

**Bachelor of Science in Information Technology**

**Internet of Things(IOT)**

**November 2022**

---

**1. Attempt any three of the following :** (15M)

**a. Define and explain Internet of Things and Ubiquitous Computing.** (5M)

**Ans.**

- Definition (IOT): Internet of Things is defined as "object or things" which is connected through our internet to communicate and receive any sort of useful and helpful information.
- Definition (Ubiquitous Computing): The term 'Ubiquitous' means to be "present Everywhere" and 'Computing' means "Computer". Computer will be useful but invisible assistant available throughout the physical environment to perform multiple task, where one person will use many computers so it is also known as pervasive computing.
- This system can be used in any sort of device in any desired location. Its requirements are OS, mobile protocols(GSM,GPRS as these are used in latest times),positioning and location.
- Example of Ubiquitous Computing in IOT is as follows:-
  - ✓ It is used on a large scale in this generation like in cabs like OLA and UBER where an unknown passenger can be provided by route to locations, electrical equipment, information regarding to tolls, etc

**b. "Any sufficiently advance technology in indistinguishable from magic." Discuss. (5M)**

**Ans.**

This particular was stated by "Mr. Clarke's We" who stated that how we use the technology with our needs and desires. Such inventions in the technology are not less to magic. As humans believe in magic , an sort of innovation in technology can be stated as an magic.

- The advancement in the technology has been evolved rapidly where some impossible or futuristic things are been able to done now over which were first impossible in the early decades. So such change in their environment with respect to technology is a sort of magic for them.

- The limitations of the technology have also increased in the day to daily lives of human beings which also acts like a magic for them as earlier it was used in a small and limited range in the earlier times and thus we would not be able to use with full potential.
- Examples are as follows :
  - a. Artificial drones : Used for video photography, delivery of goods, etc.
  - b. IOT in Agriculture : Fusing up of some ancient tools with the latest features of IOT in order to make things easy for the farmers like monitoring soil moisture, temperature & nutrient levels in soil.
  - c. IOT in Medicine : It is used as a reminder as smart bottle caps or holders which frequently reminds the patient that when do they have to intake their medicines with its changing colors technology and if the medicine is not taken on time it informs the doctors which alerts them so that they could keep an eye on the patient who is been recovering from an disease.

**c. What is calm and ambient technology ? Explain with example.**

**(5M)**

**Ans.**

- The Internet of Things has its roots in the work done by Mark Weiser at Xerox PARC in the 1990s. His work didn't assume that there would be network connectivity but was concerned with what happens when computing power becomes cheap enough that it can be embedded into all manner of everyday objects.
- He coined the term ubiquitous computing, or ubicomp for short, to describe it, and through his research and writing sought to explore what that would mean for the people living in such a world. With its focus on computing power being embedded everywhere, ubicomp is often also referred to as ambient computing.
- However, the term "ambient" also has connotations of being merely in the background, not something to which we actively pay attention and in some cases as something which we seek to remove. The example of it is as follows :
- Smart Home Ambient Lighting : this is a specific and a simple feature which consists of a lighting technology , via this technology we can create or it can simply create a simple, cool and a calm environment. It is connected to such sensors and some specific algorithms which helps it to function properly and can also be adjusted as the person wants the lighting to be.

**d. “Be conservative in what you do, be liberal in what you accept from others”. Explain (5M)**

Ans.

This statement was stated as ‘Postel’s Law’, which was stated after Jon Postel who guide us with design and implementation of communication protocols. This principle was stated in two parts :

1. Be conservative in What you Do : This part states us that whatever the situation is, we should always be cautious, attentive and careful. It avoids and prevents us from taking up of unnecessary risks or making assumptions . As followed by this step it also minimizes potential errors, and thus helps in creation of systems that are less likely to fail or break.

2. Be Liberal in What You Accept from Others : This is the second approach which is relevant in the terms of communication system where different entities are not fitted to use or due to some fluctuations they are not able to use it properly. Basically, it allows the systems to continue functioning even in the presence of minor errors in the data.

So by balancing both the statements given above it concludes as follows :

a. Conservation during creation : While creating something, be cautious, follow practices and be reliable enough.

b. Liberalism during reception : While receiving any sort of information from others, we should be tolerant and flexible enough in order to handle the things properly and smoothly.

**e. Define protocol. Explain the following application layer protocols: (5M)**

Ans.

