

## (AMARAVATI, AMRITAPURI, BANGALORE, CHENNAI, COIMBATORE)

# **B.** Tech Minor in Internet of Things

## **CURRICULUM AND SYLLABI**

## 2023

## GENERAL INFORMATION

## ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
Т	-	Tutorial
Р	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
CGPA	-	Cumulative Grade Point Average

**Course Outcome (CO)** – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

**Program Outcomes (POs)** – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

## **PROGRAM OUTCOMES FOR ENGINEERING**

- 1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- 4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid

Amrita Vishwa Vidyapeetham.B.Tech-IoT MinorB.Tech Curriculum July 20231

conclusions.

- 5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## Motivation

IoT is a potential remedy for making the life of people better. Data exchange between the machines not only makes information more accessible, but it also has the potential to improve safety, health, education, and other elements of daily life. The smartwatch, which keeps a connection to the cloud while monitoring health, is an example of this.

Communication between the embedded systems offer the potential to boost efficiency, develop fresh manufacturing approaches, and get a deeper understanding of the market in sectors and businesses that deal directly with the end consumer. In the current technology scenario, IoT is gaining importance due to the features such as:

- Better Decision Making
- Real-time Tracking and Monitoring
- Automation
- Security and Privacy

## IoT skill set



A Minor in Internet of Things therefore, brings in this added advantage to a graduating student.

## **PROGRAM-SPECIFIC OUTCOMES FOR MINOR IN INTERNET OF THINGS**

On completion of a Minor in Internet of Things, a student will be able to

**PSO1:** Design and develop secured and socio relevant IoT based embedded applications.

**PSO2:** Apply modern software and hardware tools to develop sustainable IoT applications to engage in lifelong learning and adapt in multi-disciplinary environments.

## PREREQUISITES FOR PURSUING MINOR DEGREE IN INTERNET OF THINGS

Students who have a CGPA of 7.5 or above at the end of their second semester are eligible to register for this minor.

## **Course Structure**

Cat.	Code	Title	L T P	Credit
ENGG	23IoT231M	Introduction to Internet of Things	302	4
ENGG	23IoT232M	Networks and Security for IoT	300	3
ENGG	23IoT233M	IoT Protocols	302	4
ENGG	23IoT234M	IoT System Design	302	4
ENGG	23IoT235M	Applications of IoT	202	3
		Total Credits		18

## 23IoT231M

#### **INTRODUCTION TO INTERNET OF THINGS**

#### Pre-Requisite(s): Nil

#### **Course Objectives:**

To make students know the IoT ecosystem and its evolution. The course also discusses the overall architecture and components of an IoT system.

## **Course Outcomes:**

**CO1:** Understand predecessor of IoT technology and emergence of Internet of Things.

CO2: Understand the architecture for Internet of Things.

CO3: Learn about computing elements in IoT devices.

CO4: Develop IoT end devices with sensors, actuators, and microcontrollers

#### **CO-PO Mapping**

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
СО														
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	3	3	3	3	-	-	-	-	-	-	-	-
CO3	2	2	3	3	3	3	-	-	-	-	-	-	-	-
CO4	3	3	3	3	3	3	-	-	-	-	-	2	2	2

#### Syllabus

#### Unit-1

Cyber Physical Systems, Architectural components of CPS. Predecessors of IoT & Emergence of IoT–Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, IoT versus M2M, IoT versus WoT, Enabling IoT and the Complex Interdependence of Technologies. IoT Architecture Reference Model, Software perspective of IoT Design, Commercial Cloud services for IoT application development.

#### Unit-2

Introduction to microcontrollers & peripherals - Programming Microcontrollers-Arduino/Raspberry-PI/ESP32-Rapid prototyping boards. Peripherals - GPIO, ADC, Timers, PWM, UART, SPI, I2C, CAN.

#### Unit-3

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensing Types, Sensing Considerations, sensor selection.

Actuators- Types, Characteristics, IoT Device Design and Selection Considerations, Interfacing circuit and power supply considerations, Case studies.

