VARDHAMAN COLLEGE OF ENGINEERING
(AUTONOMOUS)
Affiliated to **JNTUH,** Approved by **AICTE,** Accredited by **NAAC** with **A++** Grade, **ISO 9001:2015** Certified
Kacharam, Shamshabad, Hyderabad - 501218, Telangana, India

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CURRICULUM

For

Bachelor of Technology (Minor)

In

Internet of Things (IoT)

Department of Electronics and Communication Engineering

Programme Curriculum Structure
Minors in Internet of Things (IoT)

S.No.	Yr/ Sem	Course Code	Course Name	Type	Credits
1	III/I	M1401	IoT Architecture and Protocols	Theory	3
2	III/I	M1402	Principles of Sensors and Signal Conditioning	Theory	3
3	III/II	M1403	IoT Security	Theory	3
4	III/II	M1404	Microcontrollers for IoT Prototyping	Integrated	3
6	IV/I	M1405	Deep Learning for IoT	Theory	3
5	IV/I	M1406	System Design using Embedded Processors Laboratory	Practice	1
7	IV/II	M1441	Mini Project in Minor Specialization	Project	2
Total Credits					18

Course Structure

M1401 - IoT Architecture and Protocols

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	42	0	0	0	30	70	100

1. Course Description

Course Overview

This course addresses the forefront of study on the Internet of Things (IoT) by presenting state-of-the-art research together with the current and future challenges in building new smart applications (e.g., Smart Cities, Smart Buildings, and Industrial IoT) in an efficient, scalable, and sustainable way. It covers the main pillars of the IoT world (Connectivity, Interoperability, Discoverability and Security/Privacy), providing a comprehensive look at the current technologies, procedures and architectures. The Internet of Things (IoT) is defined as a paradigm in which objects equipped with sensors, actuators, and processors communicate with each other to serve a meaningful purpose. In this course, learners will also study about survey on state-of-the-art methods, protocols, and applications in this new emerging area.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

M1401.1. Identify the IoT networking components with respect to OSI layer
M1401.2. Design and develop IoT based sensor systems
M1401.3. Evaluate the wireless technologies for IoT
M1401.4. Examine IoT protocols and software to build schematic for IoT solutions

3. Course Syllabus

Evolution of IoT: Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting,IPV4 addressing and challenges), IPV6 addressing, IoT architecture reference layer.

Introduction to IoT components: Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open source hardwares, Examples of IoT infrastructure

IoT protocols and softwares: IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE, SIG, NFC, LORA, Lifi, Widi)

Introduction to Cloud computation and Big data analytics: Evolution of Cloud Computation, Commercial clouds and their features, open source IoT platforms, cloud

dashboards, Introduction to big data analytics and Hadoop.

Case Studies: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0,IoT standards.

4. Books and Materials

Text Books:

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016.
2. 2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.

Reference Books:

1. LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.
2. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014.
3. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010.
4. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010.
5. RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to Secure Cloud Computing,Wiley-India, 2010.

Course Structure

M1402 - Principles of Sensors and Signal Conditioning

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	42	0	0	3	30	70	100

1. Course Description

Course Overview

This course provides a comprehensive introduction to electronics, amplification and attenuation of various sensors. These sensor signal inputs accepted by signal conditioners include DC voltage and current, AC voltage and current, frequency and electric charge. Sensor inputs can be accelerometer, thermocouple, thermistor, resistance thermometer, strain gauge or bridge, and LVDT or RVDT. Specialized inputs include encoder, counter or tachometer, timer or clock, relay or switch, and other specialized inputs. Outputs for signal conditioning equipment can be voltage, current, frequency, timer or counter, relay, resistance or potentiometer, and other specialized outputs.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

M1402.1. Identify appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters
M1402.2. Design and develop sensors using optical methods with desired properties.
M1402.3. Evaluate performance characteristics of different types of sensors.
M1402.4. Build analytical design and development solutions for sensors.

