

BACHELOR'S DEGREE PROGRAMME

B.Tech.

**Computer Science and Engineering with Specialization in Internet of
Things**

Academic Curricula

2024-2028



SCHOOL OF COMPUTER ENGINEERING

KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY

BHUBANESWAR – 751024

ODISHA, INDIA

Programme Specific Outcome (PSO)

- To develop students with in-depth knowledge of internet of things (IoT), artificial intelligence (AI), cloud based IoT and various other sub fields related to internet of things which will provide a strong foundation to pursue a career in education and IT industry for innovation, research and development.
- 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.
- Apply standard and advanced internet of things-based concepts, practices and strategies in order to develop sustainable products using AI-based technology to deliver a quality product for Business, Education and Training and/or E-governance.
- Analyze and develop computer systems connected together using IoT network protocols, and also work towards making them more secure and efficient using blockchain, machine learning algorithms, fog and edge computing for efficient design of computer-based systems of varying complexity. Finally specify, design, develop, test and maintain usable systems that behave reliably and efficiently..

Guideline and Notes to obtain the Specialization

A student has to follow the B.Tech Computer Science curricula. To get the specialization the student has to take the following as the professional electives in the respective semester from the basket.

PE: Professional Elective				
Sl.No	CourseCode	Course Title	Pre-requisites	Credits
PE-I	CS30029	Sensor and Devices	CS21002	3
PE II	CS30031	Privacy Security in IoT	-	3
PE III	CS30028	Data Science for IoT		3
PE IV	CS40015	Industrial IoT		3
PE V		Any one Subject from PE- V Basket of CSE Syllabus.		3

Course Title	Sensors and Devices
CourseCode(Credit)	CS 30029 (L-T-P-Cr: 3-0-0-3)

Course Objectives

- To introduce the terminology, technology and its applications
- To introduce the concept of M2M (machine to machine) with necessary protocols
- To introduce the Python Scripting Language which is used in many IoT devices
- To introduce the Raspberry PI platform, that is widely used in IoT applications
- To introduce the implementation of web-based services on IoT devices

Course Contents:

UNIT I

Introduction to Internet of Things: Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT, IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture and Industry.

UNIT II

IoT and M2M: Software defined networks, network function virtualization, difference between SDN and NFV for IoT, Basics of IoT System Management with (NETCONF, YANG- NETCONF, YANG, SNMP NETOPEER

UNIT III

IoT Physical Devices and Endpoints: Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Controlling Hardware: Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors

UNITIV

Sensors: Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor.

UNIT V

IoT Physical Servers and Cloud Offerings: Introduction to Cloud Storage models and communication APIs Web Server, Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1: Understand IoT value chain structure (device, data cloud), application areas and technologies involved.

CO2: Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules

CO3: Market forecast for IoT devices with a focus on sensors

CO4: Explore and learn about Internet of Things with the help of preparing projects designed for Raspberry Pi

Textbooks:

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547.

Reference Books:

1. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.
2. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermesan.
4. Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014.
5. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

Course Title	Privacy and Security in IoT
CourseCode(Credit)	CS 30031 (L-T-P-Cr: 3-0-0-3)

Course Objectives

1. To impart knowledge on the state-of-the-art methodologies and Security in Internet of Things (IoT).

2. To understand the Privacy Preservation and Trust Models in Internet of Things (IoT).
3. To study the Internet of Things (IoT) Security protocols and Security framework.

UNIT I

Security in IoT

IoT security: Vulnerabilities, Attacks and Countermeasures - Security Engineering for IoT development - IoT security lifecycle.

UNIT II

Network Robustness and Malware Propagation Control in IoT

Network Robustness - Fusion Based Defense Scheme - Sequential Defense Scheme - Location Certificate Based Scheme - Sybil node detection scheme - Formal Modeling and Verification - Sybil Attack Detection in Vehicular Networks - Performance evaluation of various Malware Dynamics Models - Analysis of Attack Vectors on Smart Home Systems.

UNIT III

Blockchain Technology in IoT

Technical Aspects - Integrated Platforms for IoT Enablem Intersections between IoT and Distributed Ledger - Testing at scale of IoT Blockchain Applications - Access Control Framework for Security and Privacy of IoT - Blockchain Applications in Healthcare.

