25/7/24

- **IOT** = [The term IoT or Internet of things, refers to the collective network of connected devices & the technology that facilitates communication b/w devices & the cloud, as well as b/w devices themselves.] ||
- **IoMT** – It stands for internet of medical things. It is a n/w of medical devices, hardware, & software applications that connect healthcare information technology.
- **Sensors & Actuators**

A sensor is a device that detects & measures changes in the environment & provides the real-time data. They are connected to the input port of a device.

Actuators are components that convert electrical signals from embedded system into physical actions. It is connected to the o/p port of a device.

Sensor

i) A device that detects events / changes in the environment & sends that info to other electronic devices.
ii) connected to the input ports of the system.

Actuators

i) A component of a machine that is responsible for moving & controlling mechanism.
ii) connected to the o/p ports of the system.

(iii) o/p is an electrical signal;

(iv) Helps to monitor the changes in the environment

Eg - bio sensors, image sensors etc.

(ii) o/p is a movement

(iv) Helps to control the environment & physical changes.

Eg - electric motors, stepper motors etc.

30.7.24

Class

• IoT

IoT refers to a network of physical devices, vehicles, appliances & other objects embedded with sensors, software and a n/w connectivity. This small objects can collect and share data over other internet enabled devices.

• Components in an IoT

i) Sensors - This detect physical changed like temp, humidity.

ii) Software - The software enables data Processing & communication.

iii) Network - This allows the device to communicate over to internet.

• Applications of IoT

i) Healthcare - smart wearable personal remote health monitoring. ii) Environment - Smart farming, smart agriculture, wild vegetation, etc. iii) Smart cities - smart homes, buildings, traffic monitoring etc. iv) Commercial - shopping system, retail v) Industrial - Smart grid, smart metering vi) Infrastructural - Real-time, Performance etc.

• Benefits of IoT -

i) Efficiency - Automate the processes & optimise resources.

ii) Data driven insights - Analysing the IoT data for insights.

iii) Processing - To reduce the manual task.

• IoT based Smart city (7-10 m)

(architecture)

① Physical layer - This layers consists of IoT devices deployed throughout the city. This devices collect the data from various sources Eg: Smart street light, environment sensors, traffic cameras, waste-management sensor.

② N/W layer - The network layer, handles the communication b/w the devices and central systems. Eg: i) Communication mgtt, CoAP, HTTP enables detections.

ii) Gateways & edge devices plays crucial role in connecting the local network with a wider internet.

③ Application layer -

i) Transportation systems - Real time traffic monitoring, Smart parking.

ii) Energy systems - Smart grid management, energy conservation, optimization, renewable

iii) Healthcare - Remote patient monitoring, health data analysis, emergency help system response

iv) Public safety - Surveillance, emergency alert, disaster management.

v) Waste management - Waste collection optimization, smart bins.

(4) management layer - This layer oversees the entire system. It includes components for monitoring, control & security. Administrators can track performance & manage resources.

11/8/24

m2m & rfg 23

- m to m communication (machine to machine)

It refers to n/wing of machines / devices for the purpose of remote monitoring & control as well as data exchange. This term is often used synonymously with IoT. IoT & m2m to are often used interchangeably, the end to end architecture of m to m comprises of m to m area n/ws, communication n/ws & application domain. The m to m area n/w comprises of machines / m nodes, which have embedded n/w modules for sensing, actuation & communicating through various communication protocols. Protocols can be used for m to m lan such as ZigBee, bluetooth, m-bus, wireless m-bus, etc. This protocols provide connectivity b/w m to m nodes within an m to m area n/w.

m2m = m to m

The communication n/w provides connectivity to remote m to m area n/w. It can either be wired & wireless. To enable the communication b/w remote m to m n/w, m to m gateways are used.

