SR UNIVERSITY, WARANGAL

BTECH (ECE-Internet of Things)

Alignment of SRU IoT Courses with ARM University Courses

S.No.	Year / Sem	SRU Course Name
1.	II-II	Introduction to IoT
2.	III-I	Microcontroller for Embedded System
3.	III-I	Microcontroller for Embedded System Lab
4.	III-II	Distributed IoT System
5.	III-II	Distributed IoT System Lab
6.	IV-I	Embedded Linux
7.	IV-I	VLSI Design and Technology
8.	IV-I	VLSI Design and Technology Lab
9.	III-I	Computer Organisation
10.	III-II (PE-2)	Cloud Computing
11.	III-II (PE-2)	Edge Computing
12.	III-II (PE-2)	Fog Computing
13.	III-II (PE-2)	IoT Wireless & Cloud Computing Emerging Technologies
14.	IV-I (PE-3)	Security in IoT
15.	IV-I (PE-3)	Cloud Security
16.	IV-I (PE-3)	Network Security
17.	IV-I (PE-3)	Applications of IoT & Multimedia Technology
18.	IV-I (PE-6)	Graphics And Mobile Gaming

INTRODUCTION TO IOT

Year /Sem: II-II

UNIT I

Introduction

What is IoT, Genesis of IoT, IoT and Digitization, IoT Architecture, IoT Impact, Convergence of IT and oT, IoT Challenges, IoT Network Architecture and Design, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

UNIT II

IoT Physical Devices #1:

System on chip Architechure Overview, Programming and Debugging, General Purpose Input output, Interrupts, Timers

UNIT III

IoT Physical Devices #2:

SoC Additional Interfaces - Analog to Digital Converter, Digital to Analog to Converter, Pulse Width Modulation. Implementation of SoC Addional interfaces using Sensors and Actuators

UNIT IV

IoT Device Networking #1

On-chip communications Protocols - USART, I2C, SPI. Industrial Networking - RS482 and MODBUS, Vechicle Networking Standards

UNIT V

IoT Device Networking #2

Wireless Interfaces - GPS, RF, Bluetooth, WIFI, LoRa, Implementing the wireless interfaces

TEXT BOOKS

1. IoT Fundamentals - Networking Technologies, Protocols and Use Cases for the Internet of Things (English, Paperback, Rowan Trollope, David Hanes, Patrick Grossetete, Jerome Henry, Rob Barton, Gonzalo Salgueiro)
2. Arshdeep Bahga and Vijay Madisetti, “Internet of Things – A Hands on Approach”,Universities Press, 2015.
3. Foundational Elements of an IoT Solutions: The Edge, The Cloud Application Development, Joe Biron and Jonathan Follett.

REFERENCE BOOKS

1. Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, ISBN: 978-1-4302-5740-0, 2013
2. Architecting the Internet of Things, by Dieter Uckelmann, Mark Harrison and Florian Michahelles, ISBN: 978-3-642-19157-2, 2011
3. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014

MICROCONTROLLER AND EMBEDDED SYSTEMS

Year /Sem: III-I

Course Outcomes (COs):

At the end of the course, the students will develop the ability to

- Understand the architectures of microcontrollers
- Describe the operation of timers
- Analyze communication protocols
- Comprehends the various real time operating systems
- Interface various devices with microcontrollers

UNIT I

Introduction

Introduction,8/16/32 bit microprocessors and controllers Microcontroller vs. Microprocessor.

CORTEX-M0+ Processor Core

Microcontroller vs. Microprocessor, Cortex-M0+ Core, Architectures and Memory Speed, Instruction Set, Modes for Addressing Memory, KL25Z GPIO Ports,

UNIT II

C Code as Implemented in Assembly Language

Programmer's World: The Land of Chocolate!, Processor's World, Program Translation Stages, Examining Assembly Code before Debugger, A Warning About Code Optimizations, Application Binary Interface, Using Registers - AAPCS Register Use Conventions, AAPCS Core Register, Memory requirements, accessing data in Memory

UNIT III

Interfacing Analog Interfacing

Analog to Digital conversion concepts, Digital to Analog Converter, Timers.

Serial Communication

Overview, Software Structure – Handling asynchronous Communication, Software Structure – Parsing Messages, KL25Z and Freedom Specifics, Asynchronous serial (UART) Communications, SPI Communications, I2C Communications, Protocol Comparison

UNIT IV

Interrupts

Exception and Interrupt Concepts - Example System with Interrupt, Example Program Requirements & Design, Example Exception Handler, Types of interrupts, Interrupt service routine (ISR).