Protocol : A Protocol is a set of rules and guidelines for communicating data. Rules are defined for each step and process during communication between the two or more computers. In order to successfully transfer the data the ‘Networks’ need to follow this rule.

i. HTTPS

Ans. Hypertext Transfer Protocol Secure (HTTPS) is an extension of the Hypertext Transfer Protocol (HTTP) for secure communication over a computer network, and is widely used on the Internet. It is basically encrypted with TLS(Transport Layer Security) or by SSL(Secure Sockets Layer)

ii. SMTP

Ans. It order to conduct any email or electronic transmission an SMTP(“Simple Mail Transfer Protocol”) is been used on Internet.

iii. FTP

Ans. FTP is a simple protocol known as “File Transfer Protocol” whose name only suggests that it is used between a client and server on a computer system in order to transport any sort of files.

iv. POP3

Ans. POP3 stands for “Post Office Protocol Version 3”. It is mainly used to carry on or retrieve the e-mails from the corresponding mail server. It also requires very low power consumption, has limited bandwidth and has good connectivity.

v. IMAP

Ans. IMAP stands for Internet “Message Access Protocol”. It also has a similar function like POP3 like retrieving any mail from a mail server but its main function is to download the particular message in a local device. It mainly allows or grants access on a remote server to view, manage and organize the messages without downloading them for a permanent basis.

**f. Discuss the following IOT Device use at Dos Liverpool. (5M)**

**i. Central Heating System**

Ans. With respect to a central heating system, IOT integration can enhance its functionality, efficiency and convenience.

Here are some points that show how the heating system has been made:

- a. **Sensor Integration** : It consists of temperature sensors placed in different rooms that can help the system adjust heating levels based on occupancy and preferences. External weather sensors can provide information to adjust heating levels according to the weather conditions.
- b. **Smart thermostat** : It helps as well as allows the users to remotely control and monitor their heating system through a mobile app or web interface. This means you can adjust the temperature, set schedules, and even turn the system on or off from anywhere using your smartphone.
- c. **Energy Monitoring and Efficiency** : It enables the home owners to monitor their energy consumption in real-time. It is one of the convenient and useful parts as it also optimizes our energy usage and might also help in saving.

## ii. Door-bot

Ans.

An door bot is an advanced IOT device which combines the internet with such other small and smart features. Some of its features are as follows:

a. Remote Video Monitoring: A door bot typically comes with a built-in camera that allows homeowners or residents to see and communicate with visitors at their front door, even when they are not physically present at home.

b. Security and Surveillance: The door bot can serve as a part of a home or building's security system. It can record video footage of visitors which is very useful for us.

c. Package Delivery and Access Control: In a city like Liverpool, where package deliveries are frequent, a door bot can be particularly useful. Residents can remotely communicate with delivery personnel and provide access instructions to leave packages securely and can also be used as an smart lock too and it grants only some persons at an respective amount of time.

## 2. Attempt any three of the following :

(15M)

### a. How can we decide between the cost and ease of prototyping ?

(5M)

Ans.

- It is also worth considering the relationship between the costs (of prototyping and mass producing) of a platform against the development effort that the platform demands.
- It is beneficial if you can choose a prototyping platform in a performance/capabilities bracket similar to a final production solution.
- That way, you will be less likely to encounter any surprises over the cost.
- For the first prototype, the cost is probably not the most important issue: the smartphone or computer options are particularly convenient if you already have one available, at which point they are effectively zero-cost.
- If your device has physical interactions , you will find that a PC is not optimized for this kind of work.
- An electronics prototyping board, unsurprisingly, *is* better suited to this kind of work.
- An important factor to be aware of is that the hardware and programming choices you make will depend on your skill set.
- For many beginners to hardware development, the Arduino toolkit is a surprisingly good choice.
- The input/output choices are basic and require an ability to follow wiring diagrams and, ideally , a basic knowledge of electronics.

**b. Discuss the merits and demerits of mixing open source and close source. (5M)**

Ans.

The merits of mixing open source and close source are as follows :

1. Prevention of an Vendor Lock-In : Mixing up of these both sources can reduce the dependence on any single or individual vendor. This gives us much more options for maintenance and support.
2. Flexibility and Customization : Generally closed system lacks in some fields of features which are not tolerable for some organizations. So by integrating an open source with it, the developers can customize and extended there reach in closed system so that it can meet its needs.
3. Security Auditing : Open source's software can be inspected by anyone. So this feature helps in identification or any such thing to be done quickly and such collective efforts increases its security.

The demerits of mixing open source and close source are as follows :

1. Support and Maintenance : It lacks in this field as both systems i.e. open and closes system lies in the hands of an organization. So this makes it a bit difficult for managing any new updates or customization.
2. Fragmented Development : As open and closed sources consists of different teams and each team or individual has its own point of view or approach to any specific task which leads in reducing overall efficiency and consistency of the system.

**c. Explain the transition from prototype to production. (5M)**

Ans.

The transition from prototype to production is a crucial phase in the development process of a product or technology. It involves moving from a proof-of-concept prototype, which is a preliminary version of the product used for testing and validation, to a fully manufacturable and market-ready product for mass production and commercialization.