LAN = Local area networks

Imp

- Diff. b/w IoT & m to m

	m to m	IoT
i)	~~IoT~~ Communication Protocol -	CoAP, ZigBee, bluetooth, mod-bus, m-bus, wireless m-bus etc.
ii)	machines in m to m vs things in IoT	Homogenious
		Heterogenious

Full forms

↓ Imp (Communication protocols - exams)

IoT uses HTTP, CoAP, web socket, security, MQTT, XMPP, DDS, AMQP

(CoAP = Constrained application Protocol)

iii) Hardware vs Software emphasis	The emphasis is more on hardware with embedded modules	The emphasis of IoT is more on S/W.
iv) Data collection & analysis	Here data is collected in point sol^ns & often in on-Premises Storage infrastructure.	Here the data is collected in Cloud that can be public, private or hybrid cloud.

Protocols

- M-bus – meter Bus
- HTTP – Hypertext transfer Protocol. It is used for data communication.
- CoAP – ~~Common often acceptable Protocol~~ Constrained application Protocol. It's an application layer Protocol designed for resource-Constrained devices & networks in the IoT.
- MQTT – message queuing telemetry transport. It's a messaging Protocol that is widely used in IoT. It is designed for limited resources, such as low power sensors, remote settings etc.

P.

- Web socket – It is a Computer Communication Protocol that allows ~~for~~ real-time, two way Commu. b/w a client & server over a single TCP connection.
- XMPP – Extensible messaging & Presence Protocol, is an open XML-based communication Protocol for real-time applications, including instant messaging (IM), Presence info ~~etc~~ & Collaboration.
- DDS – Data distribution service, a S/w Connectivity Standard for real-time info exchange in distributed systems. (~~main~~ managed by OMG-object management group)
- AMQP – Advanced message queuing Protocol, & it's an open-Source Standard that can be used for client/server messaging & IoT device management.
- M-bus Protocal – It is a cost-effective Communication Protocal that connects meters to a ~~central~~ central data collection system / Pre payment unit. It is used ~~for~~ to log, analyze etc.

Adv – i) It is fast, ii) It is flexible, iii) It is expansionable.

- Wireless M-bus – It is also called WM-Bus. It is a low cost, low Power, open standard for Smart metering & advanced metering infrastructure (AMI) applications.

• m2m n/w - It allows machines to communicate with e/o without human inter-vention, using wired/wireless communication channels. Eg - Smart home, smart phone, Smart vending machines etc.

• Application domain - It is a segment of reality for which a s/w system is developed. This can include organizations, departments within it or single workplace etc. Eg - Smart city, Smart energy, Smart transport etc.

• LAN - It is a computer n/w that interconnects computers within a limited area such as a residence, school etc.

• modbus - It is a communication protocol that allows devices to communicate over various types of media, including ethernet, serial lines etc. [Communication b/w IoT devices, sensors, controllers over ethernet n/w.]

• Gateways - It is a centralized hub that connects IoT devices & sensors to cloud-based computing & data processing. [Normal IoT gateways often allow bidirectional data flow b/w the cloud & IoT devices.]

• Edge device - It is an internet enabled device typically comprised of sensors. It collects & process data near the source, rather than sending it to the cloud & back.

Arduino Programming (in syllabus)
3 formulas → 1 mark (20 m)

① 6/8/24

(In exam have to write case for the Smart home)

• Smart home

It is a residence, equipped with connected devices & appliances that can be controlled remotely via a Smart phone/tablet. This device's are linked by using via a central hub/n/w the v Part of the IoT following.

i) Smart devices - A smart home comprises of interconnected, remotely controlled devices that include smart library: Adjust your light from anywhere using an app / voice command etc.

ii) Smart thermostat - Regulate your home temp. remotely for energy efficiency. (Works on perception due to heat)

iii) Smart security system - Cameras, locks, doorbells.

iv) Smart appliances - coffee machines, dish washes that can be done autonomously. (Auto light on, auto AC on, auto tv on, auto light dim etc based on situations)

Smart devices are connected wirelessly using protocols like wifi, bluetooth, zigbee/z-bus. Once connected they share data among themselves. Even if made by diff. manufacturers they can be controlled by using same platform or hub. For eg

Google Partners with various smart device members, allowing unified control through the google app or devices like smart speakers.

