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INTERNET OF THINGS   **Course Code : 314006**

Programme Name/s	: Information Technology/ Computer Science & Information Technology
Programme Code	: IF/ IH
Semester	: Fourth
Course Title	: INTERNET OF THINGS
Course Code	: 314006

I. RATIONALE

IoT is responsible for the super-fast evolution of industry 4.0, where the operations are mostly automated thus eliminating the need for much human intervention. The Internet of Things(IoT) describes the network of physical objects-"things" that are embedded with sensors , softwares and other technologies. IoT devices gather information and send it along to a data server where the information is collected, processed and used to make host of tasks easier to perform. IoT enables the creation of innovative solutions to real world challenges.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop and implement creative solutions for real time problems that can enhance efficiency, safety and convenience across various domains.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Integrate hardware and software for simple IoT applications.
- CO2 - Create IoT applications by interfacing various sensors and embedded boards.
- CO3 - Create IoT applications by interfacing various actuators and embedded boards.
- CO4 - Develop IoT applications using IoT networking devices.
- CO5 - Develop database based IoT application by integrating sensors with single board computer.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314006	INTERNET OF THINGS	IOT	SEC	1	-	4	1	6	3	-	-	-	-	-	25	10	25@	10	25	10	75

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Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V.   THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe IoT building blocks with their relationship. TLO 1.2 State the features of various Embedded boards. TLO 1.3 Write simple Arduino program.	**Unit - I Basics of Internet of Things** 1.1 Introduction of IoT 1.2 Applications of IoT 1.3 Building blocks of IoT device: sensors, processors, gateways, applications 1.4 Embedded Boards for IoT: Arduino Uno, Raspberry pi, Node Microcontroller Unit, ESP32 1.5 Arduino Uno hardware architecture and Peripheral features 1.6 Arduino programming: Arduino programming of Blinking LED and Fading LED, Buzzer	Presentations Video Demonstrations Hands-on
2	TLO 2.1 Select various sensors for IoT applications. TLO 2.2 Write steps to interfacing sensors with Arduino TLO 2.3 Explain working techniques of Sensor.	**Unit - II Sensors in IoT** 2.1 Introduction of Sensors 2.2 IoT sensors types: Active and Passive Sensors, Analog sensors Digital Sensors 2.3 Programming with Arduino Sensors: Light sensor, Humidity Sensor, Temperature Sensor, Water Sensor, Motion Sensor, Fire Detection Sensors, Smoke Detection Sensors, Gas Detection Sensors, Soil moisture sensors 2.4 Basic working Technique of Sensor	Presentations Case Study Hands-on Demonstration Collaborative learning

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Select various Actuators available. TLO 3.2 Explain the process of interfacing appropriate actuator with Embedded boards. TLO 3.3 Write the steps for displaying output on various display devices.	**Unit - III Actuators in IoT** 3.1 Introduction of Actuators 3.2 Programming and Interfacing of actuators: displaying on LED/LCD with ATMEGA328 3.3 Displays: LCD, I2C LCD, 7 segment display 3.4 Actuators: Relay, Stepper Motor, Buzzer, Potentiometer	Presentations Demonstration Video Demonstrations Hands-on Model Demonstration
4	TLO 4.1 Explain IoT Protocols. TLO 4.2 Write the process to use IoT Wireless networking devices in developing IoT applications. TLO 4.3 Explain the method of performing Wi Fi connectivity to WEB.	**Unit - IV Communication in IoT devices** 4.1 Introduction to IoT networking: IoT Protocols- HTTP, MQTT, CoAP etc. 4.2 IoT Wireless devices and uses in IoT: LPWAN(Low Power Wide Area Networks),Cellular(3G/4G/5G), Bluetooth, Zigbee, Wi-fi, RFID 4.3 Wi Fi connectivity to WEB using ESP826	Presentations Demonstration Hands-on Video Demonstrations Flipped Classroom
5	TLO 5.1 Write the steps to install any operating system on Raspberry Pi. TLO 5.2 Write various Linux commands to be used on Raspberry Pi. TLO 5.3 Write steps to Install database on Raspberry Pi. TLO 5.4 Write database query to be performed on Raspberry Pi.	**Unit - V Programming with Single Board Computer** 5.1 Raspberry Pi Architecture, Features, Raspberry Pi Vs Arduino 5.2 Raspbian OS 5.3 Linux Programming Environment, Linux Commands 5.4 Installation of MariaDB server with Raspberry Pi	Presentations Demonstration Video Demonstrations Hands-on

