SRM
UNIVERSITY
(Under section 3 of UGC Act 1956)

M.TECH. (FULL TIME)
INTERNET OF THINGS
CURRICULUM AND SYLLABUS

2017 – 2018

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
FACULTY OF ENGINEERING AND TECHNOLOGY
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
M.Tech – INTERNET OF THINGS
CURRICULUM – 2017-18

COURSE CODE	COURSE NAME	L	T	P	C
SEMESTER I					
CS2034	Wireless Sensor Protocols and Programming	3	0	2	4
CS2041	Computer Networks and Management	4	0	0	4
CS2042	Embedded System Design and Architecture	4	0	0	4
CAC2001	Career Advancement Course for Engineers-I	1	0	1	1
	Program Elective-I	3	0	0	3
	Program Elective-II	3	0	0	3
TOTAL		**18**	**0**	**3**	**19**
Total Contact Hours: 21					
SEMESTER II					
CS2043	Embedded Systems and Real Time Operating System	4	0	0	4
CS2044	IoT Architecture and Protocols	4	0	0	4
CS2045	Cloud Architecture and Computing	3	0	2	4
CAC2002	Career Advancement Course for Engineers-II	1	0	1	1
	Program Elective-III	3	0	0	3
	Program Elective-IV	3	0	0	3
TOTAL		**18**	**0**	**3**	**19**
Total Contact Hours: 21					
SEMESTER III					
	Program Elective-V	3	0	0	3
	Program Elective-VI	3	0	0	3
CAC2003	Career Advancement Course for Engineers-III	1	0	1	1
CS2047	Seminar	0	0	2	1
CS2049	**Project Phase I**	0	0	12	6
TOTAL		**7**	**0**	**15**	**14**
Total Contact Hours: 22					
SEMESTER IV					
CS2050	**Project Phase II**	0	0	32	**16**
Semester I-III					
	Supportive course (1 course of 3 credits in I or II or III sem.)	3	0	0	3

	Interdisciplinary Elective (1course of 3 credits in I or II or III sem.)	3	0	0	3
TOTAL		**6**	**0**	**0**	**6**
	TOTAL CREDITS	**74**			

Total credits to be earned for the award of M.Tech degree – 74 credits

PROGRAM ELECTIVES

Course Code	Name of the course	L	T	P	C
CS2151	Cooperative Communication Systems	3	0	0	3
CS2152	Big Data Analytics for IoT	3	0	0	3
CS2153	Privacy and Security in IoT	3	0	0	3
CS2154	Internet of Things: Sensing and Actuator Devices	3	0	0	3
CS2139	Smart Convergent Technologies	3	0	0	3
CS2155	RFID and Microcontrollers	3	0	0	3
CS2145	Fog Computing	3	0	0	3
CS2156	Wearable Computing, Mixed Reality and Internet of Everything	3	0	0	3
CS2157	Programming and Interfacing with Microcontrollers	3	0	0	3
CS2158	SDN and NFV for IOT	3	0	0	3
CS2159	Advanced Distributed Systems	3	0	0	3
CS2160	Software Architecture and Interoperability	3	0	0	3
CS2161	Energy Harvesting Technologies and Power Management for IoT Devices	3	0	0	3
CS2162	Cloud Storage and Computing	3	0	0	3
CS2163	Kernel and Driver Programming	3	0	0	3
CS2164	Design And Testing Of Digital Systems	3	0	0	3
EM2107	Embedded Control Systems	3	0	0	3

SUPPORTIVE COURSES

Course Code	Name of the course	L	T	P	C
MA2013	Mathematical Foundations of Computer Science	3	0	0	3
MA2010	Graph Theory and Optimization Techniques	3	0	0	3
MA2011	Stochastic Processes and Queueing Theory	3	0	0	3

NOTE:

Students have to register for the courses as per the following guidelines:

Sl. No.	Category	Credits				
		I Semester	II Semester	III Semester	IV Semester	Category total
1	Core courses	12 (3 courses)	12 (3 courses)	---	---	24
2	Program Elective courses	18 (in I to III semesters)			---	18
3	Interdisciplinary elective courses (any one program elective from other programs)	3 (One course to be taken in Semester I or II or III)				3
4	Supportive courses - mandatory	3 (One course to be taken in Semester I or II or III)			---	3
5	Career Advancement courses	1	1	1		3
6	Seminar	---	---	1	---	1
7	Project work	---	---	06	16	22
	Total					74

Legend:

L - Number of lecture hours per week
T - Number of tutorial hours per week
P - Number of practical hours per week
C - Number of credits for the course

SEMESTER I

CS2034	**WIRELESS SENSOR PROTOCOLS AND PROGRAMMING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 75	3	0	2	4
	Prerequisite: Nil				
	Nil				
PURPOSE	This course provides a broad coverage of challenges and research issues to the design and management of wireless sensor networks				

INSTRUCTIONAL OBJECTIVES	
1.	Understand basic sensor network concepts
2.	Know physical layer issues, understand and analyze Medium Access Control Protocols
3.	Comprehend network and transport layer characteristics and protocols and implement conventional protocols
4.	Understand the network management and Middleware services

UNIT I – FUNDAMENTALS OF SENSOR NETWORKS **15 hours**

Introduction to computer and wireless sensor networks and Overview of the syllabus-Motivation for a network of Wireless Sensor nodes- Sensing and sensors-challenges and constraints - node architecture-sensing subsystem, processor subsystem-communication interfaces- prototypes, Application of Wireless sensors- Introduction of Tiny OS Programming and TOSSIM Simulator.

UNITII- COMMUNICATION CHARACTERISTICS AND DEPLOYMENT MECHANISMS **15 hours**

Wireless Transmission Technology and systems-Radio Technology Primer-Available Wireless Technologies - Hardware- Telosb, Micaz motes- Time Synchronization-Clock and the Synchronization Problem - Basics of time synchronization-Time synchronization protocols - Localization- Ranging Techniques- Range based Localization-Range Free Localization- Event driven Localization

UNIT III- MAC LAYER **15 hours**

Overview-Wireless Mac Protocols-Characteristics of MAC protocols in Sensor networks – Contention free MAC Protocols- characteristics- Traffic Adaptive Medium Access-Y-MAC, Low energy Adaptive Clustering - Contention based MAC Protocols-Power Aware Multi-Access with signaling, Sensor MAC-Timeout MAC-Data gathering MAC- Case study –Implementation and Analysis of MAC player protocol in TinyOS.

UNIT IV- ROUTING IN WIRELESS SENSOR NETWORKS **15 hours**

Design Issues in WSN routing- Data Dissemination and Gathering-Routing Challenges in WSN - Flooding-Flat Based Routing – SAR, Directed Diffusion, Hierarchical Routing- LEACH, PEGASIS - Query Based Routing- Negotiation Based Routing-

Geographical Based Routing- Transport layer- Transport protocol Design issues- Performance of Transport Control Protocols.Case study- Implementation and analysis of Routing protocol or transport layer protocol in Tiny OS

UNIT V - MIDDLEWARE AND SECURITY ISSUES **15 Hours**

WSN middleware principles-Middleware architecture-Existing middleware - operating systems for wireless sensor networks-performance and traffic management - Fundamentals of network security-challenges and attacks - Protocols and mechanisms for security. Case study- Handling attacks in Tiny OS

REFERENCES

1. Waltenegus Dargie, Christian Poellabauer , "Fundamentals of Wireless Sensor Networks, Theory and Practice", Wiley Series on wireless Communication and Mobile Computing, 2011
2. Kazem Sohraby, Daniel manoli , "Wireless Sensor networks- Technology, Protocols and Applications", Wiley InterScience Publications 2010.
3. Bhaskar Krishnamachari , " Networking Wireless Sensors", Cambridge University Press, 2005
4. C.S Raghavendra, Krishna M.Sivalingam, Taiebznati , "Wireless Sensor Networks", Springer Science 2004.

CS2041	**COMPUTER NETWORKS AND MANAGEMENT**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	4	0	0	4
	Prerequisite				
	Nil				
PURPOSE	This course gives an overview of Computer Networks and different aspects of network management and tools.				

INSTRUCTIONAL OBJECTIVES	
1.	To study the different kinds of network.
2.	Effects of congestion and congestion control in networks
3.	Learn the different approaches to support the provision of Quality of service
4.	To study about SNMP application and network management tools.

UNIT I -COMPUTER NETWORKS AND INTERNET 12 hours

Internet - The network edge- The network core- Delay , Loss and Throughput in packet switched networks- protocol layers and their service models- TCP/IP protocol architecture- Frame relay networks- ATM networks- protocol architecture- ATM logical connections- ATM cell.

UNIT II - CONGESTION CONTROL IN DATA NETWORKS AND INTERNET 12 hours

Effects of congestion - Congestion control - Traffic management - Congestion control in packet switching networks - Frame relay- Congestion control -TCP flow control and TCP congestion control.

UNIT III - QUALITY OF SERVICE IN IP NETWORKS 12 hours

Integrated services architecture - Queuing discipline- Random early detection - Differentiated service - Resource reservation -RSVP- multiprotocol label switching- Real time transport protocol.

UNIT IV - NETWORK MANAGEMENT 12 hours

Network management - architecture and organization- network management perspectives-NMS platform- SNMPv3 - architecture- applications- Management information base- Remote monitoring- RMON1 - RMON2.

UNIT V- NETWORK MANAGEMENT TOOLS, SYSTEMS AND ENGINEERING 12 hours

System utilities for Management - Network statistics measurement systems- NMS design- Network management systems- Configuration management - fault management - fault management- performance management .

REFERENCES

1. William Stallings, "Computer Networking with Internet protocols and Technology", Pearson Education, 6th printing 2011.
2. Mani Subramanian, " Network Management" Principles and Practice, Pearson education, second edition,2012.
3. William Stallings, " High speed networks and Internet ", Pearson Education, second edition 2012.

