TYBSC IT

Internet of Things (IOT)

SEM5 (APRIL-2019) Q.P.Code:53702

Q1 a) Explain the components of Internet of Things. (5)

The components of Internet of things are:-

- Physical Object.
- Sensors.
- Actuators.
- Connectivity
- User Interface

1) Physical Object

- Physical objects embedded with electronics, software, sensors and network connectivity which enables these objects to collect and exchange data and play a remarkable role in many domains including transportation, healthcare, industrial automation, etc.

2) Sensors

- Sensors work to gather minute data from the surrounding environment.
- They are sometimes also known as 'detectors, as the primary function of sensors is to detect.
- This allows an IoT device to capture relevant data for real-time or post-processing.
- This piece of hardware can measure absolutely anything i.e. smoke, motion and even blood pressure

3) Actuators

- Actuators work opposite to that of sensors.
- While sensors sense; actuators act.
- They receive a signal or a command and on that basis they perform an action.
- They are as crucial as sensors as once the sensors have detected a change in the environment, an actuators is required to make something happen based on trigger.
- E.g. actuator controls the heating and cooling in a smart air conditioner.

4) Connectivity

- The sensors/devices can be connected to cloud through a variety of methods including: cellular, satellite, Wi-Fi, Bluetooth, low-power wide-area networks, or connecting directly to the internet via Ethernet.

5) User Interface

- The user interface is the visible components that is easily accessible and in control of the IoT user.
- This is where a user can control the system and set their preferences.
- The more user-friendly this component of the IoT ecosystem is, the easier is a user's interaction.
- A user may interact with the system via the device itself, or can be conducted remotely via Smartphone.

Q1 b) Write a note on Calm and Ambient Technology. (5)

- The IoT has its roots in the work done by Mark Weiser at Xerox PARC in the year 1990s.
- His work didn't assume that there would be network connectivity but was concerned with what happen when computing power becomes cheap enough that it can be embedded in to all manners of everyday objects.
- He coined the term ubiquitous computing or ubicomp. Ubicomp is ambient technology.
- Calm and Ambient technology means technology which acts in background, not something to which we actively pay attention i.e. Ambient noise in background recording.
- The term Calm technology means system that doesn't seek your attention.

Example: 1) **Live Wire**

- Live wire is one of the first IOT devices.
- Created by artist Natalie Jeremijenko.
- Live wire also known as Dangling String.
- It is a simple device: an electric motor connected to an eight-foot long piece of plastic string.
- The power for the motor is provided by the data transmissions on the Ethernet network to which it is connected, so it twitches whenever a packet of information is sent across the network.
- Under normal, light network load, the string twitches occasionally.
- If the network is overloaded, the string whirls madly.

Example: 2) **Split-flap display**

- Split-flap displays have been phased out in and are replaced by dot-matrix LED displays.
- The newer displays are much easier to update with new destinations.
- Split-flap displays are at airport and railway stations.

Example: 3) **Air Tunes Wi-Fi speakers**

- Which anyone play music through.
- Users will often wonder exactly what a particular track was but had no way of finding out who was in charge of the music at that moment and what was playing right now.

Q1 c) What is MAC (Media Access Control) address? Explain. (5)

i. Every network-connected device also has a MAC address.
ii. It is used to differentiate different machines on the same physical network so that they can exchange packets.
iii. This relates to the lowest-level "link layer" of the TCP/IP stack.
iv. Though MAC addresses are globally unique, they don't typically get used outside of one Ethernet network (for example, beyond your home router).
v. So, when an IP message is routed, it hops from node to node, and when it finally reaches a node which knows where the physical machine is, that node passes the message to the device associated with that MAC address.
vi. MAC is a 48-bit number, usually written as six groups of hexadecimal digits, separated by colons—for example:- 01:23:45:67:89:ab
vii. Most devices, such as your laptop, come with the MAC address burned into their Ethernet chips.
viii. The basic function of MAC is to provide an addressing mechanism and channel access so that each node available on a network can communicate with other nodes available on the same or the other networks. Sometimes people refer to this as MAC layer.
ix. The Arduino board, as a low-cost prototyping platform for developers, doesn't bother with that nicety, to save time and cost.
x. Yet it does come with a sticker with a MAC address printed on it. Although this might seem a bit odd, there is a good reason for it: that MAC address is reserved and therefore is guaranteed unique if you want to use it.
xi. For development purposes, you can simply choose a MAC address that is known not to exist in your network.
xii. MAC protocol will play a very crucial role in achieving the desired quality of service.

Q1 d) Discuss the issue of Privacy in Internet of Things. (5)

i. The Internet of Things devices that we own aren't the only ones that should concern us when it comes to matters of trust.
ii. With more sensors and devices watching us and reporting data to the Internet, the privacy of third parties who cross our sensors' paths (either by accident or design) is an important consideration.
iii. Designers of an Internet of Things service will need to balance these concerns carefully.
iv. However, even seemingly innocuous applications can leak personal information, so you should be alert to the danger and take measures to avoid it.
v. Example: - From an early instrumented car park in a Westfield shopping mall in Australia.
vi. Each parking bay is overlooked by a small sensor from Park Assist, which uses a cheap camera to tell whether the space is occupied.
vii. The sensors are all networked and presumably can provide analytics to the owner of the car park as to its usage.
viii. A light on the sensor can help guide drivers to a free space.
ix. The problem came with a more advanced feature of the system. The shopping mall provided a Smartphone app for visitors to download so that they could find out more information about the facilities.
x. When you are going out of mall it tells you where you have parked your car from find My Car app.
xi. A simple http request was unencrypted and returned a chunk of data (JSON format).
xii. Extra data, for example, the IP addresses of each of the sensors units, full license plate for each vehicle length of time it had been parked there.
xiii. Obviously data is already public but difference is that hacker is easily getting all the information at once in bulk.
xiv. The best way to keep a secret is to never have it.
xv. If you can avoid gathering and or storing the data i n the first place, you need not worry about disclosing it accidently.
xvi. Example: - It is standard practise to never store password as clear text you could also consider applying the standard mechanism for password encryption, such as one-way hash.

