# Information Booklet cum Syllabus

## Of

# Internet of Things and its Applications
# (O level M4-R5.1 Module)


**National Institute of Electronics and Information Technology**

An Autonomous Scientific Society under
Ministry of Electronics and Information Technology, Government of India

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## 1. About Course

The module is designed to equip the students to understand the basics of connected world that is Internet of Things (IoT) and its applications. IoT primarily refers to the connected and smarter world having physical and virtual objects with some unique identities. IoT applications span across domains of industrial control, retail, energy, agriculture, etc. This module provides the theoretical and practical aspects of interfacing sensors and actuators, making informed world of Things speaking to each other. The different type of communication modes and models are discussed in detail. The in-depth knowledge of software and packages is provided to make applications in IoT paradigm.

## 2. NIELIT

National Institute of Electronics and Information Technology, NIELIT, (Erstwhile DOEACC Society) is an autonomous scientific society of the Ministry of Electronics & Information Technology, Government of India. The Society is registered under the Societies Registration Act, 1860. NIELIT was set up to carry out Human Resource Development and related activities in the area of Information, Electronics & Communications Technology (IECT). NIELIT is engaged both in Formal & Non-Formal Education in the areas of IECT besides development of industry oriented quality education and training program in the state-of-the-art areas. NIELIT has endeavored to establish standards to be the country's premier institution for Examination and Certification in the field of IECT. It is also one of the National Examination Body, which accredits institutes/organizations for conducting courses in IT and Electronics in the non-formal sector.

## 3. Objective of Course

After completing the module, the learner will be able to:

- Understand how connected devices work together to update other applications.
- Acquire knowledge to interface sensors and actuators with microcontroller based Arduino platform.
- Writing C programs in Arduino IDE.
- Understand the Communication between microcontroller and PC using serial communication.
- Build IoT based applications and understand how data flows between things.
- Understand how electronic devices control electrical appliances working at 220v AC.
- Understand security aspect of IoT devices.
- Enhance skill set towards better personality development.

This course covers the "**Internet of Things and its Applications"** paper (Module Code: **M4-R5.1** / **A4-R5.1**) of the NIELIT 'O'/'A' Level course.

## 4. Job Roles of Course

After successful completion of the qualification, the candidates shall be employed in the industries for following occupations:

- IoT Developer (Junior Level)
- Trainer/Faculty
- IoT Application Tester
- Technical Support – IoT Devices

## 5. Eligibility

12th Pass, Basic Knowledge of Computer.

## 6. Total duration of the Course

60 Hours (Theory: 30 Hrs, Practical: 30 Hrs)

## 7. Course Details

### 7.1.Course Outline and Objective of Each Unit

| S. No. | Unit Name | Duration (Theory) in Hours | Duration (Practical) in Hours | Total Learning Hrs. | Learning Objectives |
|---|---|---|---|---|---|
| 1 | Introduction to IoT – Applications/ Devices, Protocols and Communication Model | 2 | 2 | 4 | After completion of this unit of module, Learner will be able to<br>• Understand various IoT Applications, protocols, architecture, etc.<br>• Understand the characteristics of IoT devices.<br>• Know about Physical Design/Logical Design, Functional blocks of IoT and Communication Models |
| 2 | Things and Connections | 2 | 2 | 4 | After completing this unit, Learner will be able to understand<br>• Closed loop/ feedback loop system. |

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| | | | | | • The use of sensors, actuators and controllers in the IoT process flow.<br>• TCP/IP Versus OSI models.<br>• Wired and wireless connectivity. |
| 3 | Sensors, Actuators and Microcontrollers | 4 | 4 | 8 | After completing this unit, Learner will be able to understand<br>• The role of Sensors, transducers in measuring physical quantities.<br>• Working and characteristics of actuators.<br>• Role and use of microcontroller in building various electronic devices. |
| 4 | Building IoT Applications | 12 | 12 | 24 | After completing this unit, Learner will be able to understand<br>• Working of microcontroller and hardware prototyping Arduino platform.<br>• The role of 'C' language in building IoT applications.<br>• Built-in Data-type, operatorsexpressions<br>• Conditional statements and loops. Arrays, functions.<br>• Digital, analog pins of Arduino.<br>• Interfacing sensors, actuator.<br>• Using ArduBlock GUI tool. |