The transition from prototype to production are as follows:

1. Evaluation of Prototype Performance: The first step is to thoroughly evaluate the performance of the prototype. This involves testing the prototype under various conditions to identify any flaws, limitations, or areas for improvement.
2. Design Refinement: Based on the feedback from prototype testing, the design is refined to address identified issues and optimize the product for better functionality, performance, and manufacturability. This step may involve making changes to materials, components, or manufacturing processes.

3. Prototype Iteration: Depending on the design refinements, additional prototype iterations may be created and tested to verify that the changes have resulted in a viable and improved product.

In conclusion The transition from prototype to production requires collaboration between design, engineering, manufacturing, and business teams.

**d. With the help of an example explain the process of Sealing up the electronics. (5M)**

**Ans.**

- Sealing up electronics refers to the process of protecting electronic components and circuitry from environmental factors such as moisture, dust, dirt, and other contaminants.
- Sealing is crucial for ensuring the long-term reliability and functionality of electronic devices, particularly those intended for outdoor or harsh environments.
- The process typically involves using various sealing techniques and materials to create a protective barrier around the electronics.
- After creating an protective barrier, cable management is the most crucial phase while sealing up of the electronics. It is very much important as the contents of the electronic system which is been sealed should be in intact and should not loosen enough so that it may not cause any chaos in the future.
- After the sealing process, sealing solutions ,i.e. gaskets are used to seal the electronic items as it forms an layer of protection against water and dust for it. It is done so as we know that electronic devices should not come in contact with moisture as it is very sensitive to the water or moisture.
- The example of such an electronic device such as outdoor GPS with its sealing techniques is as follows :
- Let's use the example of a rugged outdoor GPS device to explain the process of sealing up electronics
  - a. Enclosure Design
  - b. Gasket and Sealing Surfaces
  - c. Conformal Coating
  - d. Potting
  - e. Mechanical Sealing
  - f. Testing



**e. Explain the following with the respect to prototyping embedded devices: Processor Speed, RAM, Networking, Power consumption and physical size and form factor. (5M)**

Ans.

- Processor Speed : The processor's speed describes that how fast or frequent (i.e. in clock speed) does it run while a specific task or code is being run. Faster the speed of processor the more it has the ability to execute the functions of the program respectively.
- ✓ Basically when we want to solve some mathematical type of calculations, if the floating – point calculations are better in a low performance processor and low floating point calculation in a high performance processor then the low performance processor would be much suitable for such mathematical calculations.
- RAM : RAM stands for Random Access Memory which is a working memory of a system.
- If we have more RAM in our system, our system becomes more versatile in its functions.
- In order to run standard protocols, we need at least 4KB or more than that as nowadays 1KB RAM is not accepted by the specific microcontrollers.
- Networking : The connecting of your respective device to the world via Internet of Things (IOT) in order to communicate or make your device operational is called as networking. For example, in order to have a remote access a mobile phone network is being used.
- Power consumption : Power consumption is defined as a trick to measure any device's power consumption under rapidly changing conditions. Power consumption depends on whether the processor is slow or fast. The fast processors consume more power than the slow processors.
- Physical Factor and Form Factor : The manufacturing and improvement in the specific types of chips i.e. silicon chips according to the connections it requires to surround the PCB. The size and its connectivity is set in such a way that it is convenient to use in future for any purpose.



**f. Compare Raspberry Pi and Arduino.**

**(5M)**

**Ans.**

Raspberry Pi	Arduino
It is called as an 'mini-computer' with an Raspbian OS. It has the potential to run many programs at an specific amount of time.	Arduino can run only any one specific program at a time as it is an part of the computer.
It cannot be powered by an battery	It is powered by using battery.
In order to make its sensors and other components work it needs install complex and difficult tasks like libraries and software.	It does not requires to install any sorts of libraries and software due to its simple interface
It is expensive but can be easily connected to the Internet via Ethernet Port or USB Wi-Fi dongles.	It is not much expensive but it requires an external hardware to connect to the internet and It needs to be properly addressed.
Consists of 4 USB ports to connect to different devices at same time.	It can be only connected to the computer as it only consists one USB port.

**3. Attempt any three of the following :**

**(15M)**

**a. Explain the sketch, iterate and explore process in prototyping.**

**(5M)**

**Ans.**

- Sketch : Sketch is defined as an process of exploring up of our ideas in the field of hardware and software in IOT. It is an similar process like how we note down the points or an set of ideas on an book with pen or pencil.
- ✓ Sketch is considered as one of the basic steps of prototyping as it assembles and helps in joining up of such small fractions of concepts before taking a huge step in an efficient and an convenient way.
- Iterate : Iterate is also an process of exploring up of an specific problem phase or space and approaching it with different ways that whether our specific ideas used are useful or not.
- Iterate process also plays an crucial role in prototyping as it identifies and gives us an direction that whether our process has an success rate or not.
- Explore : This process in prototyping is defined as an allowance to in order to explore our ideas and to gather all basic stuffs, points i.e. basic design concepts, so that we can take a

look in it before we invest our precious time as well as money in it for further development purpose.