Q1 e) Explain the working of IP Protocol. (5)

The preceding scenario describes how the Internet Protocol (IP) works.

- Data is sent from one machine to another in a packet, with a destination address and a source address in a standardised format (a "protocol").
- Just like the original sender of the message in the example, the sending machine doesn't always know the best route to the destination in advance.

- Most of the time, the packets of data have to go through a number of intermediary machines, called routers, to reach their destination.
- The underlying networks aren't always the same: just as we used the phone, the postal service, and delivery by hand, so data packets can be sent over wired or wireless networks, through the phone system, or over satellite links.
- In our example, a postcard was placed in an envelope before getting passed onwards. This happens with Internet packets, too.
- So, an IP packet is a block of data along with the same kind of information you would write on a physical envelope: the name and address of the server, and so on.
- But if an IP packet ever gets transmitted across your local wired network via an Ethernet cable—the cable that connects your home broadband router or your office local area network (LAN) to a desktop PC—then the whole packet will get bundled up into another type of envelope, an Ethernet Frame, which adds additional information about how to complete the last few steps of its journey to your computer.
- Of course, it's possible that your cousin Bob didn't know about the London Hack space and then maybe the message would have got stuck with him.
- You would have had no way to know whether it got there. This is how IP works. There is no guarantee, and you can send only what will fit in a single packet.

Q1 f) Write note on DNS (Domain Name System). (5)

i. Computers can easily handle 32-bit numbers, even formatted as dotted quads they are easy for most humans to forget.

ii. The Domain Name System (DNS) helps our feeble brains navigate the Internet. Domain names, such as the following, are familiar to us from the web, or perhaps from email or other services:
   - **google.com**
   - **bbc.co.uk**
   - **wiley.com**
   - **arduino.cc**

iii. Each domain name has a top-level domain (TLD), like **.com** or**.uk**, which further subdivides into **.co.uk** and **.gov.uk**, and so on.

iv. This top-level domain knows where to find more information about the domains within it; for example**, .com knows where to find google.com and wiley.com.**

v. The domains then have information about where to direct calls to individual machines or services. For example, the DNS records for **.google.com** know where to point you for the following:
   - **www.google.com**
   - **mail.google.com**
   - **calendar.google.com**

vi. The preceding examples are all instantly recognizable as website names, which is to say you could enter them into your web browser as,

vii. For example**, http://www.google.com.**

viii. But DNS can also point to other services on the Internet—for example:

- **pop3.google.com** — For receiving email from Gmail
- **smtp.google.com** — For sending email to Gmail
- **ns1.google.com** — The address one of Google's many DNS servers

ix. Configuring DNS is a matter of changing just a few settings. Your registrar (the company that sells you your domain name) often has a control panel to change these settings. You might also run your own authoritative DNS server. The settings might contain entries like this one for **roomofthings.com**: **book A 80.68.93.60 3h**

x. This entry means that the address **book.roomofthings.com** (which hosts the blog for this book) is served by that IP address and will be for the next three hours.

Q2 a) Write note on Sketching (5)

The first step you'll take when working on your prototype will be draw out some design idea with pen and paper.

That is an important first step in exploring your idea and one we'd like to extend beyond the strict definition to also include sketching in hardware and software.

Sketching enable you to brainstorm, explore multiple ideas, define flows, communicate with team members all why being quick and cheap.

The process of exploring the problem space:-

- Iterating through different approaches and ideas to work what works and what doesn't.
- The focus isn't on fidelity of the prototype but rather on the ease and speed with which you can try things out.

Example: - **Printernet Fridge**

- The IoT design firm BERG invited Adrian along to their inaugural Little Printer hack day in June 2012.
- They filled their office with a bunch of interesting techies and creatives.
- Most of attendees focus of creating new publications.
- Adrian decided that having a connected device as the output for the system wasn't enough and spend the day prototyping a custom hardware input device called the Printernet Fridge.
- The Internet fridge is an exercise in seeing that a semi-automated shopping list would be like.

Benefits of sketching:-

- Validate Assumptions.
- Discover problem early.
- Brainstorm ideas.
- Design more iteration.
- Cheaper and fast to implement.
- Disposable.
- Help communicate between the team.

Q2 b) Differentiate between open source and closed source. (5)

Generally, the key difference between open and closed depends on five factors.

- Cost.
- Service.
- Innovation.
- Usability.
- Security.

1) **Cost.**

- One of the main advantages of open source software is the cost because open source software is free of cost.
- Close source, the cost can vary between a few thousand to a few hundred thousand dollars.

2) **Service**

- Open source software relies on a loyal and engaged online user community to deliver support via forums and blog, but this support often fails to deliver the high-level of response.
- Services and support are probably the greatest advantages of using closed software support is a key selling skills and one of the main reason people choose closed source over open source software.

3) **Innovation**

- Open source software provides a large amount of flexibility and freedom to change the software without restrictions.
- Close source software are not flexible and customization software only available for specific users only.

4) **Usability**

- Usability is the major area of criticism for open source software because it is not reviewed by experts and caters to developers,
- For closed source usability is the high selling point due to expert testing for more targeted audience. User manuals are proper and support service also available.

5) **Security**

- Security of open source is often a concern for large companies because software is not always developed in a controlled environment hence; open source software is less secure.
- Close software is generally more secure because it developed in a controlled environment and security is the first priority in closed source software.

