MINOR DEGREES OFFERED UNDER SVEC-19 REGULATIONS

Offering Dept.	Title of the Minor	Students of Eligible Branches
CSE	Artificial Intelligence and Machine Learning	All branches except CSE, IT and CSSE
IT	Internet of Things	All branches except IT
CSSE	Cyber Security	All branches except CSE, IT and CSSE
ECE	VLSI and Embedded Systems	All branches except ECE
EEE	Power Systems and Drives	All branches except EEE
EIE	Instrumentation and Control Engineering	All branches except EIE
ME	Robotics	All branches except ME
CE	Sustainable Engineering	All branches except CE

Academic Regulations for Minor Degree:

The concept of Minor degree is introduced in the curriculum of all B.Tech. programs offering a Major degree. The main objective of Minor degree in a discipline is to provide additional learning opportunities for academically motivated students and it is an optional feature of the B.Tech. Program. To earn a Minor degree in a discipline, a student has to earn 18 extra credits (By studying FIVE theory & THREE laboratory courses or SIX Theory Courses) from the core courses of the minor discipline.

a. Students having a CGPA of 8.0 or above up to II B.Tech I-Semester without any backlogs shall be permitted to register for a Minor degree by paying the requisite fee.

b. In the subsequent semesters, the student has to pass all the courses registered for Major and Minor Degrees in the first attempt i.e., regular examinations without any backlog to keep the Minor Degree registration active or else it shall be cancelled.

c. If a student becomes ineligible for continuing the Minor Degree, the earned credits under Minor Degree cannot be transferred to Major

Degree; they will remain extra. These additional courses will be mentioned in the transcript. However, they are eligible to receive B.Tech. Degree after satisfying its requirements.

d. The evaluation pattern of the courses shall be similar to the evaluation of regular program courses.

e. Minimum strength required for offering Minor Degree in a discipline is 40 students.

f. A student registered for Minor degree shall pass in all subjects that constitute the requirement for the Minor degree program. No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for Minor degree program.

g. The Minor degree shall be mentioned in the degree certificate as Bachelor of Technology in XXX with Minor in YYY. For example, Bachelor of Technology in Computer Science & Engineering with Minor in Title of the Minor Pursued. This shall also be mentioned in the transcripts, along with the list of courses taken for Minor degree program. However, the performance of the student in the Minor courses will not be considered for the calculation of SGPA and CGPA for the award of Major Degree.

h. Separate course/class work and time table shall be arranged for the various Minor degree programs. Attendance regulations for these Minor discipline programs shall be as per regular courses.

i. Students aspiring for Minor degree must register from III B.Tech I-Semester onwards and must opt for a Minor in a discipline other than the discipline he is registered in.

j. A Student shall register for Minor with the following combinations:

Offering Theory and Laboratory Courses: SEVEN credits in a semester starting from III B.Tech I-Semester to III B.Tech II-Semester (TWO theory & ONE laboratory courses) and FOUR credits in IV B.Tech I-Semester (ONE theory & ONE laboratory courses).

Offering Theory Courses only: SIX credits in a semester starting from III B.Tech I-Semester to IV B.Tech I-Semester (TWO theory courses).

NOTE: Interested meritorious students shall be permitted to register either for a Minor degree in a discipline (or) Honors Degree in a discipline only, but not both.

MINOR DEGREE IN
INTERNET OF THINGS

Offering Department: INFORMATION TECHNOLOGY
Students of Eligible Branches: CSE, CSSE,ECE, EEE, EIE, ME and CE

COURSE STRUCTURE

Year & Semester	Course Code	Course Title	Contact Periods per week				C	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
III B.Tech. I-Sem (2 Theory + 1 Lab)	19BT51208	Embedded System Design and Architecture	3	-	-	3	3	40	60	100
	19BT51209	IoT Architecture and Protocols	3	-	-	3	3	40	60	100
	19BT51210	Sensor Technologies	3	-	-	3	3	40	60	100
	19BT51234	Sensors based IoT Lab	-	-	2	2	1	50	50	100
III B.Tech. II-Sem (2 Theory + 1 Lab)	19BT61207	Cloud Storage and Computing	3	-	-	3	3	40	60	100
	19BT61208	Privacy and Security in IoT	3	-	-	3	3	40	60	100
	19BT61209	Software Defined Networks for IoT	3	-	-	3	3	40	60	100
	19BT61233	IoT Application Development Lab	-	-	2	2	1	50	50	100
IV B.Tech. I-Sem (1 Theory + 1 Lab)	19BT71210	Advanced IoT	3	-	-	3	3	40	60	100
	19BT71211	Big Data Analytics for IoT	3	-	-	3	3	40	60	100
	19BT71234	Advanced IoT Lab	-	-	2	2	1	50	50	100

Note: If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

III B. Tech. – I Semester
(19BT51208) EMBEDDED SYSTEM DESIGN AND ARCHITECTURE

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES:-

COURSE DESCRIPTION: Concepts of Embedded systems and its computing; The programming of 8051; The Embedded C and Applications; Applications of RTOS and Embedded Software Development Tools; The ARM and SHARC Processor's Architectures.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Demonstrate knowledge on Fundamental concepts of Embedded Systems in Real-time.
CO2. Demonstrate programming skills using 8051.
CO3. Develop the Embedded Systems applications.
CO4. Demonstrate knowledge on RTOS concepts and Embedded Software Development Tools through RTOS.
CO5. Demonstrate knowledge on advanced processors architecture such as ARM and SHARC and the bus protocols such as I2C and CAN bus.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO EMBEDDED COMPUTING (08 periods)

Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, complex systems and microprocessor, classification, major application areas, the embedded system design process, formalisms for system design, design examples

UNIT-II: THE 8051 ARCHITECTURE (09 periods)

Introduction, 8051 Micro controller Hardware, Input/output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/output, Interrupts.The Assembly Language Programming Process, Instructions of 8051 Programming Tools and Techniques, Simple Programs.

