

Internet of Things (IoT)

Minor Degree in “Internet of Things”

Course Structure		
S. No.	Course Code	Title
1	MINOR301I	Introduction to Internet of Things
2	MINOR401I	Introduction to Security of Cyber-Physical Systems
3	MINOR501I	Ubiquitous Sensing, Computing and Communication
4	MINOR601I	Embedded Systems for IoT
5	MINOR701I	IoT with Arduino, ESP, and Raspberry Pi

Course Coding Nomenclature:

- IoT denotes that minor degree in “Internet of Things”.
 - 01, 02, 03, 04, 05 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).
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Detailed Syllabus

Course Code	:	MINOR301I
Course Title	:	Introduction to Internet of Things
Course Category	:	IoT

Course Objective:

- To make students know the IoT ecosystem.
- To provide an understanding of the technologies and the standards relating to the Internet of Things.
- To develop skills on IoT technical planning.

Course Contents:

Module 1 [8 Lectures]

IoT & Web Technology: The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Module 2 [9 Lectures]

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, the international driven global

value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module 3 [9 Lectures]

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module 4 [8 Lectures]

IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Module 5 [8 Lectures]

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smart Approach. Data Aggregation for the IoT in Smart Cities, Security.

Text Books/References:

1. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher/O'Reilly Publisher.
2. Internet of Things, RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, John Wiley and Sons.
3. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
4. Cuno Pfister, "Getting Started with the Internet of Things", Shroff Publisher/Maker Media.
5. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications.
6. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/Maker Media Publishers.

Corresponding Online Resources:

Coursera: Internet of Things and AI Cloud Specialization

1. <https://www.coursera.org/specializations/internet-of-things>

Course Outcomes: After completion of course, students would be able:

1. To understand the technology and standards relating to IoTs.
2. To understand the critical ecosystem required to mainstream IoTs.
3. To Acquire skills on developing their own national and enterprise level technical strategies.

Course Code	:	MINOR401I
Course Title	:	Introduction to Security of Cyber-Physical Systems
Course Category	:	IoT

Course Objective:

- To learn the basics of security and various types of security issues.
- To study different cryptography techniques available and various security attacks.
- Explore network security and how they are implemented in real world.
- To get an insight of various issues of Web security and biometric authentication.

Course Contents:

Module 1 [6 Lectures]

Overview of Security and Privacy in Information System.

Module 2 [10 Lectures]

Applied Cryptography & Intrusion Detection, Architecture of Applied Cryptography, One Way Hash Function and Integrity, Encryption Algorithms and Confidentiality, Digital Signature and Authentication (DH, RSA, 2 class), Intrusion Detection and Information Theory.

Module 3 [10 Lectures]

Internet of Things Security, Security and Privacy for IoT Case Study: Smart Home, Smart Grid Network, Modern Vehicle, Wearable Computing & BYOD, Mobile HealthCare.

Module 4 [8 Lectures]

Software-Defined Networks, Introduction of Software-Defined Networks, Security for Software-Defined Networks, Privacy Leakages for Software-Defined Networks, Case Studies: How to Attack Software-Defined Networks.

Module 5 [8 Lectures]

Cyber-Physical Systems (CPS), CPS - Platform components, CPS implementation issues, Intelligent CPS, Secure Deployment of CPS.

Text Books/References:

1. Cyber Security, Nina Godbole, John Wiley & Sons.
2. Li Da Xu, Shancang Li, "Securing the Internet of Things", Syngress.
3. Alasdair Gilchrist, "IoT Security Issues", De Gruyter
4. Sean Smith, "The Internet of Risky Things", Sean Smith, Shroff Publisher/O'Reilly Publisher

Corresponding Online Resources:

Coursera: Web Connectivity and Security in Embedded Systems

1. <https://www.coursera.org/learn/iot-connectivity-security>

Course Outcomes: After completion of course, students would be able:

1. To Apply basics of security and issues related to it.

2. To use biometric techniques available and how they are used in today's world.
3. To investigate Security issues in web and how to tackle them.
4. To Learn mechanisms for transport and network security

Course Code	:	MINOR501I
Course Title	:	Ubiquitous Sensing, Computing and Communication
Course Category	:	IoT

Course Objective:

- Basic introduction of all the elements of IoT-Mechanical, Electronics/sensor platform, Wireless and wireline protocols, Mobile to Electronics integration, Mobile to enterprise integration.
- To have an understanding of basics of open source/commercial electronics platform for IoT.
- To have an understanding of basics of open source /commercial enterprise cloud platform for IoT.