UNIT V

Embedded Systems Design

Introduction, Options for Building Embedded Systems, Example Embedded System: Attributes of Embedded Systems, MCU Hardware & Software for Concurrency, , Impact of Constraints, Target Board - FRDM-KL25Z, CPU Scheduling, Scheduling Approaches, Event-Triggered Scheduling using Interrupts, Static Schedule Example, Dynamic Schedule, Common Schedulers

– (Cyclic executive - non-preemptive and static, Run-To-Completion Scheduler, Preemptive Scheduler) Task State and Scheduling Rules,

TEXTBOOKS

1. Embedded Systems Fundamentals on Arm Cortex-M based Microcontrollers: A Practical Approach by Alexander G. Dean
2. The Designer's Guide to the Cortex-M Processor Family: A Tutorial Approach by Trevor Martin
3. The Definitive Guide to the ARM Cortex-M0 by Joseph Yiu
4. The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors, Third Edition by Joseph Yiu

REFERENCES

1. Joseph Yiu, "The definitive guide to ARM Cortex-M3", Elsevier, 2nd Edition
2. VenkatramaniB. and Bhaskar M. "Digital Signal Processors: Architecture, Programming and Applications" , TMH , 2nd Edition
3. Sloss Andrew N, Symes Dominic, Wright Chris, "ARM System Developer's Guide: Designing and Optimizing", Morgan KaufmanPublication.
4. Steve furber, "ARM System-on-Chip Architecture", PearsonEducation
5. White Paper: Cortex-M for Beginners - An overview of the Arm Cortex-M processor family and comparison
6. Technical references and user manuals on www.arm.com, NXPSemiconductor www.nxp.com and Texas Instruments www.ti.com

MICROCONTROLLER AND EMBEDDED SYSTEM LAB

Year /Sem: III-I

Pre-requisite: Digital Electronics

The experiments are executed using FREEDOM KL 25Z boards

LIST OF EXPIREMENTS

CYCLE-I

1. Processing Text in Assembly Language
2. C as implemented in Assembly Lab Exercise
3. General Purpose I/O Lab Exercise: Basic User Interface,

CYCLE-II

4. ADC Lab Exercise: Voltage Monitor
5. DAC Lab Exercise: Signal Generator
6. Timer Lab Exercise: Signal Generator with Precision Timing and Buffering
7. Serial Communications Lab Exercise: Performance Analysis
8. Interrupt Lab Exercise: Stack Use and Timing Behavior

CASE STUDY:

Develop microcontroller based Embedded system

DISTRIBUTED IOT SYSTEMS

Year/Sem: III-II

UNIT I

Smart Objects

The "Things" in IoT, Sensors, Actuators, and Smart Objects, Hardware Communications Criteria (Ethernet, Wi-Fi, Bluetooth, Zigbee) M2M To IOT -M2M Vs IOT

UNIT II

Communication & Networking Technologies in IoT

Introduction Sensor Networks, Network Layer Model (OSI or TCP/IP), Network Topologies, Communication Models; Wired: RS232, RS485, CAN, Ethernet. Wireless: Bluetooth, WLAN, GPS, LoRa, Cellular.

UNIT III

IoT Gateway

Introduction Gateway, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M, Data Exchange Formats (JSON, XML), MQTT Protocol, HTTP REST, CoAP, XMPP and AMQP, Protocol Interoperability & Bridging, Data Aggregation using Gateway.

UNIT IV

Real-Time Operating System

Introduction, Real-Time Systems Concepts, Kernel Structure, Task Management, Semaphores, Mutual Exclusion (MUTEX), Message Mailbox, Message Queue, Memory Management, Porting RTOS.

UNIT V

Case Studies

Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture. IoT Wearables, Health care systems, Agri and Allied sectors.

TEXT BOOKS

1. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0 - by Giacomo Veneri and Antonio Capasso.
2. Mastering the FreeRTOS Real Time Kernel – a Hands On Tutorial Guide

REFERENCES

1. Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, ISBN: 978-1-4302-5740-0, 2013
2. Architecting the Internet of Things, by Dieter Uckelmann, Mark Harrison and Florian Michahelles, ISBN: 978-3-642-19157-2, 2011 Arduino Yun", Packt Publishing, 2014.
3. IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition by Perry Lea.