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| 5 | Security and Future of IoT Ecosystem | 4 | 4 | 8 | After completing this unit, Learner will be able to understand<br>• Need of security in IoT.<br>• Various basic concept of security.<br>• Security levels.<br>• Need of powerful CPU for Future IoT eco system. |
| 6 | Soft skills - Personality Development | 6 | 6 | 12 | After completing this unit, Learner will be able to understand<br>• Role of positive personality and determinants of personality.<br>• Self-esteem.<br>• Communication and writing skills. |

### 7.2.Detailed Syllabus

| S.No | Unit Name | Contents |
|---|---|---|
| 1 | Introduction to Internet of Things – Applications/Devices, Protocols and Communication Model | • Introduction - Overview of Internet of Things(IoT), the characteristics of devices and applications in IoT ecosystem, building blocks of IoT<br>• Various technologies making up IoT ecosystem, IoT levels<br>• IoT design methodology, The Physical Design/Logical Design of IoT, Functional blocks of IoT and Communication Models, Development Tools used in IoT. |
| 2 | Things and Connections | • Working of Controlled Systems, Real-time systems with feedback loop e.g. thermostat in refrigerator, AC, etc.<br>• Connectivity models – TCP/IP versus OSI model, different type of modes using wired and wireless methodology<br>• The process flow of an IoT application. |
| 3 | Sensors, Actuators and Microcontrollers | • Sensor - Measuring physical quantities in digital world e.g. light sensor, moisture sensor, temperature sensor, etc.<br>• Actuator – moving or controlling system e.g. DC motor, different type of actuators<br>• Controller – Role of microcontroller as gateway to interfacing sensors and actuators, microcontroller vs microprocessor, different type of microcontrollers in embedded ecosystem. |
| 4 | Building IoT applications | • Introduction to Arduino IDE – writing code in sketch, compiling-debugging, uploading the file to Arduino board, role of serial monitor.<br>• Embedded ‘C’ Language basics - Variables and Identifiers, Built-in Data Types, Arithmetic operators and Expressions, Constants and Literals, assignment.<br>• Conditional Statements and Loops - Decision making using Relational Operators, Logical Connectives - conditions, if-else statement |

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| | | • Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement. Arrays – Declaring and manipulating single dimension arrays<br>• Functions - Standard Library of C functions in Arduino IDE, Prototype of a function: Formal parameter list, Return Type, Function call. Interfacing sensors – The working of digital versus analog pins in Arduino platform, interfacing LED, Button<br>• Sensors-DHT, LDR, MQ135, IR. Display the data on Liquid Crystal Display(LCD), interfacing keypad<br>• Serial communication – interfacing HC-05(Bluetooth module) Control/handle 220V AC supply – interfacing relay module. |
| 5 | Security and Future of IoT Ecosystem | • Need of security in IoT - Why Security? Privacy for IoT enabled devices- IoT security for consumer devices- Security levels, protecting IoT devices.<br>• Future of IoT ecosystem - Need of power full core for building secure algorithms, Examples for new trends - AI, ML penetration to IoT. |
| 6 | Soft skills-Personality Development | • Personality Development - Determinants of Personality- self-awareness, motivation, self-discipline, etc., building a positive personality, gestures.<br>• Self-esteem - self-efficacy, self-motivation, time management, stress management, Etiquettes & manners.<br>• Communication and writing skills-objective, attributes and categories of communication, Writing Skills – Resume, Letters, Report, Presentation, etc. Interview skills and body language. |

## 8. Reference Books/Study Material

1. Macro Schwartz, “Internet of Things with Arduino- Cookbook”, Packt 2016
2. Arshdeep Bajga and Vijay Madisetti, “Internet of Things- A Hands-on Approach” Universities Press, 2014
3. Massimo Banzi, “Getting started with Arduino”, 2nd Edition, Oreilly, 2011 [Make:Makezine.com]
4. Macro Schwartz, “Internet of Things with Arduino”, Open Home Automation
5. Michael Margolis, “Arduino Cookbook”, Oreilly, 2011

