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- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Internet of Things	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Digital Electronics (DSC-5 , Sem II) , Basic Instrumentation & Measurement Techniques (DSC-4, Sem 2)

Learning Objectives

This course describes the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Broad objectives are:

- 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 commonly used in IoT devices/systems
- To introduce the Arduino / Raspberry Pi platform, widely used in IoT applications
- To introduce the implementation of web-based services on IoT devices

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand internet of Things, its hardware and software components and the IoT value chain structure (device, data cloud).
- Interface I/O devices, sensors & communication modules.

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- Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules
- Remotely monitor data and control devices and develop real life IoT based projects.

SYLLABUS OF ELDSE-2A

Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction to Internet of Things - Definition and Characteristics of IoT, Architectural overview (cellular, star, mesh, ring)

Physical design of IoT: Things in IoT, IoT protocols in Link Layer, Network/Internet Layer, Transport Layer, Application Layer (with specific reference to Communication protocols as MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP, WebSocket etc.), Basics of Networking, Security aspects in IoT.

Logical design of IoT: Functional blocks, Communication Models, Communication APIs, Enabling Technologies, IoT levels and deployment templates, Design principles IoT and M2M- Definitions, differences between M2M & IoT systems, Software defined networks (SDN), network function virtualization (NFV), difference between SDN and NFV for IoT, Basics of IoT System Management with SNMP, NETCONF -YANG

UNIT – II (11 Hours)

Transducers, Sensors and Actuators: Review of Transducers, Concept of Sensing and Actuation, Sensor characteristics (static/dynamic), Sensor classification (passive/active, analog/digital, scalar/vector), Actuator classification (Electric/Fluid Power/ Linear Chain /Manual / Linear vs Rotary)

Types of Sensors: Contact and Proximity, Position, Velocity, Force, Humidity, Tactile unipolar and bipolar Stepper motors Sensors- Light sensor, temperature sensor, 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 etc.

Selection of Transducers for various IoT applications, Wireless Sensor Networks

UNIT – III (12Hours)

Computing (using Arduino, Raspberry Pi), I/O interfaces.

Software components- Programming API's (using Python/Node.js/Arduino). Introduction to Arduino/Raspberry Pi- Installation, Interfaces (serial, SPI, I2C)

Raspberry Pi: Communication with devices through the pins of the Raspberry Pi, RPi. GPIO library, Python Functions, setting up the pins, General purpose IO Pins, Protocol Pins, GPIO Access, applying digital voltages, and generating Pulse Width Modulated signals, Tkinter Python library, accessing pins through a graphic user interface

OR

Arduino: Introduction to the Arduino environment, the Arduino board, the Arduino IDE, and the Arduino compatible shields together with their libraries. Arduino board main components, inputs, and outputs. Arduino Integrated Development Environment (IDE), Compiling Code, Arduino Shields and Libraries.

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Basics of C programming, composition of an Arduino programs, Arduino tool chain, Arduino IDE, basic structure of a sketch, including the use of the setup() and loop() functions. Accessing the pins from a sketch for input and output, introduction on debugging embedded software on an Arduino, UART communication protocol, Synchronization, parity and stop, the use of the Serial library to communicate with the Arduino through the serial monitor.

Programming – Python programs with Arduino/Raspberry Pi with focus on interfacing external gadgets, controlling output, reading input from pins

Note: It is optional to choose either Arduino or Raspberry Pi environment

UNIT – IV (11 Hours)

IoT Physical Devices and Endpoints, Domain specific IoTs, IoT Physical Servers and Cloud Offerings

Cloud Computing: Characteristics, Introduction to Cloud Service models (SaaS, PaaS, IaaS, XaaS etc.,) Deployment models, Cloud storage APIs, IoT-Cloud convergence, Communication Enablers

Webservices – Web server for IoT, Python-Web frameworks, RESTful Web API, ThingSpeak API, MQTT, IoT security, Basics of symmetric and non-symmetric encryption standards

IoT Application Development - Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration
Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

IoT Case Studies based on Smart Environment, Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Practical component (if any) – Internet of Things

Learning outcomes

The Learning Outcomes of this course are as follows:

- Interfacing of various sensors using Arduino/Raspberry Pi
- Interfacing using Bluetooth, Web server, TCP, ThingSpeak Cloud, MQTT broker

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Connect an LED to GPIO pin 24 and a Switch to GPIO 25 and control the LED with the switch. The state of LED should toggle with every press of the switch.
2. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
3. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.

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4. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
 5. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
 6. Create a traffic light signal with three colored lights (Red, Orange and Green) with a duty cycle of 5-2-10 seconds.
 7. Create an application that has three LEDs (Red, Green and white). The LEDs should follow the cycle (All Off, Red On, Green On, White On) for each clap (use sound sensor).
 8. Write a program on Arduino/Raspberry Pi to upload/retrieve temperature and humidity data using ThingSpeak cloud.
 9. Write a program on Arduino/Raspberry Pi to publish/subscribe temperature data using MQTT broker.
 10. To install MySQL database on Raspberry Pi and perform basic SQL queries.
 11. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
 12. Create a web application for the above applications wherever possible with functionalities to get input and send output.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven.

Essential/recommended readings

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
4. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 9789352133895
5. Adrian McEwen, "Designing the Internet of Things", Wiley

Suggestive readings

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 Editors Ovidiu Vermesan
2. Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014
3. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.