Program Name : **Diploma in Automation and Robotics**
Program Code : **AO**
Semester : **Sixth**
Course Title : **Internet of Things**
Course Code : **22679**

1. RATIONALE

The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The focus will be more on the possibilities offered by the different technologies, and on the creative thinking techniques to find innovative applications of combinations of such technologies in real- life scenarios.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Apply knowledge of technology for solving real-life problems in industry.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Identify different basic blocks of IoT systems.
b. Use hardware and IoT components.
c. Integrate IoT hardware and components.
d. Demonstrate different platforms and their interfacing.
e. Design applications of IoT.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

***Legends:* L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment**

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the center of this map..

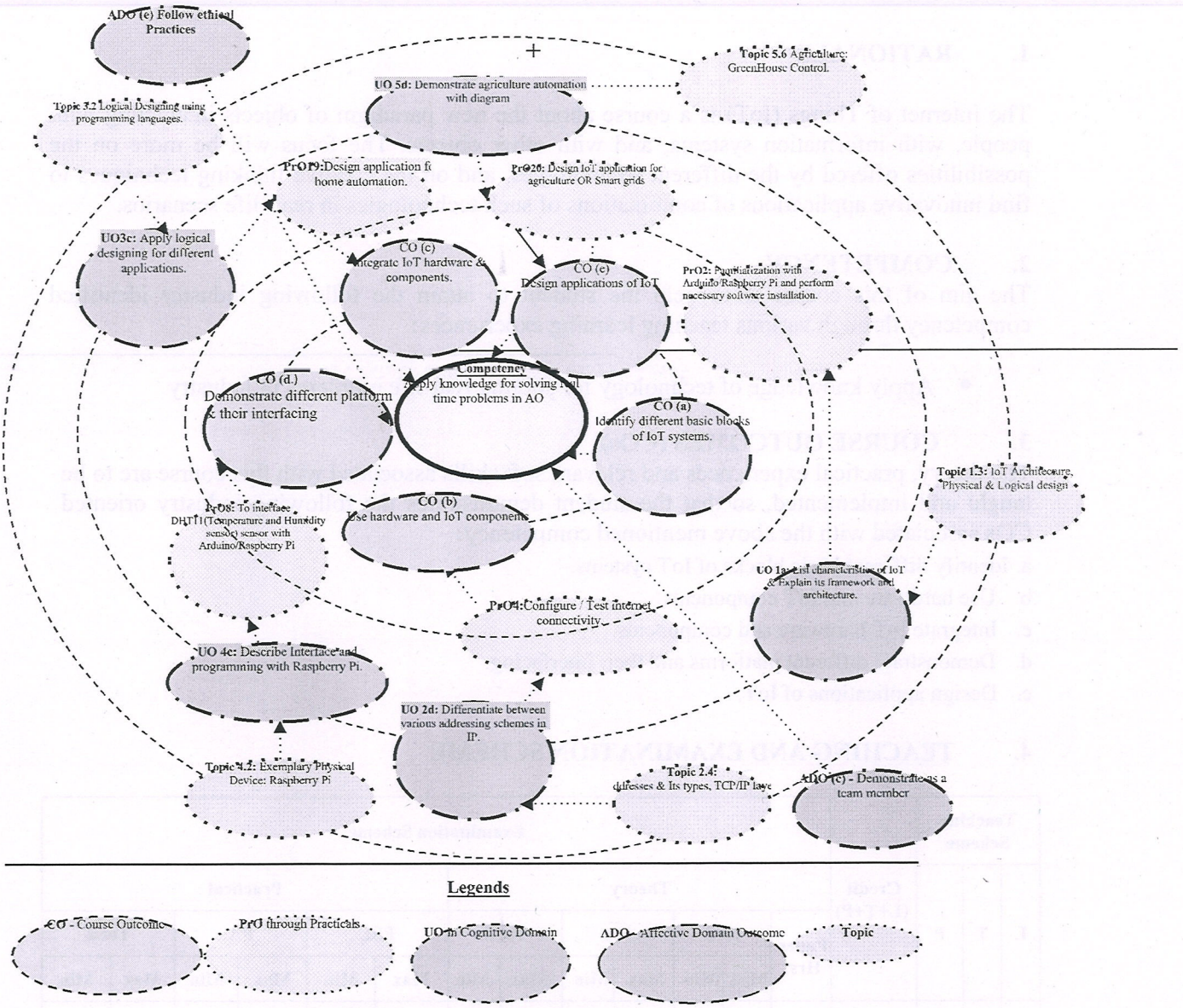

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

Sr.	Practical Outcomes (PrOs)	Unit	Approx.