- Like iterate the explore process also acts as an critical process as it helps us to identify and lookout towards the reality of the concept that whether it will work or not and become profitable.

**b. What are the features that need to be considered while choosing a laser cutter? (5M)**

**Ans.**

An laser cutter is an piece of kit which is used to cut or shape 2-dimensional planes and 3-dimensional planes(3D planes require much more complicated parts). In the field of IOT it is an computer oriented or controlled machine which consists mainly of an laser beam which helps in cutting up of different materials & objects in different places. It is called flexible as well as versatile in nature as it can be used in both small -scale as well as in big – scale industries to.

The features that should be considered while choosing an laser cutter are as follows :

- a. The type of the laser : Each type of laser is compatible or used for different purposes with its compatible range. CO2, diode and fiber lasers are some types in it. The differences in these lasers are that the fiber lasers are much sufficient or strong enough for metal cutting where as CO2 lasers cannot be used for cutting up of metals. The diode laser been low power consuming cutter can only do moderate jobs like engraving , carving , scripting etc.
- b. Cutting speed : The greater and higher the speed of the cutter the more are the chances for us to complete such projects in an limited time. In most of the cases the faster laser cutting might increases the productivity and thus it makes us much flexible to do such more projects in the same duration of time.
- c. The dimensional size of the bed : It works on an simple concept that an larger bed can cut an larger large item which can be costly due to its material's size and whereas if an smaller sized item is been cut it can be cut in several pieces in some time which saves our time and effort.
- d. The power of the laser : Thicker the material the more power it requires in order to cut it. Its range are as follows

Power(In Watts)	Thickness which it can cut through
40W	10 mm to 15 mm(max)
60W	25 mm to 27mm(max)

**c. Explain the use of repurposing/recycling in prototyping in IOT Devices. (5M)**

**Ans.**

Repurposing or recycling in IOT devices is done on an existing product by the team of an hardware team of engineers which can help in following prototypes :

- Re-built the design
- Re-building of the launch timeframe and budget in order to make a good amount of profit in the market
- The interfaces is increased with better connectivity management so that it can power up the monitor's inputs and outputs.
- In short or to conclude, the process of repurposing/recycling in IOT devices is done for the betterment of the system and to build its quality better.

**d. What is API ? What do you mean by mashing up API ? (5M)**

**Ans.**

An API, defines the path or from where the messages are send, i.e. whether it is send from client to the server or from the server to the client. This data which is send is mostly in an existing standard because then only the libraries for both server and the client would be available. Without the libraries it would become impossible to send messages from one side to another.

- Mashup API : Mashup API is an web service which follows the principles of usage of HTTP as an application protocol, which helps in providing of a good and simple communication platform for application.
- ✓ Example : Web application used in Google Maps to show the location of the most recent pictures or events related to any region.
- Mashup system can be used to combine user-interfaces , data and functionality.
- With respect to the IOT devices it is used as by direct intervention of the user via keyboards, touch enabled displays or mouse area, or any other possible input areas with respect to the environment.

**e. What are the legalities associated with scrapping ?**

**(5M)**

**Ans.**

- Screen-scrapping is defined as making use of an computer in order to navigate the UI elements in proper manner for them so that they can function properly in the browser.
- Scrapping is legal if we or any authority scrapes data for some public use or for some data research like for information of how to reach on an religious place and for school/college projects or activities respectively.
- Third parting of information of an personal authority or theft of his information for make huge sums of profit without his permission leads to

The legalities in scrapping are as follows :

- It is not much useful for some specific types of websites as it may break their terms and conditions which the website needs to follow.
- Other types of data is been protected by via many other security types like allowance to only authentic users in the data base in order to prevent the theft of data ,disclaimers, copyrights etc.
- If the specific unknown user to whom the service is been provided by the browser is misused or breached(As they provide the API) then they will exclude or discontinue to provide their services depending on our activity.

✓ Some of the laws regarding to it are as follows :

- DMCA – Violation of the Digital Millenium Copyright Act
- CFAA – Violation of Computer Fraud and Abuse Act
- Breach of Contract

**f. Explain HTML5 web socket.**

**(5M)**

**Ans.**

- HTML5 web socket is an bidirectional API which is used to directly talk to the TCP layer. This web socket was discovered in order to provide some similar type of capabilities like the HTTP layer and thus calling it Web Sockets.
- They work in modern browsers, servers and in other clients too.