CS2042	**EMBEDDED SYSTEM DESIGN AND ARCHITECTURE**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	4	0	0	4
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to impart the concepts and architecture of Embedded systems and to make the students capable of designing Embedded systems.				

INSTRUCTIONAL OBJECTIVES	
1.	To understand the Embedded concepts and Embedded systemArchitecture
2.	To learn the architecture and programming of ARM Cortex Microcontroller
3.	To select a proper Microcontroller for an application
4.	To understand the usage of the development and debugging tools
5.	To learn and apply the knowledge of Memory systems and Peripherals

UNIT I – INTRODUCTION TO EMBEDDED CONCEPTS **12 hours**

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems, Hardware architecture, Software architecture, Application Software, Communication Software.

UNIT II – OVERVIEW OF ARM AND CORTEX-M3 **12 hours**

Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture. Cortex-M3 Basics: Registers, General Purpose Registers, StackPointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. Cortex-M3Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions.Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus. Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus

UNIT III – CORTEX EXCEPTION HANDLING AND INTERRUPTS **12 hours**

Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, Supervisor Call and Pendable Service Call. NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts and SYSTICK Timer. Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals and Interrupt Latency.

UNIT IV – CORTEX-M3/M4 PROGRAMMING **12 hours**

Cortex-M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. Exception Programming: Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation. Memory Protection Unit and other Cortex-M3 features: MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication.

UNIT V – CORTEX-M3/M4 DEVELOPMENT AND DEBUGGING TOOLS 12 hours

STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART. Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc.

REFERENCES

1. Joseph Yiu," The Definitive Guide to the ARM Cortex-M3", Second Edition, Elsevier Inc. 2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier Publications,2006
3. Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education, India ISBN: 9788131708408, 8131708403 , 2015
4. Dr. K.V.K. Prasad, "Embedded / Real-Time Systems: Concepts, Design and Programming Black Book" , New ed (MISL-DT) Paperback – 12 Nov 2003
5. David Seal "ARM Architecture Reference Manual", Addison Wesley, England; Morgan Kaufmann Publishers,2001
6. Ajay Deshmukh, "Microcontroller - Theory & Applications", Tata McGraw Hill, 2005
7. Arnold. S. Berger, "Embedded Systems Design - An introduction to Processes, Tools and Techniques", Easwer Press, 2001
8. Raj Kamal, "Microcontroller - Architecture Programming Interfacing and System Design" 2nd Edition, Pearson Education, 2011
9. Cortex-M series-ARM Reference Manual
10. Cortex-M3 Technical Reference Manual (TRM)
11. STM32L152xx ARM Cortex M3 Microcontroller Reference Manual 5/97
12. ARM Company Ltd. "ARM Architecture Reference Manual– ARM DDI 0100E"
13. ARM v7-M Architecture Reference Manual (ARM v7-M ARM).

	ELECTIVE - I	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
Students to choose one Elective course from the list of courses mentioned in the curriculum					

	ELECTIVE - II	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
Students to choose one Elective course from the list of courses mentioned in the curriculum					

	SUPPORTIVE COURSE	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
Students to choose one course from the list of supportive courses mentioned in the curriculum either in I, II or III semester					

		L	T	P	C
	INTER DISCIPLINARY ELECTIVE	3	0	0	3
	Total Contact Hours - 45				
Students to choose one Elective course from the list of Post Graduate courses specified under the Faculty of Engineering and Technology other than courses under M.Tech (CSE), M.Tech (IOT), M.Tech (SDN), M.Tech(Mobile and Pervasive Computing) curriculum either in I, II or III semester					

SEMESTER II

CS2043	**EMBEDDED SYSTEMS AND REAL TIME OPERATING SYSTEM**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	4	0	0	4
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to provide understanding of the techniques essential to the design and implementation of device drivers and kernel internals of embedded operating systems				

INSTRUCTIONAL OBJECTIVES	
1.	To understand the aspects of Real Time Embedded concepts
2.	To learn the Essentials of Open Source RTOS and their usage
3.	To select the proper technique to design a Real-Time System
4.	To understand VxWorks RTOS and real time application programming with it
5.	To build the device driver and kernel internal for Embedded OS and RTOSearn and apply the knowledge of Memory systems

UNIT I - EMBEDDED OS INTERNALS **12 hours**

Linux internals: Process Management, File Management, Memory Management, I/O Management. Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication – Semaphore, Pipes, FIFO, Shared Memory Kernel: Structure, Kernel Module Programming Schedulers and types of scheduling. Interfacing: Serial, Parallel Interrupt Handling Linux Device Drivers: Character, USB, Block & Network.

UNIT II - OPEN SOURCE RTOS **12 hours**

Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management, File systems, I/O Systems, Advantage and disadvantage of RTOS. POSIX standards, RTOS Issues – Selecting a Real-Time Operating System, RTOS comparative study.

UNIT III – REAL TIME KERNEL BASICS **12 hours**

Converting a normal Linux kernel to real time kernel, Xenomai basics. Overview of Open source RTOS for Embedded systems (Free RTOS/ ChibiosRT) and application development. Real Time Operating Systems: Event based, process based and graph based models, Petrinet models. Real time languages, real time kernel, OS tasks, task states, task scheduling, interrupt processing, clocking, communication and

Synchronization. Control blocks, memory requirements and control, kernel services, basic design using RTOS.

UNIT IV – VXWORKS / FREE RTOS **12 hours**

VxWorks/ Free RTOS Scheduling and Task Management – Realtime scheduling, Task Creation, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts I/O Systems – General Architecture, Device Driver Studies, Driver Module explanation, Implementation of Device Driver for a peripheral.

UNIT V – CASE STUDY **12 hours**

Software Development and Tools: Simulators, debuggers, cross compilers, in circuit emulators for the microcontrollers. Interface Issues Related to Embedded Systems: A/D, D/A converters, FPGA, ASIC, diagnostic port. Cross compilers, debugging Techniques, Creation of binaries & porting stages for Embedded Development board (Beagle Bone Black, Rpi or similar), Porting an Embedded OS/ RTOS to a target board ().Testing a real-time application on the board.

REFERENCES

1. VenkateswaranSreekrishnan," Essential Linux Device Drivers" , Ist Kindle edition, Prentice Hall, 2008
2. Jerry Cooperstein , "Writing Linux Device Drivers: A Guide with Exercises", J. Cooperstein publishers ,2009
3. Qing Li and CarolynYao,"3Real Time Concepts for Embedded Systems – Qing Li, Elsevier ISBN:1578201241 CMP Books © 2003
4. Raj Kamal," Embedded Systems Architecture Programming and Design":, Tata McGraw Hill, 2011
5. KVK Prasad, "Embedded/Real Time Systems Concepts, Design and Programming Black Book", , Wiley India 2003
6. Seppo J. Ovaska Phillip A. Laplante,"Real-Time Systems Design and Analysis:Tools for the Practitioner", 4ed Paperback – 17 May 2013
7. Ward, Paul T & Mellor, Stephen," Structured Development for Real - Time Systems v1, v2,V3 : Implementation ModelingTechniques " Prentice hall, 2015
8. David E. Simon, ".Embedded Software Primer": Addison-Wesley Professional , 2000

CS2044	**IoT ARCHITECTURE AND PROTOCOLS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	4	0	0	4
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to impart knowledge on IoT Architecture and various protocols, study their implementations				
INSTRUCTIONAL OBJECTIVES					
1.	To Understand the Architectural Overview of IoT				
2.	To Understand the IoT Reference Architecture and RealWorld Design Constraints				
3.	To Understand the various IoT Protocols (Datalink, Network, Transport, Session, Service)				

UNIT I – OVERVIEW **12 hours**

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management

UNIT II – REFERENCE ARCHITECTURE **12 hours**

IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

UNIT III – IOT DATA LINK LAYER & NETWORK LAYER PROTOCOLS **12 hours**

PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), WirelessHART,Z-Wave,Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

UNIT IV – TRANSPORT & SESSION LAYER PROTOCOLS **12 hours**

Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

UNIT V – SERVICE LAYER PROTOCOLS & SECURITY **12 hours**

Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer

REFERENCES

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, **"**From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence**",** 1st Edition, Academic Press, 2014.
2. Peter Waher**, "**Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI
3. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
5. Vijay Madisetti and ArshdeepBahga, **"**Internet of Things (A Hands-on-Approach)**",** 1st Edition, VPT, 2014.
6. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

CS2045	**CLOUD ARCHITECTURE AND COMPUTING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 75	3	0	2	4
	Prerequisite				
	Nil				
PURPOSE	To learn the advanced software engineering principles and methodologies for effective Software tools and development				
INSTRUCTIONAL OBJECTIVES					
1.	To understand the differences between traditional deployment and cloud computing				
2.	To determine whether existing applications to the cloud makes technical and business sense				
3.	To analyze and compare the long-term costs of cloud services				
4.	To learn how to build a transactional web application for the cloud or migrate one to it				
5.	Change your perspective on application scaling in cloud environment for qualitymetrics				

UNIT I – CLOUD ARCHITECTURE BASICS 15 hours

The Cloud -Hype cycle-metaphorical interpretation-cloud architecture standards and interoperability- Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public, private clouds community cloud, role of virtualization in enabling the cloud.

UNIT II – END TO END DESIGN 15 hours

Requirement analysis: strategic alignment and architecture development cycle-strategic impact-Risk impact-financial impact-Business criteria-technical criteria-cloud opportunities –evaluation criteria and weight-End to end design-content delivery networks-capacity planning-security architecture and design

UNIT III – CLOUD APPLICATION ARCHITECTURES 15 hours

Development environments for service development; Amazon, Azure, Google App-cloud platform in industry

UNIT IV – HOW TO MOVE APPLICATION INTO THE CLOUD 15 hours

Web Application Design- Machine Image Design-privacy design –Database management

UNIT V – SPECIALIZED CLOUD ARCHITECTURE 15 hours

Workload distribution architecture-Dynamic scalability-Cloud bursting-hypervisor clustering-service quality metrics & SLA.