- IoT connected vehicles

Connected vehicals also known as smart vehicals / intelligent vehicals are automobiles defused with communication technologies & sensors. This vehicals use the power of IoT to connect to other vehicals, infrastructure & the internet.

They collect, process & share real time position, speed, acclabation, breaking data.

Wireless connectivity -

The connected vehicals use technologies like 4g-/5g nlws; DSRC (Dedicated short range communications) & vehicle-to-vehicle communications (V2V).

sensors - This vehicals are equipped with sensors like radders, camerss, lidar, ultrasonic sensors. They gathers the data from the surrounding.

- Edge computation - The computation that we have done at local network level / edge level. As we don't have the time to send it to servers for the device being time sensetive. Eg- A car stops on red signal it is time sensitive, we can't wait for the servers)

- Cloud Computing :- Eg - Heart beat eg. this thing computes at cloud.

It simplifies the processing & management of data from IoT devices. Cloud platforms often the scalability & processing capacity retuined to handle the enormous amounts of data produced by IoT devices facilitating real-time analytics & decision-making.

- Fog Computing - Eg- Heart bit rate when normal she need to send the data, when it goes high then the rate should be send the data goes to the fog level.

This is a form of distributed computing that brings computation & data storage closer to the nlw edge where many IoT devices are located. It is an alternative to cloud computing that's designed to improve the performance, reduce latency & resource-intensive tasks.

- Diff. blw Clouds & fog computing

Cloud C.	Fog C.
i) Latency - High	Low.
ii) Location of service - within internet	At the edges of the local nlw.
iii) Geo-distribution - centralized	Distributed
iv) mobility - Limited support	High support
v) Location awareness - NO	yes

COAP = constraint application protocol

iv) Type of last mile connectivity —	Leased line / wireless
v) Distance b/w client & server —	multiple hops / one hop

IoT connected vehicles

Benifits -

i) Enhance Safety

ii) Real time data exchange helps to prevent accidents & adapt to changing load conditions.

ii) Personalized settings - Drivers can have personalized setings for things like seat pos., temp. etc.

iii) Fuel Efficiency - optimise fuel consumption through fuel efficiency.

iv) Traffic management - IoT-Enabled V. can detect traffic jams, suggest routes etc.

IoT connected vehicles

Challenges -

i) Data is being recorded (not safe) / data security

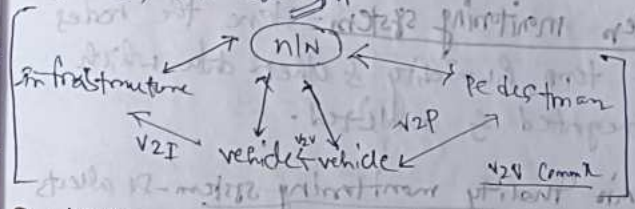
ii) Hacking problem (the cars can be hacked).

iii) Connected cars can face the same n/w connectivity issues as phones, such as losing their connection in certain areas.

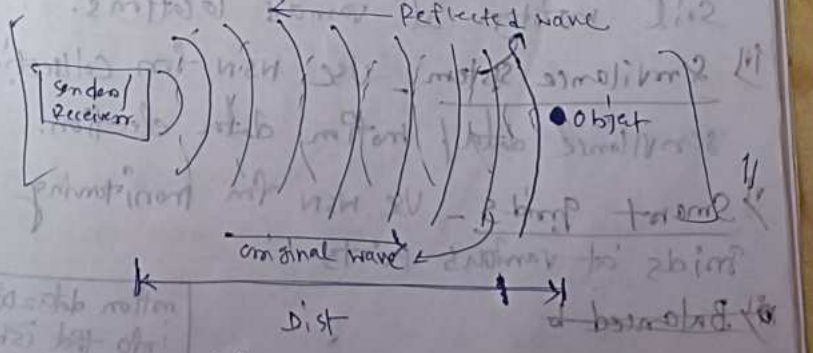
iv) connected vehicles can generate huge amount of data, that can cause data overload.