Q2 c) Write note on Sensors and Actuators. (5)

1) Sensors

- Sensors are the way of getting information into your device from the surroundings.
- Pushbuttons and switches, which are probably the simplest sensors, allow some user input. Potentiometers (both rotary and linear) and rotary encoders enable you to measure movement.
- Sensing the environment is another easy option. Light-dependent resistors (LDRs) allow measurement of ambient light levels, thermostats and other temperature sensors allow you to know how warm it is, and sensors to measure humidity or moisture levels are easy to build.
- Microphones obviously let you monitor sounds and audio, but piezo elements (used in certain types of microphones) can also be used to respond to vibration.
- Distance-sensing modules, which work by bouncing either an infrared or ultrasonic signal off objects, are readily available and as easy to interface to as a potentiometer.

2) Actuators

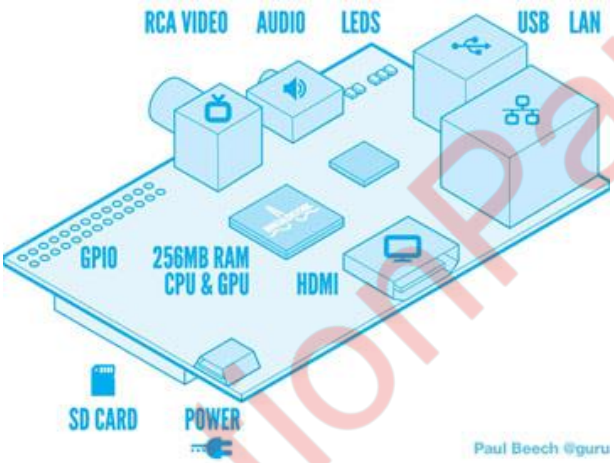
- Actuators are the outputs for the device which let your device do something to the outside world.
- One of the simplest and yet most useful actuators is light, because it is easy to create electronically and gives an obvious output.
- Light-emitting diodes (LEDs) typically come in red and green but also white and other colours. RGB LEDs have a more complicated setup but allow you to mix the levels of red, green, and blue to make whatever colour of light you want.
- More complicated visual outputs also are available, such as LCD screens to display text or even simple graphics.
- Piezo elements, as well as responding to vibration, can be used to create it, so you can use a piezo buzzer to create simple sounds and music.

- You might also want to use components that move things in the real world. Solenoids can be used to create a single, sharp pushing motion, which could be useful for pushing a ball off a ledge or tapping a surface to make a musical sound**.**

Q2 d) Write note on Raspberry Pi. (5)

In 2012, the foundation's work came to fruition with the creation of the Raspberry Pi, a credit card-sized, low-cost but fully functional and programmable computer with modern high-definition multimedia capabilities. It may be the device that gets us back to computing basics.

The Raspberry Pi device looks like a motherboard, with the mounted chips and ports exposed (something you'd expect to see only if you opened up your computer and looked at its internal boards), but it has all the components you need to connect input, output, and storage devices and start computing.



Here are the various components on the Raspberry Pi board:

1. **ARM CPU/GPU:** The CPU performs all basic computations and the GPU performs graphics related functions.
2. **GPIO:** These are exposed general-purpose input/output connection points that will allow the real hardware hobbyists the opportunity to tinker.
3. **RCA:** Used for connecting analog devices.
4. **Audio out:** It is 3.5mm audio output jack.
5. **LEDs:** Used for giving some notification. USB : Used for connecting some peripherals or even cascading the USB ports.
6. **HDMI:** Used for connecting HD devices.
7. **Power:** Used for power supply.

8. **SD card slot:** It has OS in it used while booting.
9. **Ethernet:** Used for wired LAN.

Q2 e) Discuss the factor we should consider when deciding to build Internet of Things. (5)

The platform you choose depends on price, performance and capabilities that suits to our requirements.

The following are the capabilities:-

- Processor Speed.
- RAM.
- Networking.
- Power Consumption.
- Physical size and form factor.

1) Processor Speed

- The processor speed or clock speed of your processor tells you how fast it can process the individual instructions in the machine code.
- You might also make a comparison based on million of instruction per second (MIPS).
- Hardware floating-point process make more time to process.

2) RAM

- RAM provides the networking memory for the system.
- If you have more RAM, you may able to do more things or more flexible.
- Amount of RAM vary from project to project.

3) Networking

- Wired Ethernet is often the simplest for the user.
- It is generally plug and play and it is the cheapest.
- WIFI is the most widely deployed to provide connection.

4) Power Consumption

- Faster processors are often more power hungry than slower ones.
- Power consumption may be an issue for portable devices.
- More powerful processor may not be a disadvantage in a low-power embedded device.

5) Physical Size and Form Factor

- The limiting factor in the size of a chip is the amount of space required for the entire transistor and other component that make circuitry on the silicon.
- Number of IC's legs on a board is the form factor.

Q2 f) What are the disadvantages of Open source? (5)

1. It adds a certain level of vulnerability.

- Some OSS products can have its coding altered so that those who wish to exploit others can do so.
- This may include identity theft, virus transfers, and other activities that irritate open source software products may also have these issues, but at a greatly reduced level.

2. It is not user-friendly.

- There is a definite learning curve involved in the use of many OSS options.
- New users will typically need to go through tutorials or training sessions in order to get the most they can out of the software right away.
- Even if users can get started right away, the interface on an OSS download is often minimal at best because all of the development resources have gone into the actual functionality of the program.

3. Less Personalized Support.

- In OSS everyone can freely edit or upgrade the software according to their level of understanding.
- But since the work is volunteered they don't provide the documentation of the code so the members may have difficulty in understanding the code.

4. You need to pay sometimes.

- Open source software is free at first but it can later costs money if you face issues in implementing the software.
- The request to third-party support or applications to set up or the maintenance of the software may charge you additionally.

Q3 a) Discuss the method of 3D printing. (5)

- The 3D printer also known as additive method.
- The term additive manufacturing is used because all the various processes which can be used to produce the output start with nothing and add material to build up the resulting model.