UNIT IV

Privacy Preservation in IoT

Privacy Preservation Data Dissemination: Network Model, Threat Model - Problem formulation and definition - Baseline data dissemination - Spatial Privacy Graph based data dissemination - Experiment Validation - Smart building concept-Privacy Threats in Smart Building - Privacy Preserving Approaches in Smart Building - Smart Meter Privacy Preserving Approaches.

UNIT V

Privacy Protection in IoT

Lightweight and Robust Schemes for Privacy Protection in IoT Applications: One Time Mask Scheme, One Time Permutation Scheme - Mobile Wireless Body Sensor Network - Participatory Sensing

UNIT VI

Trust Models for IoT

Trust Model Concepts - Public Key Infrastructures Architecture Components - Public Key Certificate Formats - Design Considerations for Digital Certificates - Public Key Reference Infrastructure for the IoT - Authentication in IoT - Computational Security for IoT.

UNIT VII

Security Protocols for IoT Access Networks

Time Based Secure Key Generation -Security Access Algorithm: Unidirectional, Bidirectional Transmission - Cognitive Security - IoT Security Framework - Secure IoT Layers – Secure Communication Links in IoT - Secure Resource Management, Secure IoT Databases.

Course Outcome:

At the end of this course, student will be able to:

1. Identify different Internet of Things technologies and their applications.
2. Assess the need for Privacy and security model for the Internet of Things.
3. Explore various Trust Model for IoT and customize real time data for IoT applications.
4. Design security framework and solve IoT security issues

Text Book(s)

1. Hu, Fei. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, 2016, 1st edition, CRC Press, USA.

Reference Books

- 1 Russell, Brian and Drew Van Duren. Practical Internet of Things Security, 2016, 1st edition, PACKT Publishing Ltd, UK
- 2 Kim, S., Deka, G. C., & Zhang, P. (2019). Role of blockchain technology in IoT applications. Academic Press.
- 3 Whitehouse O Security of things: An Implementers' guide to cyber-security for internet of things devices and beyond, 2014, 1 st edition, NCC Group, UK.

Course Title	Data Science for IoT
CourseCode(Credit)	CS30028 (L-T-P-Cr: 3-0-0-3)

Course Objectives

- To provide knowledge and experience of developing data science solutions for big data generated from IoT systems.

Course Contents:

UNIT I

Introduction to IoT and Data Science

Overview of IoT technology, Definition and evolution of IoT, Key components of an IoT system: devices, sensors, actuators, connectivity, data processing, and user interface, IoT architecture models: from edge devices to cloud services, Industry standards and protocols for IoT Role of data science in IoT, data science drives value from IoT data, Data science workflows in IoT: from data collection to actionable insights, Case studies of IoT in various industries.

UNIT II

IoT Architecture and Components Sensors and actuators, Types of sensors used in IoT: temperature, humidity, motion, light, etc., Role of actuators in IoT systems: motors, valves, switches, etc., Sensor data acquisition and signal conditioning, Integration of sensors and actuators with microcontrollers and IoT devices Connectivity protocols, Wired and wireless communication protocols: Bluetooth, Wi-Fi, Zigbee, LoRaWAN, 5G, Comparison of protocols based on range, data rate, power consumption, and scalability, Network topologies in IoT: star, mesh, tree, Security considerations for IoT connectivity Cloud computing and edge computing in IoT Cloud computing services for IoT: IaaS, PaaS, SaaS, Edge computing: bringing computation closer to the data source, Benefits of edge computing: reduced latency, bandwidth optimization, Use cases for cloud and edge computing in IoT scenarios.

UNIT III

Data Analytics for IoT with Security Data preprocessing techniques (Cleaning IoT data Handling missing values, Data normalization and transformation), Time-series analysis (Understanding time-series

dataTechniques for trend, seasonality, and noise analysis, Forecasting models for IoT applications), Real-time analytics (Stream processing fundamentalsWindowing techniques and real-time data pipelines, Real-time decision-making algorithms), Security challenges in IoT, Data encryption and anonymization techniquesRegulatory compliance (e.g., GDPR).

