CS3691 EMBEDDED SYSTEMS AND IOT

QUESTION BANK

Unit – I 8 bit Embedded Processor

PART-A

1. What is microcontroller?
    A single IC which contains the microprocessor with integrated peripherals like memory, serial ports, parallel ports, timer/counter, interrupt controller, data acquisition interfaces like ADC, DAC is called Microcontroller.

CPU	ROM	RAM
Timers	I/O Ports	Serial Port

Internal blocks of Microcontroller

2. Compare Microprocessor and Microcontroller.

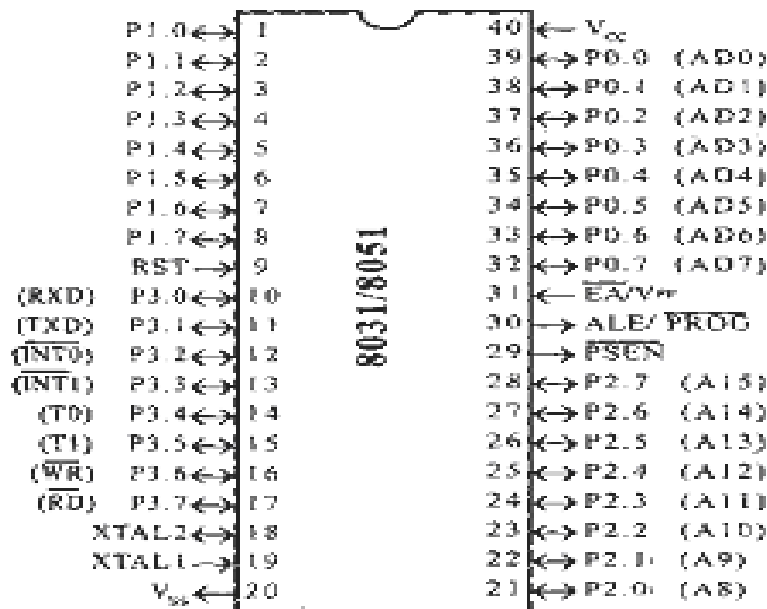| S.No	Microprocessor	Microcontroller
1	The functional blocks of a microprocessor are <u>CPU</u> which contains ALU, few registers, timing and control unit.	The functional blocks of microcontroller includes a <u>CPU, Timers, Parallel I/O ports, Serial I/O port, and internal RAM and ROM memory</u>. Some microcontrollers have even ADC and/or DAC on-chip.
2	µP operates on byte/word data. Hence, it has <u>LESS</u> <u>bit manipulation instructions</u>.	µC operates on bit/byte data. Hence, it has <u>MORE</u> <u>bit manipulation instructions</u>.

3	A μP based system requires large no. of peripherals and hence, its <u>PCB will be LARGE.</u>	A μC based system can be formed without using additional peripheral ICs. Hence, its <u>PCB will be SMALL</u>.
4	A μP based system is used for <u>General purpose computing</u> and <u>Data processing</u> applications.	A μC based system is used for <u>application specific dedicated systems</u>. Eg. Washing machines, Mobile phones, Microwave oven, Elevators, etc.
5	It involves movement of code & data <u>between μP and external</u> <u>memory.</u> Hence <u>MORE instructions</u> are made available for data transfer with external memory.	It involves movement of code & data between <u>internal memory &</u> <u>CPU inside μC</u>. Hence <u>LESS instructions</u> are available for data transfer with external memory.

3. List the features of 8051.

<u>Features of 8051 are:</u>
- Data size is 8-bit
- Address lines is 16-bit ($\because$Memory capacity $= 2^{16} = 64$ KB)
- Memory capacity of On-chip RAM is 128 Bytes
- Memory capacity of On-chip ROM is 4 KB
- Total program memory space is 64KB
- Total data memory space is 64KB
- On-chip Timers - 2 x 16-bit each
- 4 x 8-bit I/O Ports
- One full duplex Serial port (TxD & RxD)
- Six Interrupt sources (inclusive of two H/w interrupts – INT0, INT1)
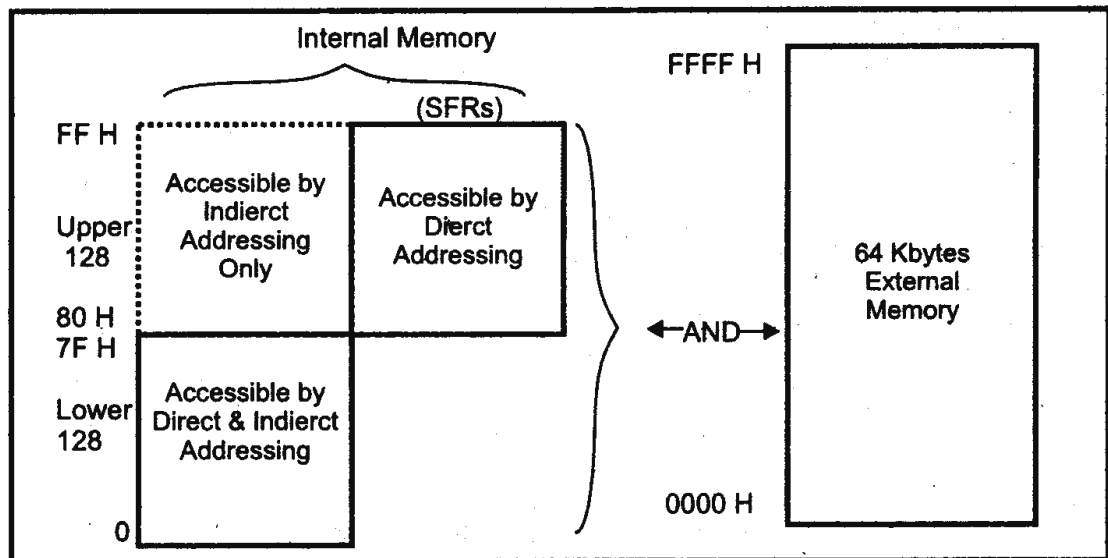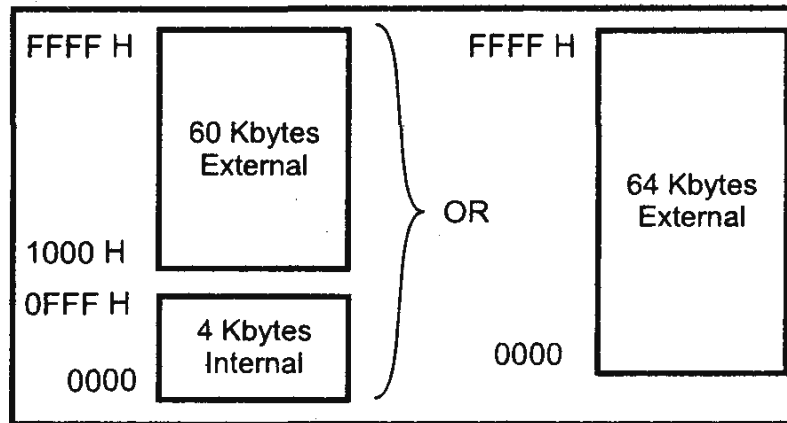
4. Draw the Pin diagram of 8051.

```
            P1.0 <-> | 1              40 | <- Vcc
            P1.1 <-> | 2              39 | <-> P0.0  (AD0)
            P1.2 <-> | 3              38 | <-> P0.1  (AD1)
            P1.3 <-> | 4              37 | <-> P0.2  (AD2)
            P1.4 <-> | 5              36 | <-> P0.3  (AD3)
            P1.5 <-> | 6              35 | <-> P0.4  (AD4)
            P1.6 <-> | 7              34 | <-> P0.5  (AD5)
            P1.7 <-> | 8              33 | <-> P0.6  (AD6)
            RST  --> | 9     8       32 | <-> P0.7  (AD7)
      (RXD) P3.0 <-> | 10    0       31 | <- EA/Vpp
      (TXD) P3.1 <-> | 11    3       30 | --> ALE/PROG
     (INT0) P3.2 <-> | 12    1       29 | --> PSEN
     (INT1) P3.3 <-> | 13    /       28 | <-> P2.7  (A15)
       (T0) P3.4 <-> | 14    8       27 | <-> P2.6  (A14)
       (T1) P3.5 <-> | 15    0       26 | <-> P2.5  (A13)
       (WR) P3.6 <-> | 16    5       25 | <-> P2.4  (A12)
       (RD) P3.7 <-> | 17    1       24 | <-> P2.3  (A11)
           XTAL2 <-> | 18              23 | <-> P2.2  (A10)
           XTAL1 --> | 19              22 | <-> P2.1  (A9)
            Vss  <-- | 20              21 | <-> P2.0  (A8)
```

5. List the alternate functions of Port3 in 8051.

Port pins	Alternate signal	Description
P0.7 – P0.0	AD7 – AD0	Multiplexed low byte address/data.
P2.7 – P2.0	A15 – A8	High byte address
P3.7	RD	External memory read control signal
P3.6	WR	External memory write control signal
P3.5	T1	External input to timer 1
P3.4	T0	External input to timer 0
P3.3	INT1	External interrupt 1
P3.2	INT0	External interrupt 0
P3.1	TxD	Serial data output
P3.0	RxD	Serial data input

—
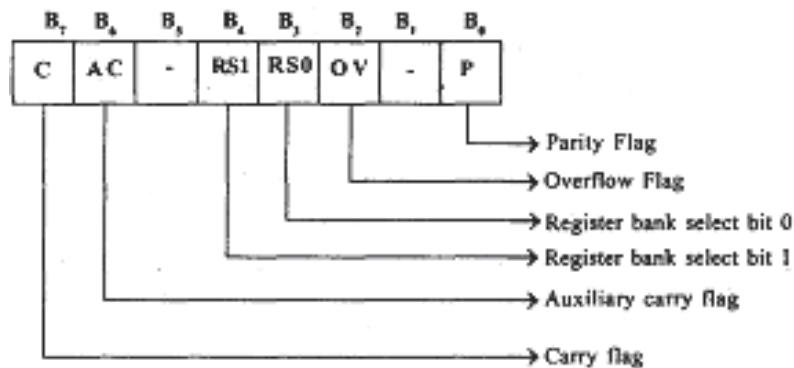
6. What is the significance of EA pin?

   EA stands for External Access. By applying LOW to this pin, makes 8051 to omit internal 4KB on-chip ROM and use only external memory for program storage. By applying HIGH to this pin, makes 8051 to use internal 4KB on- chip ROM along with external memory for program storage.

7. Draw the data memory organization in 8051& Draw the program memory organization in 8051

FFFF H

60 Kbytes
External

1000 H

0FFF H

4 Kbytes
Internal

0000

OR

FFFF H

64 Kbytes
External

0000

Internal Memory

(SFRs)

FF H

Accessible by
Indierct
Addressing
Only

Accessible by
Dierct
Addressing

Upper
128

80 H

7F H

Accessible by
Direct & Indierct
Addressing

Lower
128

0

AND

FFFF H

64 Kbytes
External
Memory

0000 H

8. What is Program Status Word?

PSW is another name for Flag register. It holds various flags, which are useful for the programmer to test the condition of the result and make decisions. The format of PSW of 8051 microcontroller is shown in fig below

B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
C	AC	-	RS1	RS0	OV	-	P

- → Parity Flag
- → Overflow Flag
- → Register bank select bit 0
- → Register bank select bit 1
- → Auxiliary carry flag
- → Carry flag

Program Status Word (Flag Register)

The PSW consists of four math flags and two register bank select bits. The math flags are Carry, Auxiliary Carry, and Overflow and Parity flags.

9. State the function of RS1 and RS0 bits in the flag register of 8051.

RS1 , RS0 – Register bank select bits

RS1	RS0	Bank Selection
0	0	Bank 0
0	1	Bank 1
1	0	Bank 2
1	1	Bank 3

The register bank select bits RS1 and RS0 are used to select any one of the four register banks of the internal RAM. At any instant, the microcontroller can work with (or access) only one register bank, which is selected by these bits List the various registers used in 8051.

The registers used in 8051 are Accumulator (A), B-Register, Stack Pointer (SP), Program counter (PC), Flag Register (PSW), Data Pointer (DPTR), Timer Registers (TH0, TL0, TH1, TL1) and other SFRs

10. Define Stack Pointer.

The stack pointer is 8 bit register which points the stack top. It is incremented before data is stored during PUSH and CALL instructions. After reset of the processor, the SP is 07H.

11. Define Program Counter.

Program counter is a 16 bit register which holds the 16-bit address of the program instruction currently executed by the processor. PC is automatically incremented after every fetch of instruction byte from the memory for its execution.

12. What is the significance of DPTR?

DPTR is a 16-bit register which is used as Data Pointer for external data memory. It holds the 16-bit address of the data stored in the external data memory.