DISTRIBUTED IOT LAB

Year/Sem: III-II

List of Experiments

1. Understanding the Distributed System
2. IoT System - Thing, Gateway, Server/Cloud.
3. Working with Various Types of Sensors.
4. Wired protocols: RS232, RS485
5. Wireless protocols: Bluetooth, WLAN, GPS, LoRa, Celluar
6. IoT Gateway: Data Exchange Formats (JSON, XML).
7. MQTT Protocol
8. HTTP REST, CoAP
9. XMPP and AMQP
10. RTOS (Real-Time Operating System)

EMBEDDED LINUX

Year/Sem : IV-I

UNIT I

Linux System Programming

Linux Kernel Overview, Gnu Toolchain, Operating System Concepts, File Managment, Process Managment, Synchorinization, Interprocess Communication, Memory Management

UNIT II

Linux Device Drivers

Linux Kernal and Device Drivers Overview, Module Programming, Character Device Drivers, Concurrency and Race Conditions, Advanced Character Device Drivers, Communicating with Hardware, Interrupt Handling, Kernal Mechanisms, Network Device Drivers, Adding a Driver to the Kernel Tree.

UNIT III

Embedded Linux #1

Introduction to embedded Linux, Bootloaders, Linux Kernal, Root File System, Embedded Linux Build System

UNIT IV

Embedded Linux #2

Board Support Pakages, GPIO Driver, Communication Protocols, DMA Driver, Ethernet Driver, WIFI Driver, Bluetooth Driver, Embedded Linux Test and Trouble shooting

UNIT V

Software Development Life

Cycle SDLC Process and Importance, Open Source Development Systems, Source Code Version Control, Git Concepts and Architecture Repositories, Useful git commands, Bug Tracking and Fixing

TEXT BOOKS

1. Mastering Embedded Linux Programming - Paperback – Import, 30 June 2017 by Chris Simmonds
2. Mastering Linux Kernel Development: A kernel developer's reference manual Paperback – 1 January 2017 by Raghu Bharadwaj.

REFERENCES

1. Linux Kernel Development (Developer's Library) Paperback – Illustrated, 1 July 2010 by Robert Love (Author)

VLSI DESIGN AND TECHNOLOGY

Year/Sem : IV-I

Pre-requisite: Analog Electronics, Digital Electronics

Course Outcomes

At the end of the course, the students will develop ability to

- Estimate the characteristics of CMOS circuits.
- Optimization/ estimation of delay and power dissipation in the circuits.
- Develop the logic circuit for best critical path/ delays.
- Design and describe the data path circuits with proper clock distribution and wiring.

UNIT I

Introduction to CMOS

CMOS Logic, Fabrication & layout, Design partitioning, Ex. Microprocessor, CMOS transistor theory, CMOS characteristics, Non ideal effects, DC transfer characteristics.

UNIT II

Delay and power

Introduction, Transient response, RC delay model, linear delay model, logical efforts of paths, timing analysis of delay models. Dynamic power, static power, delay optimization.

UNIT III

Scaling and simulation

VLSI Design Flow, MOS layers, design rules, stick and layout diagrams for NMOS, PMOS and Reliability, scaling, simulation introduction, spice models, device models, device characterization, and circuit characterization.

UNIT IV

Combinational and sequential circuit design

Circuit families, silicon on insulator circuit design, sub threshold circuit design. Sequencing static circuits, flip flops, synchronizers.

UNIT V

Data path subsystem and testing

Adders, subtractors, counters, multipliers, SRAM, clocking, testing, packaging, I/O & power distribution.

TEXT BOOK

1. CMOS VLSI Design: A Circuits and Systems Perspective-Book by David Harris and Neil Weste
2. Digital Design and Computer Architecture-Book by David Harris

REFERENCE BOOK

1. Wayne Wolf, "Modern VLSI Design", Pearson education, 3rd edition. 1997.
2. Digital VLSI Chip Design with Cadence and Synopsys CAD Tools-Book by Erik Brunvand
3. Principles of CMOS VLSI Design, Neil H.E. Weste, K.Eshraghian, Pearson, 2009.
4. CMOS Digital Integrated Circuits Analysis and Design, Kang and Leblebici, McGraw-Hill

VLSI DESIGN AND TECHNOLOGY LAB

Year/Sem : IV-I

Design and implementation of the following Cadence/Mentor Graphics/ Synopsys/ GEDA/ Equivalent CAD tools. Draw the schematic, Layout and verify DC Analysis, AC Analysis and Transient Analysis.

Course Outcomes

At the end of coursework, the student will develop the ability to

- Construct layouts for CMOS inverter and universal gates.
- Simulate and verify the operation of logic blocks.
- Placing and routing the digital blocks.
- Assemble a chip from schematic, layout, and tape out in GDSII format.