VI.   LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install any embedded system. LLO 1.2 Write simple Arduino program using Arduino Uno IDE.	1	* Install any one embedded system(ex- Arduino IDE)and execute program to turn LED ON/OFF using delay	2	CO1
LLO 2.1 Interface RGB LED with Arduino. LLO 2.2 Write program to change the color of LED.	2	Change the color of LED	2	CO1
LLO 3.1 Interface Potentiometer and LED with Arduino. LLO 3.2 Write a program to control the brightness of LED.	3	Control the brightness of LED using PWM Techniques	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Interface LDR sensor with Arduino. LLO 4.2 Write a program for detection of Light.	4	* Detect the presence or absence of Light using LDR Sensor	2	CO2
LLO 5.1 Interface Analog Temperature Sensor (e.g. LM35) with Arduino. LLO 5.2 Write a program to sense Temperature of Object.	5	Measure the temperature of the object	2	CO2
LLO 6.1 Interface touch Sensor with Arduino. LLO 6.2 Write program to sense the touch when finger is placed on board.	6	Sense the touch of finger when it is placed on board	2	CO2
LLO 7.1 Interface IR Sensor with Arduino/ Raspberry Pi. LLO 7.2 Write program to Detect the obstacle.	7	Detect the obstacle using IR sensor	2	CO2
LLO 8.1 Interface Ultrasonic Sensor with Arduino/Raspberry Pi. LLO 8.2 Write a program to measure the Distance between sensor and object.	8	* Measure the Distance between sensor and object using ulatrasonic sensor	2	CO2
LLO 9.1 Interface Gas Sensor with Arduino/ Raspberry Pi. LLO 9.2 Write program to detect the presence of Gas.	9	Detect the presence of Gas	2	CO2
LLO 10.1 Interface DHT11 sensor and I2C LCD with Arduino. LLO 10.2 Write a program to display Humidity and Temperature on LCD.	10	Detect the vibration of an object using vibration detector sensor SW-420 with Arduino	2	CO2
LLO 11.1 Interface PIR Sensor with Arduino/ Raspberry Pi to Detect Motion of object. LLO 11.2 Write a program to display motion detected or not.	11	Change the status of Buzzer ON/OFF	2	CO1 CO3
LLO 12.1 Interface DHT11 sensor and I2C LCD with Arduino. LLO 12.2 Write a program to display Humidity and Temperature on LCD.	12	* Display Humidity and Temperature on LCD using DHT11 sensor	2	CO2 CO3
LLO 13.1 Interface PIR Sensor with Arduino/ Raspberry Pi to Detect Motion of object. LLO 13.2 Write a program to display motion detected or not.	13	* Display the message as per detection of motion of object	2	CO2 CO3
LLO 14.1 Interface DHT11 sensor and I2C LCD with Arduino. LLO 14.2 Write a program to display Humidity and Temperature on LCD.	14	* Control relay state based on input from IR sensor	2	CO2 CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Interface DHT11 sensor and I2C LCD with Arduino. LLO 15.2 Write a program to display Humidity and Temperature on LCD.	15	* Switch the LED ON/OFF on detection of obstacles using PIR sensor	2	CO2 CO3
LLO 16.1 Interface Ultrasonic Sensor, Buzzer with Arduino. LLO 16.2 Write program to start the buzzer when obstacle is detected in some specified range of distance.	16	* Measure the Distance between sensor and object and ring the buzzer when obstacle is detected in some specified range of distance	2	CO2 CO3
LLO 17.1 Interface Smoke Sensor with Arduino/ Raspberry Pi. LLO 17.2 Write program to detect smoke and play Burglar Alarm if smoke detected.	17	Play the Burglar Alarm if smoke detected	2	CO2 CO3
LLO 18.1 Interface Smoke Sensor with Arduino/ Raspberry Pi. LLO 18.2 Write program to detect smoke and play Burglar Alarm if smoke detected.	18	* Display percentage of moisture in soil using soil moisture sensor	2	CO2 CO3
LLO 19.1 Interface fire detector sensor with NodeMCU. LLO 19.2 Write program to display to glow LED and play the alarm when fire detected.	19	Detect the fire and turn ON LED and play the alarm	2	CO2 CO3
LLO 20.1 Interface Ultrasonic Sensor with Arduino/Raspberry Pi. LLO 20.2 Write a program to measure the Distance between sensor and object.	20	* Display temperature value on serial monitor	2	CO3
LLO 21.1 Interface Piezo speaker with Arduino. LLO 21.2 Write program to play Melody.	21	* Play Melody sound with a Piezo speaker.	2	CO3
LLO 22.1 Interface Temperature sensor, Relay with Arduino. LLO 22.2 Write a program to turn it ON/OFF when Temperature increases or decreases.	22	* Control action using Relay based on temperature value	2	CO3
LLO 23.1 Interface seven segment display with Arduino. LLO 23.2 Write a program to display 0 to 9 numbers continuously .	23	* Display 0 to 9 numbers continuously on seven segment display	2	CO3
LLO 24.1 Interface I2C LCD with Arduino. LLO 24.2 Write program to display simple message.	24	Display simple message on I2C LCD	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 25.1 Interface Potentiometer and LCD with Arduino. LLO 25.2 Write program to display POT reading on LCD.	25	* Display POT value of potentiometer on LCD	2	CO3
LLO 26.1 Interface Bluetooth with Arduino/Raspberry Pi. LLO 26.2 Write a program to send sensor data to smartphone using Bluetooth.	26	* Transfer sensor collected data to smartphone using Bluetooth	2	CO4
LLO 27.1 Connect Camera module with Arduino. LLO 27.2 Write program to display the message on serial monitor when image is captured.	27	Display the message on serial monitor when image is captured	2	CO4
LLO 28.1 Connect temperature sensor with embedded board. LLO 28.2 Write program to display Temperature on Web Browser.	28	* Create Web based IoT application using Node MCU/Raspberry Pi to display Temperature on Web Browser	2	CO4
LLO 29.1 Install appropriate OS for embedded board. LLO 29.2 Connect various accessories to Rasberry Pi.	29	* Setup Raspberry Pi as an Single board computer b with following accessories: a display a cable to connect Raspberry Pi to display a keyboard a mouse SD card	2	CO5
LLO 30.1 Install database on single board computer. LLO 30.2 Perform various queries for displaying desired result.	30	* Install MariaDB database in Raspberry Pi and execute basic SQL queries	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII.   SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Other