UNIT-III: INTRODUCTION TO EMBEDDED C AND APPLICATIONS (10 periods)

Embedded systems programming in C, binding and running embedded C program in Keil IDE, dissecting the program, building the hardware. Basic techniques for reading and writing from I/O port pins, LED interfacing, interfacing with keyboards, displays, D/A and A/D conversions, using embedded C interfacing.

UNIT-IV: INTRODUCTION TO REAL – TIME OPERATING SYSTEMS (10 periods)

Tasks and Task States, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer Functions, Events, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Interrupt Routines in an RTOS Environment.

EMBEDDED SOFTWAREDEVELOPMENT TOOLS: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded Software into the Target System; Debugging Techniques: Testing on Host Machine.

UNIT-V: INTRODUCTION TO ADVANCED ARCHITECTURES (08 periods)

ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus.

Total Periods: 45

Topics for self-study are provided in the lesson plan

TEXT BOOKS:

1. Wayne Wolf, *Principles of Embedded Computing System Design*, 2nd Edition, Elsevier, 2014.
2. Kenneth J. Ayala, *The 8051 Microcontroller*, Thomson, 2nd Edition, 2016.

REFERENCE BOOKS:

1. David E. Simon, *An Embedded Software Primer*, Pearson Education, 2009.
2. Dr. KVKKPrasad, *Embedded/Real-Time Systems: Concepts, Design And Programming*, Black Book, DreamTech Press, 2003.

ADDITIONAL LEARNING RESOURCES:

Web References:

1. https://www.smartzworld.com/notes/embedded-systems-es/
2. http://notes.specworld.in/embedded-systems-es/
3. http://education.uandistar.net/jntu-study-materials
4. http://www.nptelvideos.in/2012/11/embedded-systems.html

E-TextBooks:

1. https://www.scribd.com/doc/233633895/Intro-to-Embedded-Systems-by-Shibu-Kv
2. http://www.ee.eng.cmu.ac.th/~demo/think/_DXJSq9r3TvL.pdf
3. https://www.scribd.com/doc/55232437/Embedded-Systems-Raj-Kamal
4. https://docs.google.com/file/d/0B6Cytl4eS_ahUS1LTkVXb1hxa00/edit

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	-		-	-	-	-	-	-	2	2	-	-
CO2	2	3	2	2	2	2	-	-	-	-	-	-	2	2	3	2
CO3	2	2	3	2	2	2	-	-	-	-	-	-	2	2	2	3
CO4	2	2	-	-	3	-	-	-	-	-	-	-	2	2	2	-
CO5	2	2	-	-	3	-	-	-	-	-	-	-	2	2	2	-
Average	2	2.25	2.5	2	2.5	2	-	-	-	-	-	-	2	2	2.25	2.5
Level of correlation of the course	2	3	3	2	3	2	-	-	-	-	-	-	2	2	3	3

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. – I Semester
(19BT51209) IoT ARCHITECTURE AND PROTOCOLS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: -

COURSE DESCRIPTION:
M2M to IoT An Architectural Overview and M2M and IoT Technology Fundamentals, IoT Architecture State of the Art, IoT Reference Architecture and Real-World Design Constraints, IoT Data Link Layer & Network Layer Protocols, Session Layer Protocols and Application Layer Protocols, Security in IoT Protocols and Case studies.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***
CO1. Demonstrate knowledge on architecture and technology of M2M to IoT.
CO2. Demonstrate knowledge on IoT architectures and identify design constraints of IoT.
CO3. Select suitable protocols of data link and network layer protocols for different applications of IoT.
CO4. Identify appropriate protocols of session and application layer protocols for different applications of IoT.
CO5**:** Evaluate security issues and challenges during implementation of real world models.

DETAILED SYLLABUS:

UNIT-I: (9 Periods)
M2M TO IoT AN ARCHITECTURAL OVERVIEW: Building 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: (9 Periods)
IoT ARCHITECTURE STATE OF THE ART: Introduction, State of the art, Architecture Reference Model- Reference model and architecture, IoT reference model.
IoT REFERENCEARCHITECTURE: Functional view, Functional view, Deployment and operational view, Other relevant architectural views
REAL-WORLD DESIGN CONSTRAINTS: Technical design constraints hardware is popular again, Data representation and visualization, Interaction and remote control

UNIT III: (9 Periods)
IoT DATA LINK LAYER: IEEE 802.15.4, IEEE 802.11ah, LoRaWAN, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy; **Network Layer Encapsulation Protocols:** 6LoWPAN, 6TiSCH, 6Lo;
NETWORK LAYER ROUTING PROTOCOLS: RPL, CORPL, CARP.

UNIT IV: (10 Periods)
SESSION LAYER PROTOCOLS: MQTT, AMQP, CoAP, XMPP, DDS;
APPLICATION LAYER PROTOCOLS: SCADA, Generic Web-Based Protocol.