List of experiments:

I. Cell Design and Verification

1. CMOS AND gate
2. CMOS OR gate
3. CMOS NOR gate
4. CMOS NAND gate
5. CMOS XOR gate
6. CMOS Multiplexer
7. CMOS fulladder
8. Pass transistor
9. Flip-Flop
10. Static / Dynamic logic circuit (register cell)
11. Multistage amplifiers
12. Operational amplifiers

II. Datapath Design and Verification

1. CMOS NOR gate
2. CMOS NAND gate
3. CMOS fulladder
4. Flip-Flop
5. Operational amplifiers

III. Controller Design and Verification

1. CMOS NOR gate
2. CMOS NAND gate
3. CMOS fulladder
4. Flip-Flop
5. Operational amplifiers

IV. Full Chip Assembly

1. CMOS NOR gate
2. CMOS NAND gate
3. CMOS fulladder
4. Flip-Flop
5. Operational amplifiers

COMPUTER ARCHITECTURE

Year/Sem : III-I

UNIT I

Fundamentals of Computer Design: Fundamentals of Computer design, Changing faces of computing and task of computer designer, Technology trends, Cost price and their trends, measuring and reporting performance, quantitative principles of computer design, Amdahl's law.

Instruction set principles and examples- Introduction, classifying instruction set- memory addressing- type and size of operands, operations in the instruction set.

UNIT II

Pipelines: Introduction, basic RISC instruction set, Simple implementation of RISC instruction set, Classic five stage pipe line for RISC processor, Basic performance issues in pipelining, Pipeline hazards, Reducing pipeline branch penalties.

Memory Hierarchy Design: Introduction, review of ABC of cache, Cache performance, Reducing cache miss penalty, Virtual memory.

UNIT III

Instruction Level Parallelism the Hardware Approach: Instruction-Level parallelism, Dynamic scheduling, Dynamic scheduling using Tomasulo's approach, Branch prediction, high performance instruction delivery- hardware based speculation.

UNIT IV

Multi Processors and Thread Level Parallelism: Multi Processors and Thread level Parallelism- Introduction, Characteristics of application domain, Systematic shared memory architecture, Distributed shared – memory architecture, Synchronization.

UNIT V

Inter Connection and Networks: Introduction, Interconnection network media, Practical issues in interconnecting networks, Examples of inter connection, Cluster, Designing of clusters.

TEXT BOOKS

1. John L. Hennessy, David A. Patterson, "Computer Architecture: A Quantitative Approach", 3rd Edition, Elsevier.
2. John P. Shen and Miikko H. Lipasti, "Modern Processor Design: Fundamentals of Super Scalar Processors", 2002, Beta Edition, McGraw-Hill

REFERENCES

1. Kai Hwang, Faye A.Brigs., "Computer Architecture and Parallel Processing", Mc Graw Hill.
2. Dezso Sima, Terence Fountain, Peter Kacsuk, "Advanced Computer Architecture - A Design Space Approach", Pearson Education.

CLOUD COMPUTING
(PE-II)

Year/Sem: III-II

UNIT I
Introduction to Cloud Computing
Introduction to Cloud Computing-Definition, Evolution of Cloud Computing, Characteristics, Components

UNIT II
Cloud Computing Services
Cloud provider, SAAS, PAAS, IAAS and other Organizational scenarios of clouds.

UNIT III
Cloud Administration and Management
Administering & Monitoring cloud services, benefits and limitations

UNIT IV
Cloud Deployment
Deploy application over cloud. Comparison among SAAS, PAAS, IAAS

UNIT V
Introduction to Open Source IoT Cloud Platforms
Introduction to IoT cloud platforms like Open Shift, Kaa etc.

TEXT BOOKS

1. Barrie Sosinsky ,"Cloud Computing Bible", Wiley-India, 1st Edition, 2011.
2. Toby Velte , Anthony Velte , Robert C. Elsenpeter, "Cloud Computing: A Practical Approach", Tata McGraw Hill, 1 st Edition, 2009.
3. Kumar Saurabh, ”Cloud Computing”, Wiley India, 1st Edition, 2016.

References:

1. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud”, O'reilly, 1 st Edition, 2009.
2. John W. Rittinghouse, James F. Ransome, “Cloud Computing Implementation, Management, and Security”, CRC Press, 1st Edition, 2009.

EDGE COMPUTING
(PE-II)

Year/Sem: III-II

UNIT I

IoT and Edge Computing Definition and Use Cases

Introduction to Edge Computing Scenario's and Use cases - Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M.

UNIT II

IoT Architecture and Core IoT Modules-A connected ecosystem,IoT versus machine-to-machine versus, SCADA, The value of a network and Metcalfe's and Beckstrom's laws, IoT and edge architecture, Role of an architect, Understanding Implementations with examples-Example use case and deployment, Case study – Telemedicine palliative care, Requirements, Implementation, Use case retrospective.