- As they are bidirectional in nature they are used in Arduino platforms to as it consists of a full Unix socket handle where the client can freely write down its requests as well as read to the responses also.
- As it was versatile in nature changes to be made in software , modifications , cancellations and sending of the information was been made possible via this web socket.

**4. Attempt any three of the following.**

**(15M)**

**a. Define business model. Explain the different factors of definition.**

**(5M)**

Ans.

An business model describes that how an specific organization delivers , creates , creates , its value in social , cultural and in such many other contexts. It also helps in innovation and construction in some set of ideas. The different factors of an business model are as follows :

- A specific group of people(i.e. customers)
- The need and requirement of those customers.
- A specific task which the business needs to do in order to reach its goal.
- A profit making criterion in order to obtain profit at its maximum level possible.
- Proper and strict practices in the organization in order to succeed.
- To make such profits for an much greater amount of time.

**b. With the help of diagram explain business model canvas.**

**(5M)**

Ans. At first sight, it looks as though each box is simply an element in a form and the whole thing could be replaced by a nine-point checklist. However, the boxes are designed to be a good size for sticky notes, emphasizing that you can play with the ideas you have and move them around. Also the layout gives a meaning and context to each item. Let's look at the model, starting with the most obvious elements and then drilling down into details that we might neglect without this kind of template.

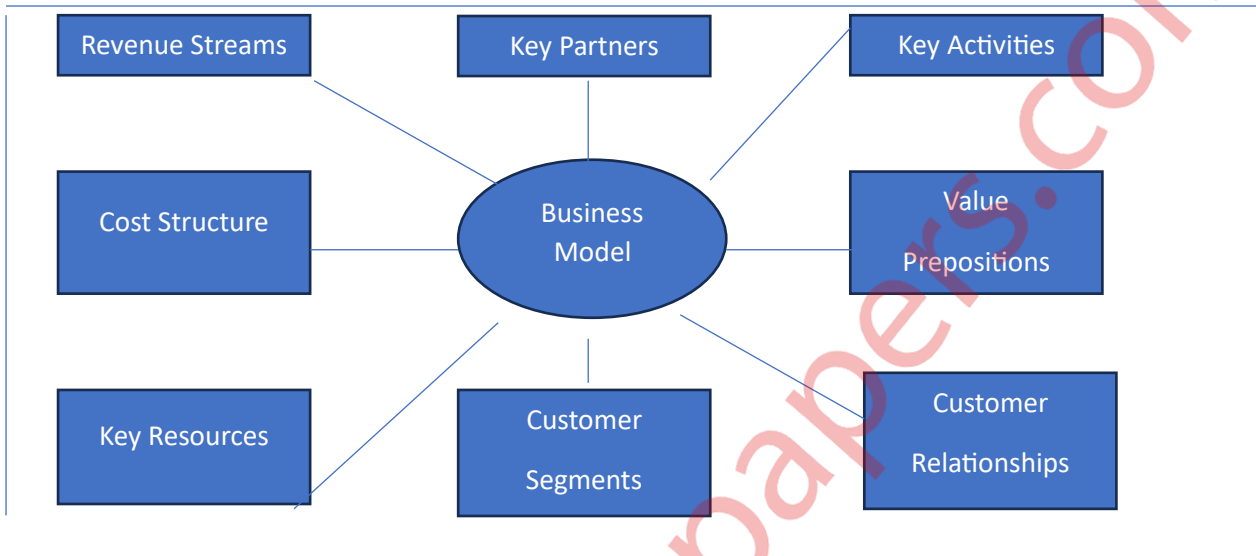


Fig 1.1 : An diagram of an business model canvas.

- a. Key Partners : Identify the company's key partners. This can consist of important supplies in your supply chain. How does the company works with these key partners and the motivation behind them.
- b. Key Activities : What specific key activities are necessary to deliver you value proportion? Its revenue streams, distribution channels or customer relationships
- c. Value Propositions : Identify the core value the company provides the customers. What exactly is the company trying to give to its customers? What problem is your company trying to solve? Is it satisfying for the customers or not
- d. Customer relationships : What type of relationship do we have with the customers ? How does it differ from the customer segments? Do you communicate frequently with your customers
- e. Customer segments : Identify who is your value proposition targets. Who are you creating value for? Who are your most important customers ?
- f. Key resources : What specific key resources or assets are necessary to deliver your value or position? Consider what resources your distribution channels and revenue system do need to preserved. Are they well integrated and cost efficient? Are they utilized efficiently?

g. Cost structure : Are they properly utilizing economies of scale? What proportion of costs are fixed and variable? Is your company focused on cost optimization value?

h. Revenue Streams : Identify the ways your value proposition generates money from your business ? Does your company have multiple methods of generating revenue ? What is pricing strategy for the products offered by your company? Does your company offers multiple forms of payment?