#### **Text Books**

- 1 Sudip Mishra, Anandarup Mukherjee, Arijit Roy "Introduction to IOT", Cambridge University Press, 2021
- 2 Vijay madisetti, Arshdeep Bahga, "Internet of Things, A Hands-on approach". University Press, 2015.

Amrita Vishwa Vidyapeetham.

B.Tech-IoT Minor

B.Tech Curriculum July 2023 4

#### **References :**

- 1. Bassi, Alessandro, et al, "Enabling things to talk", Springer-Verlag Berlin -2016
- 2. Neil Cameron, "Arduino Applied-Comprehensive Projects for Everyday Electronics", Apress. 2019.
- 3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, "Internet of Things", John Wiley & Sons, 2019.
- 4. Massimo Banzi, Michael Shiloh Make, "Getting Started with the Arduino", Shroff Publisher/Maker Media Publishers.

#### **Evaluation Pattern**

Assessment	Internal	External
Continuous Assessment (CA)*	30	
Midterm Exam (MT)	30	
End Semester (ES) <sup>#</sup>		40

\*CA – Can be Quizzes and Assignments.

# ES- Can be Exam/Project

## 23IoT232M

## NETWORKS AND SECURITY FOR IoT

L-T-P-C: 3-0-0-3

#### Pre-Requisite(s): Nil

#### **Course Objectives:**

To understand the fundamental principles of networking and different network models. The course describes the design principles for sensor networks and IoT systems. The course also focuses on basics of network & data security in the context of IoT systems.

#### **Course Outcomes:**

**CO1:** To understand basics of computer networks.

CO2: To learn various protocols in networks.

**CO3:** To gain knowledge on data security aspects.

CO4: To gain knowledge on network security aspects

## **CO-PO Mapping**

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
СО	101	102	105	101	105	100	107	100	10)	1010	1011	1012	1501	1502
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2	2	3	-	-	-	-	-	-	2	-	-
CO3	2	2	2	2	3	2	-	-	-	-	-	2	2	-
CO4	2	2	2	2	3	2	-	-	-	-	-	2	2	2

#### **Syllabus**

#### Unit-1

Basics of Networking & Sensor Networks - ISO/OSI Model, TCP/IP Model. Sensor network architecture and design principles. Applications, challenges. Low power and lossy networks. IoT Networking Components. Gateways - Types, Configurations, Gateway as an extension of the cloud. Processing in IoT.

#### Unit-2

IoT technology stack - Overview of protocols in each layer. Medium Access Control, Discovery, Error Control, Addressing Strategies, Routing, Sockets. Power aware strategies

#### Unit-3

Basics of Network Security: Network Types, Addressing, Security, Network Confidentiality, Cryptography-AES, DES, Digital signatures and authentication protocols – standard – authentication applications – overview architecture – web security - socket layer and transport layer security – Intruders – Detection – Malicious software – viruses and related threats –denial of service - counter measures. Case Studies: Influence of Malware, data thefts, phishing attacks, spoofing and denial of service attacks.

## **Text Books**

- 1 David Hanes, Gonzalo Salgueiro, Patrick Grosseteste, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.
- 2 Anthony Sabella, Rik Irons Mclean, Marcelo Yannuzzi, "Orchestrating and Automating Security for the Internet of Things: Delivering Advanced Security Capabilities from Edge to Cloud for Io" Cisco Press, 2018,

## References

- 1. Shancang Li Li Da Xu, Syngress, "Securing the Internet of Things", Elsevier, 2017.
- 2. Fei Hu, "Security and Privacy in Internet of Things (IoTs)-Model, Algorithms and Implementation", CRC Press, 2016
- 3. Aditya Gupta, "The IoT Hacker's Handbook: A Practical Guide to Hacking the Internet of Things", Apress publisher, 2019.
- 4. William Stallings, "Data and Computer Communications", Pearson Education Pvt Ltd., 8th Edition, 2017

#### **Evaluation Pattern**

Assessment	Internal	External
Continuous Assessment (CA)*	30	
Midterm Exam (MT)	30	
End Semester (ES) <sup>#</sup>		40

\*CA – Can be Quizzes and Assignments. # ES- Can be Exam/Project

#### 23IoT233M

#### **IoT PROTOCOLS**

## L-T-P-C: 3-0-2-4

Pre-Requisite(s): Networks and Security for IoT

#### **Course Objectives:**

Amrita Vishwa Vidyapeetham.