- DSRC - It is a wireless communication technology designed to allow automobiles in the intelligent transportation system (ITS) to communicate with other automobiles / infrastructure technology.

- V2V Comm - It is a n/w of vehicles that can communicate with elo directly to share info. It allows vehicles to connect using various comm (communication) methods such as dedicated short-range comm (DSRC) 4G, 3G, wifi etc.



- LiDAR - It stands for light detection & ranging. It is a remote-sensing technology that uses lasers beams to measure distance & movement in real time.



LiDAR

13/8/24

Technologies used in IoT

- ES, wireless sensor n/w (WSN), WBS N., ml, C. C., communication protocol etc.
- **Wireless sensor n/w** – It comprises of distributed devices with sensors that are used to monitor the environmental & physical conditions. Zigbee is one of the most popular wireless technology used by WSN. It is used in IoT systems are as follows –
  - i) **Weather monitoring system** – Here the nodes collect temp, humidity & other data which are aggregated & analyzed.
  - ii) **Indoor air quality monitoring system** – It collects data on the indoor air quality & concentration of various gases.
  - iii) **Soil moister monitoring system** – It monitors soil moister at various locations.
  - iv) **Servilance system** – Use WSN for collecting servilance data / motion data detection.
  - v) **Smart grids** – Use WSN for monitoring grids at various points.
  - vi) **Patented to**

motion data is digitized into that is being transferred dn to locations.

11923

- **Wireless body sensors n/w (WBSN)** – It collects the data from the diff. parameters of the body. It collects data from diff. wearable (wireless) devices from the body. Eg: include smart watch, smart ring, smart strap, smart patch. It WBSN is a subset of WSN that collects data from the body, aggregates & analyses it.
- **Cloud computing** – Services are offered to users in diff forms:
  - i) **Infrastructure as a service (IaaS)** – It provides users the ability to use the computing & the storage resources. Eg: g drive
  - ii) **Platform as a service (Paas)** – Provides the users the ability to develop & deploy application in cloud using the development tools, APIs, S/W libraries & services provided by the Cloud Service Provider.
  - iii) **S/W as a service (SaaS)** – Provides users a complete S/W application for the user interface to the application. Eg – google Sheet, Powerpoint etc.
- **Big data analytics** – The huge amount of data that is generated by IoT have to be analysed. Egs include sensor data generated by IoT systems, machine sensor data collected

from sensors in industrial & energy systems, health & fitness data generated by wearable & mobile devices, [data generated by location tracking vehicles, data generated by retail inventory monitoring systems.] ||

• Communication Protocols - It forms the backbone of IoT systems & enables n/w connectivity & coupling to applications. Functions include -

i) Allow devices to exchange data over n/w.

ii) Define the exchange formats, data encoding addressing schemes, speeds for device & routing of packets from src to destination.

iii) It includes sequence control, flow control & retransmission of the lost packets.

• Embedded systems (ES) - It is a computer system that has complex hardware & SW embedded to perform specific tasks. It ranges from low cost, miniaturized such as digital devices, cameras, POS terminals (swapping cards), & vending machine etc.

• POS terminals - It stands for Point of sales. They are also called card readers, are an essential part of this infrastructure, & the move to cashless payments had driven explosion in IoT.

• Vending machine - They are automated machines that use internet connectivity & SW to perform advance functions such as accepting payment, collecting customer data etc.

(2)

22/8/24

• RFID - It is an acronym for radio frequency identification, data is digitally encoded in RFID tags, that can be read by a reader. It is similar to barcodes. It is similar to barcodes. The data that is read from tags and stored in a database by the reader. As compared to traditional barcodes & QR codes, RFID data can be read outside the line of sight.

features - It consists of an integrated circuit (RFID tag) & an antenna. The tag is covered by a protective material which also acts as a shield as a various environmental effects/factors. The tags may be active/passive. Passive RFID tags are most widely used. It is powered by a reader inductively before they can transmit information, whereas active tags have their own power supply.

working principle - It is derived from auto matic identification identification & data capture (AIDC). AIDC performs object identification, object data collection & mapping of the collected

data to computer systems with little or low human interaction. AIDC uses wired communication. RFID uses radio based to perform AIDC functions. The main components of an RFID system include an RFID tag/smart label, an RFID reader & an antenna.