This can also be used as two numbers of 8-bit data pointers namely DPH and DPL. The 8-bit data pointers are used for accessing internal RAM and SFR. The contents of data pointer are programmable using instructions.

13. List the Special Function Registers (SFRs) :

In the 8051 microcontroller registers A, B, PSW and DPTR are part of the group of registers commonly referred to as special function registers (SFR).The 21 internal registers which forms SFR are listed in table below. Each register of SFR has one byte address (between 80H and FFH). Some of the registers are both byte and bit addressable (the registers whose address ends with 0H or 8H are bit addressable). These registers can be accessed either by their names or by their 8-bit address in direct addressing mode.

Special Function Register		Byte Address in hexa
Symbol	Name	
*A or ACC	A-register or Accumulator	E0
*B	B-register	F0
DPH	Data pointer higher order register	83
DPL	Data pointer lower order register	82
*IE	Interrupt enable register	A8
*IP	Interrupt priority register	B8
*P0	Port-0	80
*P1	Port-1	90
*P2	Port-2	A0
*P3	Port-3	B0
PCON	Power control register	87
*PSW	Program Status Word	D0
*SCON	Serial port control register	98
SBUF	Serial port data buffer	99
SP	Stack Pointer	81
TMOD	Timer/Counter mode control register	89
*TCON	Timer/Counter control register	88
TL0	Timer-0 low order register	8A
TH0	Timer-0 high order register	8C
TLI	Timer-1 low order register	8B
THI	Timer-1 high order register	8D

* - *Bitwise Accessible*

14. Draw the structure of a pin in port 1.
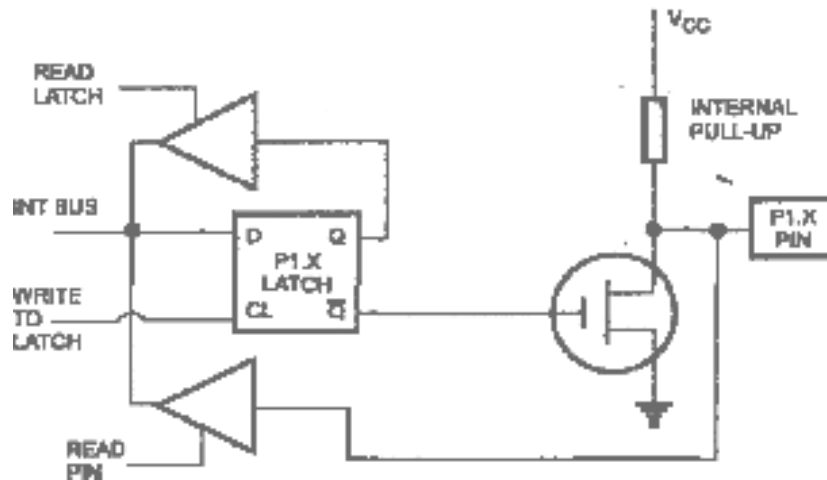
15. Why all pins of a port is loaded with value "FF" before using it?

All ports of 8051 are configured by default as Output port.

Hence, to make it configured as Input Port, all pins of a port are loaded with value "FF" i.e., 1111 1111.

16. Justify why the crystal oscillator frequency in 8051 is chosen as 11.0592Mhz.

When an 8051 microcontroller based system is connected to an external serial communication device, the speed of the data transfer should be in standard baud rates such as 4800, 9600, etc.

Only XTAL (Crystal Oscillator) of 11.0592 MHz can provide such standard baud rates, after down scaling down by 12, 32 at UART and by a factor set in timer register TH1.

17. Draw the format of TMOD register of 8051.

TMOD: TIMER/COUNTER MODE CONTROL REGISTER. NOT BIT ADDRESSABLE.

GATE	C/T	M1	M0	GATE	C/T	M1	M0

Timer 1   Timer 0

GATE — When GATE = 1 (hardware control).
When GATE = 0, (software control).

C/T — Timer or Counter selector. Cleared for Timer operation. Set for Counter operation

M1 — Mode selector bit.

M0 — Mode selector bit.

18. List the modes of Timer in 8051.

   The modes of timer in 8051 are chosen with the help of two bits, viz., M0 & M1 in TMOD register. The different modes of timer are as follows.

M1	M0	Mode	Description of Timer mode
0	0	0	13 bit timer
0	1	1	16-bit timer
1	0	2	8-bit timer with auto reload
1	1	3	Split timer

19. What is the significance of C/T bit in TMOD register of 8051?

   The C/T bit in the TMOD register is a selector bit for the type of operation we want to perform in the timer register.

   HIGH in that bit indicates Counter operation and LOW in that bit indicates Timer operation.

0	Timer operation
1	Counter operation

20. What is the significance of TRx bit in TCON register of 8051?

   TRx bit in the TCON register is used to Start / Stop the timer register for both timer and counter operation, by setting that bit with value '1' or '0'.

21. Draw the format of TCON register of 8051.

TCON: TIMER/COUNTER CONTROL REGISTER. BIT ADDRESSABLE.

TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0

TF1	TCON.7	Timer 1 overflow flag. Set by hardware when the Timer/Counter 1 overflows.
TR1	TCON.6	Timer 1 run control bit. Set/cleared by software to turn Timer/Counter 1 ON/OFF.
TF0	TCON.5	Timer 0 overflow flag. Set by hardware when the Timer/Counter 0 overflows.
TR0	TCON.4	Timer 0 run control bit. Set/cleared by software to turn Timer/Counter 0 ON/OFF.
IE1	TCON.3	External Interrupt 1 edge flag. Set by hardware when External Interrupt edge is detected.
IT1	TCON.2	Interrupt 1 type control bit. to specify falling edge/low level triggered Interrupt.
IE0	TCON.1	External Interrupt 0 edge flag. Set by hardware when External Interrupt edge detected.
IT0	TCON.0	Interrupt 0 type control bit. to specify falling edge/low level triggered Interrupt.

22. Explain the Timer operation of 8051.

In this mode, the timer register is used to generate the time delay using the clock signal applied to the processor.

An initial count is loaded in the timer register. When the timer is started, the timer register content gets incremented after every machine cycle. When the timer register crosses (i.e., overflows) the count FFFFH and goes to 0000H, the timer overflow flag in TCON register becomes set.

Hence, by loading appropriate value in the timer register, a specific time delay can be generated using timer. One machine cycle consists of 12 clock signal periods and the delay is equal to count value loaded * time period of one machine cycle.
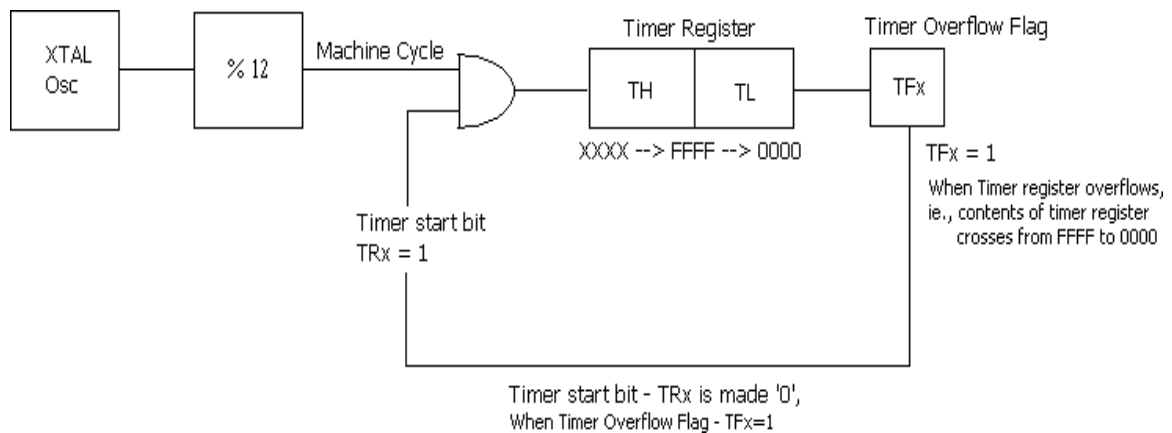
23. Explain the Counter operation of 8051.
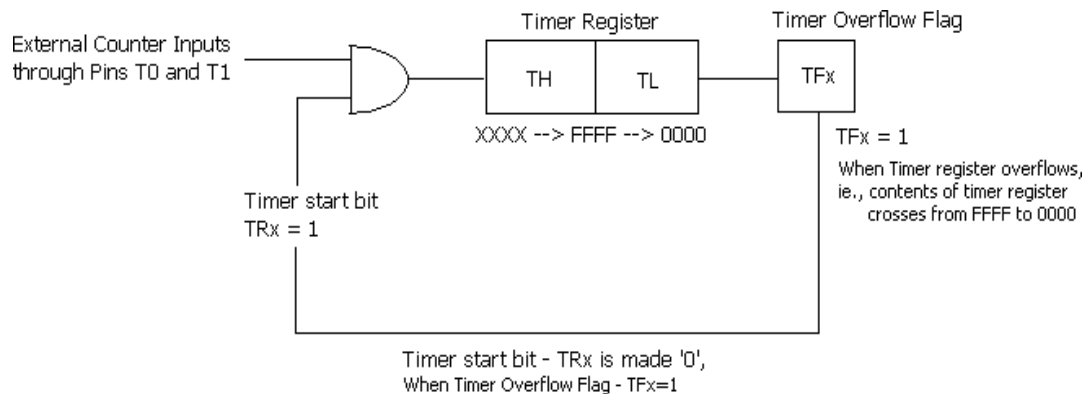
In this mode, the timer register is used to count the external events with the help of external pulses received through the counter input (t0 & T1).

An initial count is loaded in the timer register. When the timer is started, the timer register content gets incremented after every external pulse. When the timer register crosses (i.e., overflows) the count FFFFH and goes to 0000H, the timer overflow flag in TCON register becomes set. Hence, by loading appropriate value in the timer register, counting of external event can be performed using timer.

24. List the Interrupt sources in 8051.

The Six Interrupt sources in 8051 are

- RESET
- INT0
- INT1
- TF0
- TF1
- SPI (TI/RI)

25. What is the default priority of the interrupts in 8051

PRIORITY LEVEL:

From high to low, interrupt sources are listed below:

IE0	Highest
TF0	
IE1	↓
TF1	
RI or TI	Lowest

26. Draw the format of IE register.

IE: INTERRUPT ENABLE REGISTER. BIT ADDRESSABLE.

If the bit is 0, the corresponding interrupt is disabled. If the bit is 1, the corresponding interrupt is enabled.

EA	–	–	ES	ET1	EX1	ET0	EX0

EA	IE.7	Disables all interrupts. If EA = 0, no interrupt will be acknowledged. If EA = 1, each interrupt source i individually enabled or disabled by setting or clearing its enable bit.
—	IE.6	Not implemented, reserved for future use.*
—	IE.5	Not implemented, reserved for future use.*
ES	IE.4	Enable or disable the serial port interrupt.
ET1	IE.3	Enable or disable the Timer 1 overflow interrupt.
EX1	IE.2	Enable or disable External Interrupt 1.
ET0	IE.1	Enable or disable the Timer 0 overflow interrupt.
EX0	IE.0	Enable or disable External Interrupt 0.

*   User software should not write 1s to reserved bits. These bits may be used in future 80C51 products to invoke new features.

27. Draw the format of IP register.

IP: INTERRUPT PRIORITY REGISTER. BIT ADDRESSABLE.

If the bit is 0, the corresponding interrupt has a lower priority and if the bit is 1 the corresponding interrupt has a higher priority.

–	–	–	PS	PT1	PX1	PT0	PX0

–	IP.7	Not implemented, reserved for future use.*
–	IP.6	Not implemented, reserved for future use.*
–	IP.5	Not implemented, reserved for future use.*
PS	IP.4	Defines the Serial Port interrupt priority level.
PT1	IP.3	Defines the Timer 1 interrupt priority level.
PX1	IP.2	Defines External Interrupt 1 priority level.
PT0	IP.1	Defines the Timer 0 interrupt priority level.
PX0	IP.0	Defines the External Interrupt 0 priority level.

*   User software should not write 1s to reserved bits. These bits may be used in future 80C51 products to invoke new features.