REFERENCES

1. Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. (2009).
2. John Rhoton ,Cloud Computing Explained: Handbook for Enterprise Implementation 2013 edition, 2013, recursive press
3. RajkumarBuyya, Christian Vecchiola, S.ThamaraiSelvi,Mastering Cloud Computing: Foundations and Applications Programming,MorganKaufmann,,Elsevier publication, 2013
4. Thomas Erl, ZaighamMahmood, and Ricardo Puttini,Cloud Computing Concepts, Technology & Architecture, PRENTICE HALL,2013

	ELECTIVE - III	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
Students to choose one Elective course from the list of courses mentioned in the curriculum					

	ELECTIVE - IV	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
Students to choose one Elective course from the list of courses mentioned in the curriculum					

SEMESTER III

	ELECTIVE – V	L	T	P	C
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
Students to choose one Elective course from the list of courses mentioned in the curriculum					

	ELECTIVE – VI	L	T	P	C
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
Students to choose one Elective course from the list of courses mentioned in the curriculum					

	SEMINAR	L	T	P	C
CS2047		0	0	2	1
PURPOSE	To train the students in preparing and presenting technical topics.				
INSTRUCTIONAL OBJECTIVE					
The student shall be capable of identifying topics of interest related to the program of study and prepare and make presentation before an enlightened audience.					

The students are expected to give at least two presentations on their topics of interest which will be assessed by a committee constituted for this purpose. This course is mandatory and a student has to pass the course to become eligible for the award of degree. Marks will be awarded out of 100 and appropriate grades assigned as per the regulations

CS2049	**PROJECT PHASE I (III SEMESTER)**	**L**	**T**	**P**	**C**
		0	**0**	**12**	**6**
CS2050	**PROJECT PHASE II (IV SEMESTER)**	**0**	**0**	**32**	**16**

PURPOSE

To undertake research in an area related to the program of study

INSTRUCTIONAL OBJECTIVE

The student shall be capable of identifying a problem related to the program of study and carry out wholesome research on it leading to findings which will facilitate development of a new/improved product, process for the benefit of the society.

M.Tech projects should be socially relevant and research oriented ones. Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester. Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for both Phase I and Phase II is shown in the following table:

Assessment	Tool	Weightage
In- semester	I review	10%
	II review	15%
	III review	35%
End semester	Final viva voce examination	40%

Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.

PROGRAMME ELECTIVES

CS2151	**COOPERATIVE COMMUNICATION SYSTEMS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to impart knowledge on the communication in Cooperative networking				
INSTRUCTIONAL OBJECTIVES					
1.	To be familiar with the concepts of Cooperative communication in networking				
2.	To learn the various modes of Cooperative communication in different networking scenarios				
3.	To study different cooperative routing methodologies				
4.	To provide an insight on the relaying techniques in Cooperative networking				
5.	To enhance the knowledge of communication quality in cooperative cross layered networks				

UNIT I - AN OVERVIEW ON COOPERATIVE COMMUNICATIONS **9 hours**

Brief History of Cooperative and Relay Channels- Characteristics of Wireless Channels -Techniques to Exploit Spatial Diversity-Capacity of Wireless -Diversity-and-Multiplexing Tradeoff- Decode-and-Forward Relaying Schemes

UNIT II - MODES OF COOPERATIVE COMMUNICATIONS **9 hours**

Cooperation protocols- Hierarchical cooperation- Cooperative communications with single relay- Multi-node cooperative communications- Relay selection: when to cooperate and with whom

UNIT III - COOPERATIVE NETWORKING **9 hours**

Cognitive multiple access via cooperation- Content-aware cooperative multiple access- Distributed cooperative routing- Broadband cooperative communications

UNIT IV - COOPERATION RELAYING **9 hours**

Resource Allocation in Pair-Wise Cooperative OFDM - Cooperative OFDM Systems with Multiple Relays- Cooperation with Slotted ALOHA- Cooperation with CSMA/CA- Throughput Optimal Scheduling Protocols for CooperativeNetworks

UNIT V- CROSS-LAYER ISSUES IN COOPERATIVE NETWORKS

9 hours

QoS in Cooperative Networks- Routing in Cooperative Networks- Security Issues in Cooperative Networks - Network lifetime maximization via cooperation

REFERENCES

1. Y.W. Peter Hong, Wan-Jen Huang C.-C. Jay Kuo, ‘‘Cooperative Communications and Networking’’, Springer edition,2013
2. K. J. Ray Liu, Ahmed K. Sadek, Weifeng Su and Andres Kwasinski, “Cooperative Communications and Networking’’ , Cambridge University Press New York, USA (http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521895132&resISBN13=9780521895132&parent=7032&ss=res#resource)
3. Murat Uysal, ‘‘Cooperative Communications for Improved Wireless Network Transmission: Framework for Virtual Antenna Array Applications’’, Information Science Reference, Hershey- New York, 2012
4. Yan Zhang, Hsiao-Hwa Chen, Mohsen Guizani, ‘‘Cooperative Wireless Communications’’, CRC Press, 2014

CS2152	**BIG DATA ANALYTICS FOR IoT**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	This course provides a way to understand the concepts and the basics of big data analytics and their role in Internet of things				
INSTRUCTIONAL OBJECTIVES					
1.	To learn the concepts of big data analytics				
2.	To learn the concepts about Internet of things				
3.	To understand and implement smart systems				

UNIT I - BIG DATA PLATFORMS FOR THE INTERNET OF THINGS **9 hours**

Big Data Platforms for the Internet of Things: network protocol- data dissemination – current state of art- Improving Data and Service Interoperability with Structure, Compliance, Conformance and Context Awareness: interoperability problem in the IoT context- Big Data Management Systems for the Exploitation of Pervasive Environments - Big Data challenges and requirements coming from different Smart City applications

UNIT II - RFID FALSE AUTHENTICATIONS **9 hours**

On RFID False Authentications: YA TRAP – Necessary and sufficient condition for false authentication prevention - Adaptive Pipelined Neural Network Structure in Self-aware Internet of Things: self-healing systems- Role of adaptive neural network- Spatial Dimensions of Big Data: Application of Geographical Concepts and Spatial Technology to the Internet of Things- Applying spatial relationships, functions, and models

UNIT III - FOG COMPUTING **9 hours**

Fog Computing: A Platform for Internet of Things and Analytics: a massively distributed number of sources - Big Data Metadata Management in Smart Grids: semantic inconsistencies – role of metadata

UNIT IV - WEB ENHANCED BUILDING **9 hours**

Toward Web Enhanced Building Automation Systems: heterogeneity between existing installations and native IP devices - loosely-coupled Web protocol stack –energy saving in smart building- Intelligent Transportation Systems and Wireless Access in Vehicular Environment Technology for Developing Smart Cities: advantages and achievements- Emerging Technologies in Health Information Systems: Genomics Driven Wellness Tracking and Management System (GO-WELL) – predictive care – personalized medicine

UNIT V - SUSTAINABILITY DATA AND ANALYTICS 9 hours

Sustainability Data and Analytics in Cloud-Based M2M Systems - potential stakeholders and their complex relationships to data and analytics applications - Social Networking Analysis - Building a useful understanding of a social network - Leveraging Social Media and IoT to Bootstrap Smart Environments : lightweight Cyber Physical Social Systems - citizen actuation

REFERENCES

1. Stackowiak, R., Licht, A., Mantha, V., Nagode, L.," Big Data and The Internet of Things Enterprise Information Architecture for A New Age", Apress, 2015.
2. Dr. John Bates , "Thingalytics - Smart Big Data Analytics for the Internet of Things", john Bates, 2015.

CS2153	**PRIVACY AND SECURITY IN IoT**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	To learn the security principles and methodologies for Internet of Things				
INSTRUCTIONAL OBJECTIVES					
1.	Ability to understand the Security requirements in IoT.				
2.	Understand the cryptographic fundamentals for IoT				
3.	Ability to understand the authentication credentials and access control				
4.	Understand the various types Trust models and Cloud Security.				

UNIT I – INTRODUCTION: SECURING THE INTERNET OF THINGS

9 hours

Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees

UNIT II- CRYPTOGRAPHIC FUNDAMENTALS FOR IOT 9 hours

Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication

UNIT III- IDENTITY & ACCESS MANAGEMENT SOLUTIONS FOR IOT

9 hours

Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control

UNIT IV- PRIVACY PRESERVATION AND TRUST MODELS FOR IOT

9 hours

Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizing
Things - Preventing unauthorized access.

UNIT V - CLOUD SECURITY FOR IOT 9 hours

Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud

IoT security controls – An enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing

REFERENCES

1. Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van Duren
2. Securing the Internet of Things Elsevier
3. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations

CS2154	**INTERNET OF THINGS: SENSING AND ACTUATOR DEVICES**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to impart knowledge on Internet of Things (IoT), which relates to the study of sensors, actuators, and controllers, among other Things, IoT applications and examples overview (building automation, transportation, healthcare, industry, etc.) with a focus on wearable electronics				

INSTRUCTIONAL OBJECTIVES	
1.	Understanding of IoT value chain structure (device, data cloud), application areas and technologies involved
2.	Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, RF and sensing modules
3.	Market forecast for IoT devices with a focus on sensors
4.	Explore and learn about Internet of Things with the help of preparing projects designed for Raspberry Pi

UNIT I – INTRODUCTION **9 hours**

Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device

UNIT II - SEVEN GENERATIONS OF IOT SENSORS TO APPEAR **9 hours**

Industrial sensors – Description & Characteristics–First Generation – Description & Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics–Polytronics Systems – Description & Characteristics–Sensors' Swarm – Description & Characteristics–Printed Electronics – Description & Characteristics–IoT Generation Roadmap

UNIT III - TECHNOLOGICAL ANALYSIS **9 hours**

Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module

UNIT IV -IOT DEVELOPMENT EXAMPLES **9 hours**

ACOEM Eagle – EnOcean Push Button – NEST Sensor – Ninja Blocks -Focus on Wearable Electronics

UNIT V - PREPARING IOT PROJECTS **9 hours**

Creating the sensor project - Preparing Raspberry Pi - Clayster libraries - Hardware- Interacting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data - Creating the actuator project- Hardware - Interfacing the hardware - Creating a controller - Representing sensor values - Parsing sensor data - Calculating control states - Creating a camera - Hardware -Accessing the serial port on Raspberry Pi - Interfacing the hardware - Creating persistent default settings - Adding configurable properties - Persisting the settings - Working with the current settings - Initializing the camera

REFERENCES

1. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Développement Copyrights ,2014
2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
3. Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research and Innovation to Market
4. Deployment', River Publishers, 2014
5. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

CS2139	**SMART CONVERGENT TECHNOLOGIES**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	This course provides the cutting edge technologies using IOT				
INSTRUCTIONAL OBJECTIVES					
1.	Describe the various technologies used in telecommunications				
2.	Explain the application of technologies, architectures, and protocols used in the telecommunications industry.				
3.	Describe 1G, 2G, 3G, 4G, LTE, WiMAX and their role in present and future Mobility.				