B.Tech-IoT Minor

The course describes various connectivity technologies and data protocols available for IoT Systems to exchange the data. The advantages of cloud platforms for developing, storing, and deploying IoT applications are also discussed. After completing the course, students can apply the various IoT protocols for developing IoT applications.

## **Course Outcomes:**

CO1: Familiarize working of IoT Connectivity Technologies.

**CO2:** Understand IoT communication protocols.

**CO3:** Learn cloud models for IoT applications.

**CO4:** Apply various IoT Protocols in practice.

## **CO-PO Mapping**

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO														
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2	2	3	-	-	-	-	-	-	2	-	-
CO3	2	2	2	2	3	2	-	-	-	-	-	2	2	-
CO4	2	2	2	2	3	3	2	-	-	-	-	2	2	2

## Syllabus

## Unit-1

IoT Connectivity Technologies: RFID, NFC, Wi-Fi, Bluetooth low energy, IEEE 802.15.4, Zigbee, Thread, Wireless HART, Z-Wave, LoRa, NB-IoT, 6LoWPAN, IoT Interoperability: Introduction, Taxonomy of interoperability, Standards, DLNA, Konnex, UPnP, Frameworks, universal, IoTivity, HomeKit.

## Unit-2

IoT Data Protocols- MQTT, CoAP, AMQP, XMPP, REST, WebSocket, Identification Protocols, EPC, URIs, Device Management, Semantic Protocols, JSON-LD, Web thing model.

## Unit-3

Cloud Computing-IOT Associated Technologies: Introduction, Virtualization, Advantages of virtualization, Types of virtualizations, Cloud Models, Service-Level Agreement in Cloud Computing, Importance of SLA, Metrics for SLA, Cloud Implementation, Cloud simulation, An open-source cloud: OpenStack, Cloud Platforms - Basic & Advanced Sensor-Cloud: Sensors-as-a-Service, Importance of sensor-cloud, Architecture of a sensor-cloud platform.

## Text Books

1. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication, 2019.

2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley and Sons, 2012

## References

- 1. David Hanes, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press 2017.
- 2. Mangla, Monika, Suneeta Satpathy, Bhagirathi Nayak, and Sachi Nandan Mohanty, eds. "Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications" John Wiley & Sons, 2021.

Amrita Vishwa Vidyapeetham.

B.Tech-IoT Minor

B.Tech Curriculum July 2023 7

3. Cirani, Simone, Gianluigi Ferrari, Marco Picone, and Luca Veltri. "Internet of things: architectures, protocols and standards", John Wiley & Sons, 2018.

## **Evaluation Pattern**

Assessment	Internal	External
Continuous Assessment (CA)*	30	
Midterm Exam (MT)	30	
End Semester (ES) <sup>#</sup>		40

\*CA – Can be Quizzes and Assignments.

# ES- Can be Exam/Project

23IoT234M	IoT SYSTEM DESIGN	L-T-P-C: 3-0-2-4

## Pre-Requisite(s): Nil

#### **Course Objectives:**

To give students insight into edge devices and computing in the edge devices in an IoT system. The course provides hands-on experience in developing an end-to-end IoT application with appropriate User Interface and efficient data storage schemes.

#### **Course Outcomes:**

CO1: To understand edge devices.CO2: To develop edge devices.CO3: To be able to develop the user interface for IoT applications.CO4: To design an IoT application using suitable data base.

## **CO-PO Mapping**

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO														
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	3	3	3	2	2	-	-	-	-	2	-	-
CO3	2	3	3	3	3	2	2	-	-	-	-	3	3	3
CO4	2	3	3	3	3	2	2	-	-	-	-	3	3	3

## Syllabus

## Unit-1

Edge Devices-Architecture, Building blocks. IoT Gateways - Edge device as a protocol converter, Edge Computing and Fog Computing. Edge device as a computing platform. Case Study: Edge device in various IoT applications.