•   Complete any one course related to "Internet of Things" freely available on Infosys Springboard/NPTEL/Spoken Tutorial.

Micro project

•   Automatic Street Light- Street Light should automatically ON at evening and automatically OFF at morning. LCD and Serial Monitor shows Light Intensity value on First Line and Status of Street Light on Second Line. USE RGB LED for street Light and use orange color.
•   Home Automation through PC- Design and develop project to control 8 home devices through PC serial monitor, LCD connected on project will shows Status of Devices is on or off. Also show the status of all devices on serial monitor.

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- Motion enabled Room Light- Light present in Room should automatically ON when human motion is detected and automatically OFF in the absence of human motion. LCD and Serial monitor shows appropriate message as "Motion detected! Light ON" and "No Motion! Light OFF" when particular condition fulfilled.
- Electronic Smart Blind Stick- If someone is in front of blind person, LED and Buzzer should on and LCD will show the message" Obstacle. Be Alert" otherwise LED and Buzzer will remains off and LCD show the message "Safe.. Keep Walking".
- Electronic Notice Board- Any Message send from Serial Monitor should get displayed on LCD. When new message sends, previous message gets automatically erased and replaced with new message.

Assignment

- Solve Assignment covering all COs given by Course Teacher.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII.   LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sensors-LDR,IR,PIR,Ultrasonic Sensor,DHT11,LM35, touch sensor,smoke sensor, gas detect sensors(CO_2,O_2,NO_2 etc.), fire sensor	20,6,12,13,14,7,15,8,16,9,17,10,11,18,19,21,22,23,24
2	Bluetooth, Wi-Fi,Ethernet modules	26,28
3	Arduino/NodeMCU/Raspberry Pi-controllers	All
4	Actuators- LED, Buzzer, Swiches, Relay,Sprinkler , I2C LCD, 7 segment display, potentiometer, Servo motor, Stepper motor, DC motor, Camera module	All
5	Accessories - Resistors, Jumper wires, Bread Board	All
6	Software tools-Arduino UNO IDE, Tinkercad, Linux	All

IX.   SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Internet of Things	CO1	3	0	0	0	0
2	II	Sensors in IoT	CO2	4	0	0	0	0
3	III	Actuators in IoT	CO3	3	0	0	0	0
4	IV	Communication in IoT devices	CO4	3	0	0	0	0
5	V	Programming with Single Board Computer	CO5	2	0	0	0	0

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
		Grand Total		**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each Practical will be assessed considering 60% weightage to the process, 40% weightage to the product.

Summative Assessment (Assessment of Learning)

- End Semester Exam based on Practical performance and Viva-voce.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	2	2	1	2	1			
CO2	1	2	2	3	2	2	2			
CO3	1	2	2	3	2	2	2			
CO4	1	2	2	3	2	2	2			
CO5	2	2	3	3	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Cornel M Amariei	Arduino Development Cookbook	PACKT publishing Ltd. New Delhi, ISBN: 978-1-78398-294-3
2	Arshdeep Bahga, Vijay Madisetti	Internet of Things: A Hands-On Approach	Orient Blackswan New Delhi ,ISBN: 978- 0996025515 628/- 2
3	David Hanes, Gonzalo Salgueiro, Patrick Grossetti	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	Cisco Press ISBN: 978-1- 58714-456- 1 599
4	Simen Monk	Raspberry Pi Cookbook	Publisher(s): O'Reilly Media, Inc. ISBN: 9781098130923
5	Agus Kurniawan	Smart Internet of Things projects	PACKT publishing Ltd. New Delhi ISBN:9788131766613

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XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://github.com/microsoft/IoT-For-Beginners	All practicals
2	https://www.javatpoint.com/difference-between-sensors-and-actuators	Sensors and Actuators
3	https://www.tinkercad.com/learn/circuits?collectionId=O0K87SQL1W5N4P2	Practical using Simulator
4	https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/	Online content of Internet of Things
5	https://hands-on-books-series.com/iot.html	Introduction to IoT
6	https://www.raspberrypi.org/	Raspberry Pi Hands on tutorial

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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