- This is in contrast to subtractive manufacturing techniques such as laser cutting and CNC milling, where you start with more material and cut away the parts you don't need.
- Various processes are used for building up the physical model, which affect what materials that printer can use, among other things.
- However, all of them take a three-dimensional computer model as the input.
- The software slices the computer model into many layers, each a fraction of a millimetre thick, and the physical version is built up layer by layer.
- One of the great draws of 3D printing is how it can produce items which wouldn't be possible with traditional techniques.
- For example, because you can print interlocking rings without any joins, you are able to use the metal 3D printers to print entire sheets of chain-mail which come out of the printer already connected together.

Types of 3D printing.

1) Fused filament fabrication (FFF):

- Also known as fused deposition modeling (FDM), this is the type of 3D printer you're most likely to see at a maker event.
- It works by extruding a fine filament of material (usually plastic) from a heated nozzle.
- The resulting models are quite robust, as they're made from standard plastic. However, the surface can have a visible ridging from the thickness of the filament.

2) Laser sintering:

- This process is sometimes called selective laser sintering (SLS), electron beam melting (EBM), or direct metal laser sintering (DMLS).
- It is used in more industrial machines but can print any material which comes in powdered form and which can be melted by a laser.

3) Powder bed:

- Like laser sintering, the powder-bed printers start with a raw material in a powder form, but rather than fusing it together with a laser, the binder is more like a glue which is dispensed by a print head similar to one in an inkjet printer.

4) Laminated object manufacturing (LOM):

- This is another method which can produce full-colour prints.
- LOM uses traditional paper printing as part of the process

5) Stereolithography and digital light processing:

- Stereolithography is possibly the oldest 3D printing technique and has a lot in common with digital light processing, which is enjoying a huge surge in popularity and experimentation at the time of this writing.
- Both approaches build their models from a vat of liquid polymer resin which is cured by exposure to ultraviolet light.

Q3 b) Write note on LASER cutting. (5)

- Three-dimensional printers can produce more complicated parts, but the simpler design (for many shapes, breaking it into a sequence of two-dimensional planes is easier than designing in three dimensions), greater range of materials which can be cut, and faster speed make the laser cutter a versatile piece of kit.
- Laser cutters range from desktop models to industrial units which can take a full 8' by 4' sheet in one pass.
- Most of the laser cutter is given over to the bed; this is a flat area that holds the material to be cut.
- The bed contains a two-axis mechanism with mirrors and a lens to direct the laser beam to the correct location and focus it onto the material being cut.
- The computer controls the two-axis positioning mechanism and the power of the laser beam. This means that not only can the machine easily cut all manner of intricate patterns, but it can also lower the power of the laser so that it doesn't cut all the way through.
- At a sufficiently low power, this feature enables you to etch additional detail into the surface of the piece.
- You can also etch things at different power levels to achieve different depths of etching, but whilst the levels will be visibly different, it isn't precise enough to choose a set fraction of a millimetre depth.

When choosing a laser cutter, you should consider two main features:

- **The size of the bed:** This is the place where the sheet of material sits while it's being cut, so a larger bed can cut larger items. You don't need to think just about the biggest item you might create; a larger bed allows you to buy material in bigger sheets (which is more ost effective), and if you move to small-scale production, it would let you cut multiple units in one pass.
- **The power of the laser:** More powerful lasers can cut through thicker material. For example, the laser cutter at our workplace has a 40W laser, which can cut up to 10mm-thick acrylic. Moving a few models up in the same range, to one with a 60W laser, would allow us to cut 25mm thick acrylic.

Q3 c) Explain the term Scraping. (5)

- Screen scraping is the process of collecting screen display data from one application and translating it so that another application can display it.
- This is normally done to capture data from a legacy application in order to display it using a more modern user interface.

- Screen scraping usually refers to a legitimate technique used to translate screen data from one application to another.

The screen scraping application must usually do both of the following:

- Capture screen input and pass it on to the legacy application for processing
- Return data from the application to the user and display it properly on the user's screen

Following are few examples of Screen Scrapping :

- Adrian has scraped the Ship AIS system to get data about ships on the river, and this information is then tweeted.
- The Public Whip website is made possible by using a scraper to read the Hansard transcripts of UK government sessions .With this, it can produce both human- and machine-readable feeds.
- ScraperWiki has an excellent platform for writing scrapers, in a number of dynamic programming languages, which collate data into database tables. Effectively, it provides infrastructure for “Mechanize” scripts that you could run on your own computer or server but allows you to outsource the boring, repetitive parts to ScraperWiki.

Q3 d) What is Polling? Explain in brief. (5)

Polling is not a hardware mechanism; it’s a protocol in which CPU steadily checks whether the device needs attention.

If you want the device or another client to respond immediately, how do you do that? You don’t know when the event you want to respond to will happen, so you can’t make the request to coincide with the data becoming available.

Consider these two cases:

- The WhereDial should start to turn to "Work" the moment that the user has checked into his office.
- The moment that the task timer starts, the client on the user's computer should respond, offering the opportunity to type a description of the task.

The traditional way of handling this situation using HTTP API requests was to make requests at regular intervals. This is called polling.

You might make a call every minute to check whether new data is available for you.

However, this means that you can't start to respond until the poll returns. So this might mean a delay of (in this example) one minute plus the time to establish the HTTP connection.

You could make this quicker, polling every 10 seconds, for example. But this would put load on the following:

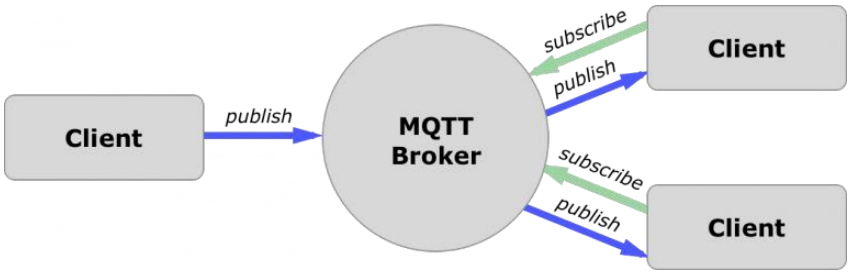
- **The server:** If the device takes off, and there are thousands of devices, each of them polling regularly, you will have to scale up to that load.
- **The client:** This is especially important if, as per the earlier Arduino example, the microcontroller blocks during each connect.

