Internet of Things

Minor Degree in “Internet of Things”

A minor degree program in the Internet of Things (IoT) provides students with an introduction to the principles and applications of IoT technologies. The IoT is a rapidly growing field that involves connecting everyday objects and devices to the internet, enabling them to collect and exchange data. The minor program typically consists of courses in computer science, electrical engineering, and data analytics, all focused on the IoT domain.

Students will learn about the hardware and software components of IoT devices, including sensors, actuators, microcontrollers, and cloud computing platforms. They will also study the communication protocols and networking technologies that enable IoT devices to communicate with each other and with internet services.

The program also covers the applications of IoT, including smart cities, healthcare, agriculture, and industrial automation. Students will explore the ethical, legal, and social implications of IoT, as well as security and privacy concerns.

The minor degree in IoT can complement majors in computer science, electrical engineering, data science, or other related fields, providing students with a broad range of skills and knowledge that will be in high demand in the job market. Graduates of the program may pursue careers in IoT product development, data analytics, or cybersecurity, among other fields.

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	IoT-01	Essential of IoT	4	0	0	4
2	IoT-02	IoT Lab	0	0	2	1
3	IoT-03	Microcontroller and RFID	4	0	0	4
4	IoT-04	Mobile Application development for IoT	4	0	0	4
5	IoT-05	Mobile Application development for IoTLab	0	0	2	1
6	IoT-06	Cloud and Fog Computing	4	0	0	4
Total			16	0	4	18

CourseCodingNomenclature:

- IoT denotes that minor degree in "Internet of Things".
- 01, 02, 03, 04, 05, 06 are course in order they have to be taken, if taken in different semesters.Multiple course may also be taken in the same semester (if required).

General Information:

Eligibility/ Target Students	B.Tech.(To be enrolled from 5th Semester)
Duration of program	5th to7th Semester
Intake	20
Mode of Delivery (Classroom / MOOC)	(Classroom / Laboratory/ MOOC)
Proposed Fee	Rs. 10,000/-

Course Code:	IoT-01
Course Title :	IoT andApplications
Number of Credits :	4(L:3;T:0;P:0)
Course Category :	Internet of Things
Offered By Department**:**	Electronics Engineering

Course Objectives: The objective of this course is:

1. Define IoT and its importance in society
2. Understand IoT architecture, communication protocols, and hardware interfacing
3. Work with Linux operating system and use shell scripting and C programming language for IoT applications
4. Configure wireless communication protocols such as Zigbee and Wi-Fi AP and Router
5. Evaluate the advantages and limitations of IoT in different application areas.

Course Content

Module 1: Introduction to Internet of Things (IoT): [08 Lectures]

Definition of the Internet of Things (IoT), The Importance of the Internet of Things (IoT) in Society IoT Architecture, History of IoT, M2M Machine to Machine, Web of Things, The Layering concepts, IoT Communication Pattern.IoT protocol: Wireless communication protocols: Wifi, IPV4/IPV6, 6LOWPAN, ZigBee, Bluetooth Low Energy (BLE), Application layer protocols: MQTT/MQTTS, CoAP, REST/HTTP, XMPP, SCADA Authentication Protocols.

Module 2: Operating System used for IoT:[07 Lectures]

Linux Operating System introduction,Working with the command line and the Shell, Managing directories and files, Managing user access and security, Setting up a Linux file system, Understanding system initialization, Connecting a system to the network, Installing and Configuring Linux.Shell Scripting Programming for IoT: Introduction, Creating Shell Scripts, Flow control in the Shell, Advanced Shell features Programming Language used in IoT, C Programming.

Module 3: Hardware Interfacing for IoT:[05 Lectures]

Overview of IoT Hardware platforms, Sensors interfacing, Actuators interfacing.Communication Protocol for IoT: UART Communication, RS485 Communication, I2C Protocol device interfacing, SPI Protocol device interfacing, Ethernet configuration, Zigbee interfacing, Wi-Fi AP and Router interfacing.

Module 4: IoT Applications:[05 Lectures]

IoT in Agriculture, IoT in Home Automation, IoT in Security Solutions, IoT in Healthcare, IoT in Robotics, Internet of Vehicles (IoV), Internet of Everything (IoE).