**c. Explain government funding for IOT projects.**

**(5M)**

Ans.

The main reasons why the government gives funds for IOT Projects are as follows:

a. For Economic Growth and Job Creation : It helps in promoting psmall-scale startups , small businesses and in research institutions. Thus, this things turns out as an job creating oppourtunity for IOT-related industries.

b. Infrastructure and Security : Government mostly invests in IOT projects to strengthen infrastructure such as communication systems, transportation and such more interconnected devices.

c. Advancement of Technology : Now days, the government finds a good scope and potential in IOT which can take India's technological activities and economical growth to the next level. Thus it creates an drive of creation of new technologies, products and services.

d. Department of Electronics and Information Technology : It started with the initial of Electronics Development Fund (EDF) whose main objective is to support the IOT device with its innovation , system development , upgradations , etc. This has been done in various schemes and programs.

e. Make in India : This is one the latest and greatest campain introduced by the government of India which fully focuses on to promote entrepreneurship. It icludes with funding support, tax incentives , and access to such centres with pecific locations so that they can carry on this intitative and motivate others to join this campain for an speedy growth in the field of IOT.

Example : According to the latest reports, India in the field of IOT might capture 20% of share in the global market in the next five years. The IOT market of India is projected to grow at CAGR more than 28.2% during the time period of 2018-2023.



**d. How can we make optimum use of RAM while writing code on embedded devices ?**

Ans.

- RAM provides the working memory for the system. If you have more RAM, you may be able to do more things or have more flexibility over your choice of coding algorithm.
- With respect to RAM very embedded system is unique, so the optimization techniques you apply will depend on the specific requirements and constraints. Some points while writing code on embedded devices are as follows :-
  - ✓ Choose right data data types as it will consume a bit less amount of memory and shows your data and presents it much accurately.
  - ✓ Analyze your tools in order to monitor your RAM's usage and identify the areas for improvement.
  - ✓ Reducing up of the code's size which directly helps in RAM's optimization, i.e. smaller the code the lesser resources it requires to run.
  - ✓ Avoid recursion as it uses RAM and uses it without any reason and becomes an reason for slow running of the RAM been used.
  - ✓ Methods like memory pooling, and efficient data structures are employed to make the best use of the limited resources.
  - ✓ Code for embedded devices should be written with portability in mind, allowing it to be easily adapted to different hardware platforms or configurations.

**e. With the help of examples compare stack and heap.**

**(5M)**

Ans.

1. Stack : New items which are added to the stack go to the top, and the items can be removed only in strict reverse order, so the first thing to be removed is the last item that was placed to the stack
  - This arrangement makes it easy for the processor to keep track of where things are and how much space is being used because it has to track only the top of the stack.
  - The stack is only useful for Items that aren't going to survive for long periods of time and Items that remain in constant use, from the beginning to the end of the program.

- As all the variables within a function are available only to code inside it, when you reach the end of that function, all those parameters and variables are ready to be discarded. So, the stack gets unwound back to the same size it was just before control passed to the function.

- Example :

//global variables

```

Function A {
    Variable A1;
    Variable A2;
    Call C();
}
Function B {
    Variable B1;
    Variable B2;
    Variable B3;
    Call C();
    Call D();
}
function C{
    variable C1;
}
function D {
    variable D1;
    variable D2;
    call A();
}

```

2. Heap: Heap allows the allocation of chunks of memory at any time.

The heap is a bit like the seating area of a train where you fill up the seats strictly from the front and have to keep everyone who is travelling as a group in consecutive seats.

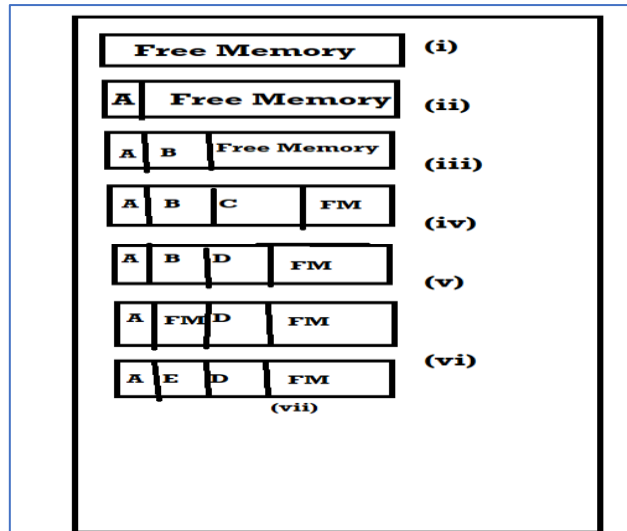
To begin, all the seats are empty. As groups of people arrive, you direct them to the next available block of seats.