Q3 e) Write note on MQTT Protocol. (5)

- MQTT is one of the most commonly used protocols in IoT projects.
- It stands for Message Queuing Telemetry Transport.
- In addition, it is designed as a lightweight messaging protocol that uses publish/subscribe operations to exchange data between clients and the server.
- Furthermore, its small size, low power usage, minimized data packets and ease of implementation make the protocol ideal of the "machine-to-machine" or "Internet of Things" world.

MQTT server is called a broker and the clients are simply the connected devices.

- When a device (a client) wants to send data to the broker, we call this operation a "publish".
- When a device (a client) wants to receive data from the broker, we call this operation a "subscribe".



MQTT has unique features you can hardly find in other protocols, like:

- **It's a lightweight protocol:** So, it's easy to implement in software and fast in data transmission.
- **It's based on a messaging technique:** Of course, you know how fast your messenger/WhatsApp message delivery is. Likewise, the MQTT protocol.
- **Minimized data packets:** Hence, low network usage.
- **Low power usage:** As a result, it saves the connected device's battery.
- **It's real time:** That's is specifically what makes it perfect for IoT applications.

Q3 f) What is CNC Milling? Explain. (5)

- Computer Numerically Controlled (CNC) milling is similar to 3D printing but is a subtractive manufacturing process rather than additive.
- However, rather than building up the desired model layer by layer from nothing, it starts with a block of material larger than the finished piece and cuts away the parts which aren't needed.
- Because cutting away material is easier, CNC mills can work with a much greater range of materials than 3D printers can.
- You still need an industrial scale machine to work with hardened steel, but wax, wood, plastic, aluminium, and even mild steel can be readily milled with even desktop mills.
- CNC mills can also be used for more specialised (but useful when prototyping electronic devices) tasks, such as creating custom printed circuit boards (PCB).
- A wide range of CNC mills is available, depending on the features you need and your budget.
- Sizes range from small mills which will fit onto your desktop through to much larger machines with a bed size measured in metres.

The main component of CNC is number of axis:

- **2.5 axis:** It can move only at any two direction but one at a time.

- **3 axis:** It moves in all three direction at the same time.
- **4 axis:** This machine adds a rotary axis to the 3-axis mill to allow the piece being milled to be rotated around an extra axis.
- **5 axis:** This machine adds a second rotary axis—normally around the Y—which is known as the B axis.
- **6 axis:** A third rotary axis—known as the C axis if it rotates around Z—completes the range of movement in this machine.

CNC milling is split into two types:-

1) CAD

- CAD is Computer-Aided Design.
- CAD software lets you design the models.

2) CAM

- CAM is Computer-Aided Manufacture.
- CAM software turns that into a suitable tool path.
- A list of co-ordinates for the CNC machine to follow which will result in the model being revealed from the block of material

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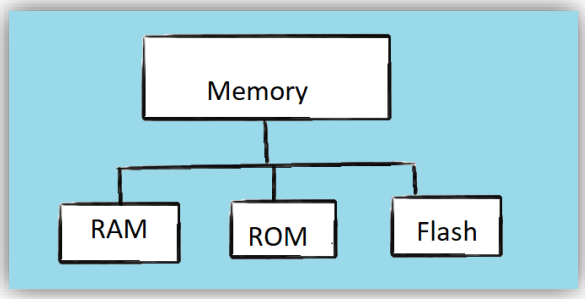
Q4 a) Explain the different types of memories. (5)

- When you don't have a lot of memory to play with, you need to be careful as to how you use it.
- This is especially the case when you have no way to indicate that message to the user.
- The computer user presented with one too many "low memory" warning dialog boxes.
- On the other hand, an embedded platform with no screen or other indicators will usually continue blindly until it runs out of memory completely.
- Even while you are developing software for a constrained device, trying to debug these issues can be difficult.
- Something that worked perfectly a minute ago now stops.

The different types of memory are:



1) RAM

- Random-access memory trade's persistence for speed of access.
- It requires power to retain its contents, but the speed of update is comparable with the time taken to read from it (particularly when compared to flash memory).
- As a result it is used as the working memory for the system—the place where things are stored while being processed.

2) ROM

- Read-only memory refers to memory where the information stored in the chips is hard-coded at the chips' creation and can only be read afterwards.
- This memory type is the least flexible and is generally used to store only the executable program code and any data which is fixed and never changes.

3) Flash

- Flash is a semi-permanent type of memory which provides all the advantages of ROM and RAM.
- The contents of flash memory can be rewritten a maximum number of times.
- Reading from flash memory isn't much different in speed as from ROM or RAM.

Q4 b) What is debugging for Internet of Things device? Explain. (5)

- It is one of the most important parts of any software development lifecycle, the most irritating part of writing a code is knowing your code has an error after debugging.
- With embedded environment it is far more frustrating, as it becomes difficult to understand whether the problem is with software or hardware.
- Modern IDE's have a good support for understanding where and in which part there is a problem.
- It allows setting breakpoints, performing memory management, and interpreting the code line by line. The debugging environment for embedded systems is usually more primitive.

Following are some examples of debugging tools:

1. Simulators: Software instruction simulators provide simulated program execution with read and write access to the internal processor registers.