UNIT III

RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout and Pinouts, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi, Connecting Raspberry Pi via SSH, Remote access tools, Interfacing DHT Sensor with Pi, Pi as Webserver, Pi Camera, Image & Video Processing using Pi.

UNIT IV

Implementation of Microcomputer RaspberryPi and device Interfacing, Edge to Cloud Protocols-Protocols,MQTT, MQTT publish-subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats, MQTT 3.1.1 working example.

UNIT V

Edge computing with RaspberryPi, Industrial and Commercial IoT and Edge, Edge computing and solutions.

TEXT BOOKS

1. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806
2. Raspberry Pi Cookbook, 3rd Edition, by Simon Monk, Publisher: O'Reilly Media, Inc., 2019, ISBN: 978149204322.

REFERENCES

1. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama, wiley publication, 2019, ISBN: 9781119524984.
2. David Jensen, “Beginning Azure IoT **Edge Computing**: Extending the Cloud to the Intelligent **Edge**, MICROSOFT AZURE

FOG COMPUTING
(PE-II)

Year/Sem: III-II

UNIT I

Introduction to Fog Computing:

Fog Computing,Characteristics,ApplicationScenarios,Issues and challenges.

Fog Computing **Architecture:**Communication and Network Model, ProgrammingModels, FogArchitecture for smart cities, healthcare and vehicles.

Fog Computing Communication Technologies: Introduction ,IEEE 802.11,4G,5G standards,WPAN,Short-Range Technologies,LPWAN and other medium and Long-Range Technologies.

UNIT II

Management and Orchestration of Network Slices in 5G, Fog, Edge, and Clouds: Introduction, Background , Network Slicing in 5G , Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog , Middleware for Fog and Edge Computing, Need for Fog and Edge Computing Middleware, Clusters for Lightweight Edge Clouds , IoT Integration , Security Management for Edge Cloud Architectures.

Fog Computing Realization for Big Data Analytics : Introduction to Big Data Analytics, Data Analytics in the Fog, Prototypes and Evaluation.

UNIT III

Fog computing requirements when applied to IoT: Scalability,Interoperability,Fog-IoT architectural model, Challenges on IoT Stack Model via TCP/IP Architecture, DataManagement,filtering,EventManagement,DeviceManagement,cloudification,virualization, security and privacy issues.

Integrating IoT,Fog, Cloud Infrastructures: Methodology , Integrated C2F2T Literature by Modeling Technique re by Use-Case Scenarios , Integrated C2F2T Literature by Metrics.

UNIT IV

Exploiting Fog Computing in Health Monitoring : An Architecture of a Health Monitoring IoT-Based System with Fog Computing , Fog Computing Services in Smart E-Health Gateways, Discussion of Connected Components.

Fog Computing Model for Evolving Smart Transportation Applications: Introduction , Data-Driven Intelligent Transportation Systems , Fog Computing for Smart Transportation Applications Case Study: Intelligent Traffic Lights Management (ITLM) System

UNIT V

Software Defined Networking and application in Fog Computing: Open Flow Protocol, Open Flow Switch, SDN in Fog Computing, Home Network using SDN.

Security and Privacy issues: Trust and privacy issues in IoT Network, web Semantics and trust Management for Fog Computing, Machine Learning based security in Fog Computing, Cyber-Physical Energy Systems over Fog Computing.

TEXT BOOKS

1. Fog Computing: Theory and Practice by Assad Abbas, Samee U. Khan, Albert Y. Zomaya
2. Fog and Edge Computing: Principles and Paradigms (Wiley Series on Parallel and Distributed Computing) by RajkumarBuyya and Satish Narayana Srirama
3. Amir VahidDastjerdi and RajkumarBuyya, ―Fog Computing: Helping the Internet of Things Realize its Potential‖, University of Melbourne.
4. Sensors, Cloud, and Fog: The Enabling Technologies for the Internet of Things Paperback by SudipMisra , Subhadeep Sarkar , Subarna Chatterjee.
5. FlavioBonomi, Rodolfo Milito, PreethiNatarajan and Jiang Zhu, ―Fog Computing: A Platform for Internet of Things and Analytics‖, Big Data and Internet of Things: A Roadmap for Smart Environments, Studies in Computational Intelligence 546, DOI: 10.1007/978-3-319-05029-4_7, © Springer International Publishing Switzerland 2014.

