Rajiv Gandhi ProudyogikiVishwavidyalaya Bhopal

M.Tech (IoT and Sensor System)

First Semester Syllabus

MTIN 101- IoT ARCHITECTURE AND PROTOCOLS

Unit I

IoT definition, Characteristics, IoT conceptual and architectural framework, Physical and logical design of IoT, IoT enablers, Modern day IoT applications, M2M communications, IoT vs M2M, IoT vs WoT, IoT reference architecture, IoT Network configurations, IoT LAN, IoT WAN, IoT Node, IoT Gateway, IoT Proxy

Unit II

Basics of IoT Networking, IoT Components, Functional components of IoT, IoT service oriented architecture, IoT challenges, 6LowPAN, IEEE 802.15.4, RFID Features, RFID working principle and applications, NFC (Near Field communication), Bluetooth, Wireless Sensor Networks and its Applications

Unit III

IoT Data Link Layer & Network Layer Protocols: PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,ZWave,Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

Unit IV

IoT Transport & Session Layer Protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, CoAP message types, CoAP Request-Response model, XMPP, AMQP, MQTT, MQTT methods and components, MQTT communication, topics and applications, SMQTT

Unit V

IoT Service Layer Protocols & Security Protocols: Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC802.15.4 , 6LoWPAN, RPL, Application Layer

IoT Platforms, Arduino, Raspberry Pi Board, Other IoT Platforms; Data Analytics for IoT, Cloud for IoT, Cloud storage models & communication APIs, IoT case studies

Reference Books:

1. Vijay Madisetti, ArshdeepBahga, “Ïnternet of Things, A Hands on Approach”, University Press
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, “Introduction to Internet of Things: A practical Approach”, ETI Labs
3. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press
4. Jeeva Jose, “Internet of Things”, Khanna Publishing House, Delhi
5. Adrian McEwen, “Designing the Internet of Things”, Wiley
6. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill
7. CunoPfister, “Getting Started with the Internet of Things”, O Reilly Media
8. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The EvolvingWorldof M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications ,2016
9. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2015
10. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”,ISBN 978-3-642- 19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016

Course Outcomes:

On successful completion of this course the students will be able to-

1. Understand the concepts of IoT Architecture
2. Apply knowledge of IoT Networking and its components to design IoT-based systems
3. Understand data link layer and network layer protocols ofIoT
4. Use the knowledge of IoT transport and session layer protocols in various applications of IoT
5. Design IoT-based systems for real-world problems

MTIN102- EMBEDDED SYSTEMAND MICROCONTROLLERS

Unit I

Fundamentals of Embedded System: Embedded systems vs General Computing systems, Classification, Applications, Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice. Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency. Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML

Unit II

8051 Microcontroller Basics: Microcontrollers Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM. 8051 Addressing Modes

UnitIII

Assembly programming and instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051. Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051. 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52

UnitIV

Interfacing: LCD interfacing, Keyboard interfacing. ADC, DAC and sensor interfacing**:** ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning. Motor control: Relay, PWM, DC and stepper motor: Relays and opt isolators, stepper motor interfacing, DC motor interfacing and PWM. 8051 interfacing with 8255: Programming the 8255, 8255 interfacing

UnitV

Introduction to PIC, AVR family of microprocessors & ARM processors:Introduction, Salient features and Architecture of 8 bit PIC and AVR microcontroller s and 32 bit ARM processor

Reference Books:

1. Ayala J.K., The 8051 Microcontroller: Architecture, programming and applications, Penram International (2005) 3rd ed.
2. Mazidi,E. and Mazidi,F., The 8051 Microcontroller and Embedded Systems, Prentice-Hall of India (2004) 2nd ed.
3. Peatman J., Embedded system Design using PIC18Fxxx, Prentice Hall, 2003.
4. Raj Kamal, "Microcontroller - Architecture Programming Interfacing and System Design" 2nd Edition, Pearson Education, 2011
5. Joseph Yiu," The Definitive Guide to the ARM Cortex-M3", Second Edition, Elsevier Inc. 2010.
6. Dr. K.V.K. Prasad, "Embedded / Real-Time Systems: Concepts, Design and Programming Black Book" , New ed (MISL-DT) Paperback – 12 Nov 2003
7. Ajay Deshmukh, "Microcontroller - Theory & Applications", Tata McGraw Hill, 2005 .
8. Shibu K.V, Introduction to embedded systems, Tata McGraw Hill