28. What are the types of serial communication?

The serial communication can be,

- Synchronous (continuous)
- Iso-Synchronous (with regular time intervals)
- Asynchronous (with irregular time intervals)

29. Draw the Frame format of Asynchronous serial communication.

The asynchronous data frame starts with a Start bit (0), followed by data byte (LSB first and MSB last) and a Stop bit (1).
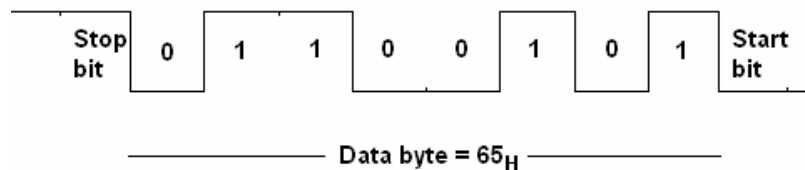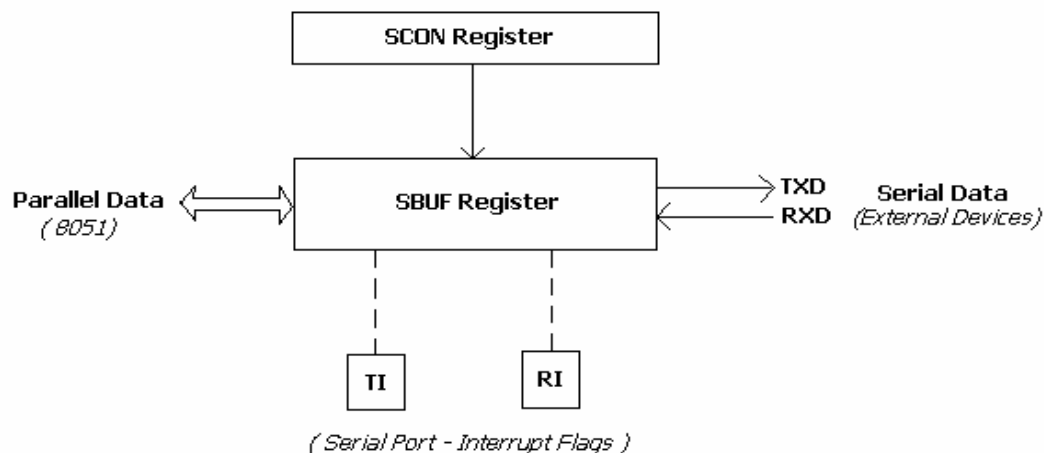

30. Define Baud rate.
Baud Rate: It is the speed of serial data transfer, expressed in bits/sec. The standard baud rates are

110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200…

31. Explain the Serial Communication in 8051.

SERIAL COMMUNICATION IN 8051

The serial communication in 8051 is carried out using two SFR registers,

1. SCON
2. SBUF

SCON register is used to control and set the mode of serial communication.

SBUF register is used to dump the data before serial transmission and hold data after serial reception.

33. Draw the format of SCON register of 8051.

SCON: SERIAL PORT CONTROL REGISTER. BIT ADDRESSABLE.

SM0	SM1	SM2	REN	TB8	RB8	TI	RI

SM0	SCON.7	Serial Port mode specifier.
SM1	SCON.6	Serial Port mode specifier.
SM2	SCON.5	Enables the multiprocessor communication feature in modes 2 & 3.
REN	SCON.4	Set/Cleared by software to Enable/Disable reception.
TB8	SCON.3	The 9th bit that will be transmitted in modes 2 & 3. Set/Cleared by software.
RB8	SCON.2	In modes 2 & 3, is the 9th data bit that was received.
TI	SCON.1	Transmit interrupt flag.
RI	SCON.0	Receive interrupt flag.

34. Draw the format of PCON register in 8051

PCON: POWER CONTROL REGISTER. NOT BIT ADDRESSABLE.

SMOD	–	–	–	GF1	GF0	PD	IDL

SMOD	Double baud rate bit. If Timer 1 is used to generate baud rate and SMOD = 1, the baud rate is doubled when the Serial Port is used in modes 1, 2, or 3.
–	reserved for future use.*
–	reserved for future use.*
–	reserved for future use.*
GF1	General purpose flag bit.
GF0	General purpose flag bit.
PD	Power Down Bit. Setting this bit activates Power Down operation in the 80C51.
IDL	Idle mode bit. Setting this bit activates Idle Mode operation in the 80C51.

If 1s are written to PD and IDL at the same time, PD takes precedence.

35. What are the modes of asynchronous serial communication in 8051?

The mode of serial communication is decided by two bits SM0 & SM1 in SCON register. The details of the various modes are described in the table given below.

SM0, SM1	Mode	Serial Mode Description	Baud rate
00	0	8-bit Shift register	F_{Osc} / 12
01	1	8-bit UART	Variable
10	2	9-bit UART	F_{Osc} / 32 or 64
11	3	9-bit UART	Variable

Note: Out of all modes, Mode-1 is commonly used mode for serial data transfer in 8051.

36. Explain how baud rate is calculated for serial data transfer in mode 1?

General Expression for setting baud rates using TH1 register is givenbelow.

$$Baud\ Rate = \frac{K \times Osc\ Freq}{32 \times 12 \times [256 - (TH1)]}$$

| If SMOD = 0, then K = 1.
| If SMOD = 1, then K = 2
| (SMOD is in the PCON register).

37. Explain how baud rate is set in 8051 for serial data transfer using timer register?
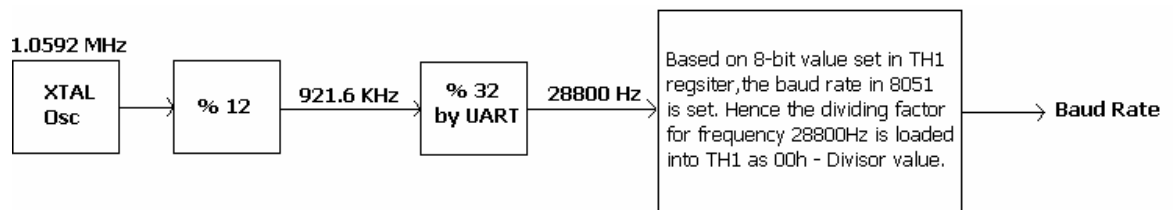
Based on the baud rate needed for serial communication, the timer register TH1 is loaded with values as per the following calculation.

External XTAL oscillator frequency is chosen as 11.0592 MHz is to make the UART output as 28800 Hz, so that the various baud rates are obtained by dividing this frequency 28800 Hz with different values set in TH1 register.

Example

For baud rate of 9600; Divisor needed is 03_H (because 28800 / 03 = 9600)
∴Value loaded in TH1 register = $00_H - 03_H = FD_H$

The sample values loaded in TH1 register for different baud rates.

Baud rate	Frequency Divisor	Hex value loaded in TH1 register
9600	03	FD
4800	06	FA
2400	12	EE
1200	24	DC

38. What are addressing modes?

The various ways of accessing data are called addressing modes.

There are six addressing modes in 8051.They are
□ Direct addressing
□ Indirect addressing
□ Register instruction
□ Registerspecific (register implicit)
□ Immediate mode
□ Indexed addressing

PART B & C

1. With neat sketch explain the architecture of 8051 microcontroller.

(May- 06,08,09,11,12,13,15,17,18,19,22)

2. Explain the different addressing modes in 8051 microcontroller with an example. (May 11,13,14,16 dec 7,8)

3. With the necessary diagram of control word format, explain the various operating modes of timer in 8051 microcontroller (may 8,9,12,13,17 Dec 11,13)

4. Draw the Pin Diagram of 8051 and explain the function of various signals.

(dec 11,18 may 11,16,17)

5. Discuss the various Instructions set available in 8051 microcontroller.

(May 11,13,14)

6. Explain the memory organization of 8051 microcontroller

7. Discuss about the Timers/counters in 8051 with suitable examples.

(may 1011,14,17 Dec 11,15)

8. Describe the different modes of operation of timers in 8051

(Dec 11,14,17)

Unit 1

Part B & C

1. **Describe The Architecture Of 8051 With Neat Diagram.**
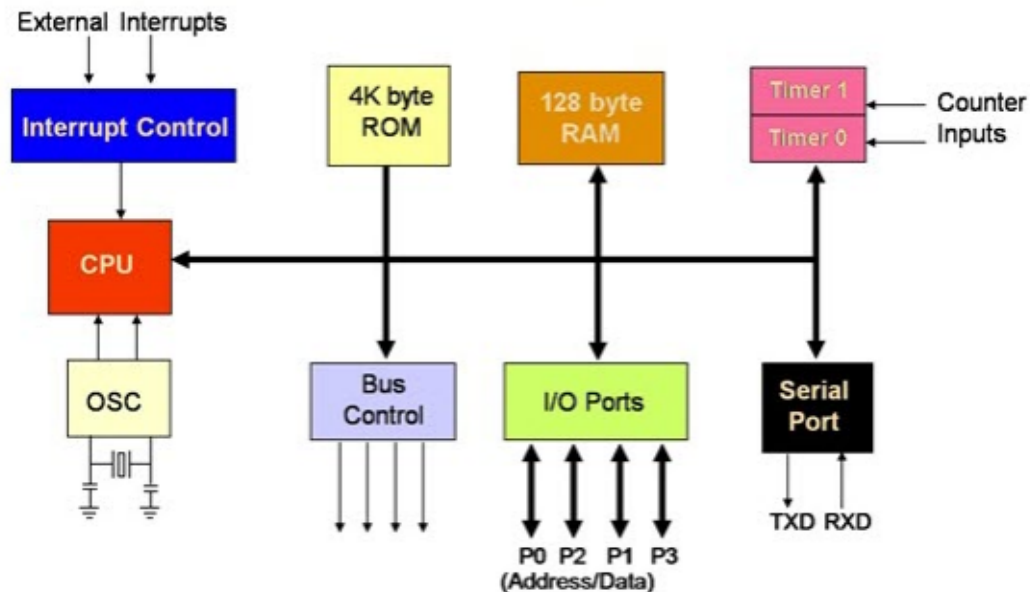
Basic components present internally inside 8051 Microcontroller architecture are:

CPU (Central Processing Unit):

- CPU act as a mind of any processing machine.
- It synchronizes and manages all processes that are carried out in microcontroller.
- User has no power to control the functioning of CPU.

Interrupts:

- Interrupts is a sub-routine call that given by the microcontroller
- when some other program with high priority is request for acquiring the system buses the n interrupts occur in current running program.

- Timer 0 overflow interrupt - TF0

- Timer 1 overflow interrupt - TF1

- External hardware interrupt - INT0

- External hardware interrupt - INT1

- Serial communication interrupt - RI/TI

Memory: For operation Micro-controller required a program. This program guides the microcontroller to perform the specific tasks.

In microcontroller 8051 there is code or program memory of 4 KB that is it has 4 KB ROM and it also comprise of data memory (RAM) of 128 bytes.

Bus : Bus is a group of wires which uses as a communication canal or acts as means of data transfer

Oscillator: As the microcontroller is digital circuit therefore it needs timer for their operation.

To perform timer operation inside microcontroller it required externally connected or on-chip oscillator. Microcontroller is used inside an embedded system for managing the function of devices.

2. **Explain The Different Modes Of Operation Of Microcontroller 8051 Timer.**

- In Intel 8051, there are two 16-bit timer registers. These registers are known as Timer0 and Timer1.
- The timer registers can be used in two modes. These modes are Timer mode and the Counter mode.
- The only difference between these two modes is the source for incrementing the timer registers.

Timer Mode

- In the timer mode, the internal machine cycles are counted. So this register is incremented in each machine cycle.
- So when the clock frequency is 12MHz, then the timer register is incremented in each millisecond. In this mode it ignores the external timer input pin.

Counter Mode

- In the counter mode, the external events are counted. In this mode, the timer register is incremented for each 1 to 0 transition of the external input pin.

- This type of transitions is treated as events. The external input pins are sampled once in each machine cycle, and to determine the 1or 0 transitions, another machine cycle will be needed.
- So in this mode, at least two machine cycles are needed.
- When the frequency is12MHz, then the maximum count frequency will be 12MHz/24 = 500KHz. So for event counting the time duration is 2 μs.

TMOD Register

- TMOD(Timer Mode) is an SFR. The address of this register is 89H. This is not bit-addressable.