UNIT V: (8 Periods)
SECURITY IN IoT PROTOCOLS: MAC 802.15.4, 6LoWPAN, RPL, IoT Challenges

CASE STUDIES: Smart Metering, Smart House, Smart Cities

Total Periods: 45

Topics for self-study are provided in the lesson plan

TEXT BOOKS:

1. Jan Holler and VlasiosTsiatsis, *From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence,* Elsevier, 2014.
2. David Hanes and Gonzalo Salgueiro, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things,* Cisco Press, 2017

REFERENCE BOOKS:

1. Peter Waher, *Learning Internet of Things*, PACKT publishing, 2015.
2. Olivier Hersent and David Boswarthick, *The Internet of Things Key Applications and Protocols*, John Wiley & Sons Ltd Publication, 2012.

ADDITIONAL LEARNING RESOURCE:

1. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	3
CO3	2	3	2	-	-	-	-	2	-	-	-	-	-	2	-	3
CO4	2	3	2	-	-	-	-	2	-	-	-	-	-	2	-	3
CO5	2	3	2	-	-	-	-	2	-	-	-	-	-	2	-	3
Average	2.2	3	2	-	-	-	-	2	-	-	-	-	-	2	-	3
Level of correlation of the course	2	3	2	-	-	-	-	2	-	-	-	-	-	2	-	3

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. – I Semester
(19BT51210) SENSOR TECHNOLOGIES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Physics.

COURSE DESCRIPTION: Sensor fundamentals and characteristics, Optical Sources and Detectors; Intensity Polarization and Interferometric Sensors, Phase sensor, Strain, Force, Torque and Pressure sensors; Position, Direction, Displacement and Level sensors, Velocity and Acceleration sensors, Electromagnetic velocity sensor, Light and Sound Sensors; Flow, Temperature and Acoustic sensors; Wearable Sensors.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Demonstrate knowledge on the characteristics of Sensors and principles of Optical Sources and Detectors.
CO2. Apply the principles of Intensity Polarization, Interferometric, Phase, Strain, Force, Torque and Pressure sensors in Sensor applications.
CO3. Apply the principles of Position, Direction, Displacement, Level, Velocity and Acceleration, Electromagnetic velocity, Sound and Light Sensors in Sensor applications.
CO4. Analyze the principles of Flow, Temperature and Acoustic sensors to build Sensor applications.
CO5**:** Analyze the principles of Wearable Sensors and identify suitable sensors for real time applications.

DETAILED SYLLABUS:

UNIT-I: (9 Periods)

SENSOR FUNDAMENTALS AND CHARACTERISTICS: Sensor Classification, Performance and Types, Error Analysis characteristics,

OPTICAL SOURCES AND DETECTORS: Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.

UNIT-II: (9 Periods)

INTENSITY POLARIZATION AND INTERFEROMETRIC SENSORS: Intensity sensor, Microbending concept, Interferometers, Mach Zehnder, Michelson, FabryPerot and Sagnac.

PHASE SENSOR: Phase detection, Polarization maintaining fibers.

STRAIN, FORCE, TORQUE AND PRESSURE SENSORS: Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.

UNIT-III: (9 Periods)

POSITION, DIRECTION, DISPLACEMENT AND LEVEL SENSORS: Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magneto strictive sensors.

Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor.

VELOCITY AND ACCELERATION SENSORS:
Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes.

UNIT-IV: (9 Periods)

FLOW SENSORS: pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. microflow sensor, coriolis mass flow and drag flow sensor.

TEMPERATURE SENSORS: thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor.

ACOUSTIC SENSORS: microphones-resistive, capacitive, piezoelectric, fiber optic, solid state electrect microphone.

UNIT-V: WEARABLE SENSORS (9 Periods)

From fibers to textile sensors - Interlaced network -Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors and other applications. FBG sensor in Intelligent Clothing and Biomechanics.

Total Periods: 45

Topics for self-study are provided in the lesson plan

TEXT BOOKS:

1. J. Fraden, *Handbook of Modern Sensors: Physical, Designs, and Applications*, AIP Press, 2004.
2. D. Patranabis, *Sensors and Transducers*, PHI Publication, 2nd Edition, 2014.

REFERENCE BOOKS:

1. Patranabis D, *Principles of Industrial Instrumentation*, Tata McGrawHill, End edition, 1997
2. Ganesh S. Hegde, *Mechatronics*, Published by University Science Press,2008.

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2			-	-	-	-	-	-	-	-	-	-	3	-	2
CO2	2	2	3	-	-	2	1	1	-	-	-	-	-	3	-	2
CO3	1	2	3	-	-	2	1	1	-	-	-	-	-	3	-	2
CO4	2	3	3	2		2	1	1	-	-	-	-	-	3	-	2
CO5	2	3	3	2		2	1	1	-	-	-	-	-	3	-	2
Average	1.8	2.5	3	2	-	2	1	1	-	-	-	-	-	3	-	2
Level of correlation of the course	2	3	3	2	-	2	1	1	-	-	-	-	-	3	-	2

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. –I Semester
(19BT51234) SENSOR BASED IoT LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	2	1

PRE-REQUISITES: -

COURSE DESCRIPTION: Hands-on experience on connecting IoT devices using Sensors, Arduino/Raspberry Pi, Bread Board.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Identify different types of Sensors and study their functionality in IoT
CO2. Demonstrate skills in connecting peripherals to Arduino/Raspberry Pi for data exchange.
CO3. Develop a Cloud platform to upload and analyze any sensor data
CO4. Demonstrate skills in connecting GSM, GPS, Gateways to micro controllers and perform Data Management in IoT.
CO5. Build a complete working IoT system involving prototyping, programming and data analysis.
CO6. Work independently or in teams to solve problems with effective communication.