REFERENCES

1. FlavioBonomi, Rodolfo Milito, Jiang Zhu, SateeshAddepalli, ―Fog Computing and Its Role in the Internet of Things‖, MCC'12, August 17, 2012, Helsinki, Finland. Copyright 2012 ACM 978- 1-4503-1519-7/12/08... $15.00.
2. Shanhe Yi, Cheng Li, Qun Li, ―A Survey of Fog Computing: Concepts, Applications and Issues‖, Mobidata'15, ACM 978-1-4503-3524-9/15/06, DOI: 10.1145/2757384.2757397, June 21, 2015, Hangzhou, China..
3. Amir M. Rahmani ,PasiLiljeberg, Preden, Axel Jantsch, ―Fog Computing in the Internet of Things - Intelligence at the Edge‖, Springer International Publishing, 2018.
4. Ivan Stojmenovic, Sheng Wen, "The Fog Computing Paradigm: Scenarios andSecurity Issues", Proceedings, Federated Conference on Computer Science and Information Systems, pp. 1–8, 2014.

IoT WIRELESS & CLOUD COMPUTING EMERGING TECHNOLOGIES
(PE-II)

Year/Sem: III-II

UNIT I
Introduction to IoT
What is IoT, Genesis of IoT, Understanding IoT Devices, IoT and Digitization, IoT Architecture, IoT Impact, Convergence of IT and IoT, IoT Challenges, Layers of IoT, Understanding IoT Components, IoT Network Architecture and Design, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

UNIT II
IoT Architecture & Technologies
IoT architecture layers, IoT sensors types, actuator types, and RFID types, IoT device platforms-Arduino, Raspberry Pi, and BeagleBoard.

UNIT III
Cloud Computing
Introduction to Cloud Computing-Definition, Characteristics, Components, Introduction to Microsoft Azure, Cloud provider, SAAS, PAAS, IAAS and other Organizational scenarios of clouds.

UNIT IV
IoT Networks
IoT network architecture, and wearable IoT networks, WLAN (Wireless Local Area Network), WPAN (Wireless Personal Area Network), and LPWAN (Low-Power Wide Area Network), WPAN (which include Bluetooth, ZigBee, 6LoWPAN, and IEEE 802.15.4 technology) and LPWAN (which include LoRa, UNB, Sigfox, and NB-IoT).

UNIT V
Wi-Fi & Bluetooth
Wi-Fi technology, EDR (Enhanced Data Rate), HS (High Speed), BLE (Bluetooth Low Energy), and Beacon technology, Bluetooth piconets and types of operations.

TEXT BOOKS

1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things – A Hands on Approach”,Universities Press, 2015.
2. Kevin,Townsend, Carles,Cufí, Akiba and RobertDavidson,"Getting Started with Bluetooth Low Energy” O'Reilly

REFERENCE BOOKS

1. Madhur Bhargava “IoT Projects with **Bluetooth Low Energy**, Packt Publishing, August 2017.
2. Robin Heydon ,”**Bluetooth Low Energy**: The Developer's Handbook”, Pearson, October 2012
3. Kumar Saurabh, ”Cloud Computing”, Wiley India, 1st Edition, 2016.

SECURITY IN IOT
(PE-III)

Year/Sem: IV-I

UNIT I
Introduction
Introduction to IoT Security – Vulnerabilities, Attacks and Countermeasures. Information Assurance. Attack types. New security threats and vulnerabilities. Fault Trees and CPS. Countermeasures to thwart attack. Threat Modeling.

UNIT II
Security Management & Cryptology- Security Controls - Authentication, Confidentiality, Integrity; Access Control, Key Management and Protocols, Cipher – Symmetric Key Algorithms, Public Private Key Cryptography; Attacks – Dictionary and Brute Force, Lookup Tables, Reverse Look Tables, Rainbow Tables, Hashing – MDS, SHA256. SHA 512, Ripe MD, WI, Data Mining

UNIT III
Attack Surface and Threat Assessment – Embedded Devices – UART, SPI, I2C, JTAG, Attacks – Software and cloud components, Firmware devices, Web and Mobile Applications.

UNIT IV
IoT Protocol Built-in Security Features – Transport Layer, SSL/TLS and DTLS, Kerberos, Cloud security for IoT

UNIT V
Case Studies and Discussion: Smart Agriculture, Cities, Grid, Healthcare, Homes, Supply Chain, and Transportation, Application of Security Concepts to Create IoT system.