UNIT IV

Machine Learning and Deep Learning with IoT Data

Supervised and unsupervised learning, Feature engineering, Model validation and evaluation, Neural networks and deep learning architectures, Convolutional Neural Networks (CNNs) for image data, Recurrent Neural Networks (RNNs) for time-series data

UNIT V

Data Visualization in IoT

Dashboard design principles,Importance of dashboards in monitoring and controlling IoT systems, Best practices for dashboard layout and design to enhance user experience, Selecting the right charts and graphs for different types of IoT data, Incorporating user feedback into dashboard design, Visualization tools and libraries, (Tableau, Power BI, and Grafana), programming libraries for visualization such as (D3.js, Plotly, and Matplotlib), Interactive data exploration, interactive data analysis: filtering, sorting, and drilling down

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1: Critically review a range of data science solutions for a variety of IoT analytics scenarios, and evaluate their efficiency for industrial applications

CO2: Demonstrate critical understanding of the data science solutions development process for IoT systems.

CO3: Analyze, evaluate, design and implement data science solutions for a variety of industrial IoT applications.

CO4: Apply industrial standards in developing IoT applications.

CO5: Seek information from appropriate sources.

CO6: Demonstrate problem solving techniques and preparation for further research in the area.

Textbooks:

- 1.Internet of Things and Data Analytics Handbook, Hwaiyu Geng, ISBN: 978-1-119-17364-9, Wiley Publication.

Reference Books:

1. IoT Data Analytics using Python, M S Hariharan, ISBN: 9789355515759,eISBN: 9789355515766, BPB Publication.
2. Doing Data Science,Cathy O'Neil, Rachel Schutt,Publisher(s): O'Reilly Media, Inc., ISBN: 9781449358655.
Andrew Minter, “Analytics for the Internet of Things (IoT)”2017, ISBN 978-1787120730.

Course Title	Industrial IoT
Course Code(Credit)	CS 40015 (L-T-P-Cr: 3-0-0-3)

Course Objectives

- To provide students with a good depth of knowledge of Designing Industrial IOT Systems for various applications.

Course Contents:

UNIT I

Introduction To Industrial Internet and Use-Cases: Industrial Internet- Key IIoT Technologies- Innovation and the IIoT -Key Opportunities and Benefits - The Digital and Human Workforce - Logistics and the Industrial Internet- IOT Innovations in Retail.

UNIT – II

The Technical and Business Innovators of The Industrial Internet: Cyber Physical Systems (CPS), – IP Mobility – Network Virtualization - SDN (Software Defined Networks)- The Cloud and Fog – Role of Big Data in IIOT - Role of Machine learning and AI in IIOT

UNIT – III

IIOT Reference Architecture: Industrial Internet Architecture Framework (IIAF) -Industrial Internet Viewpoints -. Architectural Topology: The Three-Tier Topology- Key System Characteristics- Data Management- Advanced data analytics.

UNIT – IV

Protocols for Industrial Internet Systems: Legacy Industrial Protocols - Modern Communication Protocols-Proximity Network Communication Protocols- Wireless Communication Technologies- Gateways: industrial gateways - CoAP (Constrained Application Protocol)- NFC.

UNIT - V

Middleware Software Patterns and IIOT Platforms:

Publish/Subscribe Pattern: MQTT, XMPP, AMQP, DDS- Middleware Architecture- SigFox- LoRaWAN Augmented reality- Real-World Smart Factories, Application of IIOT: Case study: Health monitoring, IoT smart city, Smart irrigation, Robot surveillance.

Course Outcomes:

CO1: Identify the Key opportunities and benefits in Industrial IoT

CO2: Apply virtual network to demonstrate the use of Cloud in Industrial IoT

CO3: Analyze industrial IoT Three tier topology and data management system

CO4: Summarize Legacy Industrial and Modern Communication Protocols

CO5: Describe Middleware Architecture, LoRaWAN- and Augmented reality

TEXT BOOKS:

1. Gilchrist, Alasdair, "Industry 4.0 The Industrial Internet of Things", Apress, 2017.

REFERENCE BOOKS:

1. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat "Industrial Internet of Things: Cyber manufacturing Systems" (Springer), 2017.
2. Zaigham Mahmood, "The Internet of Things in the Industrial Sector: Security and Device connectivity, smart environments and Industry 4.0 (Springer), 2019.
3. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)
4. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
5. Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642- 19156-5 e-ISBN 978-3-642- 19157-2, Springer
6. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
Cuno Pfister, Getting Started with the Internet of Things, O "Reilly Media, 2011, ISBN: 978-1-4493-9357-1