No.		No.	Hrs. Required
1	Observe operations of USB cables, Wires, Power Supply Units, Transistors, Breadboards, Relay, Multimeter, Tester, Soldering Kit, Wire cutter, Hot glue gun and other components required for designing of IoT available in your lab.	I	2
2	Familiarization with Arduino/Raspberry Pi and perform necessary software installation.	I	2*
3	Assign IP address to the PC connected to the internet.	II	2
4	Configure / Test internet connectivity.	II	2*
5	Configure Raspberry Pi using programming language (Python or any other)	III	2*
6	Interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.	IV	2*
7	Interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.	IV	2*
8	To interface DHT11(Temperature and Humidity sensor) sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.	IV	2*
9	Interface the motor using a relay with Arduino/Raspberry Pi and write a program to turn ON the motor when push button is pressed.	IV	2*
10	Interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.	IV	2
11	Interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from a smartphone using Bluetooth.	IV	2*
12	Interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to a smartphone using Bluetooth.	IV	2
13	Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.	IV	2*
14	Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.	IV	2
15	To install MySQL database on Raspberry Pi and perform basic SQL queries.	IV	2
16	Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.	IV	2

17	Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.	IV	2
18	Write a program to create a TCP server on Arduino/Raspberry Pi and respond with humidity data to the TCP client when requested.	IV	2
19	Design application for home automation.	V	2*
20	Design IoT application for agriculture OR Smart grids	V	2
		Total	**40**

Note:

i. A suggestive list of **PrOs** *is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1.	Preparation of experimental setup. 1	20
2.	Setting and operation.	20
3.	Safety measures.	10
4.	Observation and recording.	10
5.	Interpretation of result and conclusion.	20
6.	Answer to sample questions.	10
7.	Submission of report in time.	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.

c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

Sr. No.	Equipment Name	PrO. S. No.
1	USB cables, wires, power supply units, transistors, breadboards, relay, Multimeter, Tester, Soldering Kit, wire cutter, Hot glue gun.	1
2	Any Open-Source Prototype Board Available in Market	All
3	Wi-Fi connection/ router with good speed (more than 50 MBPS)	All
4	Desktop computer: Softwares - Arduino / MicroPro C RAM - 4GB , Windows OS / Linux	All
5	Python Interpreter/ IDE	5
6	DC motor /stepper motor (50/100 RPM)	9
7	CRO 20MHz /DSO, Digital Multimeter, Power Supply (Single and Dual)-0-30v,0-10A	6 to 11
8	IR / LDR, Buzzer / LED and OLED, Push buttons	6 to 11
19	DHT11 & Humidity sensor, Bluetooth module	8,10,12

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I	1a. State characteristics of IoT &	1.1 Introduction to IoT: Definition

Introduction to Internet of Things (IoT)	Explain its framework and architecture. 1b. Explain Physical & logical designing. 1c. Explain different IoT enabling technologies. 1d. Explain different deployment levels.	Vision & characteristics of IoT, IBM IoT Conceptual Framework, IoT Architectural View. 1.2 Physical design of IoT: Things in IoT, IoT Protocols. 1.3 Logical design of IoT: IoT Fundamental blocks, IoT Communication Model, IoT Communication API's 1.4 IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems 1.5 IoT Levels and Deployment templates — IoT Level-1, IoT Level-2, IoT L el-3, IoT Level-4, IoT Level-5, IoT Level-6. 1.6 Challenges in IoT.
Unit– II IoT Middleware & Internet Principles	2a. Difference between IoT and M2M. 2b. Explain Four Pillars of IoT. 2c. Describe any relevant application of RFID, WSN, M2M & SCADA. 2d. Differentiate between various addressing schemes in IP. 2e. Describe the function of the given layer of TCP/IP Reference model.	2.1 Middleware:Definition & Its types. 2.2 M2M Communication: Journey from M2M to IoT, M2M system Architecture. 2.3 RFID: Middleware Architecture, Frequency ranges, Bar code format & its Application. WSN: Middleware Architecture, The Internet of Transducers & its Application. SCADA: Middleware Architecture, The Internet of Controllers & its Application. 2.4 IP Addresses & Its types: static and dynamic, TCP/IP layers: TCP and UDP. 2.5 MAC addresses, Application layer protocols.
Unit– III IoT Design Methodology	3a. State the requirement and specifications for IoT design Methodology. 3b. Apply logical designing for different applications.	3.1 IoT Design Methodology: Purpose and requirement specification, Process specification, Domain model specification, Information model specification, Service specification, IoT level specification, Device and component integration, Functional view specification, Operational view specification, Device and