Example:

```

create object A (size 20 bytes)
create object B (size 35 bytes)
create object C (size 50 bytes)
// do some work that needs object C
delete object C
create object D (size 18 bytes)
// do more work with objects B and D
delete object B
create object E (size 22 bytes)

```



- (a) At the start of execution, the heap will be empty (i).  
 (b) Object A is added to the heap (ii), taking up 20 bytes of space.  
 (c) Object B is added to the heap (iii), consuming a further 35 bytes straight after the space for object A.  
 (d) Object C is added to the heap (iv), adding 50 bytes to the heap right after object B.  
 (e) Object C is no longer needed and is deleted, releasing the space it consumed on the heap and taking us back to heap (iii).  
 (f) Object D is created and takes up 18 bytes of the space just vacated by object C (v).  
 (g) Now object B is finished with and deleted. As other code might be relying on the position of object D, we can't move it, so there's now a free space between objects A and D (vi).  
 (h) Object E is created. It requires 22 bytes of space, which means it will fit in the hole left by object B (vii)

**f. Explain in detail the process of debugging the code for embedded devices. (5M)**

Ans.

Debugging code for embedded devices is a crucial process to identify and resolve software issues and errors in the embedded system. Debugging in the embedded context can be more challenging compared to traditional software due to limited resources, real-time constraints, and the lack of a standard user interface. Here's a step-by-step explanation of the process of debugging code for embedded devices:

**Step 1: Set Up a Debugging Environment :** To begin debugging, you need a development environment specifically tailored for embedded systems. This environment typically includes an Integrated Development Environment (IDE) that supports debugging features

**Step 2: Use Logging and Print Statements :** Embedded devices might not have a display screen or a standard user interface, making traditional debugging challenging. A common practice in embedded systems is to use logging and print statements to output diagnostic messages to a serial port or a debugging interface. These messages provide insight into the program flow, variable values, and important events, helping developers identify potential issues.

Step 3: Use Debugging Tools :Modern debugging tools designed for embedded systems offer valuable features to aid the debugging process. These tools include Hardware Debuggers/Emulators Real - Time Debugging/Emulators and Code Profilers

Step 4: Reproduce the Issue : To effectively debug, it's crucial to reproduce the issue or error consistently. This might involve setting specific conditions or using test scenarios that trigger the problem reliably. Reproducibility is essential for isolating the cause of the issue.

Step 5: Analyse the Code : Once the issue is reproduced, developers use the debugging tools to step through the code, inspect variable values, and examine program flow. By analysing the code execution in the context of the specific issue, developers can identify where the problem occurs and understand why it happens.

Step 6: Fix the Issue : With a clear understanding of the problem, developers can now fix the issue. This might involve modifying the code, adjusting configurations, or changing hardware settings.

Step 7: Test the Fix After making the changes, it's essential to thoroughly test the fix to ensure it resolves the issue without introducing new problems.

Debugging embedded code requires a combination of skills, tools, and attention to detail. It involves a systematic approach to identify and fix issues to ensure the embedded device operates reliably and as intended.

**5. Attempt any three of the following :** **(15M)**

**a. How are printed circuit board are designed ? Explain.** **(5M)**

Ans.

Designing a printed circuit board (PCB) involves several steps and considerations to create a functional and reliable electronic circuit. Here's an overview of the typical process for designing a PCB:

1. Schematic Design : The first step is to create a schematic diagram of the electronic circuit. A schematic is a graphical representation of the components in the circuit and their interconnections. It helps the designer visualize the circuit's functionality and relationships between components.
2. Component Selection : Based on the schematic, appropriate electronic components are selected for the design. Factors like performance, availability, cost, and size are considered during component selection.
3. PCB Layout: Using PCB design software, the designer lays out the components on the board, deciding their positions and orientations. Components are placed to minimize interference, optimize signal integrity, and facilitate efficient routing.

4. Routing: Routing involves connecting the components' pins with copper traces to establish electrical connections according to the schematic. The goal is to create a low-impedance and efficient path for current flow while adhering to design rules and minimizing electromagnetic interference.

5. Power and Ground Planes: To ensure stable power distribution and minimize noise, power and ground planes are added to the PCB design. These planes provide large areas of copper for power and ground connections, reducing impedance and enhancing signal integrity.

6. Signal Integrity Analysis: Signal integrity analysis is performed to identify potential issues that could affect signal quality, such as signal reflections, crosstalk, and impedance mismatches. The designer may use simulation tools to validate the design's high-frequency behaviour.

**b. Write a short note on mass – producing the case and other fixtures. (5M)**

Ans.

Mass-producing cases and other fixtures in IoT refers to the large-scale manufacturing of the physical enclosures and supporting structures used to house IoT devices, sensors, and related components. These cases and fixtures play a crucial role in protecting the internal electronics, providing environmental resistance, and facilitating seamless integration of IoT devices into various applications.