Timer	Timer1 Mode				Timer0 Mode			
Bit Details	Gate (G)	C/T	M1	M0	Gate (G)	C/T	M1	M0
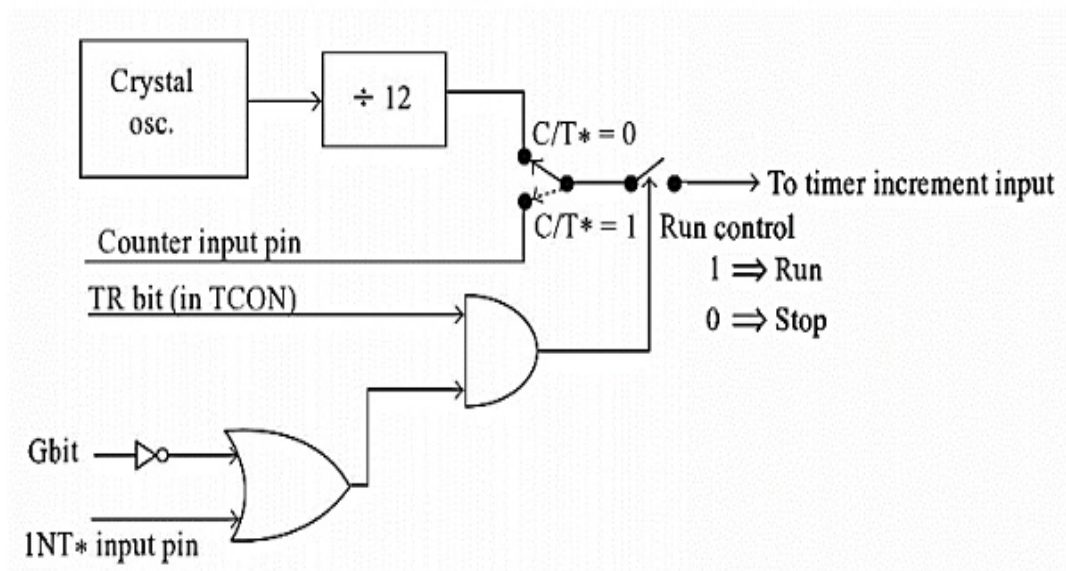
3. **Explain The Addressing Modes In 8051.**

In 8051 There are six types of addressing modes.

- Immediate Addressing Mode
- Register Addressing Mode
- Direct Addressing Mode
- Register Indirect Addressing Mode
- Indexed Addressing Mode

- Implied Addressing Mode

Immediate addressing mode

```
MOVA, #0AFH;
MOVR3, #45H;
MOVDPTR, #FE00H;
```

Register addressing mode

```
MOVA, R5;
MOVR2, #45H;
MOVR0, A;
```

Register indirect addressing Mode

```
MOV0E5H, @R0;
MOV@R1, 80H
```

Indexed addressing mode

```
MOVCA, @A+PC;
MOVCA, @A+DPTR;
```

Implied Addressing Mode

```
RLA;
SWAPA;
```

4. **Explain The Instruction Set Of 8051 Microcontroller**

- Arithmetic Instructions
- Branch Instructions
- Data Transfer Instructions
- Logic Instructions
- Bit-oriented Instructions

Instruction Set in 8051 Microcontroller Family
Here is a list of the operands and their meanings:

A – accumulator;
Rn – is one of working registers (R0-R7) in the currently active RAM memory bank;

Direct – is any 8-bit address register of RAM. It can be any general-purpose register or a SFR (I/O port, control register etc.);

@Ri – is indirect internal or external RAM location addressed by register R0 or R1;

#data – is an 8-bit constant included in instruction (0-255);

#data16 – is a 16-bit constant included as bytes 2 and 3 in instruction (0-65535);

addr16 – is a 16-bit address. May be anywhere within 64KB of program memory;

addr11 – is an 11-bit address. May be within the same 2KB page of program memory as the first byte of the following instruction;

rel – is the address of a close memory location (from -128 to +127 relative to the first byte of the following instruction). On the basis of it, assembler computes the value to add or subtract from the number currently stored in the program counter;

bit – is any bit-addressable I/O pin, control or status bit; and

C – is carry flag of the status register (register PSW).

Arithmetic Instructions

ADD A,Rn	Adds the register to the accumulator
ADD A,direct	Adds the direct byte to the accumulator
ADD A,@Ri	Adds the indirect RAM to the accumulator
ADD A,#data	Adds the immediate data to the accumulator

Branch Instructions

There are two kinds of branch instructions:

Unconditional jump instructions: upon their execution a jump to a new location from where the program continues execution is executed.

Conditional jump instructions: a jump to a new program location is executed only if a specified condition is met. Otherwise, the program normally proceeds with the next instruction.

ACALL addr11	Absolute subroutine call

Data Transfer Instructions

Data transfer instructions move the content of one register to another. The register the content of which is moved remains unchanged. If they have the suffix "X" (MOVX), the data is exchanged with external memory.

MOV A,Rn   Moves the register to the accumulator

                                  Moves the direct byte to the accumulator
MOV A,direct

MOV A,#data   Moves the immediate data to the accumulator

Logical Instructions

Logic instructions perform logic operations upon corresponding bits of two registers. After execution, the result is stored in the first operand.

ANL A,Rn   AND register to accumulator

ANL A,direct   AND direct byte to accumulator

ANL A,#data   AND immediate data to accumulator

XRL A,#data   Exclusive OR immediate data to accumulator

Bit-Oriented Instructions

Similar to logic instructions, bit-oriented instructions perform logic operations. The difference is that these are performed upon single bits

CLR C   Clears the carry flag

CLR bit   Clears the direct bit

SETB C   Sets the carry flag

UNIT II EMBEDDED C PROGRAMMING

PART-A

1. What is memory mapped I/O?(Nov/Dec 2014)

This is one of the techniques for interfacing I/O devices with µp. In memory mapped I/O, the I/O devices assigned and identified by 16-bit addresses. To transfer the data between MPU and I/O devices memory related instructions (such as LDA, STA etc.) and memory control signals (MEMR, MEMW) are used.

2. What is I/O mapped I/O?(April/May 2013)

This is one of the techniques for interfacing I/O devices with µp. In I/O mapped I/O, the I/O devices assigned and identified by 8-bit addresses. To transfer the data between MPU and I/O devices I/O related instructions (IN and OUT) and I/O control signals (IOR, IOW) are used.

3. What is key debounce?(Nov/Dec2014)

The push button keys when pressed, bounces a few times, closing and opening the contacts before providing a steady reading. So reading taken during bouncing may be faulty. Therefore the microprocessor must wait until the key reach to steady state. This is known as key debounce.

4. What is memory mapping?(Nov/Dec 2007)

The assignment of memory addresses to various registers in a memory chip is called as memory mapping.

7. How is the 8051 serial port different from other micro controllers? (Nov/Dec2013)

The 8051 serial port is a very complex peripheral and able to send data synchronously and asynchronously in a variety of different transmission modes.

8. When is an external memory access generated in 8051?

In 8051, during execution the data is fetched continuous. Most of the data is executed out of the 8051"sbuilt-in control store. When an address is outside the internal control store, an external memory access is generated

9.What is an embedded system?

An embedded system is a system that has embedded software and computer hardware, which makes it a system dedicated for applications or specific part of an application or product or a part of a larger system

10.Mention the applications of embedded system.

Consumer appliances, industrial automation, medical electronics, computer networking, telecommunication, wireless technologies, instrumentation, robotics, security and finance.

11.Mention the elements of C program. (Understanding, CO3)

- Files:
    - Header files
    - Source files
    - Configuration files
    - Preprocessor directives
- Functions:
    - Macro function
    - Main function
    - Interrupt service routines or device drivers
- Others:
    - Data types
    - Data structures
    - Modifiers
    - Statements
    - Loops and pointers

12.What are the various types of memory in embedded system?

- RAM
- ROM/PROM/EEPROM/Flash
- Cache memory

13. Difference between C and Embedded C   (may 15)

C is a high level programming language and it is hardware independent.	Embedded C is basically an extension to the Standard C Programming Language with additional features like Addressing I/O, multiple memory addressing and fixed-point arithmetic, etc
C Programming Language is generally used for developing desktop applications	Embedded C is used in the development of Microcontroller based applications

14. What are the data types in embedded c?

1. Function Data Types –void
2.Integer Data Types -int, short, and long.

15. What is RTOS?

RTOS is a real time operating systems and it has been developed for real time applications. It is typically used for embedded systems applications such as a mobile,telephones,robots etc.,.

16. Define process.
Process is defines as a computational unit that processes on a CPU and whose state changes under the control of kernel of an OS. It has state, which at an instance defines by the process status.

17.Define thread.
A thread defines a minimum unit of a multithreaded process that an OS schedules onto theCPU and allocates other system resources.

18.What is meant by multiple threads?
A multiprocessing OS runs more than one processes. When a process consists of multiple threads, it is called multithreaded process.

19.How does a task differ from a thread?
- Thread is a concept used in Java or UNIX.A thread can either be a sub-process within a process or a process within an application program. To schedule the

multiple processes, there is the concept of forming thread groups and thread libraries.

- A task is a process and the OS does the multitasking. Task is a kernel-controlled entity while thread is a process-controlled entity.
-

20. What is meant by context and context switching?

- **Context** –Each task has a context CPU registers and parameters, which includes registers for the task PC and pointer to the called function stack top. This reflects the CPU state just before the OS blocks one task and initiates another task into the running state. The context thus continuously updates during the running of a task, and the context is saved before switching occurs to another task.

- **Context switching** – Only after saving these registers and pointers does the CPU control switch to any other process or task. The context must retrieve on transfer of program control to the CPU back for running the same task again, on the OS unblocking its state and allowing it to enter the running state again. The context switching action must happen each time the scheduler blocks one task and runs another task.

21. List the functions of a kernel. (Analyzing, CO4)
a. Process management
b. Process creation to deletion
c. Processing resource requests
d. Scheduling
e. IPC
f. Memory management
g. I/O management
h. Device management

22. Mention the different types of RTOS

In house developed RTOS – The codes are written for the specific need, and application or product and customizes.
Broad based commercial RTOS – A readily available broad band commercial RTOS package.
General purpose OS with RTOS – It can be used in combination with the RTOS function.
Special focus RTOS – It is used with specific processors like ARM or 8051 or DSP.

22. Name any two important RTOS.
a. MUCOS
b. VxWorks

PART-B& C

1. **Explain the interfacing of Keyboard/Display with 8051 microcontroller (April/May2011)**

2. **How does one interface a 16 x 2 LCD display using 8051 microcontroller. (April/May2015)**

3. **How to interface an LCD display with microcontroller? Explain how to display acharacter using LCD display. (Nov/Dec 2014).**

4. **With a neat circuit diagram explain how a 4x4 keypad is interfaced with 8051 microcontrollerand write 8051 ALP for keypad scanning. [NOV/DEC'15][MAY/JUNE'13]**

5. **Explain 8051 serial port programming with examples. [May/June 2016]**

6. **Explain in detail about multiple processes and threads with an application.**

7. **What is meant by tasks and show the various states present in the tasking process?**

8. **Describe in detail about the basic functions and types of RTOS.**

9. **Describe in detail about the scheduling policies with suitable examples.**

Unit II

Part B & C

1. **Explain The Memory Interfacing In 8051 Microcontroller.**

- To interface with external memory, the 8051 microcontroller uses dedicated pins such as ALE (Address Latch Enable), PSEN (Program Store Enable), and RD (Read) and WR (Write) signals. These signals are used to control the flow of data between the microcontroller and the external memory device.

- The Memory Interfacing in 8085 is used to access memory quite frequently to read instruction codes and data stored in memory.

- This read/write operations are monitored by control signals. The microprocessor activates these signals when it wants to read from and write into memory.

- Microcontroller 8051 Peripheral devices. Interfacing is the process of connecting devices together so that they can exchange the information and that proves to be easier to write the programs.

- The 8051 microcontroller's memory is divided into Program Memory and Data Memory. Program Memory (ROM) is used for permanent saving program being executed, while Data Memory (RAM) is used for temporarily storing and keeping intermediate results and variables.

- Types, memory interfacing and I/O interfacing. When we are executing any instruction, we need the microprocessor to access the memory for reading instruction codes and the data stored in the memory.

- For this, both the memory and the microprocessor requires some signals to read from and write to registers.

2. **Discuss about The LCD Interfacing.**

- The LCD requires 3 control lines (RS, R/W & EN) & 8 (or 4) data lines.
- The number on data lines depends on the mode of operation.

- If operated in 8-bit mode then 8 data lines + 3 control lines i.e. total 11 lines are required. And if operated in 4-bit mode then 4 data lines + 3 control lines i.e. 7 lines are required.

- To display letters and numbers. ASCII code for the letters A to Z, a to 7, and numbers 0 to 9 is sent to the data lines (D0 -D7).