Course Outcomes:

On successful completion of this course the students will be able to-

1. Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
2. Understand the basics of Microcontrollers and describe the internal architecture of microcontroller systems, including counters, timers, ports, and memory.
3. Do programming for microcontrollers
4. Interface a microcontroller system to user controls and other electronic systems
5. Demonstrate knowledge of ARM and AVR microcontrollers

MTIN103- PRINCIPLES OF SENSORS AND SIGNAL CONDITIONING

UNIT I

Sensor Classification, Sensor Characteristics, Physical Principles of Sensing, Optical Components of Sensors
Interface Electronic Circuits: Signal Conditioners, Sensor Connections, Excitation Circuits, Analog-to-Digital Converters, Integrated Interfaces, Data Transmission, Noise in Sensors and Circuits, Batteries for Low-Power Sensors, Energy Harvesting

UNIT II

Sensor Materials and Technologies; Occupancy and Motion Detectors: Ultrasonic Detectors, Microwave Motion Detectors, Micropower Impulse Radars, Ground Penetrating Radars, Capacitive Occupancy Detectors, Triboelectric Detectors, Optoelectronic Motion Detectors, Sensor Structures, Visible and Near IR Light Motion Detectors, Far-Infrared Motion Detectors, Optical Presence Sensors, Pressure-Gradient Sensors, 2D Pointing Devices, Gesture Sensing, Tactile Sensors

UNIT III

Position, Displacement and Level: Potentiometric Sensors, Piezoresistive Sensors, Capacitive Sensors, Inductive and Magnetic Sensors, Optical Sensors, Thickness and Level Sensors
Velocity and Acceleration: Stationary Velocity Sensors, Inertial Rotary Sensors, Inertial Linear Sensors (Accelerometers)

UNIT IV

Force, Strain, and Tactile Sensors: Strain Gauges, Pressure-Sensitive Films, Piezoelectric Force Sensors, Piezoelectric Cables, Optical Force Sensors
Pressure Sensors: Concepts and units of pressure, Mercury Pressure Sensor, Bellows, Membranes, and Thin Plates, Piezoresistive Sensors, Capacitive Sensors, Optoelectronic Pressure Sensors, Indirect Pressure Sensor, and Vacuum Sensors
Flow Sensors: Basics of Flow Dynamics, Pressure Gradient Technique, Thermal Transport Sensors, Ultrasonic Sensors, Electromagnetic Sensors, Drag Force Sensors, Dust and Smoke Detectors,

UNIT V

Microphones: Microphone characteristics, Microphone Types
Humidity and Moisture Sensors: Concept of Humidity, Capacitive and Resistive humidity Sensors, Electrical Conductivity Sensors, Thermal Conductivity Sensor, Optical Hygrometer, Oscillating Hygrometer
Light Detectors: Image Sensors, UV Detectors, Thermal Radiation Detectors, Detectors of Ionizing Radiation, Temperature Sensors, Chemical and Biological Sensors

Reference Books:

1. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 5th edition, Springer, New York.
2. Jon. S. Wilson, “Sensor Technology Hand Book”, 1st edition, Elsevier, Netherland.

Course Outcomes:

On successful completion of this course the students will be able to-

1. Use concepts and common methods for converting a physical parameter into an electrical quantity
2. Know about the Sensor Materials and Technologies
3. Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc.
4. Evaluate performance characteristics of different types of sensors
5. Compete in the design, construction, and execution of systems for measuring physical quantities

MTIN104 - WIRELESS SENSOR NETWORKS

Unit I

Overview of Wireless Sensor Networks: Network Characteristics, Network Applications, Network Design Objectives, Network Design Challenges, Technological Background : MEMS Technology , Wireless Communication Technology , Hardware and Software Platforms, Wireless Sensor Network Standards, Introduction, Network Architectures for Wireless Sensor Networks, Classifications of Wireless Sensor Networks, Protocol Stack for Wireless Sensor Networks.