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Explain the various concepts of IoT.
2. Use Devices and Software needed in IoT.
3. Design state-of the-art architecture of IoT related to the domain the problem.
4. Develop IoT based Application.

Text Books:

1. Shriram K Vasudevan, Abhishaek S Nagarajan and RMD Sundaram, "Internet of Things", 1st Edition, Wiley, 2019.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
3. Rajkumar Buyya and Amir Vahid Dastjerdi, "Internet of Things: Principles and paradigms", Elsevier, 2016.

Course Code :	IoT-02
Course Title :	IoT Lab
Number of Credits :	4(L:3;T:0;P:0)
Course Category :	Internet of Things
Offered By Department**:**	Electronics Engineering

Course Objectives: The objective of this course is:

1. Study and use of IOT Builder Platform
2. Implementation of Linux OS commands
3. Programming basics of Raspberry Pi
4. Interfacing sensors, LCD display, and implementing health monitoring, facial recognition door, temperature transmission, and house monitoring using Raspberry Pi.

List of Experiments:

1. Study and working of IOT Builder Platform.
2. Implementation of different Linux OS Commands.
3. Basics programming of Raspberry Pi.
4. Interfacing Sensors with Raspberry Pi.
5. Interfacing LCD display with Raspberry Pi.
6. Health monitoring using Raspberry pi.
7. Facial Recognition Door using android and Raspberry pi.
8. Temperature transmission using Raspberry Pi.
9. House monitoring using Raspberry Pi.
10. Study the Temperature sensor and Write Program for monitoring temperature using Raspberry Pi.
11. Write a Program to upload temperature and humidity data oncloud.

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Write program in C on Raspberry Pi platform.
2. Write program in Python on Raspberry Pi platform.
3. Design interfacing program using Raspberry Pi.
4. Develop applications using RaspberryPi.

Reference Books:

1. Shriram K Vasudevan, Abhishaek S Nagarajan and RMD Sundaram, “Internet of Things”, 1st Edition, Wiley, 2019.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
3. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st

Edition, VPT, 2014.
4. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.
5. RajkumarBuyya and Amir Vahid Dastjerdi, “Internet of Things: Principles and paradigms”, Elsevier,2016.

Course Code :	IoT-03
Course Title :	PythonProgramming
Number of Credits :	4(L:3;T:0;P:0)
Course Category :	Internet of Things
Offered By Department**:**	Electronics Engineering

Course Objectives: The objective of this course is:

1. Understand the fundamental concepts of Python programming language.
2. Gain proficiency in using variables, operators, control structures, sequences, and dictionaries in Python.
3. Develop skills in creating and calling functions and working with classes and objects.
4. Learn how to handle files and exceptions in Python for input/output operations and error handling.

Course Content

Module1:Introduction and Overview : [05 Lectures]

Introduction to Python, Origin, Comparison, Comments, Operators, Variables and Assignment, Numbers, Strings, Lists and Tuples, Dictionaries, if Statement, while Loop, for Loop and the range(), Built-in Function, Files, Errors and Exceptions, Functions, Classes, Modules Syntax and Style Statements and Syntax, Variable Assignment, Identifiers, Memory Management, Python Applications.

Module2:Numbers and Strings: [05 Lectures]

Introduction to Numbers, Integers, Floating Point Real Numbers, Complex Numbers, Operators, Built-in Functions. Sequences: Strings, Lists, and Tuples, Sequences, Strings, Strings and Operators, String-only Operators, Built-in Functions, String Built-in Methods, Special Features of Strings.

ListsandDictionaries: Operators,Built-inFunctions,ListTypeBuilt-inMethods,SpecialFeatures ofLists,Tuples,TupleOperatorsandBuilt-inFunctions,SpecialFeaturesofTuples,IntroductiontoDictionaries,Operators,Built-inFunctions,Built-inMethods,DictionaryKeys.

Module3:Functions: [05 Lectures]

Functions, Calling Functions, Creating Functions, Formal Arguments, Positional Arguments, Default Arguments, Default Function ObjectArgumentExample,Variable-lengthArguments,Non-keywordVariableArguments(Tuple),KeywordVariableArguments(Dictionary). Classes: Problems in Procedure Oriented Approach, Features of Object Oriented Programming System (OOPS), Classes and objects, Encapsulation, Abstraction, Inheritance,Polymorphism.