Applications

i) Inventory management (This uses sensors to track & monitor inventory in real time)
ii) Asset tracking
iii) Personnel management
iv) Controlling access to restricted areas
v) IT badging (Badging means identification & Credentials on any smart device (watch, tv etc))
vi) Supply chain management
vii) Counterfeit prevention. In pharma critical industry.

- Asset tracking - It is a system that uses the Iot framework to track the location, condition & performance of assets in real-time. (companies.)
- Personnel management - It is an administrative function within an organization that oversees the hiring, organization & support of employee positions.
- Supply chain management - It provides real-time management data collection & analysis that can help operations monitor & manage their supply chain.

- Counterfeit prevention - It is a set of strategies to prevent counterfeit parts, notes, & other items from entering the supply chain or being used.
- Antenna - An Iot antenna is a device that allows Iot devices to communicate wirelessly by transmitting & receiving radio waves.
- FASTag - It is a device that uses radio identification (RFID) technology to allow drivers to pay tolls electronically while their vehicles are moving.

pay toll - A small amt of money that we have to pay to use a road, cross a bridge etc

3/9/24

- IEEE 802.15.4 IMP (Shortrack)

Features

i) It is a well known standard for low data rate (WBAN)
ii) Developed for low monitoring & control applications & extended for low power consumption usage.
iii) This standard uses only the 1st 2 layers - physical & mac layers, plus the logical link control (llc) & service specific convergence sublayer (SSCS). Addi-ons to communicate with all upper layers.
iv) Operates in the ISM band.

v) Uses direct sequence Spread Spectrum (DSSS) modulation. [Highly tolerant of noise & interference & offers fine bandwidth improvement mechanisms.]

vi) Low speed versions uses binary phase shift keying (BPSK). High data rate version uses offset quadrature phase shift keying (QPSK); uses carrier sense multiple access (CSMA/CA) for shared access with collision avoidance

vii) multiplexing allows multiple users or nodes interference free access for the same channel at different times (multiplexing).

viii) Power consumption is minimized due to infrequently occurring of very short packet transmission with low duty cycle.

ix) The min power level defined is -3dBm (decibel-milliwatt) or 0.5 mW (milliwatt).

x) Transmission for most cases is line of sight. Standard transmission range varies from (10m - 75m. Best case transmission ranges upto 1000m.

xi) N/W topologies - Star & mesh

Prof (exam) (5-10 m)

• Zigbee

Features - is most widely deployed enhancement of IEEE 802.15.4. The zigbee protocol is defined by layer 3 & above. It works with the 802.15.4 layer's 1 & 2. The standard uses layers 3 & 4 to define additional comm enhancements.

i) This enhancements include authentication with valid nodes, encryption for security & a data routing & forwarding capability that enables mesh n/w ing.

iii) The most popular use of zigbee is wireless sensor n/w (WSN) using the mesh topology

Important Component of zigbee

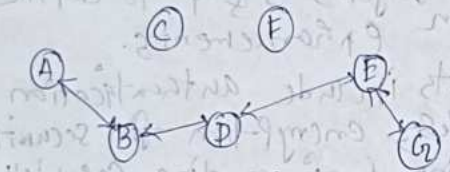
i) ZDO - zigbee device object (used for device management, security, policies)

ii) APS - Application support sublayer (used for interfacing & control services, bridge b/w n/w & other layers.)