TEXT BOOKS

1. Practical Internet of Things Security, Brian Russell & Drew Van Duren – 2016
2. Security and the IoT ecosystem, KPMG International, 2015

REFERENCES

1. Internet of Things: Privacy & Security in a Connected World, Federal Trade Comission, 2015
2. Internet of Things: IoT Governance, Privacy and Security Issues by European Research Cluster

CLOUD SECURITY
(PE-III)

Year/Sem: IV-I

UNIT I
Security Concepts
Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defense in depth, least privilege, how these concepts apply in the cloud, what these concepts mean and their importance in PaaS, IaaS and SaaS. e.g. User authentication in the cloud; Cryptographic Systems- Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL.

UNIT II
Multi-Tenancy Issues
Isolation of users/VMs from each other. How the cloud provider can provide this; Virtualization System Security Issues- e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup and recovery; Virtualization System Vulnerabilities- Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware (botnets etc).

UNIT III
Virtualization System-Specific Attacks
Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyper jacking.

UNIT IV
Technologies For Virtualization-Based Security Enhancement
IBM security virtual server protection, virtualization-based sandboxing; Storage Security- HIDPS, log management, Data Loss Prevention. Location of the Perimeter.

UNIT V
Legal and Compliance Issues
Responsibility, ownership of data, right to penetration test, local law where data is held, examination of modern Security Standards (eg PCIDSS), how standards deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.
PRACTICAL - (30 Hours)

TEXT BOOKS

1. Tim Mather, Subra Kumaraswamy, ShahedLatif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance” O'Reilly Media; 1 edition [ISBN: 0596802765], 2009.
2. Ronald L. Krutz, Russell Dean Vines, “Cloud Security” [ISBN: 0470589876], 2010.

REFERENCES

1. John Rittinghouse, James Ransome, “Cloud Computing” CRC Press; 1 edition [ISBN: 1439806802], 2009.
2. J.R. ("Vic") Winkler, “Securing the Cloud” Syngress [ISBN: 1597495921] 2011.

NETWORK SECURITY
(PE-III)

Year/Sem: IV-I

UNIT I

Model of network security – Security attacks, services and attacks – OSI security architecture – Classical encryption techniques – SDES – Block cipher Principles- DES – Strength of DES – Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – RC4 - Differential and linear cryptanalysis – Placement of encryption function – traffic confidentiality

UNIT II

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA - HMAC – CMAC - Digital signature and authentication protocols – DSS.

Authentication services - E-mail security (Pretty Good Privacy (PGP) and S/MIME).

IP security - IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.

Web security- Web Security Requirements, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET).

UNIT III

Introduction to IoT Security – Vulnerabilities, Attacks and Counter measures .Information Assurance. Attack types. New security threats and vulnerabilities. Fault Trees and CPS. Counter measures to thwart attack. Threat Modelling.

UNIT IV

Security Management & Cryptology - Security Controls - Authentication, Confidentiality, Integrity; Access Control, Key Management and Protocols, Cipher – Symmetric Key Algorithms, Public Private Key Cryptography; Attacks – Dictionary and Brute Force, Lookup Tables, Reverse Look Tables, Rainbow Tables, Hashing – MDS, SHA256. SHA 512, Ripe MD, WI, Data Mining

UNIT V

Attack Surface and Threat Assessment – Embedded Devices – UART, SPI, I2C, JTAG, Attacks – Software and cloud components, Firmware devices, Web and Mobile Applications.

TEXT BOOKS

1. William Stallings, “Cryptography & Network Security”, Pearson Education, 4th Edition, 2010.
2. Security and the IoT ecosystem, KPMG International, 2015

REFERENCE:

1. Charlie Kaufman, Radia Perlman, Mike Speciner, “Network Security, Private communication in public world”, PHI, 2nd edition, 2002.
2. Bruce Schneier, Neils Ferguson, “Practical Cryptography”, Wiley Dreamtech India Pvt Ltd, 2003. Douglas R Simson “Cryptography – Theory and practice”, CRC Press, 1995.

3. William Stallings and Lawrie Brown, “Computer Security: Principles and Practice”, PHI, 2008
4. Practical Internet of Things Security, Brian Russell & Drew Van Duren – 2016
5. Internet of Things: Privacy & Security in a Connected World, Federal Trade Comission, 2015
6. “Internet of Things: IoT Governance, Privacy and Security Issues” by European Research Cluster

APPLICATIONS OF IoT & MULTIMEDIA TECHNOLOGY
(PE-III)

Year/Sem: IV-I

UNIT I
Fundamentals of IoT
Introduction to Internet of Things- The Internet of Things Today, Towards the IoT Universe, Internet of Things Vision, IoT Concepts, IoT Standards, Components of IoT System, Domain Specific IoTs - IoT Applications - Home, Cities, Environment, Energy Systems, Retail, Logistics, Industry, Agriculture, Health and Life style.