Module4:Files and Input/output:[05 Lectures]

File Objects, File Built-in Function, File Built-in Methods, File Built-in Attributes, Standard Files, Command-line Arguments, File System, File Execution, Persistent Storage Modules, Using context managers with files.

Module 5 :Errors and Exceptions : [03 Lectures]

Introduction to Exceptions, Exceptions in Python, Detecting and Handling Exceptions, Exceptions as Strings, Raising Exceptions, Assertions, Standard Exceptions, Regular Expressions, Special Symbols and Characters for Regular expressions.

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Explain the various concept of Python Programming.
2. Apply the basic concepts of Python Programming for writing simpler programs in Python.
3. Apply the advance concepts of Python Programming for writing advance programs in Python.
4. Develop applications in Python.

Text/Reference Books:

1. Wesley J. Chun, "Core Python Programming", 2nd Edition, Pearson, 2007 (Reprint 2010).
2. Paul Barry, "Head First Python", 2nd Edition, O Rielly, 2010.
3. Mark Lutz, "Learning Python", 4th Edition, O Rielly, 2009.

Course Code :	IoT-04
Course Title :	EmbeddedIoT
Number of Credits :	4(L:3;T:0;P:0)
Course Category :	Internet of Things
Offered By Department**:**	Electronics Engineering

Course Objectives: The objective of this course is:

1. Understand the fundamentals of embedded system design and architecture and their role in IoT applications.
2. Gain knowledge of IoT controllers and their features, types, architecture, and programming using Embedded C.
3. Learn how to use Arduino and interface it with various sensors, actuators, and other devices.
4. Understand the need for cloud in IoT applications, cloud architecture for IoT, challenges in IoT with cloud, and cloud service providers for IoT.

Course Content

Module1 : Introduction to Embedded IoT: **[06 Lectures]**
Introduction to Embedded System Design, Categories of ES, Overview of Embedded System Architecture, Recent Trends in Embedded Systems, Hardware Architecture of Embedded System, Real-time Embedded Systems and Robots, Robots and Robotics, Microprocessors and Microcontrollers, Microcontroller or Embedded Controller.

Module2 : IoT Controllers: [06 Lectures]
Introduction to IoT controllers, features of IoT controllers, different types of IoT microcontroller, architecture, memory access and instruction execution, pipelining, program memory considerations, addressing modes, CPU registers, Instruction set, and simple operations, Embedded C Programming of IoT controllers.

Module3 : Arduino: [08 Lectures]
Architecture, Setup the IDE, Writing Arduino Software, Arduino Libraries, Embedded C programming for Arduino, Interfacing LED, pushbuttonandbuzzerwithArduino,InterfacingArduinowithLCD,InterfacingofTemperature,Humidity,Motion,LightandGasSensorwith Arduino, Interfacing of Actuators with Arduino, Interfacing of Relay Switch and Servo Motor withArduino.

Module4 : Cloud for IoT: [05 Lectures]
Need of Cloud for IoT applications, Cloud Architecture for IoT applications, challenges in IoT

with Cloud, Various Cloud Service Providers for IoT: ThingSpeak, Blynk etc., Embedded C programming for posting sensors data to web server.

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Understand about various types of Robots & Controls used in the Robotics.
2. Know the Sensors and Actuators in Robotics.
3. Work on various Robotic Platforms.
4. Develop applications based on theseplatforms.

Text/ Reference Books:

1. Shriram K Vasudevan, Abhishaek S Nagarajan and RMD Sundaram, "Internet of Things", 1st Edition, Wiley,2019.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press,2014.
3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT,2014.
4. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications,2013.
5. Rajkumar Buyya and Amir Vahid Dastjerdi, "Internet of Things: Principles and paradigms", Elsevier,2016.