- These codes may be sent to LCD data lines through one port of 8255 (PPI), port A is used as the output port and send the data to the LCD.
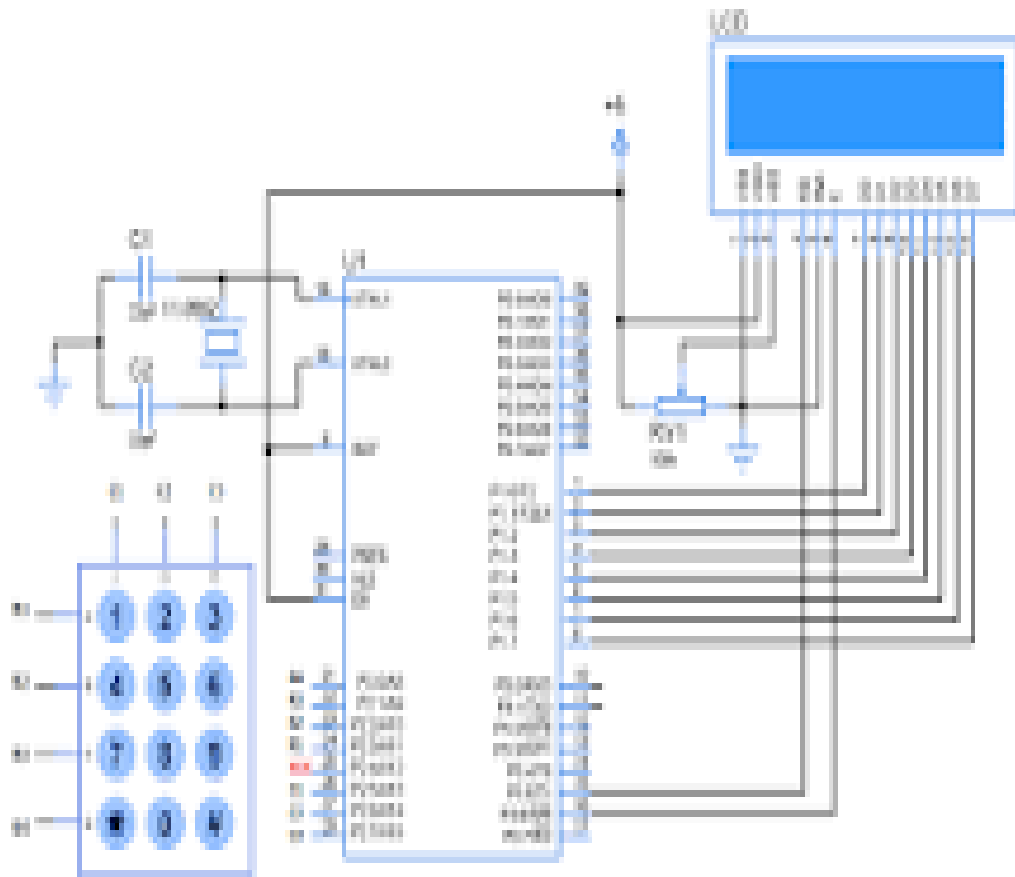
3. Explain about multiple task and processes.

- A *process* is a single execution of a program. If we run the same program two different times, we have created two different processes.
- Each process has its own state that includes not only its registers but all of its memory.
- In some OSs, the memory management unit is used to keep each process in a separate address space.
- In others, particularly lightweight RTOSs, the processes run in the same address space. Processes that share the same address space are often called *threads*.
- The control panel of the compression box may, for example, include a compression mode button that disables or enables compression, so that the input text is passed through unchanged when compression is disabled.
- We certainly do not know when the user will push the compression mode button the button may be depressed asynchronously relative to the arrival of characters for compression.
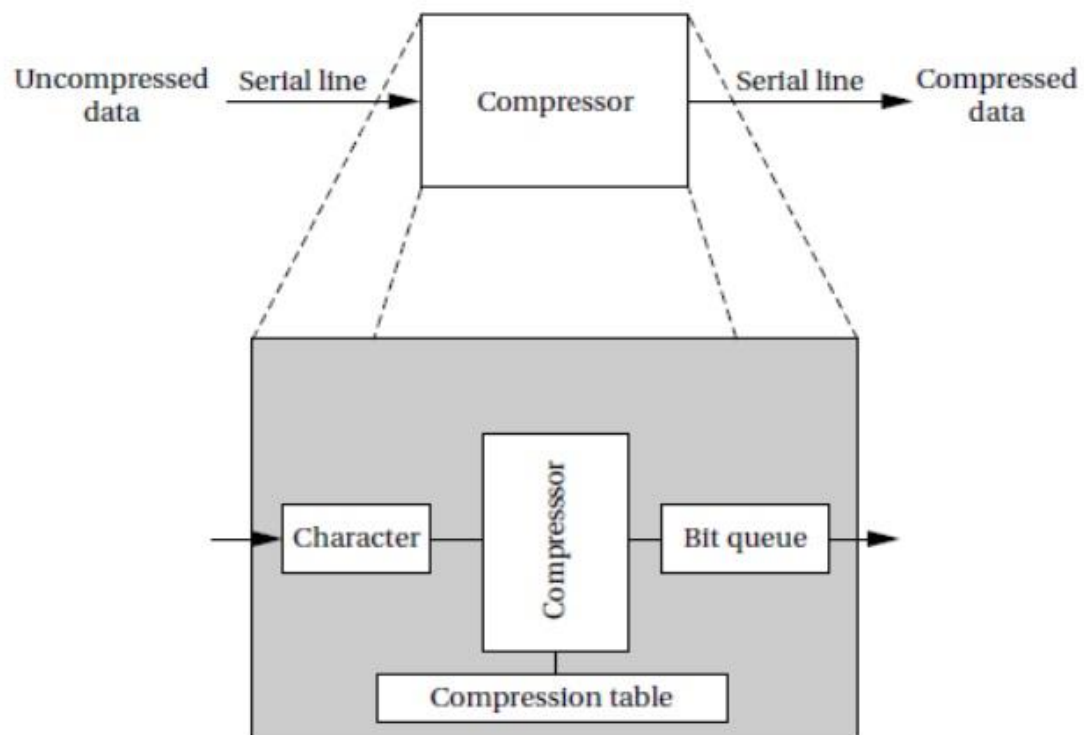
Fig 3.1 An on-the-fly compression box.

- The text compression box provides a simple example of rate control problems. A control panel on a machine provides an example of a different type of rate control problem, the *asynchronous input*.

UNIT 3 IOT AND ARDUINO PROGRAMMING

1.What is a "Thing" in the context of Internet of Things (IoT)?

The "Thing" commonly referred to by the concept of the Internet of Things is any item that can contain an embedded, connected computing device. A "Thing" in the IoT could be a shipping container with an RFID tag or a consumer's watch with a WiFi chip that sends fitness data or short messages to a server somewhere on the Internet.

2. How the Internet of Things (IoT) makes a difference to the businesses?

Businesses focus on getting products to the marketplace faster, adapting to regulatory requirements, increasing efficiency, and most importantly, persisting to innovate. With a highly mobile workforce, evolving customer, and changing supply chain demand, the IoT can move your enterprise forward, starting today.

3. What are the major Previacy and Security Issues in case of Internet Of Things (IoT)?

Cyberattacks may also compromise privacy, resulting in access to and exfiltration of identifying or other sensitive information about an individual. For example, an intrusion into a wearable device might permit exfiltration of information about the location, activities, or even the health of the wearer. In addition to the question of whether security measures are adequate to prevent such intrusions, privacy concerns also include questions about the ownership, processing, and use of such data. With an increasing number of IoT objects being deployed, large amounts of information about individuals and organizations may be created and stored by both private entities and governments.

4.How Does the Internet of Things (IoT) Work?

The IoT is not separate from the Internet, but rather, a potentially huge extension and expansion of it. The things that form the basis of the IoT are objects. They could be virtually anything? streetlights, thermostats, electric meters, fitness trackers, factory equipment, automobiles, unmanned aircraft systems (UASs or drones), or even cows or sheep in a field. What makes an object part of the IoT is embedded or attached computer chips or similar components that give the object both a unique identifier and Internet connectivity. Objects with such components are often called "smart"?such as smart meters and smart cars.

5.What is the difference between the Internet of Things (IoT) and Machine to Machine (M2M)?

Generally speaking, M2M could be considered a subset of IoT. M2M is like a line connecting 2 points, and IoT is like a network, a system composed of lots of M2M and triggering lots of interactions/activities. Giving a simple definition to M2M which is transferring data from one machine to another one. It's been used everywhere in our daily life. For example, entrance security. Just like using your employee card to unlock a door. When the security detector receives the ID from the employee card and then unlock the door once the ID is approved. This is M2M.

6.Difference between IoT devices and Computers:

IOT Devices	Computers
IoT devices are special-purpose devices.	Computers are general-purpose devices.
IoT devices can do only a particular task for which it is designed.	Computers can do so many tasks.
The hardware and software built-in in the IoT devices are streamlined for that particular task.	The hardware and software built-in in the computers are streamlined to do many tasks(such as calculation, gaming, music player, etc.)

IOT Devices	Computers
IoT devices can be cheaper and faster at a particular task than computers, as IoT devices are made to do that particular task.	A computer can be expensive and slower Examples: Desktop computers, Laptops, etc.

7. What is difference between Wireless Sensor Network (WSN) and Internet of Things (IoT) network (sensor)?

About WSN: Wireless sensor network is the foundation of IoT applications. WSN is the network of motes, formed to observe, to study or to monitor physical parameters of desired application.

8. What is IoT?

IoT stands for Internet of Things. It is basically a network using which things can communicate with each other using internet as means of communication between them. All the things should be IP protocol enabled in order to have this concept possible. Not one but multiple technologies are involved to make IoT a great success.

9. How does the Internet of Everything relate to the Internet of Things?

The "Internet of Everything" builds on the foundation of the "Internet of Things" by adding network intelligence that allows convergence, orchestration and visibility across previously disparate systems.

10. What are the important Components of Internet of Things?

Many people mistakenly think of IoT as an independent technology. Interestingly, internet of things is being enabled by the presence of other independent technologies which make fundamental components of IoT. The fundamental components that make internet of things a reality are:- 1. Hardware- Making physical objects responsive and giving them capability to retrieve data and respond to instructions 2. Software – Enabling the data collection, storage, processing, manipulating and instructing 3. Communication Infrastructure – Most important of all is the communication infrastructure which consists of protocols and technologies which enable two physical objects to exchange data.

11. List out the Application of IoT:

- Smart home● Connected car● Smart city● Smart Retail
- Connected Health● Smart grids● Smart Farming

12. What is Arduino?

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

13. What is difference between IoT and Arduino?

Arduino boards do not come with an operating system. IoT developers write C code in a specific way, compile it, and run it on hardware. As a result, manual coding is required for functions performed by operating systems, such as memory management, multi-tasking, I/O interruptions, and others.

14. What are the examples of IoT Arduino?

Gas Detector.
Water quality monitoring,Food spoilage detector.
A Sunlight Monitoring Panel
Car Parking System.

15. What is the difference types of Arduino?

Features of Different Types of Arduino Boards

- **Arduino Board**

- Arduino Uno

- Arduino Due

- Arduino Mega

- Arduino Leonardo

16. How sensors and actuators work together in IoT?

Sensor to **Actuator** Flow

In a typical IoT system, a sensor may collect information and route to a control center. There, previously defined logic dictates the decision. As a result, a corresponding command controls an actuator in response to that sensed input. Thus, sensors and actuators in IoT work together from opposite ends.

17. How sensor and actuators are integrated with Arduino?

Arduino can do analog and digital inputs, and only digital outputs. The sensors themselves usually are analog, but most of times they have a small circuit that translates values into digital format. In some cases you'll find both connectors on the same device. So, analog pins on Arduino are always input.

18. What is Arduino program structure?

Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error.

19. What is the structure and function of Arduino?
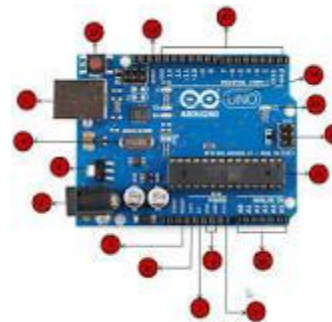
The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc.