Course Contents:

Module 1

Introduction, Overview, Challenges in IoT, Networking Basics of IoT, NFC, Wireless LAN.

Module 2

Location in ubiquitous computing: Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications, Location based social networks (LBSN), LBSN Recommendation.

Context-aware computing: Context and Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture.

Module 3

Privacy and security in ubiquitous computing, Energy constraints in ubiquitous computing.

Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper, Mobile social networking & crowd sensing, Event based social network.

Module 4

Mobile affective computing: Human Activity and Emotion Sensing, Health Apps, Mobile p2p computing, Smart Homes and Intelligent Buildings, Mobile HCI, Cloud centric IoT, Open challenges, Architecture, Energy Efficiency, Participatory sensing, Protocols, QoS, QoE.

Module 5

IoT and data analytics IoT and Data Management, Data cleaning and processing, Data storage models.

Search techniques, Deep Web, Semantic sensor web, Semantic Web Data Management, Searching in IoT.

Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High-dimensional Data Processing, Parallel and Distributed Data Processing.

Text Books/References:

1. N. Jeyanthi, Ajith Abraham, Hamid Mcheick, "Ubiquitous Computing and Computing Security of IoT".
2. John Krumm, Ubiquitous Computing Fundamentals, CRC Press.
3. Dirk Slama, "Enterprise IoT", Shroff Publisher/O'Reilly Publisher

Corresponding Online Resources:

Coursera: **IoT Communications**

1. <https://www.coursera.org/learn/iot-communications>

Course Outcomes: After completion of course, students would be able:

1. To understand merging technological options, platforms and case studies of IoT implementation in home & city automation.
2. To determine the Market perspective of IoT.

Course Code	:	MINOR601I
Course Title	:	Embedded Systems for IoT
Course Category	:	IoT

Course Objective:

- To make students know the basic concept and architecture of embedded systems.
- Different design platforms used for an embedded system for IoT applications.
- To have knowledge about the IoT enabled technology.

Course Contents:**Module 1 [7 Lectures]**

Purpose and requirement specification, IoT level specification, Functional view specification, Operational view specification, Device and component integration, Pillars of Embedded IoT and Physical Devices: The internet of devices.

Module 2 [8 Lectures]

Design of Embedded Systems: Common Sensors, Actuators, Embedded Processors, Memory Architectures, Software architecture.

Module 3 [7 Lectures]

Inputs and Outputs: Digital Inputs and Outputs, Digital Inputs, Digital Outputs, BusIn, BusOut, and BusInOut, Analog Inputs and Outputs, Analog Inputs, Analog Outputs, Pulse Width Modulation (PWM), Accelerometer and Magnetometer, SD Card, Local File System (LPC1768).

Module 4 [10 Lectures]

IoT Enabling Technologies: Communications, RFID and NFC (Near-Field Communication), Bluetooth Low Energy (BLE), LiFi, 6LowPAN, ZigBee, Z-Wave, LoRa, Protocols, HTTP, WebSocket, MQTT, CoAP, XMPP, Node-RED, Platforms, IBM Watson IoT—Bluemix, Eclipse

IoT, AWS IoT, Microsoft Azure IoT Suite, Google Cloud IoT, ThingWorx, GE Predix, Xively, macchina.io, Carriots.

Module 5 [10 Lectures]

Web of Things and Cloud of Things: Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Cloud of Things. IoT Physical Servers,

Cloud Offerings and IoT Case Studies: Introduction to Cloud Storage Models, Communication API.

Text Books/References:

1. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, Internet of Things, John Wiley and Sons.
2. Klaus Elk, "Embedded Software for the IoT".
3. Perry Xiao, "Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed".
4. Elizabeth Gootman et. al, "Designing Connected Products", Shroff Publisher/O'Reilly Publisher.