UNIT I – INTRODUCTION TO TELECOMMUNICATIONS AND TRANSMISSION
9 hours

Human–Machine Interactions - Embedded Devices - Intelligent Wearable - Traffic Patterns - The Electromagnetic Spectrum - Analog and Digital, Multiplexing Media: Twisted-Pair - Coaxial Cable- Microwave – Satellites - Fiber Optics - Data Communication Traffic - Data Transmission - OSI and TCP/IP Reference Models

UNIT II - INTRODUCTION TO THE INTERNET AND IP TELEPHONY
9 hours

Internet and Routing Protocols- Internet Architecture, andInfrastructure - Subnetting: IPv4, IPv6; DNS, QoS- Service Providers - IPT Network Architecture, QoS - VoIP Call Signaling Protocols - Digital Voice, ENUM- VPNs: Layer 3, 2, Security- Unified communications- IP voice and IPTV- The Broadband Infrastructure - Quality of Service-Virtualization- Cloud Computing

UNIT III - FIBRE OPTIC NETWORKS, WIRED AND WIRELESS BROADBAND **9 hours**

Optical Networking Elements : Switches, Edge, Core - DSL - Cable TV Networks,Packet Cable- Fiber Solutions- Wireless Broadband- HANs PANs, CANs, MANs- Broadband PLT - Antennas- Wireless Bandwidth - Spectrum Utilization- Spread Spectrum

UNIT IV - CELLULAR SERVICES AND STANDARDS **9 hours**

Cellular: 2G, 2,5G, 3G, 4G. 5G - WiMax,LTE - mobile security - Digital Cellular Radio - Enhanced Data Services - Broadband Wireless 3G Standards : : UMTS, TD-SCDMA,CDMA Solutions

UNIT V - WIRELESS NETWORK ARCHITECTURE, WIRELESS AND MOBILITY
9 hours

BFWA- WLANs -IEEE 802.11a,b,g,n - IEEE 802.16, WiMax, WiBro and Mobile-Fi - VoWLAN - Integration of WLANs and Cellular Networks, RFIDMesh Networks - Mobile IP, IP Multimedia Subsystem - Applications, Mobile Video,Mobile TV, and Content

REFERENCES

1. LIDO Telecommunications Essentials: by Lillian Goleniewski, 2nd edition, Addison-Wesley Professional, Copyright: 2007

CS2155	**RFID AND MICROCONTROLLERS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	This course helps to learn RFID's basic technology and 8051 microcontrollers for designing general purpose applications.				
INSTRUCTIONAL OBJECTIVES					
1.	To learn the basics of RFID and 8051 microcontrollers				
2.	Interfacing RFID with microcontrollers				
3.	To develop real time applications based on microcontrollers				
4.	Analyze different case studies.				

UNIT I - BAR CODES AND RFID 9 hours

Bar codes and RFID basics- Components of an RFID system-Data -Tags-Antennas-Connectors- Cables- Readers- encoder/ printers for smart labels- Controllers-software- RFID advantages over Bar codes.

UNIT II – MICROCONTROLLERS 9 hours

Intel 8051 - architecture- memory organization- special function registers- timing and control- port operation- memory interfacing - I/O interfacing- Programming the 8051 resources- interrupts- Measurement of frequency,period and pulse width of a signal-power down operation.

UNITIII - INTEL 8051 MICROCONTROLLER- INSTRUCTION SET AND PROGRAMMING 9 hours

Programmers model of Intel-Operand types- Operand addressing- Data transfer instructions- Arithmetic Instructions - Logic instructions- Control transfer instructions.- 8051 Interfacing and applications.

UNIT IV - RFID APPLICATIONS 9 hours

Short range RFID applications- access control - personal identification - Transportation ticketing- blood , tissue and organ identification- fleet management-personal identification- car body production-passport security. Long range RFID applications- supply chain management- Mail and shipping- Clothing Tags.

UNIT V - CASE STUDIES 9 hours

Reading RFID cards using 8051- RFID in the supply chain- Vehicles parking using RFID- library management system- electronic toll payment- smart shipping containers-fleet monitoring and management.

REFERENCES

1. Dennis E. Brown , " RFID implementation" Tata McGraw - Hill, 2007
2. Steven Shepard, "RFID: Radio frequency and Identification", Tata McGraw - Hill.
3. Ajit Pal, " Microcontrollers- principles and applications", Prentice hall of India, 2011
4. Krishna Kant. " Microprocessors and Microcontrollers", Prentice hall of India,2011
5. www.circuitstoday.com/interfacing-rfid-module-to-8051

CS2145	**FOG COMPUTING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	This course gives an overview of Fog Computing and its architecture, challenges and applications in different context.				
INSTRUCTIONAL OBJECTIVES					
1.	Become familiar with the concepts of Fog				
2.	Understand the architecture and its components and working of components and its performance				
3.	Explore Fog on security , multimedia and smart data				
4.	Model the fog computing scenario				

UNIT I - INTRODUCTION TO FOG COMPUTING **9 hours**

Fog Computing-Definition-Characteristics-Application Scenarios - Issues -Fog Computing and Internet of Things-Pros and Cons-Myths of Fog Computing -Need and Reasons for Fog Computing Fog Computing and Edge Computing-IoT , FOG, Cloud-Benefits

UNIT II - ARCHITECTURE **9 hours**

Working Procedure -Performance Evaluation Components- Software Systems – Architecture-Modeling and Simulation –Challenges

UNIT III - FOG PROTOCOLS **9 hours**

Fog Protocol-Fog Kit- Proximity Detection Protocols- DDS/RTPS computing protocols -

UNIT IV - MANAGEMENT OF DATA AND SECURITY ANALYSIS **9 hours**

Smart Management of Big Data-Smart Data-Structure of Smart Data- Smart Data Life Cycle-System Architecture-Multi-dimensional Payment Plan- -Security and Privacy Issues-Multimedia Fog Computing-Architecture-Deduplication-Hybrid Secure Deduplication- Security Challenges-Security Requirements

UNIT V - CASE STUDY **9 hours**

Case Study: Wind Farm - Smart Traffic Light System, Wearable Sensing Devices, Wearable Event Device ,Wearable System, Demonstrations , Post Application Example . . Event Applications Example .

REFERENCES

1. Ivan Stojmenovic, Sheng Wen ," The Fog Computing Paradigm: Scenarios and Security Issues" Proceedings of the 2014 Federated Conference on Computer Science and Information Systems pp. 1–8

2. Fog Computing: Helping the Internet of Things Realize its Potential Amir VahidDastjerdi and RajkumarBuyya, University of Melbourne
3. Multi-Dimensional payment Plan in Fog Computing with Moral Hazar,YanruZhang,Nguyen H. Tran,DusitNiyato, and Zhu Han,IEEE,2016
4. FarhoudHosseinpour,JuhaPlosila,HannuTenhunen,"An Approach for Smart management of Big Data in the Fog ConputingContext",IEEE 8th International Conference on Cloud Computing Technology and Science,2016
5. Hua-Jun Hong, Jo-Chi Chuang and Cheng-HsinHsu,"Animation Rendering on Multimedia Fog computing Platforms", IEEE 8th International Conference on Cloud Computing Technology and Science,2016
6. Dongyoung Koo, Youngjoo Shin, Joobeom Yun, junbeomHur,"A Hybrid deduplicaton for secure and Efficiet data Outsourcing n Fog Computing", IEEE 8th International Conference on Cloud Computing Technology and Science,2016
7. Fog Computing: A Platform for Internet of Things and Analytics, FlavioBonomi, Rodolfo Milito, PreethiNatarajan and Jiang Zhu, 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
8. Fog Computing and Its Role in the Internet of Things,FlavioBonomi, Rodolfo Milito, Jiang Zhu, SateeshAddepalli, MCC'12, August 17, 2012, Helsinki, Finland. Copyright 2012 ACM 978-1-4503-1519-7/12/08... $15.00.
9. A Survey of Fog Computing: Concepts, Applications and Issues,Shanhe Yi, Cheng Li, Qun Li, Mobidata'15, June 21, 2015, Hangzhou, China. Copyright c
10. 015 ACM 978-1-4503-3524-9/15/06 ...$15.00. DOI: http://dx.doi.org/10.1145/2757384.2757397.
11. Security and Privacy Issues of Fog Computing: A Survey,Shanhe Yi, Zhengrui Qin, and Qun Li
12. IEEE INTERNET OF THINGS JOURNAL, VOL. XX, NO. X, JUNE 2017 1 LoDPD: A Location Difference-based Proximity Detection Protocol for Fog Computing Yan Huo∗ , Member, IEEE,, Chunqiang Hu† , ‡ , Member, IEEE,, Xiaowei Qi∗ , Tao Jing∗
13. Fog Protocol and FogKit: A JSON-Based Protocol and Framework for Communication Between Bluetooth-Enabled Wearable Internet of Things Devices Spencer Lewson,by Spencer Lewson June 2015