20. What is sketch and sketch structure in Arduino with an example?

All sketches are divided into two parts – setup function and loop function. You should put code that will run only once (for example, code to set up a board for the application) in the setup function. The loop function contains the code that will be run continuously after the initial setup is complete

Part B &C

1.Explain About The Block Diagram Of Iot Device With Diagram.
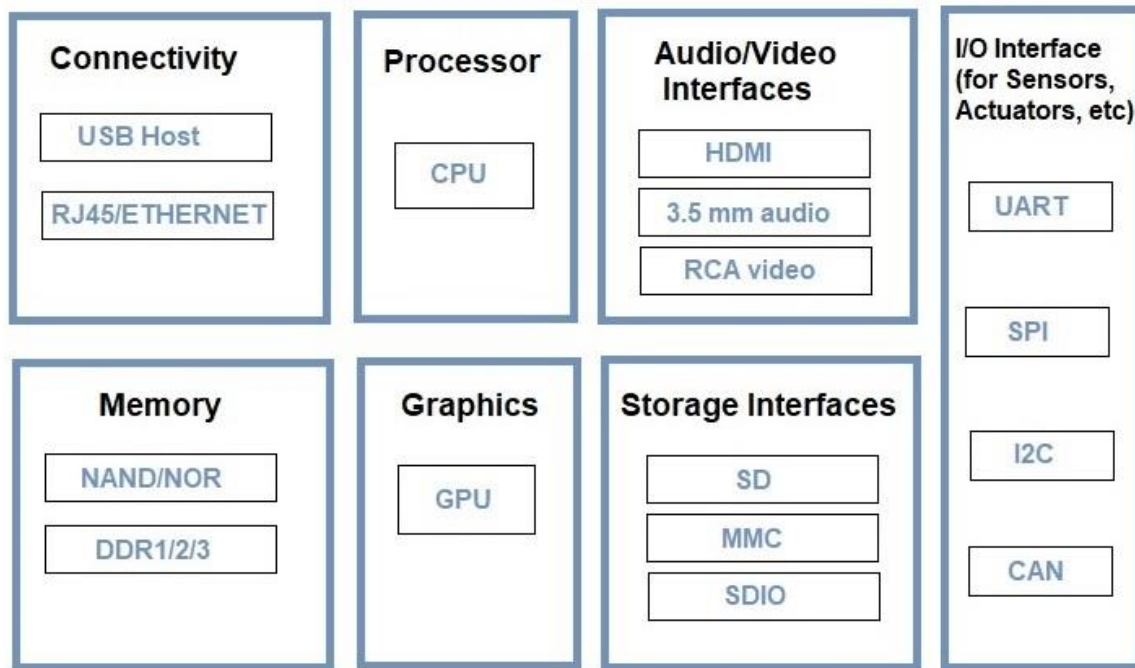
Generic Block Diagram of IoT Devices

An IoT system comprises four basic building blocks: sensors, processors, gateways, and applications. This article will thoroughly discuss what each component of the IoT architecture represents. The architecture of IoT components: Sensors convert a non-electrical input to an electrical signal. These functional blocks consist of devices that handle the communication between the server and the host, enable monitoring control functions, manage the data transfer, secure the IoT system using authentication and different functions, and provide an interface for controlling and monitoring various terms.

2.**Discuss About Various Iot Devices In Detail.**

IoT devices include computer devices, software, wireless sensors, and actuators. These IoT devices are connected over the internet and enabling the data transfer among objects or people automatically without human intervention

SENSORS: Arguably, the most critical component in IoT, the sensor is a device designed to detect, measure, or indicate a specific quantity, characteristic, or attributes, such as heat, light, motion, moisture, or pressure.
ACTUATORS: As their name suggests, actuators are designed to take or activate actions based on the signals and inputs from sensors and the parameters set in the programming.

GATEWAY: An IoT gateway can be a physical device or virtual platform such as hardware or software or a combination that connects sensors, IoT modules, and smart devices to the cloud. Gateways give IoT devices access to the Internet by bringing together multiple devices, technologies, solutions, and systems.

An **IoT platform** can be an on-premises software suite or a cloud service – a middleware that monitors and controls various endpoints by acting as the medium between the more hardware-based layers of IoT devices, gateways, the business, and application layers at the user end of the IoT system.

CONNECTIVITY AND COMMUNICATION

The ability of IoT devices to communicate back and forth across the network through several protocols and technologies is critical for the success of an IoT deployment. Today, there are many communication technologies available, including:

1. RFID
2. Ethernet
3. Wi-Fi
4. VHF/UHF/SHF radio
5. Bluetooth
6. DSL
7. Fiber
8. IPv4 and IPv6
9. En Ocean
10. GSM (Global System for Mobile communications)
11. NFC (Near-Field Communications)

- Local Area Networks (LAN)
- Wide Area Networks (WAN)
- The Internet
- Power Line Communication (PLC)
- Mesh networks
- WiMAX networks
- Satellite networks
- Cellular/mobile networks

3. Explain About Various Application Of Iot.

IoT allows you to connect all your home applications like air conditioners, lighting, locks, thermostat, theft alarm systems, and whatnot into a single system and have the control at your fingertips with a smart phone. It is predicted that by 2023, 309M homes worldwide will have smart systems installed.

- IoT Connectivity Platforms. An IoT Connectivity Platform is used to manage and monitor the communication protocols that connect devices across WiFi, bluetooth, and mobile internet. ...
- IoT Device Management Platforms. ...
- IoT Application Enablement Platforms. ...
- IoT Analytics Platforms.

Applications of IoT in Smart Homes

- Lighting. Today, home lighting can automatically adjust to personal needs. ...
- Bathrooms. IoT technologies in the bathroom can make your home routine more entertaining and convenient. ...
- Gardens. ...
- Kitchen. ...
- Security Systems. ...
- Safety Sensors. ...
- Temperature Control. ...
- Doors.

4. List Out The IOT Challenges In Detail

- IoT security. From the beginning, IoT devices have been notoriously vulnerable to cyber attacks.
- Coverage.
- Scalability
- Interoperability.
- Bandwidth availability. ...
- Limited battery life. ...
- Remote access
- Data Diversity. IoT data streams are multi-model and heterogeneous in nature.
- Data Quality. Most IoT streams are noisy and incomplete. ...
- Real-Time Data. ...
- Time & Location Dependencies. ...
- Cyber Security. ...
- Phase 1: Data Collection. ...
- Phase 2: Data Analysis. ...
- Phase 3: Data Deployment and Reuse

5. Discuss The Functions Of Arduino and its types.

Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

The electronic platform contains microcontrollers, connections, leds and many more. There are various types of arduino boards present in the market that includes arduino uno, red board, lilypad arduino, arduino mega, arduino leonardo

There are two required functions in an arduino sketch or a program i.e. setup () and loop() .

The popular types of Arduino boards.

- Arduino Uno R3. ...
- Arduino Nano. ...

o   Arduino Micro. ...
o   Arduino Leonardo. ...
o   Arduino Micro. ...
o   Arduino Mega2560 Rev3. ...
o   Arduino Nano 33 BLE. ...
o   Arduino Due.

6.Explain About The Arduino Programming Structure.

o   Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error.

o   A basic Arduino sketch consists of two *functions* called **setup()** and **loop()**.
o   Open the Arduino IDE and select **File → Examples → 01.Basics → BareMinimum** to see the two functions.
o   These two functions now appear in a default new Arduino IDE window, so it is not necessary to open the BareMinimum example sketch in a new version of the IDE.

❖ The Arduino program is divided into three main parts that are structure, values, and functions.
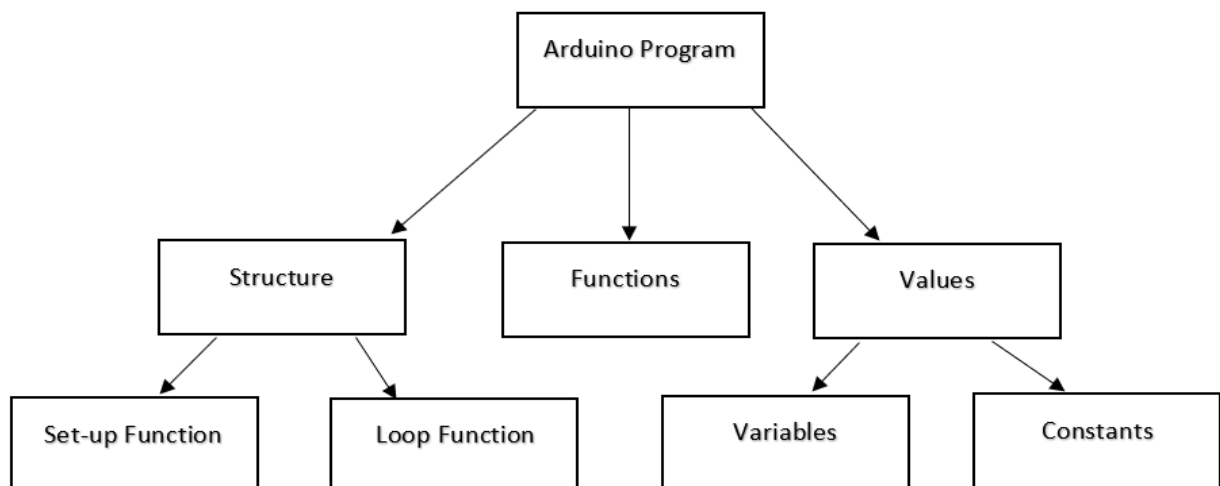
UNIT IV IOT COMMUNICATION AND OPEN PLATFORMS

IoT Communication Models and APIs – IoT Communication Protocols – Bluetooth – WiFi – ZigBee -GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture - Programming –Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins –Connecting to the Cloud.

TWO MARKS

1.What Is The Need Of IOT Communication Model?

Being an IOT bidirectional communication model, this model combines full dual communication between client and server. The connection does not change and remains open until the client submits a request to close the connection. The server has a record of all open communication.

2. List Out The Communication Models In IOT

- Request & Response Model – This model follows a client-server architecture. ...
- Publisher-Subscriber Model – This model comprises three entities: Publishers, Brokers, and Consumers. ...
- Push-Pull Model – ...
- Exclusive Pair –

3. What Is Meant By Stateless And Stateful Protocol In Iot?

Stateless Protocol is a network protocol in which Client send request to the server and server response back as per the given state. Stateful Protocol is a network protocol in which if client send a request to the server then it expects some kind of response, in case of no response then it resend the request

4.What Is An Iot API?

The term API (application programming interface) is the tool software developers use to gather and transfer data from one application or computer to another. Or in other words, APIs enable developers to programmatically interact with software components both inside and outside of their own code.

5.Define REST Based Communication API.

REST Based Communication API : REpresentational State Transfer (REST) is a set of architectural principles by which you can design web services and web APIs that focus on a system's resources and how resource states are addressed and transferred. REST APIs follow the request-response communication model.

6.What Are Advantages Of REST Apis?

Lightweight. One of the main benefits of REST APIs is that they rely on the HTTP standard, which means it's format-agonistic and you can use XML, JSON, HTML, etc. This makes REST APIs fast, and lightweight — which is necessary for mobile app projects, internet of things devices, and more.

7. What Is Meant By Web Socket Based Communication Apis?

The WebSocket API invokes your backend based on the content of the messages it receives from client apps. Unlike a REST API, which receives and responds to requests, a WebSocket API

supports two-way communication between client apps and your backend. The backend can send callback messages to connected clients.

8. What Is The Difference Between REST API And Web Socket API?

REST API and Web Socket API serve different purposes and are used in different contexts. REST API is used for stateless, request/response communication over HTTP, while Web Socket API is used for persistent, bi-directional communication over the WebSocket protocol.

9.Is Websocket Is A Protocol Or API?

WebSocket is a computer communications protocol, providing full-duplex communication channels over a single TCP connection.

10. What Are The Advantages Of Websocket?

WebSocket provides a full-duplex, bidirectional communication channel. This means that the server can send messages to the client, and both can send low-latency messages at the same time. Thus, WebSockets are suitable for two-way, multi-user realtime web applications such as chat rooms.

11. List Out The Iot Communication Parameters.

- Speed or Data Rate: the amount of information to be transmitted within a time duration. ...
- Range: the maximum distance between two intercommunicating nodes. ...
- Power Consumption: the amount of energy that a node needs to work within its lifetime.

12. How Many Types Of Communications In IOT?

➢ Cloud-to-device communication is critical for IoT device remote control.
➢ Peer-to-peer communication is useful when cloud-based communication is impractical or undesirable, and
➢ machine-to-machine communication is essential when human intervention is impractical or undesirable.

13. List Out The Examples Of IOT Communication Protocols.

❖ Wifi.
❖ Bluetooth.
❖ Zigbee.
❖ MQTT.
❖ Z Wave.
❖ Cellular data.
❖ NFC (Near Field Communication)
❖ LoRaWAN

14.Define Bluetooth

Bluetooth is a wireless communication technology that can be used for close-range data transmission from one digital device to another. Bluetooth is essentially a one-to-one wireless connection that uses 2.4 GHz-band radio waves

Bluetooth Role in The Future of IoT
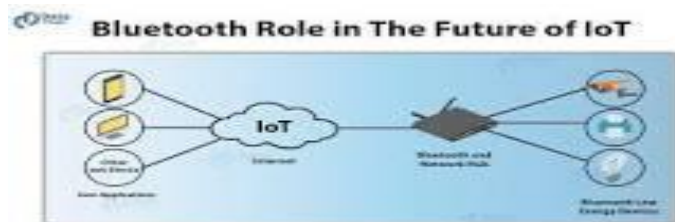
15.Define Piconet And Scatternet

Piconets have a 7 member address space (3 bits, with zero reserved for broadcast), which limits the maximum size of a piconet to 8 devices, i.e. 1 master and 7 slaves.

A scatternet is a number of interconnected piconets that supports communication between more than 8 devices.

16. Define Wi-Fi

Wi-Fi stands for Wireless Fidelity or Frequencies, which allows multiple computers to communicate and provides a means to connect to the Internet from the access point to the computer or laptop. A common misconception is that the term Wi-Fi is short for

"wireless fidelity," however Wi-Fi is a trademarked phrase that refers to IEEE 802.11x standards.

17. Difference Between Bluetooth And WiFI

.