3. Course Syllabus

Sensor fundamentals and characteristics & Optical Sources and Detectors: Sensor Classification, Performance and Types, Error Analysis characteristics, Electronic and Optical properties of semiconductor as sensors, Semiconductor lasers, Fiber optic sensors, Thermal detectors.

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.

Position, Direction, Displacement and Level: Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, magnetostrictive sensors, fiber optic

liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor, signal condition circuits for reactive and self generating sensors.

Velocity, Acceleration sensors, Flow, Temperature and Acoustic sensors: Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, ultrasonic, electromagnetic and Laser anemometer, microflow sensor, coriolis mass flow and drag flow sensor, Piezoelectric temperature sensor, microphones-resistive, capacitive, piezoelectric, fiber optic, solid state electric microphone.

4. Books and Materials

Text Books:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.

Reference Books:

1. GerdKeiser, "Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi.
2. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida.
3. Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", 2013, 2nd edition, Wiley, New Jersey.
4. Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York.

Course Structure
M1403 - IoT Security

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	42	0	0	3	30	70	100

1. Course Description

Course Overview

The purpose of this course is to expose students to new developments in the areas of cyber security for the Internet of Things (IoT). As the Internet of Things (IoT) continues to grow the number of privacy and security concerns and issues also increases. To become a professional in this field, it is essential to understand the potential security risks and how to best mitigate them by learning the security and privacy issues in IoT environments. We'll explore the organizational risks posed by IoT networks, and the principles of IoT device vulnerabilities also look at software and hardware IoT Applications for industry. With billions of devices tracking our every move, privacy is a critical issue so you will be explored to the social and commercial implications the IoT brings to society.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

M1403.1. Examine the need for cyber security laws and methods
M1403.2. Design and implement cryptography algorithms using C programs
M1403.3. Solve network security problems in various networks and build trustable cloud based IoT systems
M1403.4. Build security systems using elementary blocks by light weight cryptography methods

3. Course Syllabus

Fundamentals of Encryption for Cyber Security: Cryptography – Need and the Mathematical basics- History of cryptography, symmetric ciphers, block ciphers, DES – AES. Public-key cryptography: RSA, Diffie-Hellman Algorithm, Elliptic Curve Cryptosystems, Algebraic structure, Triple Data Encryption Algorithm (TDEA) Block cipher.

IoT Security Framework: IIOT security frame work, Security in hardware, Boot process, OS & Kernel, application, run time environment and containers. Need and methods of Edge Security, Network Security: Internet, Intranet, LAN, Wireless Networks, Wireless cellular networks, Cellular Networks and VOIP.

Elementary blocks of IoT Security & Models for Identity Management: Vulnerability of IoT and elementary blocks of IoT Security, Threat modeling – Key elements,

Identity management Models and Identity management in IoT, Approaches using User-centric, Device-centric and Hybrid.

Identity Management and Trust Establishment: Trust management lifecycle, Identity and Trust, Web of trust models. Establishment Cryptosystems – Mutual establishment phases – Comparison on security analysis. Identity management framework, Capability-based access control schemes, Concepts, identity-based and identity-driven, Light weight cryptography, need and methods, IoT use cases.

Security and Digital Identity in Cloud Computing: Cloud security , Digital identity management in cloud, Classical solutions, alternative solutions, Management of privacy and personal data in Cloud.

4. Books and Materials

Text Books:

1. John R. Vacca, "Computer and Information Security Handbook", Elsevier, 2013. Parikshit Narendra Mahalle , Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, 2015.
2. William Stallings, "Cryptography and Network security: Principles and Practice", 5th Edition, 2014, Pearson Education, India
3. Maryline Laurent, Samia Bouzefrane, "Digital Identity Management", Elsevier, 2015.
4. Joseph Migga Kizza, "Computer Network Security", Springer, 2005.