CS2156	WEARABLE COMPUTING, MIXED REALITY AND INTERNET OF EVERYTHING	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE	This course introduces to programming techniques for various day to day devices				

INSTRUCTIONAL OBJECTIVES	
1.	Understand advanced and emerging technologies
2.	Obtain skills to do advanced research and programming
3.	Learn how to use software programs to perform varying and complex tasks
4.	Expand upon theknowledge learned and apply it to solve real world problems

UNIT I - INTRODUCTION **9 hours**

Introduction – History - Creative Coding Platforms - Open Source Platforms – PIC - Arduino, Sketch, Raspberry Pi, Iterative coding methodology – Python Programming - Mobile phones and similar devices - Arm Devices - Basic Electronics (circuit theory, measurements, parts identification) Sensors and Software: Understanding Processing Code Structure, variables and flow control, Interfacing to the Real World

UNIT II - SOFTWARE HARDWARE FRAMEWORKS **11 hours**

Software: openFrameworks as our IDE (C/C++) - "Arduino" Language (C/C++) - Hardware: Desktop / Laptop / Raspberry Pi - How to approach a programming problem?Representing "reality" with computers.Digital vs. Analog circuits, audio, communication, etc.Analog to Digital Conversion (ADC) - Digital to Analog Conversion (DAC)– Microcontrollers - Communication – Serial& Parallel - Hardware to Hardware Communication - I2C/IIC (Inter-Integrated Circuit) - SPI (Serial Peripheral Interface) – Serial UART Communication

UNIT III - CYBERNETICS AND HUMANISTIC INTELLIGENCE

11 hours

Wearables - Augmented Reality – Mixed Reality.Case studies, Oculus Rift (2012, 2013), AR versus VR - IoT and Wearables: Smart Cites and Wearable Computing as a form of urban design - Advanced I/O - openFrameworks:Live Network feeds (push and pull) - Data persistence (saving data and preferences) - Database interface (MySQL, sqLite, XML, PHP/Web) - Arduino:Wired/Wireless Networking (hardware vs. USB proxy) - Software serial (RS-232) talking to other devices - Advanced sensor/device communication SPI - Advance IC interfacing / Bitbanging (bitwise operators) - Linux – GPIO

UNIT IV - THE WORLD OF THE FUTURE – INTERNET OF EVERYTHING **8 hours**

Humanistic Intelligence, Mann 1998. Wearable Computing and IoT (Internet of Things) The scalespace theory; sur/sousveillance; integrity; VeillanceContract; Humanistic Intelligence; MedialityAxis? Overview of Mobile and Wearable Computing, Augmented Reality, and Internet of Things. The fundamental axes of the Wearables + IoT + AR space - Free-roaming AR: Wearable Computing, Wireless, Sensing, and Metasensing with light bulbs Phenomenal Augmented Reality: Real world physical phenomena as the fundamental basis of mobile and wearable AR.

UNIT V - FUTURE AND PERSPECTIVES **6 hours**

Internet of Everything – The Future and perspectives - Challenges

REFERENCES

1. "Practical Electronics for Inventors, Third Edition," by Paul ScherzandSimon Monk. 2016
2. Intel Galileo and Intel Galileo Gen 2API Features and Arduino Projects for Linux Programmers, Ramon, Manoel 2014 (Open Access)
3. Fundamentals of Wearable Computers and Augmented Reality, Second Edition by Woodrow Barfield 2015
4. Making Sense of Sensors: End-to-End Algorithms and Infrastructure Design By OmeshTickoo, Ravi Iyer 2016
5. Programming Interactivity, Second Edition By Josha Noble, 2012
6. Programming the Raspberry Pi: Getting Started with Python 2E, 2016

CS2157	**PROGRAMMING AND INTERFACING WITH MICROCONTROLLERS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	This course introduces to programming techniques for various microcontrollers like Arduino, Raspberry Pi and other ARM devices.				
INSTRUCTIONAL OBJECTIVES					
1.	Understand advanced and emerging networking technologies				
2.	Obtain skills to do advanced networking research and programming				
3.	Learn how to use software programs to perform varying and complex networking tasks				
4.	Expand upon theknowledge learned and apply it to solve real world problems				

UNIT I- INTRODUCTION **9 hours**

Introduction – History - Creative Coding Platforms - Open Source Platforms – PIC - Arduino, Sketch, Raspberry Pi, Iterative coding methodology – Python Programming - Mobile phones and similar devices - Arm Devices - Getting used to Arduino - Sensor Characterization: Safety, Basic Electronics (circuit theory, measurements, parts identification) Sensors and Software: Understanding Processing Code Structure, variables and flow control, Interfacing to the Real World

UNIT II - SOFTWARE FRAMEWORKS **11 hours**

Software: openFrameworks as our IDE (C/C++) - "Arduino" Language (C/C++) - Hardware: Desktop / Laptop / Raspberry Pi - How to approach a programming problem?Representing "reality" with computers.Digital vs. Analog circuits, audio, communication, etc.Analog to Digital Conversion (ADC) - Digital to Analog Conversion (DAC) - Microcontrollers

UNIT III - HARDWARE COMMUNICATION **8 hours**

Communication – Serial& Parallel - Hardware to Hardware Communication - I2C/IIC (Inter-Integrated Circuit) - SPI (Serial Peripheral Interface) – Serial UART Communication - Introduction to the command line – git/github. Introduction to Programming: A comparative studio between Arduino + openFrameworks - Arduino-compatible Microcontrollers Sensors and Actuators

UNIT IV: ADVANCED I/O INTERFACING **11 hours**

Advanced I/O - openFrameworks:Live Network feeds (push and pull) - Data persistence (saving data and preferences) - Database interface (MySQL, sqLite, XML, PHP/Web) - Arduino:Wired/Wireless Networking

UNIT V - IoT, FUTURE AND PERSPECTIVES **6 hours**

Talking to the cloud: Baby steps to Internet of Things, TCP/IP and UDP - Building peer to peer communication system using Bluetooth &WiFi - Experiments

REFERENCES

1. Programming Interactivity, Second Edition By Josha Noble, 2012
2. Programming the Raspberry Pi: Getting Started with Python 2E, 2016

CS2158	**SDN and NFV FOR IoT**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	To understand the underlying principles of Data Center Networking over the conventional network.				
INSTRUCTIONAL OBJECTIVES					
1.	Understand the principles behind the Modern Network approaches such as SDN NFV and IoT				
2.	Ability to analyze Data Center topologies and virtualized environment				
3.	Understand the data traversal over virtualized environment for IoT				
4.	Design algorithms for virtualization over multi-tenant environments				
5.	Understand the various types of key routing and switching techniques used in modern networks.				

UNIT I - MODERN NETWORKING 9 hours

Cloud Computing - Internet of Things - Types of Network and Internet Traffic - Demand: Big Data, Cloud Computing, and Mobile Traffic - Requirements: QoS and QoE - Routing Congestion Control - SDN and NFV - Modern Networking Elements

UNIT II - SOFTWARE DEFINED NETWORKS 9 hours

Network Requirements - The SDN Approach - SDN- and NFV-Related Standards - SDN Data Plane - OpenFlow Logical Network Device - OpenFlow Protocol - SDN Control Plane Architecture - REST API - SDN Application Plane Architecture

UNIT III - VIRTUALIZATION 9 hours

Background and Motivation for NFV - Virtual Machines - NFV Concepts - NFV Reference Architecture - NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration - NFV Use Cases - SDN and NFV

UNIT IV - THE INTERNET OF THINGS: COMPONENTS 9 hours

The IoTEra - Scope of the Internet of Things - Components of IoT-Enabled Things - IoT World Forum Reference Model - ITU-T IoT Reference Model - IoTivity - Cisco IoT System - ioBridge - SDN and NFV over IoT Deployment

UNIT V - SECURITY 9 hours

Security Requirements - SDN Security - NFV Security - ETSI Security Perspective - IoT Security - The Patching Vulnerability - IoT Security and Privacy Requirements Defined by ITU-T - An IoT Security Framework - The Impact of the New Networking on IT Careers

REFERENCES

1. "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" William Stallings Publisher: Addison-Wesley 2015 ISBN: 9780134175393
2. SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization 1st Edition by Jim Doherty
3. Network Function virtualization with a touch of sdn by Paresh Shah, Syed Farrukh Hassan, RajendraChayapathi
4. Software Defined Networks A Comprehensive Approach Ist Edition by Paul Goransson Chuck Black

CS2159	**ADVANCED DISTRIBUTED SYSTEMS**	**L**	**T**	**P**	**C**
	Total contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to impart knowledge on design concepts and system level and support required for distributed system.				

INSTRUCTIONAL OBJECTIVES	
1.	To learn of the concepts, principles and technologies of Distributed systems
2.	To introduce advanced idea of peer to peer and file system management
3.	To understand the issues involved in resource management and process.

UNIT I -DISTRIBUTED SYSTEMS 9 hours

Introduction to Distributed Systems - Characterization of Distributed Systems - Distributed Architectural Models - Remote Invocation - Request-Reply Protocols - RPC - RMI - Group Communication - Coordination in Group Communication - Ordered Multicast - Time Ordering - Physical Clock Synchronization - Logical Time and Logical Clocks.