Bluetooth	WIFI
❖ wireless technologies ❖ to send and receive data wirelessly using radio signals.	❖ wireless technologies ❖ to send and receive data wirelessly using radio signals.
Bluetooth is used for connecting devices in short range. Bluetooth is also slower than WiFi	WiFi is for high-speed Internet access that connects nearby devices with each other and share the Internet via hotspots..

18.Define zigbee

Zigbee is an open standard for a low-cost, low-power, wireless mesh network targeted at the wide development of devices for wireless control and monitoring applications. By building on top of the physical layer and media access control defined in the IEEE

standard802.15.
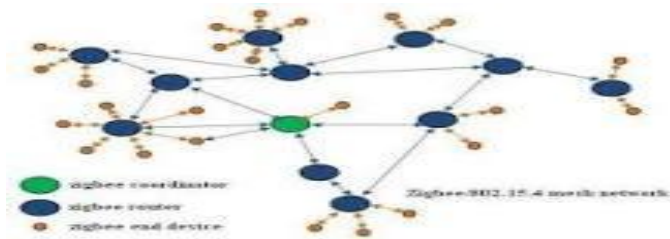
19.what are the types of zigbee?

ZigBee specifies three different device types: the ZigBee Coordinator (ZC), the ZigBee Router (ZR), and the ZigBee End Device (ZED). These three devices play different roles in a ZigBee network, two important applications of ZigBee – Home Automation and Smart Irrigation Systems, and a comparative study of ZigBee with other short-range protocols such, i.e., Wi-Fi and Bluetooth. Cluster tree topology.

20. List Out The Advantage Of Zigbee

- ❖ Support for multiple network topologies such as point-to-point, ...
- ❖ Low duty cycle – provides long battery life.
- ❖ Low latency.
- ❖ Direct Sequence Spread Spectrum (DSSS)
- ❖ Up to 65,000 nodes per network.
- ❖ 128-bit AES encryption for secure data connections.
- ❖ Collision avoidance, retries and acknowledgements.

21. Define Raspberry Pi In Iot

The Raspberry Pi is a very cheap computer that runs Linux, but it also provides a set of GPIO (general purpose input/output) pins, allowing you to control electronic components for physical computing and explore the Internet of Things (IoT).

Using the IoT technology with Raspberry Pi 3 allows you to monitor and control devices remotely, collect and exchange data and create automation systems with relative ease. Moreover, Raspberry Pi 3 can be expanded by adding different sensors and modules.

22.What Is Cloud Computing In Iot?

Cloud Internet of Things (IoT) uses cloud computing services to collect and process data from IoT devices, and to manage the devices remotely. The scalability of cloud IoT platforms enables the processing of large amounts of data, as well as artificial intelligence (AI) and analytics capabilities.

23. Define GSM Modules.

GSM, short for Global System for Mobile Communications, is a standard that outlines how 2G cellular networks function. GSM networks are commonly used for cellular IoT because they offer long-range, low-complexity cellular communications for IoT devices while conserving energy.

Part B &C

**1.Explain About Various Iot Communication Protocol Model In Detail.**

Some of the major IoT technology and protocol (IoT Communication Protocols) are Bluetooth, Wifi, Radio Protocols, LTE-A, and WiFi-Direct. These IoT communication protocols cater to and meet the specific functional requirement of an IoT system.

BLUETOOTH

❖ An important short-range IoT communications Protocols / Technology. Bluetooth, which has become very important in computing and many consumer product markets.

❖ It is expected to be key for wearable products in particular, again connecting to the IoT albeit probably via a smartphone in many cases
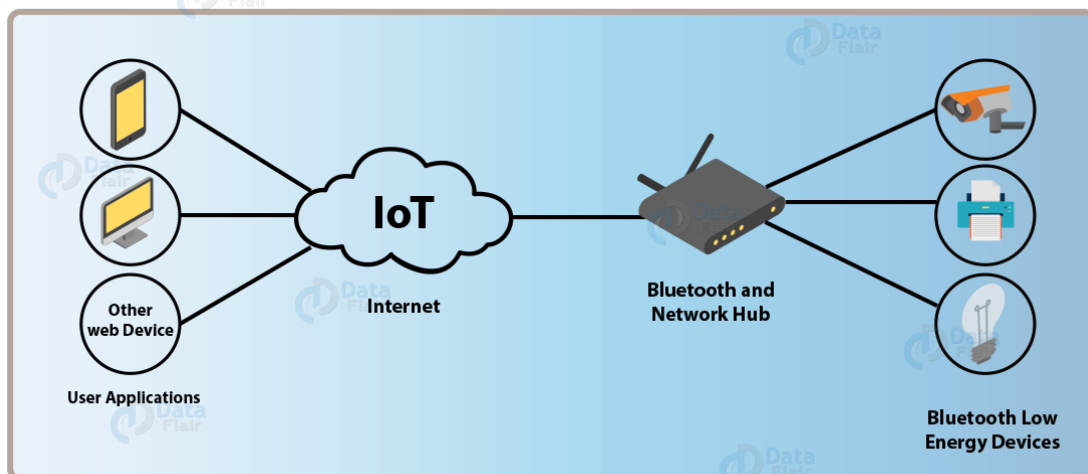
ZIGBEE

❖ ZigBee is similar to Bluetooth and is majorly used in industrial settings.

❖ It has some significant advantages in complex systems offering low-power operation, high security, robustness and high and is well positioned to take advantage of wireless control and sensor networks in **IoT applications**.

❖ The latest version of ZigBee is the recently launched 3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard.
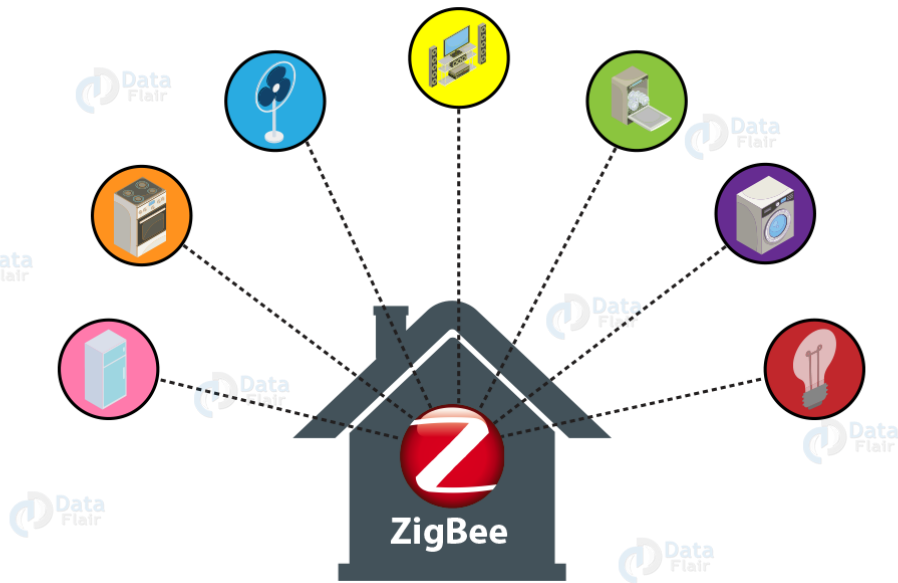
Z-Wave

- ❖ Z-Wave is a low-power RF communications IoT technology that primarily design for home automation for products such as lamp controllers and sensors among many other devices.
- ❖ A Z-Wave uses a simpler protocol than some others, which can enable faster and simpler development, but the only maker of chips is Sigma Designs compared to multiple sources for other wireless technologies such as ZigBee and others.

Wi-Fi

- ❖ WiFi connectivity is one of the most popular IoT communication protocol, often an obvious choice for many developers, especially given the availability of WiFi within the home environment within LANs.
- ❖ There is a wide existing infrastructure as well as offering fast data transfer and the ability to handle high quantities of data.

2. Discuss About Iot Communication APIS

- ❖ The Internet of Things (IoT) has changed how we interact with devices and created new opportunities for businesses to gather and analyze data. .
- ❖ IoT Communications APIs are a set of protocols and interfaces that allow IoT devices and platforms to communicate with one another.
- ❖ These APIs enable developers to create apps that interface with IoT devices over conventional web protocols including HTTP, MQTT, CoAP, and others.
- ❖ Internet of Things Communications APIs standardizes how IoT devices communicate with one another and with other systems. .

Types of Communication APIs in IoT
- **REST APIs**

  REST APIs are a popular choice for IoT communications because they offer a straightforward and scalable method of exposing IoT device capabilities over the web.
  - ❖ REST APIs can be used to access and alter IoT data and devices, allowing developers to create novel IoT−powered apps.
  - ❖ Internet of Things communications APIs that use REST APIs follow the same concepts as normal REST APIs but with an emphasis on IoT−specific resources and capabilities.
  - ❖ An IoT Communications API, for example, may provide resources such as sensors, actuators, or data streams.
- **WebSocket**
  - ❖ WebSocket is a protocol that provides for bidirectional, real−time communication between a client and a server.
  - ❖ WebSocket is frequently used in the context of IoT Communications APIs to provide low−latency, real−time data streaming between IoT devices and cloud services.
  - ❖ WebSocket, unlike HTTP, is a persistent connection between the client and server, allowing for real−time communication
- **CoAP**
  - ❖ Constrained Application Protocol (CoAP) is a protocol used in Communications APIs for resource−constrained devices and networks.
  - ❖ It is a simple protocol for exposing and manipulating IoT device resources via the internet.
  - ❖ CoAP is a low−overhead protocol
- **MQTT**
  - ❖ MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol used in IoT Communications APIs to link devices to the cloud.
  - ❖ MQTT was created to be efficient, dependable, and simple to use, making it an excellent choice for IoT applications.

**3. Explain The Function Of Bluetooth With Neat Diagram.**

- Bluetooth is universal for short-range wireless voice and data communication.
- It is a Wireless Personal Area Network (WPAN) technology and is used for exchanging data over smaller distances.
- This technology was invented by Ericson in 1994. It operates in the unlicensed, industrial, scientific, and medical (ISM) band from 2.4 GHz to 2.485 GHz.
- Maximum devices that can be connected at the same time are 7. Bluetooth ranges up to 10 meters. It provides data rates up to 1 Mbps or 3 Mbps depending upon the version.

- The spreading technique that it uses is FHSS (Frequency-hopping spread spectrum).
- A Bluetooth network is called a **piconet** and a collection of interconnected piconets is called **scatternet**

- Bluetooth simply follows the principle of transmitting and receiving data using radio waves.

- It can be paired with the other device which has also Bluetooth but it should be within the estimated communication range to connect.

- When two devices start to share data, they form a network called piconet which can further accommodate more than five devices.

- Bluetooth Transmission capacity 720 kbps.
- Bluetooth is Wireless.
- Bluetooth is a Low-cost short-distance radio communications standard.
- Bluetooth is robust and flexible.

Bluetooth Architecture:

The architecture of Bluetooth defines two types of networks:

1. Piconet

2. Scatternet
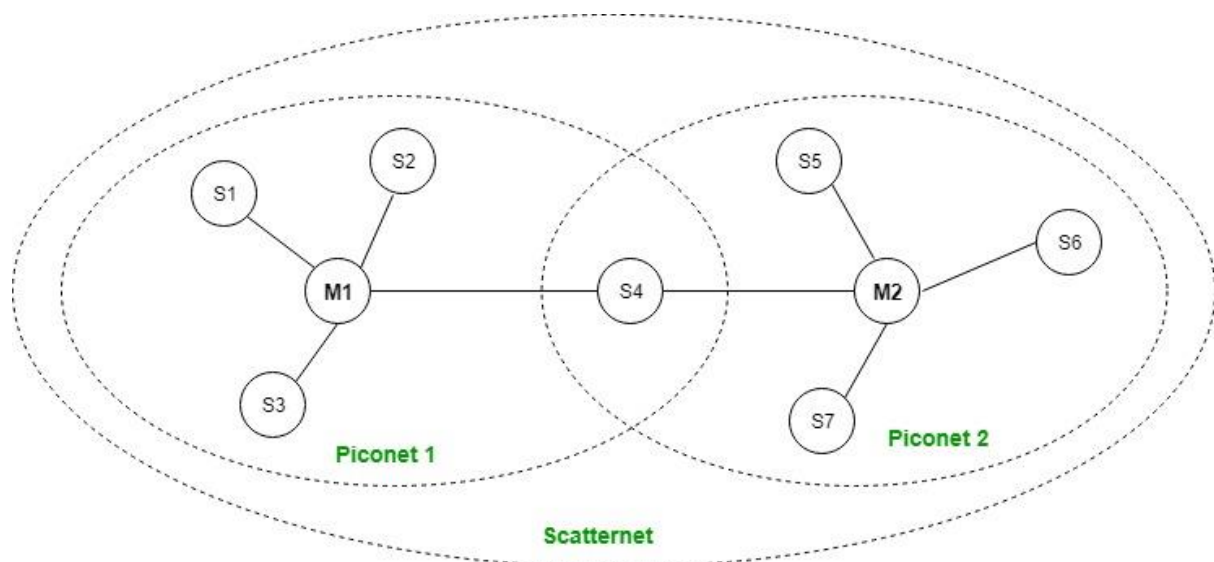
Piconet:

- Piconet is a type of Bluetooth network that contains **one primary node** called the master node and **seven active secondary nodes** called slave nodes.