LIST OF EXPERIMENTS:

1. Study of Different types of Sensors and Introduction to Arduino platform and programming.
2. Interfacing Arduino to Zigbee module.
3. Interfacing Arduino to GSM module and Bluetooth Module.
4. Introduction to Raspberry PI platform and python programming.
5. Interfacing sensors to Raspberry PI.
6. Communicate between Arduino and Raspberry PI using any wireless medium.
7. Log Data using Raspberry PI and upload to the cloud platform.
8. Design an IoT based system.

REFERENCE BOOKS:

1. ArshdeepBahga, Vijay Madisetti, *Internet of Things- A hands on approach*, 1st edition, VPI publications, 2014.
2. Adrian McEwen, HakinCassimally, *Designing the Internet of Things*, Wiley India, 2013
3. Massimo Banzi and Michael Shiloh, *Getting Started with Arduino*, 3rd Edition, Maker Media, 2015
4. Getting Started with Raspberry pi, Matt Richardson & Shawn Wallace, O'Reilly, 2014.

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	2	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO3	1	2	3	-	-	-	-	-	-	-	-	-	-	2	-	3
CO4	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	3
CO5	2	2	2	-	-	-	3						-	2	-	3
Average	2	2.6	2.5	2	-	-	3	-	-	-	-	-	-	2	-	3
Level of correlation of the course	2	3	3	2	-	-	3	-	-	-	-	-	-	2	-	3

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. –II Semester
(19BT61207) CLOUD STORAGE AND COMPUTING

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: -

COURSE DESCRIPTION: Introduction to Cloud Computing, Data Storage Networking fundamentals, Cloud Services and Platforms, Cloud Application Design.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to*:**
CO1. Demonstrate basic concepts and terminologies of Cloud Computing, Cloud-based Services and Applications.
CO2. Demonstrate Cloud, Virtualization and Data Storage Networking concepts.
CO3. Analyze Cloud Services, Platforms and Applications.
CO4. Apply different Cloud Services and Platforms to construct Cloud applications.
CO5. Design Cloud applications as per societal needs through different design approaches.

DETAILED SYLLABUS

UNIT-I: INTRODUCTION TO CLOUD COMPUTING (9 Periods)
Introduction, Characteristics of Cloud Computing. Cloud Models, Cloud Services Examples, Cloud-based Services and Applications.

UNIT-II: CLOUD AND DATA STORAGE (9 Periods)
CLOUD CONCEPTS AND TECHNOLOGIES: Virtualization, Load Balancing, Scalability and Elasticity, Deployment, Replication, Monitoring, Software Defined Networking, Network Function Virtualization, MapReduce, Identity and Access Management, Service Level Agreements and Billing.
DATA STORAGE FUNDAMENTALS: Server and I/O Architectures, Storage Hierarchy, From Bits to Bytes, Disk Storage Fundamentals, Initiators and Targets, How Data Is Written to and Read from a Storage Device, Storage Sharing vs. Data Sharing, Different Types of Storage.

UNIT-III: CLOUD SERVICES AND PLATFORM -I (9 Periods)
Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines, Amazon Simple Storage Service, Google Cloud Storage, Windows Azure Storage, Amazon Relational Data Store, Amazon DynamoDB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database and Windows Azure Table Service.

UNIT-IV: CLOUD SERVICES AND PLATFORM -II (9 Periods)
Application Runtimes and Framework, Queuing Services, Email Services, Notification Services, Media Services, Amazon CloudFront, Windows Azure Content Delivery Network, Amazon Elastic MapReduce, Google MapReduce Service, Google BigQuery, Amazon Elastic Beanstalk and Amazon CloudFormation.

UNIT-V: CLOUD APPLICATION DESIGN (9 Periods)
Introduction, Design Considerations for Cloud Applications, Reference Architectures for Cloud Applications, Cloud Application Design Methodologies and Data Storage Approaches.

Total Periods: 45

Topics for self-study are provided in the lesson plan

TEXT BOOKS:

1. ArshdeepBahga and Vijay Madisetti, *Cloud Computing – A Hands-on Approach,* Universities Press (India) Private Limited, 2014.
2. Greg Schulz, *Cloud and VirtualDataStorageNetworking,* CRC PressTaylor& Francis Group, 2012.

REFERENCE BOOKS:

1. Barrie Sosinsky, *Cloud Computing Bible,* Wiley India Pvt Ltd, 2011 (Reprint 2017).
2. Thomas Erl and RicardoPuttini, *Cloud Computing- Concepts, Technology and Architecture,* Pearson, 2014 (Seventh Impression 2017).

ADDITIONAL LEARNING RESOURCES:

1."Exploring the Google Toolkit", https://code.google.com/, drafted on 21 June, 2021.
2."Understanding Amazon Web Services", https://aws.amazon.com/, drafted on 21 June, 2021.

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-		-	-	-	-	-	-	-	1	1	3	-
CO2	3	-	-	-		-	-	-	-	-	-	-	2	2	2	-
CO3	2	3	-	-	2	-	-	-	-	-	-	-	2	2	2	-
CO4	1	2	2	-	2	-	-	-	-	-	-	-	1	1	3	-
CO5	1	2	3	-	2	-	-	-	-	-	-	-	2	2	3	-
Average	2	2.3	2.5	-	2	-	-	-	-	-	-	-	1.6	1.6	2.6	-
Level of correlation of the course	2	3	3	-	2	-	-	-	-	-	-	-	2	2	3	-

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. –II Semester
(19BT61208) PRIVACY AND SECURITY IN IoT

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Internet of Things Lab.