UNIT II - DISTRIBUTED SECRUITY AND TRANSACTIONS 9 hours

Introduction - Overview of security techniques - Cryptographic algorithms - Digital signatures - Cryptography pragmatics - Flat and nested distributed transactions - Atomic commit protocols - Concurrency control in distributed transactions - Distributed deadlocks - Transaction recovery

UNIT III - DISTRIBUTED MUTUAL EXCLUSION ALGORITHMS 9 hours

Introduction - Lamport's algorithm - RicartAgrawala algorithms - Singhal's dynamic information structure algorithm - Lodha and Kshemkalyani's fair mutual exclusion algorithms - Quorum based algorithm - Mackawa's algorithms - Token based algorithms - Roymaond's tree based algorithms

UNIT IV - DEADLOCK DETECTION IN DISTRIBUTION SYSTEMS 9 hours

System Model - Models of deadlocks - Knapp's classsificatipon of distributed deadlock detection algorithms - Mitchell & Merritt's algorithm for the single resource model - ChandyMisra Haas slgorithm for the AND & OR Model - Kshemkalyanisinghal algorithm for P out of Q model - Global predicate detection

UNIT V - ADVANCED IN DISTRIBUTED SYSTEMS 9 hours

Authentication in distributed systems - Protocols based on symmetric cryptosystems - Protocols based on asymmetric cryptosystems - Password-based authentication - Authentication protocol failures - Self-stabilization - Peer-to-peer computing and overlay graphs - Unstructured overlays - Chord distributed hash table - Content addressable networks (CAN) - Tapestry - Some other challenges in P2P system design - Tradeoffs between table storage and route lengths - Graph structures of complex networks - Internet graphs - Generalized random graph networks - Small-world networks - Scale-free networks - Evolving networks.

REFERENCES

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems Concepts and Design”, Fifth Edition, Pearson Education Asia, 2012.
2. Ajay D. Kshemkalyani, MukeshSinghal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2008
3. Liu, "Distributed Computing: Principles and Applications", Pearson Education , 2004

CS2160	**SOFTWARE ARCHITECTURE AND INTEROPERABILITY**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite: Knowledge about cloud computing				
	Nil				
PURPOSE	To gain the basic principles of software architecture and interoperability				
INSTRUCTIONAL OBJECTIVES					
1.	To learn importance of software architecture				
2.	To learn about architectural life cycle				
3.	To learn More Interoperability Challenges to Cope Today				
4.	To know about various architecture model				

UNIT I – INTRODUCTION **9 hours**

Software Architecture –Architecture Structures and Views – Importance of Software Architecture – Predicting System Quality – Influencing Organizational Structure – Improving Cost and Schedule estimates – Context of Software architecture.

UNIT II - QUALITY ATTRIBUTES **9 hours**

Understanding quality attributes – availability – interoperability – modifiability - performance and security – testability - usability – quality attribute modeling and analysis.

UNIT III - ARCHITECTURE IN THE LIFE CYCLE **9 hours**

Architecture in the agile projects – Architecture and requirements – Designing and documentation – Implementation and testing – Architecture reconstruction and conformance.

UNIT IV - INTEROPERABILITY **9 hours**

Physical vs Virtual - The Data Interoperability - The Semantic Interoperability - The Organizational Interoperability - Eternal Interoperability - The Important Economic Dimension - Roadmap for IoT Testing Methodologies

UNIT V - ARCHITECTURE IN ADVANCE **9 hours**

Architecture in Cloud - Cloud Definition – Service Model – Economic Justification – Base Mechanism – Architecture for the Edge – Edge Document system – SDLC – Metropolis Model.

REFERENCES

1. Len Bass, Paul Clements, Rick Kazman, “Software Architecture in Practice”, 3 rd edition Pearson, 2013.

2. Mary Shaw, David Garlan, “Software Architecture: Perspectives on an Emerging Discipline”, Prentice Hall, 1996.
3. Dr. OvidiuVermesan, Dr. Peter Friess, Internet of Things:Converging Technologies
4. for Smart Environmentsand Integrated Ecosystems, RIVER PUBLISHERS SERIES IN COMMUNICATIONS,2013.
5. Taylor R. N, Medvidovic N, Dashofy E. M, “Software Architecture: Foundations, Theory, and Practice”, Wiley, 2009.

CS2161	**ENERGY HARVESTING TECHNOLOGIES AND POWER MANAGEMENT FOR IoT DEVICES**	**L**	**T**	**P**	**C**
	Total contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	To learn the techniques in involved in Energy harvesting				
INSTRUCTIONAL OBJECTIVES					
1.	Understand the various energy sources and energy harvesting based sensor networks				
2.	Learn about the various Piezoelectric materials and Non-linear techniques				
3.	Understand the various Power sources for WSN				
4.	Learn about the applications of Energy harvesting systems.				

UNIT I – ENERGY HARVESTING SYSTEMS 9 hours

Introduction – Energy sources – energy harvesting based sensor networks – photovoltaic cell technologies – generation of electric power in semiconductor PV cells – types

UNIT II - PIEZO-ELECTRIC ENERGY HARVESTING AND ELECTROMECHANICAL MODELING 9 hours

Piezoelectric materials – transducers – harvesters – microgenerators – strategies for enhancing the performance of energy harvesters. Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed-form solutions

UNIT III- ELECTROMAGNETIC ENERGY HARVESTING AND NON-LINEAR TECHNIQUES 9 hours

Basic principles – micro fabricated coils and magnetic materials – scaling – power maximations – micro and macro scale implementations. Non-linear techniques – vibration control & steady state cases

UNIT IV- ENERGY HARVESTING WIRELESS SENSORS 9 hours

Power sources for WSN – Power generation – conversion – examples – case studies. Harvesting micro electronic circuits – power conditioning and losses

UNIT V - SELECTED APPLICATIONS OF ENERGY HARVESTING SYSTEMS 9 hours

Case studies for Implanted medical devices – Bio-MEMS based applications – harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes

REFERENCES

1. Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva VeríssimoPaulino, “CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications”, springer
2. Danick Briand, Eric Yeatman, Shad Roundy ,“Micro Energy Harvesting”

CS2162	**CLOUD STORAGE AND COMPUTING**	**L**	**T**	**P**	**C**
	Total contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	To gain the basic principles of cloud storage and computing				
INSTRUCTIONAL OBJECTIVES					
1.	To learn colud computing bascis				
2.	To learn about cloud storage and security				
3.	To learn about optimization of cloud storage				
4.	To know about various cloud service provider				

UNIT I- CLOUD COMPUTING 9 hours

Introduction to the Cloud Computing, History of cloud computing, Cloud service options, Cloud Deployment models, Business concerns in the cloud, Exploring virtualization, Load balancing, Hypervisors, Machine imaging, Cloud marketplace overview, Comparison of Cloud providers

UNIT II - INFORMATION STORAGE SECURITY & DESIGN 9 hours

Storage strategy and governance; security and regulations. Designing secure solutions; the considerations and implementations involved. Securing storage in virtualized and cloud environments.Monitoring and management; security auditing and SIEM.

UNIT III - STORAGE NETWORK DESIGN 9 hours

Architecture of storage, analysis and planning. Storage network design considerations; NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE), design for storage virtualization in cloud computing, host system design considerations.

UNIT IV - OPTIMIZATION OF CLOUD STORAGE 9 hours

Global storage management locations, scalability, operational efficiency.Global storage distribution; terabytes to petabytes and greater. Policy based information management; metadata attitudes; file systems or object storage.

UNIT V – CLOUD SERVICE PROVIDER 9 hours

Cloud Service Providers: EMC, EMC IT, Captiva Cloud Toolkit, Google Cloud Platform, Cloud Storage, Google Cloud Connect, Google Cloud Print, Google App Engine, Amazon Web Services, Amazon Elastic Compute Cloud, Amazon Simple Storage Service, Amazon Simple Queue ,Service, Microsoft Windows Azure, Microsoft Assessment and Planning Toolkit, SharePoint, IBM Cloud Models, IBM Smart Cloud, SAP Labs, SAP HANA Cloud Platform, Virtualization Services Provided by SAP, Sales

force, Sales Cloud, ServiceCloud: Knowledge as a Service, Rack space, VMware, Manjra soft Aneka Platform

REFERENCES

1. Cloud Computing: Principles and Paradigms by RajkumarBuyya, James Brobergand Andrzej M. Goscinski, Wiley, 2011.
2. Distributed and Cloud Computing , Kai Hwang, GeofferyC.Fox, Jack J.Dongarra, Elsevier, 2012.
3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, SubraKumaraswamy, ShahedLatif, O'Reilly, SPD, 2011.
4. Cloud Computing Bible. Barrie Sosinsky. John Wiley & Sons. ISBN-13: 978-0470903568.
5. Amazon Web Services For Dummies. Bernard Golden. For Dummies. ISBN-13: 978-18571835
6. RajkumarBuyya, Cloud Computing: Principles and Paradigms, John Wiley & Sons, First Edition
7. Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications [ISBN: 978-1439851739], 2011.
8. Marty Poniatowski, "Foundations of Green IT" Prentice Hall; 1 edition [ISBN: 978-137043750] , 2009.