Unit II

Fundamental MAC Protocols, MAC Design for Wireless Sensor Networks, MAC Protocols for Wireless Sensor Networks: Contention-Based Protocols, Contention-Free Protocols, Hybrid Protocols. Introduction, Fundamentals and Challenges, Taxonomy of Routing and Data Dissemination Protocols, Overview of Routing and Data Dissemination Protocols: Location-Aided Protocols, Layered and In-Network Processing-Based Protocols, Data-Centric Protocols, Multipath-Based Protocols, Mobility-Based Protocols, QoS Based Protocols, Heterogeneity-Based Protocols.

Unit III

Wireless Sensor Network Architectures and Overview of Node Clustering Structures, Query Processing in Wireless Sensor Networks, Data Aggregation in Wireless Sensor Networks,Node Localization: Concepts and Challenges of Node Localization Technologies, Ranging Techniques for Wireless Sensor Networks, Wireless Localization Algorithms, Wireless Sensor Node Localization.

Unit IV

Need for Energy Efficiency and Power Control in Wireless Sensor Networks, Passive Power Conservation Mechanisms: Physical-Layer Power Conservation Mechanisms, MAC Layer Power Conservation Mechanisms, Higher Layer Power Conservation Mechanisms, and Active Power Conservation Mechanisms: MAC Layer Mechanisms, Network Layer Mechanisms, Transport Layer Mechanisms.

Unit V

Fundamentals of Network Security, Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security .

Reference Books:

1. Wireless Sensor Networks A Networking Perspective, Jun Zheng &Abbas Jamalipour, a john Wiley & sons, Inc., publication .
2. Wireless sensor networks Technology, Protocols, and Applications , kazemsohraby, danielminoli, taiebznati , a john Wiley & sons, Inc., publication .
3. Fundamentals of wirelesssensor networks theory and practice, WaltenegusDargie,Christian Poellabauer, A John Wiley and Sons, Ltd., Publication.

Course Outcomes:

On successful completion of this course the students will be able to-

1. Explain the basic concepts of wireless sensor networks, sensing, computing and communication tasks
2. Demonstrate knowledge of MAC protocols and routing protocols developed for WSN
3. Describe and explain radio standards and communication protocols adopted in wireless sensor networks
4. Be able to carry out simple analysis and planning of WSNs
5. To develop wireless sensor systems for different applications

MTIN 105[A] PYTHON FOR IoT

UNIT I

PythonConcepts, Data Structures, Classes, Interpreter – Program Execution – Statements – Expressions – Flow Controls – Functions - Numeric Types – Sequences - Strings, Tuples, Lists and - Class Definition – Constructors – Inheritance – Overloading – Text & Binary Files - Reading and Writing

UNIT II

Data Wrangling, Combining and Merging DataSets – Reshaping and Pivoting – Data Transformation – String Manipulation, RegularExpressions

UNIT III

Data Aggregation, Group Operations, Time series & Web Scrapping ,GoupBy Mechanics – Data Aggregation – GroupWise Operations and Transformations – Pivot Tables and CrossTabulations – Date and Time Date Type tools – Time Series Basics – Data Ranges, Frequencies and Shifting. Data Acquisition by Scraping web applications –Submitting a form - Fetching web pages – Downloading web pagesthrough form submission – CSS Selectors

UNIT IV

Visualization in Python ,Matplot lib package – Plotting Graphs – Controlling Graph – Adding Text – More Graph Types – Getting and setting values – Patches

UNIT V

Implementation using Raspberry Pi,Working with Raspberry Pi 3 Model - Installing OS and Designing Systems using Raspberry pi - Configuring Raspberry Pi for VNC Connection - Getting introduced to Linux OS Basic Linux commands and uses - Getting Started with Python - Interface sensor and Actuator with Raspberry Pi

Reference Books:

1. Mark Lutz, “Learning Python”, O'Reilly Media, 5th Edition,
2. White, “Hadoop: The Definitive Guide”, Third Edition - O’Reilly,
3. Brandon Rhodes and John Goerzen, “Foundations of Python Network Programming: The ComprehensiveGuide to Building Network Applications with Python”, Apress, Second Edition,

Course Outcomes:

On successful completion of this course the students will be able to-

1. Interpret the fundamental Python syntax and semantics and be fluent in the use of Python control flow statements.
2. Determine the methods to create and manipulate Python programs by utilizing the data structures like lists, dictionaries, tuples and sets.
3. Develop Python programs
4. Plot data using appropriate Python visualization libraries
5. Develop intelligent IoT devices using Python

MTIN 105[B]DATABASE MANAGEMENT SYSTEM

Unit I

Structure of relational databases, Relational Algebra, Functional Dependency, Different anomalies in designing a database., Normalization using functional dependencies, Lossless Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF

Unit II

Transaction processing, Concurrency control and Recovery management, Conflict and View serializability, Lock based protocols, Two phase locking

Unit III

Distributed DBMS features and needs. Reference architecture. Levels of distribution transparency, replication. Distributed database design - fragmentation, allocation criteria. Distributed deadlocks. Time based and quorum-based protocols. Comparison. Reliability- non-blocking commitment protocols

Unit IV

Partitioned networks, Checkpoints and cold starts, Management of distributed transactions- 2 phase unit protocols, Architectural aspects, Node and link failure recoveries, Distributed data dictionary management, Distributed database administration, Heterogeneous databases-federated database, reference architecture, loosely and tightly coupled

Unit V

Case Study of Oracle RDBMS and PostgreSQL

Reference Books:

1. Leon & Leon, Essentials of DBMS, McGraw Hill
2. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, McGraw Hill.
3. Saeed K. Rahimi, Frank S. Haug, “Distributed Database Management Systems: A Practical Approach”, Wiley

Course Outcomes:

On successful completion of this course the students will be able to-

1. Describe the fundamental elements of relational database management systems
2. Understand the principles of storage structure and recovery management
3. Explain the need for distributed database technology to tackle deficiencies of the centralized database systems
4. Understand transaction management, concurrency control techniques
5. Create a relational database schema

MTIN 105[C] ADVANCE DISTRIBUTED SYSTEMS

Unit I

Characterization of Distributed Systems:Introduction, Examples of Distributed Systems, Trends in Distributed Systems, Challenges, System Models, Interprocess Communication, Network Protocols, Naming, Remote Procedure Call, Remote Method Invocation, Models for Communication, Distributed File Systems

Unit II

Time in a Distributed System:Introduction, Logical Clocks, Vector Clocks, Events and Process States, Clock Synchronization, Algorithms for Internal and External Synchronization; Distributed Mutual Exclusion: Introduction, Solutions on Message Passing Systems, Token Passing Algorithms; Distributed Snapshot: Chandy-Lamport Algorithm; Distributed Debugging

Unit III

Global State Collection: Termination Detection Algorithms, Distributed Deadlock Detection; Coordination Algorithms: Introduction, Leader election, Bully Algorithm; Distributed Consensus: Introduction, Consensus in asynchronous and synchronous systems, Distributed Shared Memory

Unit IV

Transactions and Concurrency Control: Transactions, Locks, Optimistic Concurrency Control, Timestamp Ordering, Distributed Transactions, Flat and Nested Transactions, Atomic Commit Protocols, Concurrency Control and serializability in Distributed Systems, Transaction Recovery, Checkpointing and Rollback Recovery; Group Communication

Unit V

Architecture of replicated data management; Security in Distributed Systems:Security Mechanisms, Common Security Attacks, Encryption, Secret key and public key Cryptosystems, Hashing, Digital signature and Digital certificate, Authentication in Distributed Systems; Self Stabilizing Systems

Reference Books:

1. Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, Second Edition
2. A.D. Kshemkalyani, M. Singhal, Distributed Computing: Principles, Algorithms, and Systems, ISBN: 9780521189842, Cambridge University Press, March 2011.
3. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems Concepts and Design”, Fifth Edition, Pearson Education Asia, 2012
4. Gerard Tel. Introduction to Distributed Algorithms
5. Nancy A. Lynch. Distributed Algorithms

Course Outcomes:

On successful completion of this course the students will be able to-

1. Identify the advantages and challenges in designing distributed algorithms for different primitives like mutual exclusion, deadlock detection, agreement, etc.
2. Design and develop distributed programs using sockets and RPC/RMI
3. Analyze different algorithms and techniques for the design and development of distributed systems
4. Understand Distributed File Systems and Distributed Shared Memory
5. Understand the importance of security in distributed systems