COURSE DESCRIPTION: Introduction of IoT; Securing The Internet Of Things; Cryptographic Fundamentals for IoT; Identity & Access Management Solutions for IoT; Privacy Preservation And Trust Models for IoT; Cloud Security for IoT.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***
CO1.Demonstrate knowledge on Security issues of IoT.
CO2. Apply Cryptographic Principles for IoT Security.
CO3. Identify suitable Access Management Solutions for IoT.
CO4. Apply Privacy Preservation and Trust Models for IoT.
CO5. Demonstrate knowledge on Cloud Security for IoT.

DETAILED SYLLABUS:

UNIT I– INTRODUCTION: SECURING THE INTERNET OF THINGS (9 periods)
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 (9periods)
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 periods)
Identity lifecycle, authentication credentials, IoT IAM infrastructure; Authorization with Publish/Subscribe schemes; access control.

UNIT IV – PRIVACY PRESERVATION AND TRUST MODELS FOR IoT (9 periods)
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 periods)
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.

Total Periods: *45*

Topics for self-study are provided in the lesson plan

TEXT BOOK:
1. Brian Russell, Drew Van Duren, *Practical Internet of Things Security*, Kindle Edition, 2016.

REFERENCE BOOK:

1. Fei Hu, *Security and Privacy in Internet of Things (IoTs)- Models, Algorithms, and Implementations*, CRC Press, 1st Edition, 2016

ADDITIONAL LEARNING RESOURCES:

1. https://www.fortinet.com/resources/cyberglossary/iot-security

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-		-	-	-	-	-	-	-	-	3	-	-
CO2	2	2	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO3	2	2	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO4	2	2	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO5	2	-	-		2	-	-	-	-	-	-	-	-	3	-	-
Average	2.2	2	3	2.5	2	-	-	-	-	-	-	-	-	3	-	-
Level of correlation of the course	2	2	3	3	2	-	-	-	-	-	-	-	-	3	-	-

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. –II Semester
(19BT61209)SOFTWARE DEFINED NETWORKS FOR IoT

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Internet of Things Lab.

COURSE DESCRIPTION: Packet Switching Terminology, Traditional Switch architecture, Fundamental Characteristics of SDN, SDN Controller, SDN Applications, SDN in the data center**,** Use Cases in the Data Center, Scope of the Internet of Things, SDN for IoT.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Demonstrate knowledge on characteristics of Data center and Network Technologies.

CO2. Demonstrate skills on Operating and performing Data flow in Software Defined Networks

CO3. Identify suitable Data Center topologies for virtualized environment.

CO4. Apply Software defined Networks concepts for the Internet of Things

CO5. Apply suitable addressing schemes and routing protocols to achieve QoS in SDN based IoT.

DETAILED SYLLABUS:

UNIT- I: INTRODUCTION TO SOFTWARE DEFINED NETWORKS (9 Periods)

Basic Packet-Switching Terminology, The Modern Data Center, Traditional Switch architecture, Autonomous and Dynamic Forwarding Tables, Evolution of Switches and Control Planes ,SDN Implications for Research and Innovation, Data Center Innovation, Data Center Needs, The Evolution of Networking Technology, Forerunners of SDN, Software Defined Networking is Born, Sustaining SDN Interoperability, Open Source Contributions, Legacy Mechanisms Evolve Toward SDN, Network Virtualization.

UNIT- II: FUNDAMENTAL CHARACTERISTICS OF SDN (9 Periods)

SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods, OpenFlow, OpenFlow Limitations, Potential Drawbacks of Open SDN,SDN via APIs, SDN via Hypervisor-Based Overlays, SDN via Opening Up the Device, Network Functions Virtualization, Alternatives Overlap and Ranking. Real-World Data Center Implementations, applications and SDN features.

UNIT-III: SDN IN THE DATA CENTER (9 Periods)

Data Center Definition, Data Center Demands, Tunneling Technologies for the Data Center, Path Technologies in the Data Center, Ethernet Fabrics in the Data Center, SDN Use Cases in the Data Center, Open SDN versus Overlays in the Data Center.

UNIT-IV: THE INTERNET OF THINGS (9 Periods)

Scope of the Internet of Things, Key Features of IoT Data, Technical requests for Openstack as a IoT-Cloud Platform, Feature of Message Broking, IoT architecture in NTT DATA, IoT architecture on Openstack, Endpoint-Aware Service Function Chaining, Service function chaining for the IoT data plane, Mobile Network Slicing for IoT, Introduction to IoTivity.

UNIT- V: SDN for IoT: **(9 Periods)**

SDN based IoT, IoT Host Management System Architecture, Network Topology, Experiment Environment, Host Address collection, Host blocking, Host address translation, Dynamic QoS Routing Algorithm in SDN,SDN based Dynamic QoS Routing Framework, Mobility Support in SDN IoT networks, SDN and Cloud based Forest Fire Detection System using IoT devices.

Total Periods: *45*

Topics for self-study are provided in the lesson plan

TEXT BOOKS:

1. Paul Goransson and Chuck Balck, *Software Defined Networks -A comprehensive Approach*, 1st Edition, 2014.
2. Sunyoung Han, Software Defined Network for Internet of Things, Chulalongkorn University, Thailand, 2016.