## 9. Practical Assignments:

1. Blink default LED on Arduino with 3 sec delay.
2. Interface LEDs on pins 4,5,6,12 to blink alternatively (forward/reverse) with 2 sec delay.
3. Generate LED patterns like 10001, 01110, etc.
4. Interface buzzer to buzz on/off with 5 sec delay.
5. Interface switch and LED (LED blinks when switch is pressed).
6. Interface button, buzzer, LED (buzzer beeps for 300ms when button pressed).
7. Interface LEDs at pins 10,11,12,13 and buttons at 7,8 to increment/decrement LED activation.
8. Interface LDR and display values on Serial Monitor (2 sec delay).
9. Interface LDR and LED (LED ON in dark, OFF in light).
10. Interface LED at PWM pin to exhibit LED fading.
11. Interface LED at PWM pin and LDR to represent smart street light.
12. Interface MQ135 gas sensor and display value on Serial Monitor (5 sec delay).
13. Interface LCD to display "NIELIT LUCKNOW".
14. Interface Hex keypad and display key on Serial Monitor.
15. Interface LCD and keypad to display key on LCD.
16. Interface LCD to slide text on second row.

17. Interface LCD and 4x4 keypad to make basic calculator.

18. Simulate password-based lock using LCD, LEDs, buzzer, and keypad.

19. Interface LCD and DHT11 sensor to display temperature on LCD.

20. Turn DC motor speed using L298N Driver Module.

21. Interface DHT11 and DC motor to turn on fan above a threshold temperature.

22. Interface LCD and Bluetooth to display mobile-sent values.

23. Interface LED and Bluetooth to turn LED ON/OFF via mobile.

24. Interface relay and Bluetooth to control AC load via mobile.

25. Make a robotic car using DC motors and Bluetooth module.

## 10. Sample Questions:

1. **Which of the following is NOT a characteristic of IoT devices?**
   a) Connectivity
   b) Autonomy
   c) Manual Operation
   d) Scalability

2. **Which of the following is considered a building block of IoT?**
   a) Relays
   b) Operating Systems
   c) Sensors and Actuators
   d) Graphic Cards

3. **Which layer manages the data format and representation in the OSI model?**
   a) Transport Layer
   b) Presentation Layer
   c) Data Link Layer
   d) Network Layer

4. **Which tool is used for writing, compiling, and uploading code to an Arduino board?**
   a) Eclipse IDE
   b) Arduino IDE
   c) Visual Studio Code
   d) Notepad++

5. **Which of the following is a logical design component of IoT?**
   a) NodeMCU
   b) Temperature sensor
   c) API endpoint
   d) Microcontroller

6. **A thermostat that automatically adjusts AC temperature is an example of:**
   a) Open loop system
   b) Closed loop system
   c) Manual system
   d) Wireless network

7. **Which model is most commonly used for Internet communication in IoT?**
   a) OSI Model
   b) TCP/IP Model
   c) UTP Model
   d) FTP Model

8. **Which of the following is a wired communication method?**
   a) Bluetooth
   b) Wi-Fi
   c) Ethernet
   d) ZigBee

9. **The process flow of an IoT application starts with:**
   a) Storing data
   b) Displaying data
   c) Sensing data
   d) Analyzing data

10. **Which of these is an example of an actuator?**
    a) DHT11
    b) LDR
    c) DC Motor
    d) Moisture sensor

11. **Which of the following converts a physical signal to digital form?**
    a) Actuator
    b) Sensor
    c) Resistor
    d) Transformer

12. **Which microcontroller is commonly used in Arduino boards?**
    a) ATmega328
    b) 8051
    c) STM32
    d) Z80

13. **Which of these is NOT a characteristic of a microcontroller?**
    a) Compact size
    b) RAM + ROM + CPU on one chip
    c) High power consumption
    d) Low cost

14. **In Embedded C, the keyword int is used for:**
    a) Input functions
    b) Integer data type
    c) Loops
    d) Character data

15. **Which statement is used for decision-making in C?**
    a) for
    b) if-else
    c) do-while
    d) goto

16. **The command Serial.begin(9600); in Arduino is used to:**
    a) Start sensor reading
    b) Begin analog read
    c) Initialize serial communication
    d) Upload code

17. **Which sensor can detect the level of light?**
    a) DHT11
    b) MQ135
    c) LDR
    d) IR sensor

18. **Which module is used to control 220V AC appliances with Arduino?**
    a) Bluetooth Module
    b) LCD
    c) Relay Module
    d) Buzzer

19. **Why is security important in IoT devices?**
    a) For better graphics
    b) To reduce cost
    c) To protect user privacy and data
    d) To increase weight

20. **Which of the following is considered a soft skill?**
    a) C Programming
    b) Time Management
    c) Sensor Interfacing
    d) Circuit Designing