using PL/SQL.	K3
CO5	Develop a GUI based environment for storage and retrieval of data for a real time application.	K3

c. Course Syllabus **Total : 60 Periods**

List of Experiments

1. WRITE AND EXECUTE SIMPLE QUERIES USING SQL
   a. DDL, TCL and DCL commands
   b. DML commands
   c. Aggregate Functions

2. WRITE AND EXECUTE ADVANCED QUERIES USING SQL
    a. Nested Queries and Sub queries
    b. SQL Join

3. WRITE AND EXECUTE VIEWS, SYNONYMS, SEQUENCE

4. WRITE AND EXECUTE QUERIES USING PL/SQL
    a. Simple programs

5. WRITE AND EXECUTE QUERIES USING ADVANCED CONCEPTS OF PL/SQL
    a. Cursors and Procedures
    b. Functions
    c. Triggers
    d. Exception Handling

6. IMPLEMENT DATABASE CONNECTIVITY CONCEPTS
    a. Design a Front End for a real time application
    b. Connect the database with the application

7. MINI PROJECT

d. Learning Resources

Reference Books

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, *Database System Concepts*, 6th edition, Tata McGraw Hill, 2017.
2. Ramez Elmasri, Shamkant B. Navathe, *Fundamentals of Database Systems*, 6th edition, Pearson Education, 2011.

LIST OF LAB EQUIPMENTS FOR A BATCH OF 30 STUDENTS:		
S.No.	**Description of Equipment**	**Quantity Required**
1.	Personal Computers (Intel Core i3, 500 GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Netbeans IDE 8.2, WAMP/XAMPP, Apache Tomcat server	30

Course Code	Course Name	L	T	P	C
CS2255	MOBILE APPLICATION DEVELOPMENT LABORATORY	0	0	4	2

Category: Professional Core Course

a. Preamble

The course has been designed to impart practical knowledge on Android application programming thus to reduce the gap between the demand and supply of Competent Android Application Developers. This course enables the students to develop mobile application to satisfy the basic needs in our daily life activities and also the applications which are needed for businesses, industries and educational institutions.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop an application using GUI Components, Layout Managers and Event Listeners.	K3
CO2	Develop an application that makes use of database	K3
CO3	Apply the concepts of Multi threading and RSS Feed for application development	K3
CO4	Implement an application that writes data to SD card	K3
CO5	Develop a native application that uses GPS location Information and E-mail service	K3

c. Course Syllabus **Total : 60 Periods**

List of Experiments

1. Develop an application that uses GUI components, Font and Colours
2. Develop an application that uses Layout Managers and event listeners.
3. Write an application that draws basic graphical primitives on the screen.
4. Develop an application that makes use of databases.
5. Develop an application that makes use of Notification Manager
6. Implement an application that uses Multi-threading
7. Develop a native application that uses GPS location information
8. Implement an application that writes data to the SD card.

9. Implement an application that creates an alert upon receiving a message
10. Write a mobile application that makes use of RSS feed.
11. Develop a mobile application to send an email.
12. Develop a Mobile application for simple needs (Mini Project)

d. Activities

Students shall be exposed to develop simple Mobile applications for real-time problems

e. Learning Resources

Reference Books

1. Wei-Meng-Lee, *Beginning Android Application Development*, Wiley Publishing Inc. 2011.

LIST OF LAB EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 8 GB RAM)	30
2.	Printer	1
3.	Software Tools: Android Studio 4.2, Android Emulator	30

Course Code	Course Name	L	T	P	C
AI2253	INTERNET OF THINGS LABORATORY	0	0	4	2

Category: Professional Core Course

a. Preamble

This course enables the students to develop simple hardware applications using Sensors, Actuators and Micro Controllers for real-time problems

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Construct simple applications using sensors.	K3
CO2	Make use of various sensors to develop IoT applications	K3
CO3	Build IoT applications using Arduino.	K3
CO4	Make use of Raspberry PI processor for developing IoT applications.	K3
CO5	Develop real time smart IoT Applications	K3

c. Course Syllabus **Total : 60 Periods**

List of Experiments

1. Working with Basic Analog and Digital Sensors
    a. LED Display
    b. Intensity Measurements (Dawn to Dusk)
    c. Human Detection
2. Working with Advanced Analog and Digital Sensors
    a. Flex Sensor
    b. Wet measurement-Soil Moisture Sensor
    c. Sound Control
    d. Load Monitoring
3. Implement the following experiments using Arduino like IDE
    a. Temp and Humidity measurement
    b. Signal Variance - Potentiometer
    c. Fire alarm indication using Buzzer

4. Write Program for monitoring sensor values in real time using Arduino.
    a. IR Temperature sensor
    b. Gas leakage detection
    c. Smart Intrusion detection with SMS alert
5. Study the ESP8266 WIFI module and write program to transfer the data in the cloud.
    a. Light Control Monitoring
    b. Soil Condition Monitoring
    c. Human detection – PIR Sensor
6. Various applications using Raspberry Pi
    a. Stepper Motor
    b. Face recognition
    c. RFID
7. Experiments on Industrial IoT
    a. Smart AC Controller System
    b. Machine health monitoring
    c. Energy Meter monitoring for theft detection.
8. Develop smart application using Jetson controller
9. Mini projects in IoT
    a. Sensor Fabrication
    b. AI Thermometer
    c. Vehicle Density Calculation
    d. Smart AI pot hole detector
    e. Open ALPR license
    f. Fruit Classifier
    g. Autonomous mine detector
    h. Water Quality Management
    i. Defect identification stereo camera
    j. Home automation
    k. Smart health monitoring
    l. Smart agriculture
    m. Smart Pest Control using Drone
    n. Field surveillance using Drone

d. Activities

Students shall be exposed to develop simple hardware applications using Sensors, Actuators and Micro Controllers for real-time problems

e. Learning Resources

Reference Books

1. Michael Margolis & Arduino Cookbook, 2011, *Recipes to Begin, Expand, and Enhance Your Projects*, 2nd ed, O'Reilly Media

LIST OF LAB EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Arduino IDE, Third Party Cloud API like (Azure/ Think speak), Python 3 interpreter	30
	HARDWARE LIST	
1.	Arduino Boards	10
2.	Node MCU	10
3.	Raspberry PI 4	10
4.	Jetson GPU Board	10
5,	Drone Kit	3