REFERENCE BOOKS:

1. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Addison-Wesley, 2015.
2. Jim Doherty, SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization, Pearson, 2017.

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	3	-	-
CO2	2	3	-	-	2	-	-	-	-	-	-	2	3	2	-	-
CO3	1	2	3	-	-	-	-	-	-	-	-	2	3	1	-	-
CO4	1	2	3		-	1	-	-	-	-	-	2	3	1	-	-
CO5	2	3	3	1	2	-	2	-	-	-	-	2	3	2	-	-
Average	1.6	2.5	3	-	2	1	2	-	-	-	-	2	3	1.6	-	-
Level of correlation of the course	2	3	3	-	2	1	2	-	-	-	-	2	3	2	-	-

Level of Correlation: 3 - High 2 - Medium 1 - Low

III B. Tech. –II Semester
(19BT61233) IoT APPLICATION DEVELOPMENT LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	2	1

PRE-REQUISITES: A course on Internet of Things Lab.

COURSE DESCRIPTION: Hands-on practice on Internet of Things (IoT); Usage of Sensors, Arduino microcontroller and Raspberry Pi microprocessor; Development of IoT Applications for societal needs; IoT with Cloud environments.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Demonstrate hands-on experience on IoT.

CO2. Use Sensors, Arduino microcontroller and Raspberry Pi microprocessor for the development of IoT applications.

CO3. Analyze the user requirements for the development of IoT applications.

CO4. Develop IoT applications to solve societal problems using cloud environment.

CO5. Work independently or in teams to solve problems with effective communication.

LIST OF EXPERIMENTS:

1. Develop an IoT application to control servo motor using Arduino/Raspberry Pi.
2. Develop an IoT application using Arduino/Raspberry Pi for fire alarm.
3. Develop an IoT application to measure temperature, humidity, light and distance using Arduino/Raspberry Pi.
4. Develop an IoT application to control home appliances using a smart phone.
5. Develop an IoT application to measure soil moisture, air and water quality using Arduino/Raspberry Pi.
6. Develop an IoT application to control and monitor Street lights using Arduino/Raspberry Pi.
7. Develop an IoT application to detect obstacles using Arduino/Raspberry Pi.
8. Develop an IoT application using Arduino/Raspberry Pi to monitor heartbeat, blood pressure, etc. of a person and to upload health information to thingspeak cloud.
9. Develop an Alexa based Home Automation System using IoT.

REFERENCE BOOKS:

1. ArshdeepBahga and Vijay Madisetti, *Internet of Things(A hands on approach),* 1st Edition, VPI Publications, 2014.
2. Adrian McEwen and HakinCassimally, *Designing the Internet of Things,* Wiley India.
3. Massimo Banzi and Michael Shiloh*, Getting Started with Arduino*, Third Edition, Maker Media.
4. Matt Richardson and Shawn Wallace, *Getting Started with Raspberry Pi*, O'Reilly, 2014.

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3	3
CO2	1	2	3	3	3	3	3	3	-	-	-	-	-	-	3	3
CO3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	3	3
CO4	1	2	3	3	3	3	3	3	-	-	-	-	-	-	3	3
CO5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	3	3
Average	1.75	2.25	3	3	3	3	3	3	3	3	-	3	-	-		
Level of correlation of the course	2	3	3	3	3	3	3	3	2	3	-	3	-	-	3	3

Level of Correlation: 3 - High 2 - Medium 1 - Low

IV B. Tech. - I Semester

(19BT71210) **ADVANCED IoT**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Internet of Things Lab.

COURSE DESCRIPTION: Introduction to the Industrial Internet; Industrial Internet Use-Cases; Technical and Business Innovators of the Industrial Internet; IIoT Reference Architecture, Designing Industrial Internet Systems; Examining the Access Network Technology & Protocols; Examining the Middleware Transport Protocols; Middleware Software Patterns; Middleware Industrial Internet of Things Platforms; IIoT WAN Technologies and Protocols; Securing the Industrial Internet; Introducing Industry 4.0; Smart Factories.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Demonstrate knowledge on IIoT Concepts, applications, Technical requirements.
CO2. Design and develop IIoT applications, using different architectures and protocols.
CO3. Identify suitable middleware Transport Protocols, and Software Patterns to design APIs and Platforms.
CO4. Demonstrate knowledge on WAN Technologies & Protocols and security management in IIoT.
CO5. Demonstrate knowledge on Industry 4.0 and smart factories

DETAILED SYLLABUS:

UNIT-I: **(9 Periods)**

INTRODUCTION TO THE INDUSTRIAL INTERNET: What is IIoT, Key IIoT Technologies Catalysts and Precursors of the IIoT, Innovation and the IIoT, Key Opportunities and Benefits, The Digital and Human Workforce.

INDUSTRIAL INTERNET USE-CASES: Healthcare, Oil and Gas Industry, Smart Office, Logistics and the Industrial Internet, Retail

THE TECHNICAL AND BUSINESS INNOVATORS OF THE INDUSTRIAL INTERNET: Miniaturization, Cyber Physical Systems (CPS), Wireless Technology, IP Mobility, Network Functionality Virtualization(NFV), Network Virtualization, The Cloud and Fog, Big Data and Analytics, M2M Learning and Artificial Intelligence, Augmented Reality, 3D Printing, People versus Automation

UNIT-II: **(9 Periods)**

IIoT REFERENCE ARCHITECTURE: The IIC Industrial Internet Reference Architecture, Industrial Internet Architecture Framework (IIAF), Architectural Topology, The Three-Tier Topology, Connectivity, Key System Characteristics, Data Management.