UNIT II
IoT Design Methodology
IoT systems management – IoT Design Methodology - Internet of Things Use cases and Examples – Specification Integration and Application Development.

UNIT III
Building IoT With Microcontroller
Various Real time applications of IoT – Connecting IoT to cloud – CLOUD STORAGE FOR IOT – Data Analytics for IoT – Software & Management Tools for IoT, Multimedia Technology and Industrial IoT Implementations.

UNIT IV
Introduction to IoT Security – Vulnerabilities, Attacks and Counter measures. Information Assurance. Attack types. New security threats and vulnerabilities. Fault Trees and CPS. Counter measures to thwart attack. Threat Modelling.

UNIT V
Case Studies and Advanced Topics
Case Study on: Home, Cities, Environment, Energy Systems, Retail, Logistics, Industry, Agriculture, Health and Life style.
Project: Smart-home Industrial IoT Implementation.

TEXT BOOK

1. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, by David Hanes, Gonzalo Salgueiro, Rob Barton, 2017,ISBN: 9780134307091.
2. Internet of Things, by Mayur Ramgir, Publisher: Pearson Education India, 2019.

REFERENCES

1. Arshdeep Bahga, Vijay Madishetti, “Internet of Things – A hands – on approach”, Universities Press, 2015.
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O’Relly (SPD), 2014, ISBN:9789350239759.
3. Manoel Carlos Ramon, “Intel Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014.

4. Marco Schwartz, “Internet Of Things With The Arduino Yun”, Packt Publising, 2014.
5. Hands-On Industrial Internet of Things, by Giacomo Veneri, Antonio Capasso, Publisher: Packt Publishing, 2018, ISBN: 9781789537222
6. Smarter Homes: How Technology Will Change Your Home Life, by Alexandra Deschamps-Sonsino, Publisher: Apress, 2018, ISBN: 9781484233634

GRAPHICS AND MOBILE GAMING
(PE-VI)

Pre-requisite: Basic understanding of C++/Java programming

Course Outcomes

At the end of the course, the students will develop ability to

- Mali GPU architecture
- Core OpenGL ES rendering techniques
- Game design methodology
- Ability to create computer graphics on mobile devices using OpenGL ES
- Ability to create 3D games from scratch using commercial game design engines

UNIT I

Introduction to Graphics and Mobile Gaming

Graphic processor, GPU pipeline, representation of a 3D scene on a flat surface, Installing the tools, initializing OpenGL, creating a renderer class, Introducing the OpenGL pipeline-vertex shader, fragment shader, GPU – generations, Architecture and features. Comparison of GPU with CPU, Mali GPU, tessellation in computer graphics, geometry processing, rendering methods.

UNIT II

Introduction to Graphics API and OpenGL ES

OpenGL vs Open GL ES, OpenGL ES versions, OpenGL vs Direct3D,Rendering Pipeline and Shader Programming-fixed vs programmable rendering, pipeline shaders, programming of shaders in OpenGL ES, clipspace, rasterization, test and blending, varying variable, uniforms, textures, attributes vs uniforms.

UNIT III

3D Graphics and Matrix Manipulation

Matrices, translation using matrix, scaling, adding rotation, Adding detail with textures-understanding textures, loading textures into OpenGL, creating a new set of shaders, creating a new class structure for our vertex data, adding classes for our shader programs, drawing our texture, UV mapping, lighting up the world –simulating of light, implementing a directional light with Lambertian reflectance, adding point lights, Performance Optimization Techniques for graph processing.

UNIT IV

Introduction to Mobile Gaming

History of video games, video game engines, coding languages for game development, Game Graphics- Color cells, NTSC, artifact coloring and television interface adapters driven graphics-for generating color, composing video games in 2D and 3D, computer graphic mapping techniques for video games.

UNIT V

Video Game Design

Role playing games, sports games, racing games, fighting games, FPS games, five phases of software development process, iterative prototyping method, key components of game and game loop, features of unity 3D scenes, 3D Effects-animation techniques, particle effects, shader effect, camera model, simulation (rigid and soft body), Virtual Reality (VR)-concepts, VR vs augmented reality, phone based products, stereoscopic rendering, eye tracking, multiview rendering, multisampling and clock locking.

TEXT BOOKS

1. OpenGL ES 2 for Android: A Quick-Start Guide (Pragmatic Programmers) by Kevin Brothaler.
2. Game Design Theory by Keith Burgun.

REFERENCES

1. Performance Optimization Techniques and Tools for Distributed Graph Processing VASILIKI KALAVRI