CS2163	**KERNEL AND DRIVER PROGRAMMING**	**L**	**T**	**P**	**C**
	Total contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	The purpose of this course is to impart knowledge of kernel programming, device driver programming in Linux				

INSTRUCTIONAL OBJECTIVES	
1.	To learn the fundamental of device driver and write simple device driver programs
2.	To learn the debugging technique and study the concurrency and Trace conditions
3.	To learn memory allocation and write driver programs for communicating with hardware
4.	To learn about the interrupt handling, PCI driver and USB driver
5.	To learn the block driver and network driver

UNIT I – INTRODUCTION TO DEVICE DRIVER AND CHAR DRIVER

9 hours

Introduction to device driver - The Role of the Device Driver –Splitting the Kernel - Classes of Devices and Modules - Security Issues – Building and running modules – Setting your test system – compiling and loading - Char Drivers - Design of scull - Some Important Data Structures - Char Device Registration - open and release - scull's Memory Usage - read and write - Playing with the New Devices

UNIT II – DEBUGGING TECHNIQUE, CONCURRENCY AND TRACE CONDITIONS 9 hours

Debugging technique -Concurrency and trace conditions – Pitfalls in scull - Concurrency and Its management - Semaphores and Mutexes - Completions – Spinlocks - Locking Traps - Alternatives to Locking - Advanced Char driver operations – ioctl 135 - Blocking I/O 147 - poll and select 163 - Asynchronous Notification - Seeking a Device - Access Control on a Device File

UNIT III – MEMORY ALLOCATION, COMMUNICATING WITH HARDWARE 9 hours

Time, delays and deferred work – Allocating memory – The Real Story of kmalloc - Lookaside Caches - get_free_page and Friends - vmalloc and Friends - Per-CPU Variables - Obtaining Large Buffers - Communicating with hardware – I/O Ports and I/O Memory - Using I/O Ports - I/O Port Example - Using I/O Memory

UNIT IV – INTERRUPT HANDLING, DATA TYPES, PCI DRIVER AND USB DRIVER 9 hours

Interrupt handling - Preparing the Parallel Port - Installing an Interrupt Handler - Implementing a Handler - Top and Bottom Halves - Interrupt Sharing - Interrupt-Driven I/O - Data types in kernel – Use of Standard C Types - Assigning an Explicit Size to Data Items - Interface-Specific Types - Other Portability Issues - Linked Lists - PCI drivers - PCI Interface - PC/104 and PC/104+ - Other PC Buses - USB drivers - USB and Sysfs - USB Urbs - Writing a USB Driver - USB Transfers Without Urbs

UNIT V – LINUX DEVICE MODEL, BLOCK DRIVER AND NETWORK DRIVERS 9 hours

Linux device model - Kobjects, Ksets, and Subsystems - Low-Level Sysfs Operations - Hotplug Event Generation - Buses, Devices, and Drivers – Classes – Hotplug - Block Driver – Registration - Block Device Operations - Request Processing - Network Drivers

REFERENCES

1. Robert love “Linux Kernel Development” Pearson Publication, Third edition 2010
2. Beck Michael et al “Linux Kernel Programming” Pearson Publication, Third edition 2015
3. Mohan LalJangir “Linux kernel and device driver programming”, Laxmi Publication, 2014

CS2164	**DESIGN AND TESTING OF DIGITAL SYSTEMS**	**L**	**T**	**P**	**C**
	Total contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE	Learning the Design of Combinational and Sequential Circuits, Simulating digital Circuits using Programmable logic devices/ VHDL and learn fault diagnosis and testability algorithms				
INSTRUCTIONAL OBJECTIVES					
1.	To impart knowledge on combinational and sequential circuits				
2.	To design digital circuits				
3.	To test combinational and sequential circuits using testability algorithms				

UNIT I - COMBINATIONAL CIRCUIT DESIGN AND SIMULATION USING GATES 9 hours

Review of Combinational Circuit Design-Design of Circuits with limited gate fan-in-Gate delays and timing diagrams-Hazards in Combinational Logic-Simulation and testing of Logic circuits-Multiplexer, three-state buffers and Decoder/Encoders

UNIT II - COMBINATIONAL CIRCUITSDESIGN WITH PROGRAMMABLE LOGIC DEVICES AND VHDL 9 hours

Designing with ROMs-Programmable Logic devices-Complex Programmable Logic Devices-Field Programmable gate Arrays-VHDL Description of combinational Circuits-VHDL models for Multiplexers-VHDL Modules and Operators-Signals, constants and Arrays-IEEE Standard Logic

UNIT III - SEQUENTIAL CIRCUITS DESIGN 9 hours

Sequential Parity Checker-Analysis by Signal Tracing and Timing charts-State Tables and Graphs-Construction and Interpretation of Timing Charts-General Models-Code converter-design Example-Design of Sequential Circuits using ROMs and PLAs

UNIT IV - FAULT MODELING AND SIMULATION 9 hours

Keyboard basics - Keyboard scanning algorithm - Character LCD modules - LCD module display Configuration - Time-of-day clock - Timer manager - Interrupts - Interrupt service routines - Interrupt-driven pulse width modulation.Triangle waves analog vs. digital values - Auto port detect - Capturing analog information in the timer interrupt service routine - Automatic, multiple channel analog to digital data acquisition.

UNIT V - TESTING FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS 9 hours

Basic Issues-ATG for SSFs in Combinational Circuits- Fault oriented ATG-Common Concepts, Algorithms and Selection Criteria-ATG for SSFs in Sequential Circuits

REFERENCES

1. Charles H. Roth, Jr.LarryL.Kinney, “Fundamentals of Logic design” Cenage Learning, 6th Edition, 2010
2. MironAbramovici, Melvin A. Breuer and Arthur D. Friedman, “Digital Systems Testing and Testable Design”, Jaico Publishing House, 2001
3. Morris Mano, M.D.Ciletti, “Digital Design” , Pearson Edition, 2013
4. Peatman, “Design of digital Systems”, McGraw-Hill, 1984
5. Adamski and Barkalov, “Design of Digital Systems and Devices, Springer Science & Business Media, 2011

EM2107	EMBEDDED CONTROL SYSTEMS	L	T	P	C
	Total contact Hours - 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE	To introduce the basic concepts of control systems and its embedded implementation.				

INSTRUCTIONAL OBJECTIVES	
1.	To learn the basics of control systems.
2.	To learn control theory as used in embedded systems.
3.	To learn application of control systems
4.	To learn I/O devices used in control systems.

UNIT I - CONTROL SYSTEM BASICS **12 hours**

Z-transforms – performance requirements - block diagrams - analysis and design - sampling theory– difference equations.

UNIT II - CONTROL SYSTEM IMPLEMENTATION **9 hours**

Discretization method – Fixed point mathematics – Nonlinear controller elements – Gain scheduling– Controller implementation & testing in Embedded Systems.Case study of robotic control system.

UNIT III - CONTROL SYSTEM TESTING **6 hours**

Software implications - Controller implementation and testing in embedded systems - Measuring frequency response.

UNIT IV - INPUT DEVICES **6 hours**

Keyboard basics - Keyboard scanning algorithm - Character LCD modules - LCD module display Configuration - Time-of-day clock - Timer manager - Interrupts - Interrupt service routines - Interrupt-driven pulse width modulation.Triangle waves analog vs. digital values - Auto port detect - Capturing analog information in the timer interrupt service routine - Automatic, multiple channel analog to digital data acquisition.

UNIT V - OUTPUT DEVICES **3 hours**

H Bridge – relay drives - DC/ Stepper Motor control – optical devices.

UNIT VI – SENSORS **7 hours**

Linear and angular displacement sensors: resistance sensor – induction displacement sensor – digital optical displacement sensor – pneumatic sensors. Speed and flow rate sensors : electromagnetic sensors – fluid flow sensor – thermal flow sensor. Force sensors: piezoelectric sensors – strain gauge sensor – magnetic flux sensor – inductive pressure sensor – capacitive pressure sensor. Temperature sensors: electrical – thermal expansion – optical.

UNIT VII - CASE STUDY **2 hours**

Examples for sensor, actuator, control circuits with applications.

REFERENCES

1. Jim Ledin, "*Embedded control systems in C/C++*", CMP Books, 2004.
2. TimWiscott, "*Applied control for embedded systems*", Elsevier Publications, 2006.
3. Jean J. Labrosse, "*Embedded Systems Building Blocks: Complete and Ready-To-Use Modulesin C*", The publisher, Paul Temme, 2011.
4. Ball S.R., "*Embedded microprocessor Systems - Real World Design*", Prentice Hall, 2002.
5. Lewin A.R.W. Edwards, "*Open source robotics and process control cookbook*", Elsevier Publications, 2005.
6. Ben-Zion Sandler, "*Robotics*", Elsevier Publications, 1999.

SUPPORTIVE COURSES

MA2013	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To impart analytical ability and to solve real life problems pertaining to branches of Computer Science and Engineering.

INSTRUCTIONAL OBJECTIVES

1.	To be exposed with logic
2.	To be thorough in mathematical induction
3.	To understand algebraic systems such as relations
4.	To be familiar with the basic concepts of lattices

UNIT I – LOGIC **9 hours**

Logic - Statements - Connectives - Truth tables - Normal forms - Predicate calculus - Inference Theory for Statement calculus and predicate calculus.

UNIT II – COMBINATORICS **9 hours**

Combinatory - Mathematical Induction - Pigeonhole principle - Principle of inclusion and exclusion.

UNIT III - RECURSIVE FUNCTIONS **9 hours**

Recursive Functions- Recurrence relation - Solution of recurrence relation using characteristic polynomial and using generating function - Recursive functions - Primitive recursive functions, Computable and non computable functions.

UNIT IV - ALGEBRAIC STRUCTURES **9 hours**

Algebraic Structures - Groups - Definition and examples only - Cyclic groups Permutation group (Sn and Dn) - Subgroups - Homomorphism and Isomorphism - Cosets - Lagrange's Theorem - Normal subgroups - Cayley's representation theorem.

UNIT V – LATTICES **9 hours**

Lattices - Partial order relations, Poset - Lattices, Hasse diagram - Boolean algebra.

REFERENCES

1. Tremblay J.P. and Manohar R., "*Discrete Mathematical Structures with applications to Computer Science*", McGraw Hill International Edition, 1987
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, 4th Edition, Tata McGraw Hill, 2002.
3. Venkataraman M.K. etal., "*Discrete Mathematics*", National Publishing Co.,2000.

4. Prof. Sundaresan V., Ganapathy Subramanian K.S.and Ganesan K., "*Discrete Mathematics*", New Revised Edition, 2001.
5. Alan Doerr and Kenneth Levasseur, "*Applied Discrete Structures for Computer Science*", Galgotia Publications (P) Ltd.,1992.
6. Liu C.L., "*Elements of Discrete Mathematics*", 2nd Edition, McGraw Hill Publications, 1985.
7. Gersting. J.L. , "*Mathematical Structures for Computer Science*", 3rd Edition, W.H. Freeman and Co., 1993.
8. Lidl and Pitz, "*Applied abstract Algebra*", Springer - Verlag, New York, 1984.