1. 3D Printing: Additive manufacturing, or 3D printing, is gaining popularity in the production of cases and fixtures, especially for prototyping or small-batch production. 3D printing allows for rapid design iterations and customization.

2. Automation and Assembly: Mass production of cases and fixtures often involves automated assembly processes. Robots and machines handle repetitive tasks, such as fastening components, ensuring consistency and efficiency.

3. Quality Control: Strict quality control measures are essential to maintain the desired level of precision and consistency in mass production. Quality checks are performed at various stages to identify defects and ensure that the final products meet the specified standards.

4. Scalability: Mass production processes are designed to be scalable, enabling manufacturers to produce large quantities of cases and fixtures efficiently and cost-effectively as demand increases.

5. Customization and Branding: Mass production allows for customization options, such as colour variations, branding, and labelling, to align the cases and fixtures with specific product lines or customer requirements.

6. Environmental Compliance: Manufacturers must adhere to environmental regulations and sustainability considerations while mass-producing cases and fixtures. Responsible material sourcing and recycling initiatives are increasingly important in the IOT industry.

**c. What is the important of certification ? Why it is required ?**

Ans.

- One of the less obvious sides of creating an Internet of Things product is the issue of certification. If you forget to make the PCB or write only half of the software for your device, it will be pretty obvious that things aren't finished when it doesn't work as intended.
- Fail to meet the relevant certification or regulations, and your product will be similarly incomplete—but you might not realise that until you send it to a distributor, or worse still, after it is already on sale.
- For the main part, these regulations are there for good reason. They make the products you use day in, day out, safer for you to use; make sure that they work properly with complementary products from other suppliers; and ensure that one product doesn't emit lots of unwanted electromagnetic radiation and interfere with the correct operation of other devices nearby.
- The regulations that your device needs to pass vary depending on its exact functionality, target market (consumer, industrial, and so on), and the countries in which you expect to sell it.
- Negotiating through all this isn't for the faint of heart, and the best approach is to work with a local testing facility. They not only are able to perform the tests for you but also are able to advise on which sets of regulations your device falls under and how they vary from country to country.

**d. Explain privacy with respect to IOT devices in detail.**

**(5M)**

Ans.

To address privacy concerns related to IoT devices, various stakeholders must take proactive steps:

- Manufacturers should prioritize privacy by design, incorporating robust security features and data protection measures into their devices from the outset.
- Privacy policies and terms of service must be transparent, clear, and easily accessible to users. They should explain how data is collected, used, shared, and stored.
- Users should be given meaningful control over their data, including options to delete, modify, or limit data sharing.
- Governments and regulatory bodies should establish comprehensive privacy laws and standards specific to IoT devices.
- Continuous monitoring, vulnerability assessments, and regular software updates can help improve the security and privacy of IoT devices.
- User education and awareness campaigns are essential to help individuals understand the risks and best practices for safeguarding their privacy in the IoT ecosystem.

**e. Discuss the environmental issues associated with IOT devices.**

**(5M)**

Ans.

Definition : The internet, which is considered as one of the vast open publishing source in environment does not provide privacy up to 100% and with such more issues. This is known as environmental issues in IOT

- Denial of Service Attack(DOS) : Sometimes the server is unable to detect multiple requests given by an specific user due to which it gets confused and gets stuck in the cycle due to which termination and leakage of data occurs.
- Information manipulation : Information is an basic primitive thing in IOT where if this information gets manipulated then the performance of our system also gets manipulated and thus results in giving less performance as compared to the earlier performance it gave.



- Information Disclosure : Our sensors in IOT devices are mainly responsible for taking up and sharing up of data/information to cloud storage, local database or on temporary basis in our devices. So attackers try to locate the position or place there amongst where is the data been stored. Then as soon as the attacker recognizes the location of the data they can black mail us with our private data in exchange of an sum of money.

**f. What is cautious optimism ? Explain**

**(5M)**

Ans.

Cautious optimism is an context which refers to maintaining an careful and realistic approach so that they can be implemented with a proper amount risks in IOT.

The key points of cautious optimism are as follows :

- Challenges and Risks : Security and privacy concerns are amongst the most critical issues, as a vast network of interconnected devices can be vulnerable to cyber – attacks.
- Monitoring and Continuous Adaptation : As IOT requires ongoing monitoring and adaptation. It needs to be updated with latest security packages and patches as an privacy concern.
- Challenges and Risks : As discussed earlier privacy issues are one of the major concerns in IOT which include vast number of interconnected devices which can be breached easily due to its vast connections. If these problems are not stopped then the system can cause such unforeseen problems and operational issues.

Overall, cautious optimism encourages embracing the possibilities of IoT while taking prudent steps to address potential challenges, mitigate risks, and ensure the technology's responsible deployment for the benefit of society.