		component integration, application development. 3.2 Logical Designing using programming languages. 3.3 Configuration of hardware platform.
Unit– IV IoT Physical Device & Cloud Platforms	4a. Explain building blocks of IoT devices. 4b. Explain Raspberry Pi board functions. 4c. Describe Interface and programming with Raspberry Pi. 4d. Explain cloud based IoT platforms. 4e. Explain Communication APIs and WAMP.	4.1 IoT device: Building Blocks of an IoT device. 4.2 Exemplary Physical Device: Raspberry Pi, About the Raspberry Pi board, Linux on Raspberry Pi, Configuring Raspberry Pi, Raspberry Pi interfaces: Serial, SPI, I2C, Programming Raspberry Pi with Python. 4.3 Other IoT Devices: pcDulno, BeagleBone Black, Cubieboard. 4.4 Role of cloud in IoT, Cloud based IoT platforms and other open-source platforms. 4.5 Introduction to cloud storage models & communication APIs, WAMP. 4.6 Web server for IoT, Cloud for IoT.
Unit-V IoT Applications	5a. State types of home automation. Explain any one type in detail. 5b.Describe smart cities in detail. 5c.Demonstrate agriculture automation with diagram 5d.Develop IoT device designing for any one health application.	5.1 Home Automation: Smart lighting, Smart Appliances, Smoke/Gas Detector. 5.2 Smart Cities: Intelligent Traffic systems, Smart Parking, Smart water management 5.5 Energy: Smart Grids, Renewable Energy Systems. 5.6 Agriculture: Green House Control. 5.7 Health: Health & fitness monitoring, Wearable electronics.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total

			Level	Level	Level	Marks
I	Introduction to Internet of Things	08	04	04	06	**14**
II	IoT Middleware & Internet Principles	08	04	04	04	**12**
III	IoT Design Methodology	10	02	04	04	**10**
IV	IoT Physical Device & Cloud Platforms	12	04	06	08	**18**
V	IoT Applications	10	02	04	10	**16**
	Total	**48**	**16**	**22**	**32**	**70**

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare a chart displaying the various types of raspberry Pi/Arm.
b. Prepare a chart displaying the various types of different IoT platforms.
c. Prepare a chart displaying the various types of sensors.
d. Visit nearby process industries and prepare a report.
e. Market survey of various IoT servers.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/subtopics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***..
e. Video programs/YouTube may be used to teach various topics and sub topics.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer to different books and websites to have a deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in the Lab
i. Use proper equivalent analogy to explain different concepts.
j. Use Flash/Animations to explain various Robotic actions

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should preferably be ***individually*** undertaken to build up the skill and confidence in every student to become a problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit a micro-project by the end of the semester to develop the industry oriented COs.
A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Raspberry Pi interface with LCD module 16x2 with One line message displaying.
b. Raspberry Pi interface with LCD module 16x2 with reading i/p from keypad.
c. Raspberry Pi interface with 2-digit Seven segment display for up and down counter.
d. Raspberry Pi interface with GSM based security system for alarm/alert and calling.
e. Raspberry Pi interface with RFID for door lock system.
f. Raspberry Pi interface with DC motor with variable speed adjustment using switch or potentiometer.
g. Raspberry Pi interface with DC motor to rotate in forward and reverse direction.
h. Raspberry Pi interface with relay to turn ON/OFF light.
i. Interface IR sensor with Raspberry Pi and write a program and use this input to control LED.
j. Raspberry Pi interface with GPRS based tracking system.
k. Develop various applications on Python and implement them on Raspberry Pi.
l. Send data on an IoT server from different inputs.
m. Retrieve data from IoT server and display it on different interfaces.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Internet of Things: A Hands-on-Approach	Vijay Madisetti and Arshdeep Bahga	1stEdition, VPT, 2014. (ISBN: 978-8173719547)
2	Internet of Things: Architecture and Design Principles	Raj Kamal	1st Edition, McGraw Hill Education, 2017

			(ISBN: 978-9352605224)
3	The Internet of things in the cloud: A Middleware Perspective	Honbo Zhou	CRC Press, London, Newyork.
4	Raspberry Pi Cookbook: Software & Hardware Problems and Solutions.	Simon Monk	1st Edition December 2013, O' Reilly Publication

14. SUGGESTED SOFTWARE / LEARNING WEBSITES:

a. https://www.arduino.cc/en/main/arduinoBoardUno
b. https://go153.com/iot-learning-box
c. https://www.youtube.com/watch?v=OogldLc9uYc