# Savitribai Phule Pune University
## Board of Studies - Mechanical and Automobile Engineering
Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

| 402044E: Internet of Things | | | | | |
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| **Teaching Scheme** | | **Credits** | | **Examination Scheme** | |
| **Theory** | **3 Hrs./Week** | **Theory** | **3** | **In-Semester** | **30 Marks** |
| | | | | **End-Semester** | **70 Marks** |

**Prerequisites:** Systems in Mechanical Engineering**,** Programming and Problem Solving, Basic Electronics Engineering, Solid Mechanics, Solid Modeling and Drafting, Electrical and Electronics Engineering, Mechatronics, Measurement Laboratory, Fluid Power & Control Laboratory

**Course Objectives:**
1. Introduction to IoT, Overview of IoT Building Blocks
2. Build small applications in IoT for Mechanical Engineering Applications using Sensors, Actuators, Microcontrollers and Cloud
3. Learn commonly used IoT Simulation Hardware platforms
4. Understand different Communication Technologies used in IoT
5. Development of application level protocol and Security of IoT Ecosystem
6. Understand IoT applications in different domains

**Course Outcomes:**
On completion of the course the learner will be able to;
- CO1. **EXPLAIN** the Applications/Devices, Protocols and Communication Models of IoT
- CO2. **DEMONSTARTE** small Mechanical Engineering IoT oriented applications using Sensors, Actuators, Microcontrollers and Cloud
- CO3. **SELECT** commonly used IoT Simulation Hardware platforms
- CO4. **APPLICATION** of Interfacing and Communication Technologies for IoT
- CO5. **ILLUSTRATE** IoT Application Development and Security of IoT Ecosystem
- CO6. **EVALUATE** Present and Future Domain specific Applications of IoT Ecosystem

| Course Contents | |
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| **Unit 1** | **Introduction to the Internet of Things (IoT)** |

Overview, History, Definition and Characteristics, Connectivity Terminologies, Building blocks, Types of technologies used in IoT System, Baseline Technologies (Machine-to-Machine ($M_2M$) communications, Cyber-Physical-Systems (CPS)), IoT Vs $M_2M$, IoT enabled Technologies, IoT Levels and Templates, Design Methodology, The Physical Design Vs Logical Design of IoT, Functional blocks of IoT and Communication Models/Technologies, Development Tools used in IoT, IoT Architecture and Protocols, Various Platforms for IoT, Real time Examples of IoT, Challenges in IoT, The process flow of an IoT application, Evolution of Connected Devices,

Applications of IoT, IoT Enablers, Overview of Governance, Privacy and Security Issues.

| Unit 2 | Sensors, Actuators and Microcontrollers |
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Measuring physical and virtual quantities in digital world, Overview of Sensors working, Analog Vs Digital Sensors, Wired Vs Wireless Sensors, Types of Sensors, Types of Converters

Types of Transducers and Actuator, Controlling Hardware, Types of Controller, Role of microcontroller as gateway to interfacing sensors and actuators, Microcontroller Vs Microprocessor, Type of microcontrollers in embedded System

| Unit 3 | IoT Simulation Environment Hardware platforms and Endpoint Interfacing |
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**IoT supported Hardware platforms:** Introduction to IoT Simulation Environment and Devices (Raspberry Pi, Espressif Processors, Arduino), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, $I_2C$), Programming with focus on interfacing for reading input from pins, connecting external gadgets/sensors/actuators, Controlling and Displaying Output, Libraries, Basics of Embedded C programming

**Interfacing:** Interfacing Input, Intermediate, Output and Display Sensors, Converters, Actuators, Controlling Hardware, Controllers and Network Devices,

**IoT Architecture:** Building architecture and Open source architecture (OIC), Main design principles and needed capabilities, An IoT architecture outline, Standards Considerations

| Unit 4 | Interfacing and Communication for Building IoT Applications |
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**Communication:** Overview and Working of Controlled Systems, Connectivity models - TCP/IP Vs OSI model, IoT Communication Models, IoT Communication APIs, Serial Vs Parallel Communication, Wires Vs Wireless Communication, their Technologies and Hardware

**IoT Communication Protocols:** Protocol Standardization for IoT, Role of $M_2M$ in IoT, $M_2M$ Value Chains, IoT Value Chains, $M_2M$ and WSN Protocols (SCADA and RFID)