Corresponding Online Resources:

Coursera: Introduction to Embedded Systems Software and Development Environments

1. <https://www.coursera.org/learn/introduction-embedded-systems>

Course Outcomes: After completion of course, students would be able to:

1. Understand the embedded system concepts and architecture of embedded systems.
2. Understand the different hardware/software co-design techniques for microcontroller-based embedded systems, apply techniques in IoT applications.
3. To be able to design web/cloud based IoT applications.

Course Code	:	MINOR701I
Course Title	:	IoT with Arduino, ESP, and Raspberry Pi
Course Category	:	IoT

Course Objective:

- To give students hands-on experience using different IoT architectures.
- To provide skills for interfacing sensors and actuators with different IoT architectures.
- To develop skills on data collection and logging in the cloud.

Course Contents:

Module 1 [5 Lectures]

IoT- introduction and its components, IoT building blocks, Sensors and Actuators, IoT Devices, IoT boards (Arduino Uno, ESP 8266-12E Node MCU, and Raspberry Pi 3).

Module 2 [10 Lectures]

Arduino Uno – getting started with the Uno boards, blink program, connection of sensors to the Uno board, reading values of sensors from the Uno board, interrupts. Case study: Temperature/Humidity Control; Case Study: Sending values Temperature/Humidity values to the Internet via GSM module.

Module 3 [10 Lectures]

ESP 8266-12E Node MCU – getting started with the ESP board, Micropython and Esplora IDE, Flushing the ESP8266 board with micropython, connecting sensors to the ESP board, Connecting ESP board to WiFi, Interfacing ESP with the Cloud (REST API- GET, POST, MQTT), interrupts, comparison of ESP 32 board with the ESP 8266 board. Case Study: Switching light on /off remotely. Case Study: Voice-based Home Automation for switching lights on/off (Android phone – Google Assistant (Assistant <- > IFTTT), MQTT (ESP <-> IFTTT), ESP 8266 <-> Lights).

Module 4 [8 Lectures]

Raspberry Pi 3 - Rpi3 introduction and installing the Raspbian Stretch OS, Headless - Computer and Rpi3 configuration to connect through SSH via Ethernet, Headless - connecting Rpi3 remotely without Ethernet cable via SSH, IP address, Rpi 3 - Testing the GPIO pins through Scripts.

Module 5 [9 Lectures]

Raspberry pi3 interfacing with Sensor DHT11, Raspberry pi3 python library install and reading sensor feed, 'Plug and play' type cloud platform overview for integration to IOT devices, 'Plug and play' cloud platform for integration to IOT device - actuator (LED), Plug and play platform - Custom widget (DHT11-Sensor) integration through Python. New - Raspberry Pi 4 Vs Raspberry Pi3 Model B Comparison, LoRaWAN /LPWAN – Overview.

Text Books/References:

1. Rao, M. (2018). Internet of Things with Raspberry Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects. Packt Publishing Ltd
2. Baichtal, J. (2013). *Arduino for beginners: essential skills every maker needs*. Pearson Education.
3. Schwartz, M. (2016). *Internet of Things with ESP8266*. Packt Publishing Ltd.
4. Richardson, M., & Wallace, S. (2012). *Getting started with raspberry PI*. " O'Reilly Publisher Media, Inc."

Corresponding Online Resources:

Coursera: IoT Devices

1. <https://www.coursera.org/learn/iot-devices-il>

Software/Hardware Requirements:

Python, IOT boards - Arduino UNO, NODEMCU ESP 8266, Raspberry PI 3, Few resistors, potentiometer (5K~10K OHM), breadboard, LEDs, DHT 11 sensor.

IoT-related Software/Hardware Project Submission:

The specific project topics will be communicated through an official notice (Google Classroom).

Course Outcomes: After completion of course, students would:

1. To understand Arduino Uno, NODE MCU 8266 and Raspberry PI along with critical protocols and its communication to cloud.
2. To apply commonly used IOT protocols such as REST API, MQTT through IOT based demonstration.
3. To solve analog sensor and digital sensor Interfacing with IOT devices.