Reference Books:

1. Christof Paar and Jan Pelzl, "Understanding Cryptography – A Textbook for Students and Practitioners", Springer, 2014.
2. Behrouz A.Forouzan : Cryptography & Network Security – The McGraw Hill Company, 2007.
3. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: "Private Communication in a public World", PTR Prentice Hall, Second Edition, 2002.
4. Alasdair Gilchrist, "IoT security Issues", Oreilly publications, 2017.

Course Structure
M1404 - Microcontrollers for IoT Prototyping

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	2	28	0	28	3	30	70	100

1. Course Description

Course Overview

This course addresses the picking the right microcontroller that have (hopefully open source) development kits available in market and also when picking an IoT board, one of the first things that always look for is the connectivity options after all, smart devices are largely defined by their connectivity. Depending on project's requirements, select a board that has what we need and nothing more. Another main factor is support for peripherals and features that we want. These can include common ports like USB or HDMI, buses for serial protocols like I2C and SPI, or pin-outs for pulse width modulation (PWM) devices like dimmable lights or servo motors. Again, this comes down to knowing most of the product specifications before we start building. Lastly, open source hardware is always a big plus.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

M1404.1.	Design embedded applications for low power microcontrollers for sensor applications
M1404.2.	Develop IoT systems using Wi-Fi CC3200
M1404.3.	Examine to interface and deploy analog and digital sensors to single board computers
M1404.4.	Explain to deploy the data on cloud after reading a sensor data in IoT environment

3. Course Syllabus

Theory

MSP430 microcontrollers: Architecture of the MSP430, Memory, Addressing modes, Reflections on the CPU instruction set, clock system, Exceptions: Interrupts and resets. Functions and subroutines, Mixing C and assembly language, Interrupts, Interrupt service routines, Issues associated with interrupts, Lowpower modes of operation.

ARM Cortex MX microcontroller: ARM Cortex M4: Assembly language basics, Thumb-2 Technology, ARM Instruction set, Cortex M4 architecture, advantages, peripherals, instruction set, floating point operations, Advanced Cortex MX Microcontroller,

core, architecture, on-chip wi-fi.

Display and Communication modules: GPIO, LCD display, graphical display, relays, Peripheral programming SPI, I2C, UART, Zigbee controller.

Sensors interfacing: Sensors interfacing techniques- Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11, single wire thermometer, Frequency counters.

Microcontrollers for IoT & Cloud Interfacing: ESP8266, NodeMCU, TI-CC3200, Intel-Gallileo boards, Raspberry pi board, porting Raspbian, sensor interface examples, interfacing and data logging with cloud: Thing speak, Things board, Blync platform.

Practice

1. Formulate an Assembly Language Program/Embedded C to 8051/LPC2148/2929 and observe the following:
    a. Blink all LEDs connected to port B on/off with 2ms delay
    b. Blink LEDs alternatively connected to port A with 10 ms time delay.
2. Compile a series of processor instructions by using Assembly Language Programming/Embedded C to interface 7-segment displays to 8051/LPC2148/2929 and refresh the data 10ms and 100ms.
3. Compose an Assembly Language Program/Embedded C to interface stepper motor to 8051/LPC2148/2929 and observe the following:
    a. 5 rotations in clockwise direction
    b. 5 rotations in anticlockwise direction
    c. Continuous rotation in clockwise direction at much faster speed
4. Formulate an Assembly Language Program/Embedded C to interface D/A converters to 8051/LPC2148/2929 and observe the following:
    a. Square wave
    b. Ramp signal
    c. Sinusoidal wave
5. Compose an Assembly Language Program/Embedded C to interface 8251 with 8051/LPC2148/2929 at an address 80H. Initialize it in asynchronous transmit mode, with 7bit character size, band factor 16, one start bit, one stop bit, even parity enable. Further transmit a message “” HAPPY NEW YEAR”” in ASCII coded form to a modem.
6. Compose an Assembly Language Program/Embedded C to interface A/D converters to 8051/LPC2148/2929.
7. Formulate an Assembly Language Programming/Embedded C for getting elevator display with 8051/LPC2148/2929.
8. Compose an Assembly Language Program/Embedded C to observe traffic signals by interfacing controller to 8051/LPC2148/2929. Observe changes in signals like Red, straight, left, right, pedestrian etc.