Zigbee topologies - star, mesh, ring etc

Zigbee mesh - In a mesh any node can comm with any other node within its range. If nodes aren't in range messages can relate through intermediate nodes.

ii) This allows the n/w deployment over large areas.
iii) meshes have increased n/w reliability.
iv) For eg, if nodes C & F are down the message packet from A can still be related to wine B & D



vi) zigbee mesh n/ws are self configuring & self healing.

zigbee types ~~of~~ vs

i) zigbee coordinator (ZC) - It is the coordinator forms the root of the zigbee n/w trees might act as bridge b/w n/ws.
ii) There is a single zc in each n/w, that originally initiates the n/w.
iii) It stores info about the n/w, under & outside it.
iv) It acts as the trust centre & repository for security ~~keys~~.

ii) zigbee router (ZR) - Capable of running applications as well as ~~be~~ vi) to relaying b/w nodes connected to it.

iii) zigbee end device (ZED) - It contains just enough functionality to talk to the parent node

v) It can't relate data from other devices.
ii) This allows the node to be asleep for a significant amount of time thereby, enhancing battery life
iii) memory requirements & cost of zeds are quite low as compared to zr or zc. (zeds - many, zc & zr = few (members))

- **mac layer** - It stands for media access control. It refers to the methods & protocols used to control access to a communication medium in a computer n/w [It is a sublayer of the data link layer in the OSI model & responsible for the transmission of data packets over a shared n/w medium.]
- **LLC** - It stands for logical link control It is a data link protocol that manages error control, flow control & multiplexing application comm^n on a local n/w.
- **Service specific convergence sublayer (SSCS)** - It is a sublayer of the MAC layer in the IEEE 802.16 reference model. It is responsible for a no. of functions including receiving packets, classifying, delivering, [associating packets etc]
- **ISM band** - Industrial, scientific, & medical radio bands, or ISM bands are a group of radio frequency bands. Parts of the radio spectrum usually reserved for purposes, diff. from telecomm's.

• DSSS – It stands for direct sequence spread spectrum [in a spread-spectrum modulation technique primarily] used to reduce overall signal interference.

• BPSK – It stands for binary phase-shift keying. It is a digital modulation scheme that conveys data by changing or modulating two diff phases of a reference signal (the carrier wave).

• QPSK – It stands for offset quaternary phase shift keying. It is a variant of the BPSK modulation scheme [where the phase or timing of either the in-phase or quadrature component is shifted relative to each other by a 1-bit period / half a symbol-period T_s as compared to QPSK.] that uses 4 phase values to transmit data.

• multiplexing – It is a technique used in computer networking to combine multiple signals into 1 signal that can be transmitted over a shared medium.

• Arduino setup & loop – After creating a setup() function, that initializes & sets the initial values, the loop() consecutively function does precisely what its name suggests, & loops consecutively allowing your Program to change & respond. use it to actively control the arduino board.

(7)

1 code (Imp exam)

10/24

• It is a open source electronic platform, based on easy to use hardware & software. Arduino boards can read i/ps like light on a sensor, finger on a button, a twitter(x) message, & turn it into o/p like activating a motor, turning on an LED, or publishing something online.

key components

i) microcontroller – the brain of the arduino that executes the code we write.

ii) USB Port – use to connect the arduino to the computer for programming

iii) Digital PINS – used for digital i/p or o/p like turning LED on or off

iv) Analog PINS – used for reading analog signals like, Potentiometers

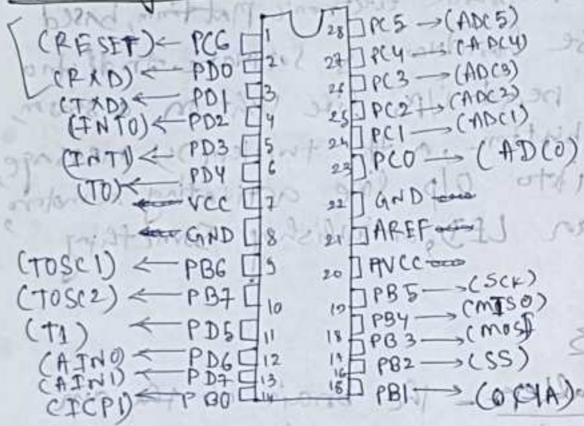
v) Power PINS – To provide power to external components (5V, 3.3V & GND)