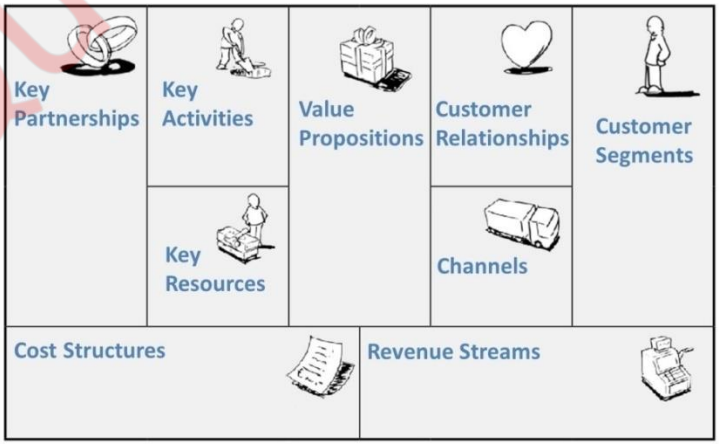
2. Burn-and-learn method: A chip is burned with a device programmer; and after plugging it into the hardware, the system crashes. At this point, an attempt is made to figure out what

went wrong; the source code is changed, the executable is rebuilt, and another chip is burned. This cycle is repeated until the chip works properly.

Q4 c) Write note on Long tail of Internet. (5)

- From Tim Berners-Lee's first demonstration of the World Wide Web in 1990, it took only five years for eBay and Amazon to open up shop and emerge another five years later as not only survivors but victors of the dot-com bubble. Both companies changed the way we buy and sell things.
- A physical bricks shop has to pay rent and maintain inventory, all of which takes valuable space in the shop; therefore, it concentrates on providing what will sell to the customers who frequent it: the most popular goods.
- In comparison, an Internet storefront exposes only bits, which are effectively free. Of course, Amazon has to
- Maintain warehouses and stock, but these can be much more efficiently managed than a public-facing shop.
- Long tail Internet giants help this process by aggregating products from smaller providers, as with Amazon Marketplace or eBay's sellers.
- This helps thousands of small third-party traders exist, but also makes money for the aggregator, who don't have to handle the inventory or delivery at all, having outsourced it to the long tail.
- Yet although Google's stated goal is "to organize the world's information and make it universally accessible and useful", it makes money primarily through exploiting the long tail of advertising, making it easy for small producers to advertise effectively alongside giant corporations.

Q4 d) Discuss the business model canvas for Internet of Things. (5)



The Business Model looks like a nine-point checklist. Each point of the checklist is described below:

1. Revenue Streams: This point describes how the company generates its revenue.

2. Value Propositions: It describes about what value the company brings to the customers.

3. Customer Segment: It describes about the targeted customers to whom the product needs to be delivered.

4. Customer Relationship: It discusses about how the company retains its relationship with its customers. Though it is beneficial from the business point of view but is costly to maintain such communities which connect the company to its customers.

5. Channels: It tells about by what means does the company reaches out to its customer.

6. Key Activities: It describes about the activities that needs to be carried out in order to make the company successful.

7. Key Resources: It describes about how the company gets its resources for fulfilling the customer demands.

8. Key Partners: Every new company invest money to do the key activities themselves but at same time for its product to be launched successfully in the market, it requires key partners who can do some of these key activities in a much better manner as they are experienced in that particular activity and that they have their own business model for it.

9. Cost Structure: In Cost structure, one has to discuss about what cost does the company incur? i.e. Whether the product is cost driven (selling large number of products at cheaper rate) or value driven (selling limited number of products but at a higher rate).

Q4 e) Explain how to achieve customization in Internet of Things. (5)

i. For an Internet of Things device, at the intersection between solid thing and software, there are options for customisation that we believe may lead to new business models.

ii. For a mass-produced item, any customisation must be strictly bounded to a defined menu: a selection of different colours for the paintwork, options for fittings such as tyres, the trimmings and upholstery inside, and for features like the onboard computer control and display. Fordian logic dictates that all these components must be optimised for manufacture and fit well together.

iii. Early websites explored the new medium of HTML to its garish extremes, with <blink> tags and animated .gif images. Yet today's equivalent of home pages, offered by incumbents such as Facebook, Twitter, and Pinterest, offer small degrees of customisation within strictly defined boundaries: a selection of (tasteful) colour schemes and a choice of image to use as your avatar.

iv. Many Internet of Things products have some possibility of customisation: Every Bubblino has a name (given to it by Adrian), but the user can also change which phrases he listens to on Twitter. BERG's Little Printer offers a selection of content to be printed but also an option of which smiley face it will print for display while waiting for a new delivery. (Of course, only a limited number of choices are available currently.)

v. Although printer output is as flexible as the software that feeds it, BERG has limited the options to fit into its product aesthetic.

vi. The new manufacturing techniques, such as laser cutting and 3D printing, should allow great possibilities for customising even the physical devices.

vii. MakieLab (http://makie.me) make dolls that can be designed online. Built to your specification, they are therefore unique and entirely yours in a way that a mass-produced doll.

Q4 f) Explain the term Venture capital. (5)

Every Start-up requires funding at some or other point of time.

Getting funding for a project from an external investor presents its own work and risks.

This funding process goes in 3 rounds, i.e. Friends, Family, and Fools (FFF) rounds, Angels round, and Venture Capital round.

Friends, Family, and Fools (FFF) Rounds:

- It is the most straight forward round, you try to get funds from family members or best friends and even local business pitch into it.
- This round totally depends on how strong your relationship is with the person you have approach for funding.

Angels Round:

- This is the next round for raising funds.
- The angels here are the entrepreneurs who are willing to invest in the start-ups.
- These entrepreneurs invest in such start-ups because of their similar background and experience in this filed.

Ventures Capital Round

- Venture capital provides large amount of funds only if angels have already invested in your company and have gained profit out of it.
- Unlike angels, venture capital round would also demand to be board members and even a significant amount of equity.