	GRAPH THEORY AND OPTIMIZATION TECHNIQUES	L	T	P	C
MA2010	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To develop analytical capability and to impart knowledge in graphs, linear programming problem and statistical methods and their applications in Engineering & Technology and to apply their concepts in engineering problems they would come across

INSTRUCTIONAL OBJECTIVES

1.	student should be able to understand graphs ,linear programming problems and statistical concepts.
2.	Students should be able to apply the concepts in solving the Engineering problems

UNIT I - BASICS OF GRAPH THEORY **9 hours**

Graphs - Data structures for graphs - Subgraphs - Operations on Graphs Connectivity – Networks and the maximum flow - Minimum cut theorem - Trees - Spanning trees - Rooted trees – Matrix representation of graphs.

UNIT II - CLASSES OF GRAPHS **9 hours**

Eulerian graphs and Hamiltonian graphs - Standard theorems - Planar graphs - Euler's formula - Five colour theorem - Coloring of graphs - Chromatic number (vertex and edge) properties and examples - Directed graphs

UNIT III- GRAPH ALGORITHM

Computer Representation of graphs - Basic graph algorithms - Minimal spanning tree algorithm - Kruskal and Prim's algorithm - Shortest path algorithms - Dijsktra's algorithm - DFS and BFS algorithms.

UNIT IV - OPTIMIZATION TECHNIQUES **9 hours**

Linear programming – Graphical methods – Simplex method (Artificial variables not included) – Transportation and assignment problems.

UNIT V – STATISTICS **9 hours**

Tchebyshev's inequality – Maximum likelihood estimation – Correlation – Partial correlation – Multiple correlations.

REFERENCES

1. Narsingh Deo, "*Graph Theory with Applications to Engineering and Computer Science*", PHI 1974.
2. Rao S.S., "*Engineering Optimization: Theory and Practice*", New Age International Pvt. Ltd., 3rd Edition 1998.

MA2011	**STOCHASTIC PROCESSES AND QUEUEING THEORY**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To impart knowledge on probability concepts to study their applications in stochastic processes & queueing theory

INSTRUCTIONAL OBJECTIVES

1.	Compute the characteristics of the random variable given the probabilities
2.	Understand and apply various distribution
3.	Solve cases of different Stochastic processes along with their properties.
4.	Use discrete time finite state Markov chains
5.	Gain sufficient knowledge in principles of queueing theory

UNIT I - RANDOM VARIABLES **9 hours**

One dimensional and two dimensional Random Variables – Characteristics of Random Variables : Expectation, Moments.

UNIT II - THEORETICAL DISTRIBUTIONS **9 hours**

Discrete : Binomial, Poisson, Negative Binomial, Geometric, Uniform Distributions.

Continuous: Uniform, Exponential, Erlang and Gamma, Weibull Distributions.

UNIT III - STOCHASTIC PROCESSES **9 hours**

Classification of Stochastic Processes – Bernoulli process – Poisson process – Pure birth process – Birth and Death process.

UNIT IV - MARKOV CHAINS **9 hours**

Introduction – Discrete-Parameter Markov Chains – Transition Probability Matrix – Chapman Kolmogorov Theorem – State classification and limiting distributions.

UNIT V- QUEUING THEORY **9 hours**

Introduction – Characteristics of Markovian Single server and Multi server queuing models [(M/M/1) : (∞ / FIFO), (M/M/1) : (N / FIFO), (M/M/s) : (∞ /FIFO)] – M/G/1 Queuing System – Pollaczek Khinchin formula.

REFERENCES

1. Kishore.S.Trivedi, "*Probability & Statistics with Reliability, Queuing and Computer Science Applications*", PHI, New Delhi, 1995.
2. Veerajan T, "*Probability, Statistics and Random Processes*", 3rd Edition Tata McGraw Hill, New Delhi, 2002.
3. Gupta S.C and Kapoor V.K, "*Fundamentals of Mathematical Statistics*", 9th revised edition, Sultan Chand & Co., New Delhi 2003.
4. Gross.D and Harris.C.M. "*Fundemental of Queuing theory*", John Wiley and Sons, 1985.
5. Allen.A.O., "*Probability, Statistics and Queuing Theory*", Academic Press, 1981.

SEMESTER I

CAC2001	**Career Advancement Course For Engineers - I**	L	T	P	C
	Total Contact Hours - 30	**1**	**0**	**1**	**1**
	Prerequisite				
	Nil				
PURPOSE					
To enhance holistic development of students and improve their employability skills					

INSTRUCTIONAL OBJECTIVES

1. To improve aptitude, problem solving skills and reasoning ability of the student.
2. To collectively solve problems in teams & group.

3. Understand the importance of verbal and written communication in the workplace
4. Understand the significance of oral presentations, and when they may be used.
5. Practice verbal communication by making a technical presentation to the class
6. Develop time management Skills

UNIT I–BASIC NUMERACY

- Types and Properties of Numbers, LCM, GCD, Fractions and decimals, Surds

UNIT II-ARITHMETIC – I

- Percentages, Profit & Loss, Equations

UNIT III-REASONING - I

- Logical Reasoning

UNIT IV-SOFT SKILLS - I

- Presentation skills, E-mail Etiquette

UNIT V-SOFT SKILLS - II

- Goal Setting and Prioritizing

ASSESSMENT

Soft Skills (Internal)

Assessment of presentation and writing skills.

Quantitative Aptitude (External)

Objective Questions- 60 marks
Descriptive case lets- 40 marks*
Duration: 3 hours
***Engineering problems will be given as descriptive case lets.

REFERENCE:

1. Quantitative Aptitude by Dinesh Khattar – Pearsons Publicaitons
2. Quantitative Aptitude and Reasoning by RV Praveen – EEE Publications
3. Quantitative Aptitude by Abijith Guha – TATA Mc GRAW Hill Publications
4. Soft Skills for Everyone by Jeff Butterfield – Cengage Learning India Private Limited
5. Six Thinking Hats is a book by Edward de Bono - Little Brown and Company
6. IBPS PO - CWE Success Master by Arihant - Arihant Publications(I) Pvt.Ltd – Meerut

SEMESTER II

CAC2002	**Career Advancement Course For Engineers - II**	L	T	P	C
	Total Contact Hours - 30	**1**	**0**	**1**	**1**
	Prerequisite				
	Nil				

PURPOSE
To enhance holistic development of students and improve their employability skills

INSTRUCTIONAL OBJECTIVES

1. To improve aptitude, problem solving skills and reasoning ability of the student.
2. To collectively solve problems in teams & group.
3. Understand the importance of verbal communication in the workplace
4. Understand the significance of oral presentations, and when they may be used.
5. Understand the fundamentals of listening and how one can present in a group discussion
6. Prepare or update resume according to the tips presented in class.

UNIT I-ARITHMETIC – II

- Ratios & Proportions, Mixtures & Solutions

UNIT II - MODERN MATHEMATICS

- Sets & Functions, Data Interpretation, Data Sufficiency

UNIT III – REASONING - II

- Analytical Reasoning

UNIT IV – COMMUNICATION - I

- Group discussion, Personal interview

UNIT V - COMMUNICATION - II

- Verbal Reasoning test papers

ASSESSMENT

Communication (Internal)

Individuals are put through formal GD and personal interviews. Comprehensive assessment of individuals' performance in GD & PI will be carried out.

Quantitative Aptitude (External)

Objective Questions- 60 marks (30 Verbal +30 Quants)
Descriptive case lets- 40 marks*
Duration: 3 hours
*Engineering problems will be given as descriptive case lets.

REFERENCES

1. Quantitative Aptitude by Dinesh Khattar – Pearsons Publicaitons
2. Quantitative Aptitude and Reasoning by RV Praveen – EEE Publications
3. Quantitative Aptitude by Abijith Guha – TATA Mc GRAW Hill Publications
4. General English for Competitive Examination by A.P. Bharadwaj – Pearson Educaiton
5. English for Competitive Examination by Showick Thorpe - Pearson Educaiton
6. IBPS PO - CWE Success Master by Arihant - Arihant Publications(I) Pvt.Ltd - Meerut
7. Verbal Ability for CAT by Sujith Kumar - Pearson India
8. Verbal Ability & Reading Comprehension by Arun Sharma - Tata McGraw – Hill Education

SEMESTER III

CAC2003	**Career Advancement Course For Engineers - III**	L	T	P	C
	Total Contact Hours - 30	**1**	**0**	**1**	**1**
	Prerequisite				
	Nil				

PURPOSE	
To develop professional skills abreast with contemporary teaching learning methodologies	
INSTRUCTIONAL OBJECTIVES **At the end of the course the student will be able to**	
1	acquire knowledge on planning, preparing and designing a learning program
2	prepare effective learning resources for active practice sessions
3	facilitate active learning with new methodologies and approaches
4	create balanced assessment tools
5	hone teaching skills for further enrichment

UNIT I- DESIGN **(2 hrs)**

- Planning &Preparing a learning program.
- Planning & Preparing a learning session

UNIT II – PRACTICE **(2 hrs)**

- Facilitating active learning
- Engaging learners

UNIT III – ASSESSMENT **(2 hrs)**

- Assessing learner's progress
- Assessing learner's achievement

UNIT IV – HANDS ON TRAINING **(10 hrs)**

- Group activities – designing learning session
- Designing teaching learning resources
- Designing assessment tools
- Mock teaching session

UNIT V – TEACHING IN ACTION **(14 hrs)**

- Live teaching sessions
- Assessments

ASSESSMENT (Internal)

Weightage:
Design - 40%
Practice – 40%
Quiz – 10%
Assessment – 10%

REFERENCES

Cambridge International Diploma for Teachers and Trainers Text book by Ian Barker - Foundation books
Whitehead, Creating a Living Educational Theory from Questions of the kind: How do I improve my Practice? Cambridge J. of Education

AMENDMENTS

S.No.	Details of Amendment	Effective from	Approval with date