4. Laboratory Equipment/Software/Tools Required

1. 89C51/52/LPC2148/2929 Trainer Boards

2. 7-segment display units
3. Stepper Motor modules
4. D/A converters
5. A/D converters
6. Elevator Interface module
7. Traffic Light Controller Interface

5. Books and Materials

Text Books:

1. John H. Davies, "MSP430 Microcontroller Basics", 2011, 2nd ed., Newnes publishing, New York.
2. 2. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2014, 4th ed., Springer, New York.

Reference Books:

1. Sergey Y. Yurish,"Digital Sensors and Sensor Systems: Practical Design", 2011, 1st ed., IFSA publishing, New York.
2. Jonathan W Valvano, "Introduction to ARM Cortex –M3 Microcontrollers", 2012, 5th ed., Create Space publishing, New York.
3. Muhammad Ali Mazidi, Shujen Chen, SarmadNaimi, SepehrNaimi, "TI ARM Peripherals Programming and Interfacing: Using C Language", 2015, 2nd ed., Mazidi and Naimi publishing, New York.

Course Structure
M1405 - Deep Learning for IoT

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	42	0	0	3	30	70	100

1. Course Description

Course Overview

The course introduces you to advance and design methodologies to design IoT system using deep learning concepts and the methods of deep learning, IoT data preprocessing concepts helps in selection of new Techniques for implementing real time Applications, it also exposes participants to communication technologies for creating and deploying networks as well as newly developed IoT specific application using tensor flow. The course also covers some case-studies on IoT Applications using deep learning

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

M1405.1. Identify and understand the concepts of deep learning elements and techniques.
M1405.2. Evaluate the Data processing method for IoT using Python
M1405.3. Design and develop Deep learning using different methods for IoT
M1405.4. Build analytical design methods for IoT Applications using deep learning techniques

3. Course Syllabus

Overview of Deep Learning: Historical context and motivation for deep learning; basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method.

IOT Data Pre-processing: Data Preparation for Predictive Maintenance Modeling, Cleaning and Standardizing IoT Data, Applying Advanced Data Exploration Techniques. Exploring Feature Engineering, Applying Feature Selection Techniques, Feature set selection using DL, Deep learning for Internet of Things data analysis.

DL Methods for IoT: Deep learning (DL) methods for IoT Applications: Convolutional neural networks (CNNs), Recurrent neural networks (RNNs), Deep autoencoders (AEs), Restricted Boltzmann machines (RBMs), Deep belief networks (DBNs), Generative adversarial networks (GANs), Ensemble of DL networks (EDLNs).

Deep Learning for IOT: Deep Learning Models for Sensor Data, Embedded Deep Learning, Real Time IOT Imaging with Deep Neural Network. Smart labeling classification datasets mixing machine and deep learning: Creating and deploying networks using

tensor flow and keras.

Applications of DL and IOT: Case Study Approach: Case Studies: IOT for Agriculture, Remote Patient Monitoring, Smart City, Smart Transportation, IOT Security using DL

4. Books and Materials

Text Books:

1. John Paul Mueller, Luca Massaron, Deep Learning for Dummies, John Wiley & Sons.
2. Adam Gibson, Josh Patterson, Deep Learning, A Practitioner's Approach, Shroff Publisher /O'Reilly Publisher Media.
3. Nicolas Modrzyk, " Real-Time IoT Imaging with Deep Neural Networks - Using Java on the Raspberry Pi 4" , Apress Publication , Year: 2020, ISBN: 9781484257210, 978148425722.