Government Funding

- Governments typically want to promote industry and technological development in their country, and they may provide funds to help achieve particular aims.
- Although governments can and do set up their own venture capital funds or collaborate with existing funds in various ways, they generally manage the majority of their funds differently.
- For one thing, they also want to fund existing companies to do new research and innovation.

- **Outputs:**

- This metric may simply be a test that you are managing the money well or may be related to the goals that the body itself wishes to promote.
- You might be required to write regular reports or pass certain defined milestones on schedule.
- If your funding is given in stages, the later payments may be conditional on successful delivery of previous outputs.

Crowd Funding:

- As the name suggests, it is getting funds from many people at a time.
- We can think of crowd funding as the long tail of funding projects.
- Getting many people to contribute to a project isn't exactly a new phenomenon.
- Over millennia many civic and religious monuments and constructions have been funded at least partly by the public.
- However, such projects have been mostly sponsored and given focus by some influential person or body.
- The main options for crowd funding are Kick-starter (www.kickstarter.com) and Indiegogo (www.indiegogo.com).

Q5 a) what is Crowdsourcing? Explain. (5)

One fascinating feature of modern Internet life is “crowdsourcing”, from knowledge to funding projects (Kickstarter, Indiegogo) to work (Mechanical Turk).

In the Internet of Things world, this concept has manifested itself in sensor networks such as Xively. Founder Usman Haque has said that their original intent wasn’t simply “making data public” but also letting “the public making data”.

Governments and companies simply do not and cannot have a monopoly on all recording of data: there are infinite combinations of data sources.

Choosing which data to record is a creative and engaged act, as well as, perhaps, a political one. After the Fukushima Daiichi nuclear disaster, there were fears that insufficient information was available to track the spread of the leaked radioactive materials.

Many hackers around the world built Geiger counters, and Xively was a focal point for Japanese engineers to publish their data to. Perhaps the Japanese government or the management of the Fukushima plant would have provided that kind of accurate, widespread data if they could. But power or financial interests might have worked against this.

Andrew Fisher, a technologist with interests in big data and ubiquitous computing, has written persuasively about a quiet revolution of the “sensor commons”, his term for this collaborative voluntary effort to provide environmental data.

Former Xively evangelist Ed Borden has led a “call to arms” for a citizen-led air-quality sensor network. As he points out, “The air quality data collected by the government is likely sampled from far, far away and then applied to you on a regional level, almost completely useless from the standpoint of trying to understand or change the local dynamics of pollution that affect you”.

Crowdsourcing this data is an entirely innocent scientific activity yet is profoundly radical, too. Javaun Moradi, product manager for NPR Digital, clarifies, “These networks aren’t trying to replace scientific and government detection equipment, they’re trying to both fill a data gap and advance conversation”.

This is an important point: local activism may be hampered by lack of available data. Coming together to produce such data raises activism from an emotional appeal (“think of the children!”) which can be ignored or co-opted by the political elite as expedient, into a reasoned thesis supported by real data.

Q5 b) Discuss the different environmental issues in Internet of Things. (5)

Let us focus on the classic environmental concerns about the production and running of the Thing.

Physical Thing:

- Whenever any product is developed it will include cost of different components which includes the raw materials, the processes used to shape, the packing materials, and the shipping required to ship them from the manufacturing plant to the customer. The cost also includes different plastics used for 3D printing.
- While developing any new product, make sure environmental ethics are followed like waste disposal/recycling.

Human Cost:

- It is also important to consider the human cost, the communications, transport, and logistics required are certainly a part of the technology.
- The combination of technical expertise and relatively low labour costs, has reduced overall manufacturing cost.
- The advances in operator-less manufacturing tools such as 3D printers and laser cutters are, however, enabling small-scale industry to return to the First World

Electronics:

- The electronics contained in a Thing have their own environmental cost.
- Ranging from PCB to advance tools like CNC milling, laser cutter, 3D printer etc. Shipping the raw material from mine to refinery to manufacturer has its own cost too.

Internet Service:

- This is one of the main component of IoT, running the Internet has a cost: the electricity to run the routers and the DNS lookups, plus establishing the

Infrastructure:

- Laying cabling across the sea, setting up microwave or satellite links, and so on. As well as the cost of transferring the data across the Internet, running your own web server uses power.

Solutions: The main aim for IoT will be high speed internet with lot of low powered intelligent sensors and that too focusing the implementation with least cost.

Q5 c) Explain common PCB (Printed Circuit Board) making techniques. (5)

If you want only a couple of boards, or you would like to test a couple of boards (a very wise move) before ordering a few hundred or a few thousand, you may decide to make them in-house.

ETCHING BOARDS

- The most common PCB-making technique for home use is to etch the board.
- Some readily available kits provide all you need.
- The first step is to get the PCB design onto the board to be etched.
- This process generally involves printing out the design from your PCB design software onto a stencil.
- If you're using photo-resist board, it will be onto a stencil which masks off the relevant areas when you expose it to UV light.
- Your stencil then needs to be transferred to the board.
- For photo-resist board, you will expose it under a bright lamp for a few minutes.
- With the board suitably prepared, you can immerse it into the etching solution, where its acidic make-up eats away the exposed copper, leaving the tracks behind.
- After all the unnecessary copper has been etched away, and you've removed the board from the etching bath and cleaned off any remaining etchant, your board is almost ready for use.
- The last step is to drill the holes for any mounting points or through-hole components.

MILLING BOARDS

- In addition to using a CNC mill to drill the holes in your PCB, you can also use it to route out the copper from around the tracks themselves.
- To do this, you need to export the copper layers from your PCB software as Gerber files.
- These were first defined by Gerber Systems Corp., hence the name, and are now the industry standard format used to describe PCBs in manufacture.
- To translate your Gerber file into the G-code that your mill needs requires another piece of software.
- Some CNC mills come with that software already provided, or you can use a thirdparty program such as Line Grinder.
- The mill effectively cuts a path round the perimeter of each track to isolate it from the rest of the copper.
- As a result, PCBs which have been milled look a bit different from those which are etched because any large areas of copper that aren't connected to anything are left on the board.