**Physical Servers and Cloud Platforms:** Web server, Posting sensor(s) data to web server, Introduction to Cloud Storage models and Communication APIs Webserver, API Virtualization concepts and Cloud Architecture, Advantages and limitations of Cloud computing, IoT Cloud platforms, Cloud services

| Unit 5 | IoT Application Development and Security of IoT Ecosystem |
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**Application Protocols:** MQTT, REST/HTTP, SQL Back-end Application Designing (Designing with Apache, MySQL, HTML, CSS), Non SQL Back-end Application Designing (MongoDB Object Type Database, jQuery for UI Designing), JSON lib for data processing

**Security:** Need of security in IoT, Security & Privacy during development, Privacy for IoT

enabled devices, IoT security for consumer devices, Security levels, protecting IoT devices, Security, Privacy and Trust in IoT-Data-Platforms

| Unit 6 | Present and Future Domain specific Applications of IoT Ecosystem |
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**IoT applications for industry:** Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, Business, Manufacturing, Smart Homes/Home automation, Surveillance applications, Connected Vehicles, Agriculture, Healthcare, Activity Monitoring, Retail, Logistics, Security, Health and Lifestyle, Legal challenges, IoT in Environmental Protection Modern Day IoT Applications, Smart Grid, Smart Cities - Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities

**Future:** Future IoT ecosystem, Need of powerful core for building secure algorithms, Examples for new trends (AI, ML penetration to IoT)

### Books and other resources

**Text Books:**
1. Bahga, A. and Madisetti, V., (2015), "Internet of Things - A Hands-on Approach," Universities Press, ISBN: 9788173719547
2. Hajjaj, S S H. and Gsangaya, K. R., (2022), "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers," CRC Press, ISBN: 9781032110950
3. Raj, P. and Raman, A. C., (2017), "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," Auerbach Publications/CRC Press, ISBN: 9781498761284
4. Adrian McEwen, A. and Cassimally, H., (2013), "Designing the Internet of Things," John Wiley and Sons, ISBN:
5. Veneri, G., Capasso, A., (2018), "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0," Packt Publishing, ISBN: 9781789537222
6. Hersent, O, Boswarthick, D., Elloumi, O., (2012), "The Internet of Things: Key Applications and Protocols", Wiley, ISBN: 9781119994350
7. Uckelmann, D., Harrison, M., Michahelles, F., (2011), "Architecting the Internet of Things," Springer, ISBN: 9781119994350

**References Books:**
1. daCosta, F., (2013), "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, ISBN: 9781430257417
2. Waher, P., (2015), "Learning Internet of Things," Packt Publishing, ISBN: 9781783553532
3. Ovidiu, V. and Friess, P., (2014), "Internet of Things - From Research and Innovation to Market Deployment," River Publishers, ISBN: 9788793102941, https://www.riverpublishers.com/pdf/ebook/RP_E9788793102958.pdf
4. Ida, N., (2020), "Sensors, Actuators and Their Interfaces," SciTech Publishers, ISBN: 9781785618352
5. Pfister, C., (2011), "Getting Started with the Internet of Things," O'Reilly Media, ISBN:

9781449393571

6. Wallace, S., Richardson, M., Wolfram Donat, W., (2021), "Getting Started With Raspberry Pi: Getting to Know the Inexpensive ARM-Powered Linux Computer," Make Community, LLC, ISBN: 9781680456998

7. Elangovan, U., (2019), "Smart Automation to Smart Manufacturing: Industrial Internet of Things," Momentum Press, ISBN: 9781949449266

8. Jha, S., Tariq, U., Joshi, G. P., Solanki, V. K., (2022), "Industrial Internet of Things: Technologies, Design, and Applications," CRC Press, ISBN: 9780367607777

9. Schwartz, M., (2016), "Internet of Things with Arduino Cookbook," Packt Publishing, ISBN: 9781785286582

10. Kurniawan, A., (2019), "Internet of Things Projects with ESP32: Build exiting and powerful IoT projects using the all-new Expresif ESP32," Packt Publishing, ISBN: 9781789956870

**Web References:**

1. https://nptel.ac.in/courses/106105166
2. https://www.udemy.com/internet-of-things-iot-for-beginners-getting-started/
3. http://playground.arduino.cc/Projects/Ideas
4. http://www.megunolink.com/articles/arduino-garage-door-opener
5. http://www.willward1.com/arduino-wifi-tutorial
6. http://www.toptechboy.com/arduino-lessons
7. https://www.eprolabs.com
8. http://www.makeuseof.com/tag/pi-overdose-heres-5-raspberry-pi-alternatives