Course Code	IoT-05
Course Title	EmbeddedIoT Lab
Number of Credits	1(L:0;T:0;P:2)
Course Category :	Internet of Things
Offered By Department**:**	Electronics Engineering

Course Objectives: The objective of this course is:

1. To interface Arduino with various communication modules like Bluetooth and ESP8266.
2. To interface Arduino with sensors like Ultrasonic sensor and keypad.
3. To interface Arduino with LCD Display.
4. To implement C and Python programs for interfacing GPIOs, DC Motors and Graphical LCD.

Course Content

List of Experiments:

1. To interface Arduino with Bluetooth.
2. To interface Arduino with ESP8266.
3. To interface Arduino 16 x 2 LCD Display.
4. To interface Arduino with Ultrasonic Sensor.
5. To interface Arduino with keypad.
6. Implement a C program to interface GPIOs.
7. Implement a C program to interface DC Motor.
8. Implement a C program to interface Graphical LCD.
9. Implement a Python program to interface GPIOs.
10. Implement a Python program to interface DC Motor.
11. Implement a Python program to interface GraphicalLCD.

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Write program in C on Arduino platform.
2. Write program in C on Arduino platform.
3. Write interfacing programs using Arduino platform.
4. Develop applications using Arduinoplatform.

Text/ Reference Books:

1. Shriram K Vasudevan, Abhishaek S Nagarajan and RMD Sundaram, “Internet of Things”, 1st Edition, Wiley,2019.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press,2014.

3. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT,2014.
4. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications,2013.
5. Rajkumar Buyya and Amir Vahid Dastjerdi, “Internet of Things: Principles and paradigms”, Elsevier,2016.

Course Code	IoT-06
Course Title	CloudComputing
Number of Credits	4(L:3;T:0;P:0)
Course Category :	Internet of Things
Offered By Department**:**	Electronics Engineering

Course Objectives: The objective of this course is:

1. understand the history, architecture, and essential characteristics of cloud computing, along with the different cloud service and deployment models.

2. learn about virtualization techniques, hypervisors, distributed management of virtual infrastructures, and service-oriented architectures (SOA).

3. introduced to Platform as a Service (PaaS), its advantages and disadvantages, and Google App Engine and Apache Hadoop as examples of PaaS.

4. gain knowledge of the challenges in cloud computing, legal issues, economics and capacity management, and security in the cloud.

Course Content

Module1 : Introduction [05 Lectures]

Cloud computing history, architecture and essential characteristics, cloud service models, Cloud Deployment models, advantages of cloud computing, cloud v/s grid computing.

Module2 : Virtualization [06 Lectures]

Virtualization techniques, Benefits and drawbacks of virtualization, VMmigration with its types, hypervisors, types of hypervisors, distributed management of virtual infrastructures, scheduling techniques for advance reservation of capacity, Service- orientedarchitectures, SOA implementation, SOAP v/s REST, web 2.0.

Module3 : PaaS[05 Lectures]

Introduction,advantagesanddisadvantagesofPaaS,introductiontogoogleappengine,GAEcoststructure,ApacheHadoop:MapReduce, HDFS, Hive, Map reduce programming model, Hadoop as aservice.

Module4 : Migrating into the cloud[08 Lectures]

Introduction, challenges in the cloud, legal issues in cloud computing, Cloud Economics and Capacity Management: Restricted Choices, Capacity Planning, Queuing and Response Time, Evidence Based Decision Making, Instrumentation (Measuring Resource Consumption), Bottlenecks, Key Volume Indicators. Security in clouds, protocols, algorithms, Security as a service, Multi-cloud.

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Explain the basic concepts along with evolution and features of cloud computing.
2. Demonstrate the concept of existing cloud paradigms andplatforms.
3. Explore the issues of cloud computing in addition with various cloudmodels.
4. Attain the knowledge of virtualization through virtualization technologies.

Text/ Reference Books:

1. RajkumarBuyya,JamesBrobergandAndrzejGoscinski,"CloudComputingPrinciplesandParadigms" ,Wiley&Sons,2011.
2. ChristianBaun,MarcelKunze,JensNimisandStefanTai,"CloudComputingWeb-BaseddynamicITservices",Springer-Verlag Berlin Heidelberg, 1st Edition,2011.
3. David E.Y. Sarna, "Implementing and Developing Cloud Computing Applications", CRC Press,2011.