## Unit-2

Sophisticated embedded/computing platforms - ARM Cortex based/FPGA/GPU/Open GL. Architecture of computing engine, peripherals, programming. Case Study: Application development for specific real world IoT solutions.

## Unit-3

Servers – User Interface & Database-architecture of web applications-3-tier architecture-Presentation logic: HTML, business logic: python, database: RDBMS.

#### **Text Books:**

1. Puneet Mathur, "IoT Machine Learning Applications in Telecom, Energy, and Agriculture, with Raspberry Pi and Arduino Using Python", ISBN 978-1-4842-5549-0

2.Sudip Misra, Chandana Roy and Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press

#### **References:**

- 1. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices Edge Gateway, and Cloud with Applications", Cengage India Publication
- 2. Richardson, M., & Wallace, S.. "Getting started with raspberry PI". O"Reilly Publisher Media Inc, 2012.
- 3. Shrirang Ambaji Kulkarni: Introduction to IOT with Machine learning and Image Processing using Raspberry *Pi, CRC Press*
- 4. Rao M. "Internet of Things with Raspberry Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects", Packt Publishing Ltd, 2018.

#### **Evaluation Pattern**

Assessment	Internal	External
Continuous Assessment (CA)*	30	
Midterm Exam (MT)	30	
End Semester (ES) <sup>#</sup>		40

\*CA – Can be Quizzes and Assignments.

# ES- Can be Exam/Project

23IoT235M

#### **APPLICATIONS of IoT**

#### L-T-P-C: 2-0-2-3

#### Pre-Requisite(s): IoT System Design

#### **Course Objectives:**

The course provides an overview of various emerging technologies that can support IoT application development. Students will be able to identify and develop the devices, communication scheme, and functionalities needed for a specific IoT application.

#### **Course Outcomes:**

**CO1:** Understand various technologies related to IoT.

CO2: Develop IoT devices for an application.

**CO3:** Develop IoT networks for an application.

**CO4:** Develop IoT services for an application.

#### **CO-PO Mapping**

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO		102	105		105	100	107	100	10)	1010	1011	1012	1501	1502

CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	3	3	3	2	2	-	-	-	-	2	-	-
CO3	2	3	3	3	3	2	2	-	-	-	-	3	3	3
CO4	2	3	3	3	3	2	2	-	-	-	-	3	3	3

#### Syllabus

#### Unit-1

Introduction: Globalization, The Fourth Revolution, LEAN Production Systems; Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Convergence of Augmented Reality and Virtual Reality with IoT, IoT Minimum Viable Product building guidelines.

#### Unit-2

Business Model and Reference Architecture. Sensing & Actuation for Agriculture/Home automation/vehicle technology/smart cities/healthcare/ smart grid/ data critical applications/logistics/planetary explorations.

#### Unit-3

Processing and Communication for Agriculture/Home automation/vehicle technology/smart cities/healthcare/ smart grid/ data critical applications/logistics/planetary explorations.

#### **Text Books:**

1 G Veneri Antonio, "Hands-on Industrial Internet of Things", Packt Publication, 2018

2. Vijay Madisetti, Arshdeep Bahga, Internet of Things, "A Hands-on approach". University Press

#### **References:**

- 1. Donald Norris, "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", McGraw-Hill Education TAB, 2015.
- 2. Mangla, Monika, Suneeta Satpathy, Bhagirathi Nayak, and Sachi Nandan Mohanty, eds. Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications" John Wiley & Sons, 2021.
- 3. Rahul K. Kher, Chirag Paunwala, Falgun Thakka, et.al, "IoT Applications for Healthcare Systems", EAI/Springer Innovations in Communication and Computing, 1<sup>st</sup> Edition, 2022.

#### **Evaluation Pattern**

Assessment	Internal	External
Continuous Assessment (CA)*	30	
Midterm Exam (MT)	30	
End Semester (ES) <sup>#</sup>		40

\*CA – Can be Quizzes and Assignments.

# ES- Can be Exam/Project