• If we want to power something then we'll connect it to arduino & provide the power.
• arduino gets power from our PC/laptop (5V, 3.3V etc)

Pin diagram

• Arduino uno will be used by us (Rather than this, also have arduino mega etc, but we won't use it)

Pin diagram



Arduino Uno Pin configuration

Arduino Uno, Connecting wires (male to male), bread board, connection on arduino, sensor (LED)

DHT 22 (temp sensor)

(I DE - sketch (said by sir))

& loop

Arduino setup (not needed)

Arduino Code Structure

i) Void setup()
→ setup is a func
→ It runs all from once, we'll do all initialization part here

ii) void loop() → The code here runs infinitely
→ we will write that code, that will run continuously here

(for exam) (10 m)

- Street light controller's code

Write an arduino code for street light controller. The street light will be switch on when a particular amount of light value goes below a threshold value.

code:

```
const int ldrPin = A0;   // A0 = Analog Pin
                         // LDR Pin connected to analog pin A0
const int ledPin = 13;   // LED Pin connected to digital pin 13

int ldrThreshold = 500;  // Threshold can be adjusted.

void setup()
{
  pinMode(ldrPin, INPUT);
  pinMode(ledPin, OUTPUT);
  Serial.begin(9600);  // It will sense for 9600 times (Baud rate)
                       // It has a limit
}

void loop()
{
  int ldrValue = analogRead(ldrPin);
  Serial.println("LDR value: ");
  Serial.println(ldrValue);   // live system monitoring print()
                              // this is showing, this isn't necessary
  if (ldrValue < ldrThreshold)
  { turnOnLights();
  }
  else
  {
    turnOffLights();
  }
  delay(1000);
}

void turnOnLights()
{
  digitalWrite(ledPin, HIGH);
  Serial.println("Street lights on"); // optional
}

void turnOffLights()
{
  digitalWrite(ledPin, LOW);
  Serial.println("street lights off"); // optional
}
```

- Diff b/w analog & digital = mhdr
- No. of pins are greater in arduino mega

Un Q) Diff. b/w analog & digital signal. 17/9/24
PYQ 23

Q2 Smoke detection controller (Vimp) — Arduino.com (for running) (Also for Prog) or IDE - Arduino

```
int smokePin = A0; // Analog pin for smoke sensor
int buzzerPin = 9; // Digital pin for buzzer
                   // 1,2,3...... // A0, 9 can be any value

void setup()
{
  serial.begin(9600);
  PinMode(smokePin, INPUT);
  PinMode(buzzerPin, OUTPUT);
}
void loop()
{
  int smokeValue = analogRead(smokePin);
  Serial.print("smoke value");
  Serial.println(smoke value);
  if (smokeValue > 500) { // smoke intensity val = 500
    activateAlarm();
  } else {
    deactiveAlarm();
  }
  delay(1000);
}

void activateAlarm()
{
  digitalWrite(buzzerPin, HIGH);
  Serial.println("smoke detected, alarm on");
}
```

* Analog pins are connected with analog sensors & digital pins are connected with digital sensors
* Diff analog & digital

```
void deactiveAlarm() {
  digitalWrite(buzzerPin, LOW);
  Serial.println("No smoke, alarm off");
}
```

Q3 Imp (exam) Smart home controller PYQ 23

Write arduino code for IOT smart home climate control, where if the temp is less than 20c the heater will be on & the fan will be off, if the temp is greater than 25°c heater should be off, fan will be on, otherwise heater & fan both will be off. (20-25) [Humidity can be added]