Reference Books:

1. Ian Goodfellow, Deep Learning, MIT Press, 2016.
2. Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 2015.
3. Mindy L Hall, Deep Learning, VDM Verlag, 2011.
4. Li Deng (Author), Dong Yu, Deep Learning: Methods and Applications (Foundations and Trends in Signal Processing), Now Publishers Inc, 2009.
5. Abadi, Martın, et al. "Tensorflow: Large-scale machine learning on heterogeneous distributed systems." arXiv preprint arXiv:1603.04467 (2016).

Course Structure

M1406 - System Design using Embedded Processors Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	28	1	30	70	100

1. Course Description

Course Overview

The course introduces you to advance and design methodologies to design IoT system using deep learning concepts and the methods of deep learning, IoT data preprocessing concepts helps in selection of new Techniques for implementing real time Applications, it also exposes participants to communication technologies for creating and deploying networks as well as newly developed IoT specific application using tensor flow and keras. The course also covers some case-studies on IoT applications using deep learning models.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

M1406.1. Identify the functionality of development boards to implement embedded applications.
M1406.2. Compile bug free assembly or C language programs for microcontrollers to a required task
M1406.3. Determine the most appropriate IoT Devices and Sensors based on Application
M1406.4. Utilize Python standard libraries for implementing various IoT Applications

3. Course Syllabus

PART -A: Programs based on 8051 / ARM Microcontroller Development Tools:

1. Compile a program to blink LED using Raspberry Pi.
2. Implement Arduino based Automated System to control an LED that should switch-on/off depending on the light.
3. Implement Arduino program for Distance Measurement using Ultrasonic Sensor and display on 16X2 LCD.
4. Compile a program to monitor temperature and humidity using DHT11 (Digital Humidity and Temperature) sensor under Arduino IDE.
5. Implement IoT based temperature and humidity monitoring system using Raspberry Pi.
6. Implement Raspberry Pi based Automated System to control an LED that should switch- on/off depending on the light
7. Implement Raspberry Pi program for Distance Measurement using Ultrasonic Sensor and display on 16X2 LCD.

8. Implement Arduino & Raspberry Pi-based traffic light pattern with three LED colours.
9. Create a web application for the above applications wherever possible with suitable modifications to get input and to send output.

PART -B: Programs based on Node MCU ESP8266 Microcontroller Development Boards:

1. Interface IR Sensor to Node MCU. Write a python program to detect obstacle using IR Sensor and notify it using LED.
2. Interface Gas Sensor to Node MCU. Write a python program to detect the concentration using Gas Sensor.
3. Interface Ultrasonic Sensor to Node MCU. Write a python program to measure the distance to a wide range of objects
4. Interface LDR Sensor to Node MCU. Write a python program to detect obstacle using LDR Sensor
5. Write a python program to Interface GPS Sensor to Node MCU.
6. Interface PH Sensor to Node MCU. Write a python program to measure the amount of alkalinity and acidity in water and other solution.

4. Laboratory Equipment/Software/Tools Required

1. Arduino Uno & Nano, Raspberry Pi & Node MCU (ESP8266) Boards
2. LEDs(red, Green, Orange)
3. Ultrasonic Sensors
4. DHT11 (Digital Humidity and Temperature) Sensors
5. LDRs
6. IR Sensors
7. Various Gas Sensors
8. pH Sensors
9. GPS Unit

5. Books and Materials

Text Books:

1. Kenneth J. Ayala (2008), The 8051 Microcontroller, 3rd edition, Cengage Learning, India
2. Andrew N. Sloss, Dominic Symes and Chris Wright (2008), ARM Systems Developer's Guides -Designing & Optimizing System software, Elsevier, New Delhi, India.
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram: Internet of Things, Wiley Publishers,2019.

Reference Books:

1. Mazidi (2000), The 8051 Microcontroller and Embedded System, Prentice Hall of India, New Delhi.
2. Deshmukh (2004), Microcontrollers, Tata McGraw Hill Edition, New Delhi