THIRD-PARTY MANUFACTURING

- If your design has more than two layers, if you want a more professional finish, or if you just don't want to go to the trouble of making the PCBs yourself, many companies can manufacture the boards for you.
- The price for getting the boards made varies based on the complexity and the size of the design but also varies quite a bit from company to company.
- If you need the boards quickly, a local firm is best.
- If you have more time you can give it outside country such as china, it might reduce cost.
- Either way, the Gerber files are what you need to provide to the manufacturer.
- Make sure you export all the relevant layers from your design, meaning each of the copper layers you're using, plus the solder mask, silkscreen and drill files.

Q5 d) Discuss the phase of Testing in manufacturing of Internet of Things devices. (5)

- Actually, through the automated assembly process, you might have had some testing steps included already. Assembly lines can include automatic optical inspection (AOI). In this process, a high-resolution camera inspects some aspect of the board and its components; for example, it could check that the solder paste is laid properly before the board goes into the pick-and-place machine and compare it to a known good version. Any boards which vary from the "golden" reference version by too high a margin are flagged for further checks from a skilled human operator.
- After the boards pass the AOI, the next step is to run them through a functional test. This step is something that you can, and should, be doing even with boards that you've soldered by hand.
- At its most basic, the functional test just involves powering up the board as it will be used in the finished product and ensuring that it does what it is supposed to. However, that might take a nontrivial amount of time. The focus here is not on ensuring it will run through all normal operations, but just that the PCB and its components are soldered correctly, that none of the components are faulty, and that there aren't any manufacturing defects in the PCB itself.
- A better approach is to build a specific test rig to exercise the different parts of the circuit and measure the voltages at set points on the board. These measurements can then be compared against known-good values and a decision made automatically as to whether or not the device under test (DUT) has passed. You might find that adding a few testing points to the PCB—exposed pads on the PCB connected to useful parts of the circuit—will make the testing process easier, so it's worth considering how the test procedure will run before finishing your PCB design.

- Building such a rig isn't too complicated, particularly if you're happy building systems with boards like Arduino and Raspberry Pi. If you're not, we recommend (re)visiting, "Prototyping Embedded Devices".
- Because you don't want to spend time making individual connections for each test, the normal practice for the test rig is to use the mounting holes for the PCB for alignment and then have it held by some clips against a number of carefully prepositioned, spring-loaded pins. These pins are known as pogo pins, and the spring means they can make a good connection to the board without any extra work, such as soldering, when the board is placed into the test rig.
- The test program can then run through its tests and measure voltages at different pogo pins at the relevant time in the test to see how the board being tested performs.

Q5 e) Explain the important guidelines to deal with issue of security in Internet of Things. (5)

Following are some of the more important guidelines:

- Make sure that your servers are kept up-to-date with the latest security patches, are hardened with the appropriate firewalls, and detect and mitigate against password hacking attempts and root kit attacks.
- User passwords should never be stored in plain text. If your database were ever compromised, an attacker could easily log in as any user. As we touched upon in the sidebar on "Hashes", passwords should be encrypted with a secure algorithm which is not known to be trivially cracked, and "salted" for additional security.
- Never simply trust user input. Check that anything that is entered into a web application fits the type of data you expect, and refuse or clean anything which doesn't. Although you may think input from your connected devices would be okay (because you wrote the code), it is possible that it has been compromised or an attacker may be "spoofing" it. In particular, be wary of passing user input to your database without checking it (otherwise, you risk an SQL injection attack were it to include SQL commands), or including unfiltered user input in your HTML pages, as this could allow a cross-site scripting (XSS) attack. Strip out all HTML tags (or allow only a limited selection of acceptable ones for formatting) or escape the output.
- Be aware of cross-site request forgery (CSRF) attacks from other malicious or compromised websites. For example, if one of your users browses a bad site which uses JavaScript to open http://some. example.com/heating?switch=off on your site, and the user is already logged in, he may come home to a cold house.

Q5 f) Discuss the main goal of Open Internet of Things definition. (5)

The Open IoT Assembly 2012 culminated in the drafting of the "Open Internet of Things Definition".

An emergent document, created after two days of open discussion, it seeks to define and codify the points of interest around the technology of the Internet of Things and to underscore its potential to "deliver value, meaning, insight, and fun".

A particularly interesting consensus in the definition was that, even though the Data Licensor (usually the person who has set up the sensor or paid for that data) should quite reasonably own the data from that sensor, some rights should also apply to individuals whose data is recorded (the Data Subjects).

They must be granted licence to any data that regards them and should be allowed to license the anonymised aggregate data for their own purposes.

We can summarize the main goals of the definition as follows:

Accessibility of data:

- As a stated goal, all open data feeds should have an API which is free to use, both monetarily and unrestricted by proprietary technologies with no alternative open source implementation.

Preservation of privacy:

- The Data Subjects should know what data will be collected about them and be able to decide to consent or not to that data collection.
- This is a very strong provision (and most likely unworkable for data which is inherently anonymous in the first instance) but one which would provide real individual protection if it were widely followed.
- As with any information gathering, "reasonable efforts" should be made to retain privacy and confidentiality.

Transparency of process:

- Data Subjects should be made aware of their rights.
- For example, the fact that the data has a licence—and that they are able to grant or withdraw consent. In addition, where the data is collected from a public space, the public should get a right to participate in decision making and governance of that data.
- We could imagine that planning-permission notices might be posted, as they are in the UK for building developments.

The importance placed by these principles on data is unsurprising: the Internet of Things brings the gathering and collation of data into the everyday world and has real consequences on individual privacy and power.