DESIGNING INDUSTRIAL INTERNET SYSTEMS: The Concept of the IIoT, The Proximity Network, WSN

Edge Node, Legacy Industrial Protocols, Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, Gateways

EXAMINING THE ACCESS NETWORK TECHNOLOGY AND PROTOCOLS: The Access Network, Access Networks Connecting Remote Edge Networks

(9 Periods)

UNIT-III:

EXAMINING THE MIDDLEWARE TRANSPORT PROTOCOLS: TCP/IP, UDP, Reliable Transport Protocol (RTP), CoAP (Constrained Application Protocol).
MIDDLEWARE SOFTWARE PATTERNS: Publish/Subscribe Pattern: MQTT, XMPP, AMQP, DDS, Delay Tolerant Networks (DTN).
SOFTWARE DESIGN CONCEPTS: API (Application Programming Interface), API: A Technical Perspective, Web Services.
MIDDLEWARE INDUSTRIAL INTERNET OF THINGS PLATFORMS: Middleware Architecture, IIoT Middleware Platforms.

UNIT-IV: (9 Periods)

IIoT WAN TECHNOLOGIES AND PROTOCOLS: IIoT Device Low-Power WAN Optimized Technologies for M2M, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio.
SECURING THE INDUSTRIAL INTERNET: Security in Manufacturing: PLCs and DCS, Securing the OT, Network Level: Potential Security Issues, System Level: Potential Security Issues, Identity Access Management

UNIT-V: (9 Periods)

INTRODUCING INDUSTRY 4.0: Defining Industry 4.0, Four Main Characteristics of Industry 4.0, The Value Chain, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, Smart Manufacturing.
SMART FACTORIES: Introducing the Smart Factory, Smart Factories in Action, Importance of Smart Manufacturing, Real-World Smart Factories - GE's Brilliant Factory, Airbus: Smart Tools and Smart Apps, Siemens' Amberg Electronics Plant (EWA), Industry 4.0: The Way Forward

Total Periods: *45*

Topics for self-study are provided in the lesson plan

TEXT BOOK:

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress Publications, 2016.

REFERENCE BOOKS:

1. Giacomo Veneri and Antonio Capasso, *Hands-on Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0*, Ingram Academic Services, 2018.
2. Vijay Madisetti and ArshdeepBahga, *Internet of Things A Hands-On- Approach*, Orient Blackswan Private Limited, 2015.
3. Francis daCosta, *Rethinking the Internet of Things: A Scalable Approach to Connecting Everything*", 1st edition, Apress Publications, 2014.

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-		-	-	-	-	-	3	-	3
CO2	2	2	3	3	2	-	-	2	-	-	-	-	-	3	-	2
CO3	2	2	-	-	2	-	-	2	-	-	-	-	-	3	-	2
CO4	2	-	-	-	2	-	-	2	-	-	-	-	-	3	-	2
CO5	2	-	-	-	2	-	-	2	-	-	-	-	-	3	-	2
Average	2.2	2	3	3	2	-	-	2	-	-	-	-	-	3	-	2.2
Level of correlation of the course	2	2	3	3	2	-	-	2	-	-	-	-	-	3	-	2

Level of Correlation: 3 - High 2 - Medium 1 - Low

IV B. Tech. - I Semester
(19BT71210)**BIG DATA ANALYTICS FOR IoT**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	1	-	4

PRE-REQUISITES: A course on Internet of Things Lab.

COURSE DESCRIPTION: The course provides introduction to IoT Analytics andBig Data Analytics, Sensors and Tools of IoT Analytics, Services of IoT, Big Data Storage Systems for IoT, Case Studies and Applications of IoT

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1.Use Analytical Architecture and its exploration in Data Analytics for IoT
CO2. Analyze and Visualize the Sensor data for IoT.
CO3. Apply Advanced Analytical Architectures as a service for IoT.
CO4. Analyze Big data storage systems in IoT.
CO5. Develop Real Time solutions for given societal problems.

DETAILED SYLLABUS:

UNIT-I: **INTRODUCING IoT ANALYTICS (9 periods)**

Introduction: IoT Data and BigData, Challenges of IoT Analytics Applications,IoT Analytics Lifecycle and Techniques.

IoT, Cloud and Big Data Integration for IoT Analytics: Cloud-based IoT Platform,Data Analytics for the IoT,Data Collection Using Low-power, Long-range Radios,WAZIUP Software Platform, iKaaS Software Platform.

UNIT-II: SENSORS AND TOOLS OF IoT ANALYTICS (9 periods)

Sensors: Architecture for Social and Physical Sensors, Local Event Retrieval, Using Sensor Metadata Streams to Identify Topics of Local Events in the City, Venue Recommendation. **Development Tools for IoT Analytics Applications:** VITAL Development Environment,Tools for IoT Semantic Analytics**,** Development Examples:Predict the Footfall,Find a Bike.

UNIT-III: IoT ANALYTICS AS A SERVICE (9 periods)

Architecture for IoT Analytics-as-a-Service, Sensing-as-a-Service Infrastructure Anatomy, Scheduling, Metering and Service Delivery, Sensing-as-a-Service Examples, From Sensing-as-a-Service to IoT-Analytics-as-a-Service, Data Collection to Deployment and Operationalization, Ethical IoT.