* temp sensor - DHT 22 (& also sense the humidity) → read with analog pin

Code (temp) only for

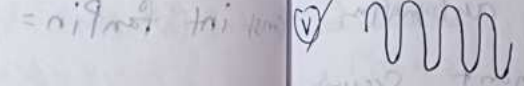
```
int tempPin = DHT22; // Analog pin for temp. sensor
const int heaterPin = 9; // Digital pin 9, 13 for heater & fan res.
const int fanPin = 13; // heater pin connected to digital pin 9
                       // fan pin - 13

void setup()
{
  serial.begin(9600);
  Pinmode(tempPin, INPUT);
  PinMode(heaterPin, OUTPUT);
  PinMode(fanPin, OUTPUT);
}
void loop() {
  int tempValue = analogRead(tempPin);
  serial.print("temp value:");
  Serial.println(tempValue); // temp, Humidity
  if (tempValue < 20) {
    turnOnHeater();
```

So we can consider temp val is also kind of measuring humidity, so the functionalities will be same, for humidity motion — all ~~~ write for both

```
turnOffFan();
}else if(tempValue > 25){
  turnOffHeater();
  turnOnFan();
}else{
  turnOffHeater();
  turnOffFan();
}
delay(1000);
}
void turnOnHeater(){
digitalWrite(heaterPin, HIGH);
Serial.println("heater is on");
}
void turnOffHeater(){
digitalWrite(heaterPin, LOW);
Serial.println("heater is off");
}
void turnOnFan(){
digitalWrite(fanPin, HIGH);
Serial.println("fan is on");
}
void turnOffFan(){
digitalWrite(fanPin, LOW);
Serial.println("fan is off");
}
```

Diff. b/w analog & digital signal.

Analog signal	Digital signal
i) It is continuous signal.	i) It isn't continuous, it is discrete signal.
ii) We can represent analog signals in the form of sine wave.	ii) We can rep digital signals in the form of square waves.
iii) The values of the voltage will be continuous in a range.	iii) The values of voltage will be discontinuous.
iv) ~~Converts~~ records the info as it is.	iv) Converts the info into binary form.
v) 	v) 
vi) It is affected during data transmission.	vi) It isn't affected during data transmission.
vii) It is more accurate.	vii) It is less accurate.
viii) It takes time to store.	viii) It is easily stored.
ix) It produces high noise.	ix) It doesn't produce noise.
x) It has lower bandwidth.	x) It has higher bandwidth.
xi) It is stored in the form of a wave signal.	xi) It is store in the form of binary bits.

• Raspberry Pi :- It is a compact single board computer developed by the Raspberry Pi foundation, it is widely used in education projects and industrial applications.

popular models - the latest model has upto 8GB of RAM, USB 3.0, dual 4K display support.

i) RASPBERRY PI ZERO - A smaller more affordable for single project.

ii) PICO - A uC board for more hardware focused projects.

Raspberry pi is used for projects such as smart mirror that displays news, weather etc.

It can be also used for home automation system, motion detection system, smart security camera etc.

How to setup

i) Raspberry Pi
ii) micro SD card (16 GB least)
iii) Power supply - 5V, 3 amp
iv) Sdmi cable
v) Keyboard, mouse, monitor etc...

JEmanoBotics.com ↓ for Purchasing

Instaration

i) Install the R. P. using, raspberry pi imagen from the official raspberry pi website

ii) Flash the OS using the raspberry pi imagen.
iii) Connect all the peripherals & then boot up.
iv) Update the s/w
- sudo apt update
- sudo apt upgrade (in ubuntu)
vi) LED (for on & off)
vii) Open the terminal & create a new py file
- nano linked.py
- ~~import RPI.GPIO as GPIO~~ (at ubuntu, any editor)
- ~~import time~~
- ~~SPIO~~

viii) Run

python3 linked.py

Raspberry pi code - imi (exam)

```
- import RPI.GPIO as GPIO
- import time
- GPIO.setmode(GPIO.BCM)
- GPIO.setup(17, GPIO.OUT)
- while True:
-     GPIO.output(17, GPIO.HIGH)
-     time.sleep(1)
-     GPIO.output(17, GPIO.LOW)
-     time.sleep(1)
```