UNIT-IV: BIG DATA STORAGE SYSTEMS AND CASE STUDIES FOR IoT (9 periods)

Perspectives and Challenges: Big data analytics for IoT,Data Storage and Access for IoT,Dynamic-Data Handling in Big Data Storage Systems,Heterogeneous Datasets in IoT Big Data,Semantic Analytics for Big Data.

Case Studies: Data Analytics in Smart Buildings, Internet-of-Things Analytics for Smart Cities.

UNIT V – APPLICATIONS OF IoT AND BIG DATA SOLUTIONS (9 Periods)

IoTBDs Applications: Smart Transportation**,** Smart Healthcare, Smart Grid, Smart Inventory System, Smart Manufacturing, Smart Retail, Smart agriculture.

Big Data Management Solutions for IoT: Case Study – Connected Car.

Total Periods: 45

Topics for self-study are provided in the lesson plan

TEXT BOOKS:

1. John Soldatos, *Building Blocks for IoT Analytics*, River Publishers, 2017.
2. Pethuru Raj, T. Poongodi, Balamurugan Balusamy, and Manju Khari, *Internet of Things and Big Data Analytics Integrated Platforms and Industry Use Cases*, 1st edition, CRC Press, 2020.

REFERENCE BOOKS:

1. HwaiyuGeng, P.E., *Internet of Things and Data Analytics Handbook*, Wiley Publishing, 2017.
2. Dey. N, Hassanien A.E, Bhatt C, Ashour A.S, Satapathy S.C, *Data Analytics: Internet of Things and Big Data Analytics Toward Next-Generation Intelligence*, Springer, 2018.

ADDITIONAL LEARNING RESOURCES:

1. https://www.tutorialspoint.com/excel_data_analysis/data_analysis_overview.html
2. https://data-flair.training/blogs/data-analytics-tutorial/
3. https://pythonprogramming.net/data-analysis-tutorials/

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	-	-			-	-	-	-	-	3	-	-	-
CO2	2	3	-	-	-	2	1	-	-	-	-	-	3	-	-	-
CO3	1	2	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO4	2	2	2	2	3	-	-	-	-	-	-	-	3	-	-	-
CO5	2	2	3	-	-	-	-	2	-	-	-	-	3	-	-	-
Average	1.8	2.2	2.75	2	3	2	1	2	-	-	-	-	3	-	-	-
Level of correlation of the course	2	2	3	2	3	2	1	2	-	-	-	-	3	-	-	-

Level of Correlation: 3 - High 2 - Medium 1 - Low

IV B. Tech. –I Semester
(19BT71234) **ADVANCED IoT LAB**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	2	1

PRE-REQUISITES: A Course on Internet of Things Lab.

COURSE DESCRIPTION: Hands-on practice on Internet of Things (IoT); IBM Bluemix; Amazon AWS cloud; Google Firebase; Git hub IoT packages; Python IoT libraries for the development of IoT applications.

COURSE OUTCOMES: ***After successful completion of this course, the students will be able to:***

CO1. Demonstrate hands-on experience on IoT.
CO2. Use IBM Bluemix, Amazon AWS cloud, Google Firebase, Git hub IoT packages and Python libraries for the development of IoT applications.
CO3. Analyze the user requirements for the development of IoT applications.
CO4. Develop IoT applications to solve societal problems using cloud environment.
CO5. Work independently or in teams to solve problems with effective communication.

LIST OF EXPERIMENTS:

1. Study of AT89S52 Ultra Development Kit with Development Tool /Environment of Kiel Software for Microcontroller programming
2. Familiarize with Intel Galileo Gen2 board and understand the procedure of creation and compilation of C source code.
3. Study of IoT Data Logging using Beaglebone Black and Thingspeak.
4. Turn your smartphone into an IoT device using the IBM Watson IoT Platform cloud-hosted service.
5. Controlling home light using WiFi Node MCU, and Relay module
6. Develop an application using the Google Firebase NodeMCU ESP8266
   a) Connecting Arduino Node-MCU with Google Firebase
   b) Control Led Using Firebase Console
   c) Control Led with Android App using Firebase database
7. Develop an application using the Google Firebase for controlling LED and Android App with NodeMCU
8. Configuring IOT Based DHT Sensor using AWS
9. Design and develop Alexa based Home Automation System using AWS.

REFERENCE BOOKS:

1. ArshdeepBahga and Vijay Madisetti, *Internet of Things(A hands on approach),* 1st Edition, VPI Publications, 2014.
2. Adrian McEwen and HakinCassimally, *Designing the Internet of Things,* Wiley India.
3. Massimo Banzi and Michael Shiloh*, Getting Started with Arduino*, 3rd Edition, Maker Media.

ADDITIONAL LEARNING RESOURCES:

1. https://aws.amazon.com/iot-core/getting-started/
2. https://www.balena.io/docs/learn/develop/integrations/bluemix/
3. https://github.com/thingsboard
4. https://www.javatpoint.com/iot-internet-of-things

CO-PO and PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	2	-	-	-	-	-	-	-	-	3	-	3
CO2	2	2	3	-	2	-	-	-	-	-	-	-	-	3	-	2
CO3	2	2	3	3	2	-	-	-	-	-	-	-	-	3	-	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	-	3	-	2
CO5	2	-	-	-	2	-	-	-	-	-	-	-	-	3	-	2
Average	2.2	2	3	2.5	2	-	-	-	-	-	-	-	-	3	-	2.2
Level of correlation of the course	2	2	3	3	2	-	-	-	-	-	-	-	-	3	-	2

Level of Correlation: 3 - High 2 - Medium 1 - Low