- Thus, we can say that there is a total of 8 active nodes which are present at a distance of 10 meters.

- Slave-slave communication is not possible. It also has **255 parked nodes.**

Scatternet:

- It is formed by using **various piconets**.

- A slave that is present in one piconet can act as master or we can say primary in another piconet.

- This kind of node can receive a message from a master in one piconet and deliver the message to its slave in the other piconet where it is acting as a master.

- This type of node is referred to as a bridge node.

- A station cannot be mastered in two piconets.

4. Describe The Working Function Of Wifi In Detail.

o Wi-Fi is a popular wireless networking technology. Wi-Fi stands for "wireless fidelity".
o Wi-Fi was invented by NCR Corporation/AT&T in the Netherlands in 1991.

o By using this technology we can exchange information between two or more devices.
o Wi-Fi has been developed for mobile computing devices, such as laptops, but it is now extensively using for mobile applications and consumer electronics like televisions, DVD players, and digital cameras.

o Wi-Fi is one type of wireless technology.

o It is commonly called a wireless LAN (local area network).

o WiFi technology allows local area networks to operate without cable and wiring.

o It is making a popular choice for home and business networks.

o A computer's wireless adaptor transfers the data into a radio signal and transfers the data into an antenna for users.

WiFi Technology Working Principle

- Wi-Fi is a high-speed internet connection and network connection without the use of any cables or wires.

- The wireless network is operating three essential elements that are radio signals, ^{Antenna,} and router.

- The radio waves are keys that make Wi-Fi networking possible.

- The computers and cell phones are ready with Wi-Fi cards.

- Wi-Fi compatibility has been using a new creation to constituent within the ground connected with community network

- Wi-Fi compatibility can make surf with stare to the company using their inspiring cable television much a smaller amount force down.

- The radio signals are transmitted from antennas and routers that signals are picked up by Wi-Fi receivers, such as computers and cell phones that are ready with Wi-Fi cards.

- Whenever the computer receives the signals within the range of 100-150 feet for the router it connects the device immediately.
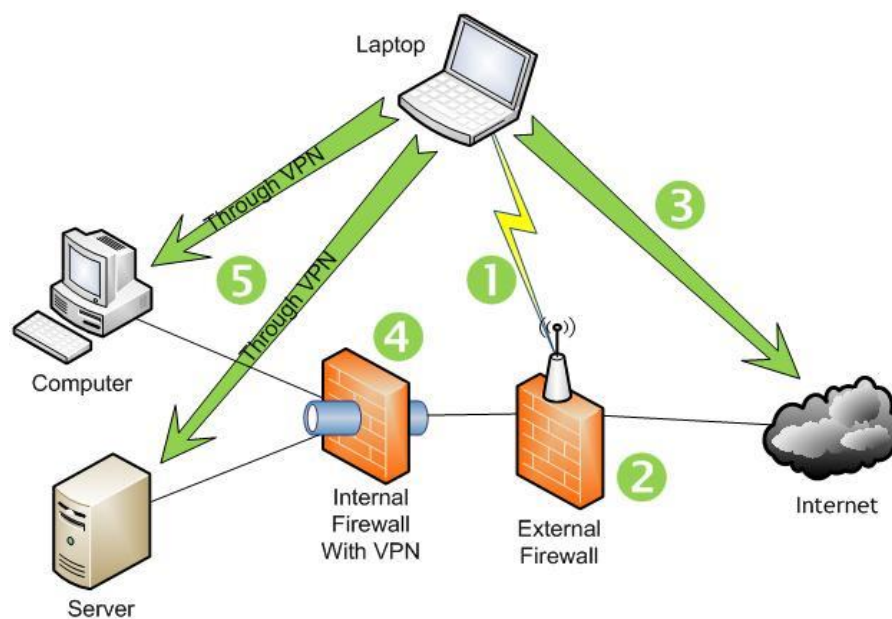
5. Explain About ZIGBEE And Its Role In Iot.

- ZigBee is an open, global, packet-based protocol designed to provide an easy-to-use architecture for secure, reliable, low power wireless networks.

- Flow or process control equipment can be place anywhere and still communicate with the rest of the system.

- Zigbee is a standards-based wireless technology developed to enable low-cost, low-power wireless machine-to-machine (M2M) and internet of things (IoT) networks.

- Zigbee is for low-data rate, low-power applications and is an open standard.

- This, theoretically, enables the mixing of implementations from different manufacturers, but in practice, Zigbee products have been extended and customized by vendors and, thus, plagued by interoperability issues.

- Wi-Fi networks used to connect endpoints to high-speed networks, Zigbee supports much lower data rates and uses a mesh networking protocol to avoid hub devices and create a self-healing architecture.

- Zigbee is built for control and sensor networks on the IEEE 802.15.4 wireless standard for wireless personal area networks (WPANs).

- The Zigbee WPANs operate on 2.4 Ghz, 900 MHz and 868 MHz frequencies.

- The Zigbee specifications, which are maintained and updated by the Zigbee Alliance, boost the IEEE 802.15.4 standard by adding network and security layers in addition to an application framework.

- The standards created by the alliance can be used to create multivendor interoperable offerings.

- Manufacturers that are developing custom applications that don't need to operate with the applications of other manufacturers can create their own specific variations and extensions.

- As of this writing, there are three Zigbee specifications: Zigbee PRO, Zigbee RF4CE and Zigbee IP.

- Zigbee is also used by vendors that provide connected lighting products for homes and businesses.

- With Zigbee-based smart home products, consumers can control LED figures, lightbulbs, remotes and switches in home and remotely to improve energy management.

6. Explain About Raspberry Pi Interfacing And Raspberry Pi Programming.

- Raspberry Pi is a series of small, single-board computers developed to teach computer science basics to school students and other people in low-income countries.

- It became a popular and easy to experiment tool to develop school projects, hardware programming, robotics, basic automated machines, circuits, etc

- The product does not require user to have extensive programming experience since it is aimed for the younger generation to learn about programming.
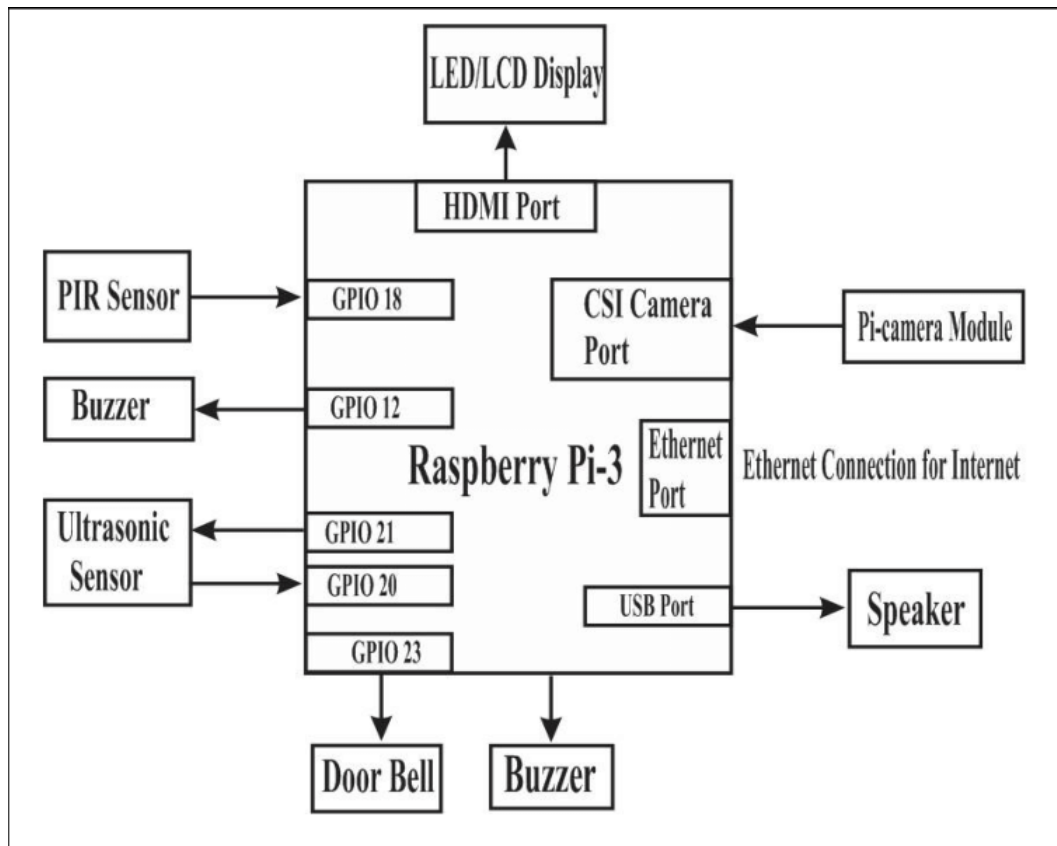
- Python, the programming language i.e.; Pi uses, is a smaller amount complex than other languages available.

- GPIO is the most commonly used interfaces used in Raspberry Pi.

- Although the Raspberry Pi GPIO pins can be programmed for multiple different hardware, protocols, this tutorial focuses on using the GPIO pins as basic digital output to glow an LED.

- The Raspberry Pi is an amazing single board computer (SBC) capable of running Linux and a whole host of applications.

- Python is a beginner-friendly programming language that is used in schools, web development, scientific research, and in many other industries.

- The Raspberry Pi has three types of serial interface on the GPIO header.

- The Raspberry Pi architecture incorporates a memory subsystem comprising 1 GB of RAM.

- The RAM is shared between the ARM processor and the GPU, and software configurations vary the split. Moreover, a microSD card slot stores the operating system and all user data.

- The Raspberry Pi 4 uses a **Broadcom BCM2711 SoC with a 1.5 GHz (later models: 1.8 GHz) 64-bit quad-core ARM Cortex-A72 processor**, with 1 MB shared L2 cache.

- HDMI. Your Raspberry Pi has an **HDMI output port** that is compatible with the HDMI port of most modern TVs and computer monitors. Many computer monitors may also have DVI or VGA ports. Raspberry Pi 4 has two micro HDMI ports, allowing you to connect two separate monitors.

UNIT V APPLICATION DEVELOPMENT

**Complete Design of Embedded Systems – Development of IoT
Applications – Home Automation –
Smart Agriculture – Smart Cities – Smart Healthcare.**

Two marks

1. Define Embedded Systems

An embedded system is a system in which the computer (generally a microcontroller or microprocessor) is included as an integral part of the system. Often, the computer is relatively invisible to the user, without obvious applications, files, or operating systems. Typically embedded systems use basic embedded system software such as C, C++, ADA, etc. Some specialized embedded systems may use OS such as Windows CE, LINUX, TreadX, Nucleus RTOS, OSE, etc.

2. What are the application of embedded systems?

Embedded systems are used in autonomous vehicle control systems, navigation systems, and communication systems, among others. These systems provide the necessary speed and accuracy to ensure the safety of passengers and pedestrians. Smart Grid: A smart grid can be developed using embedded systems.

3. Design Process Of Embedded System With Example.
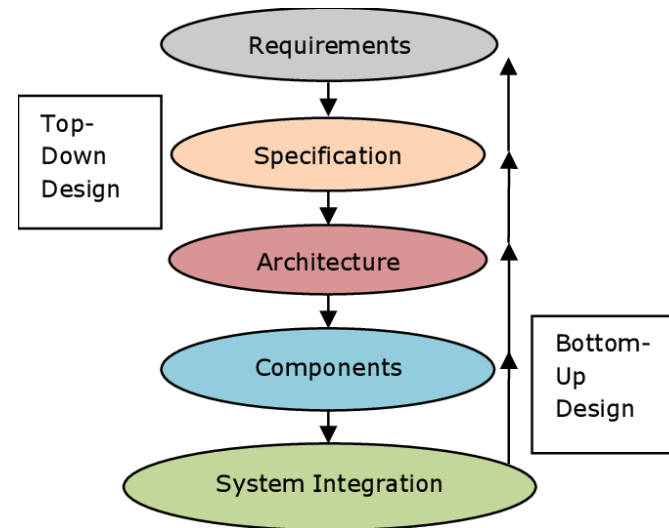
4.What Are the Types of Embedded Systems?

- **Soft Real Time Embedded Systems** – In these types of embedded systems time/deadline is not so strictly followed. If deadline of the task is passed (means the system didn't give result in the defined time) still result or output is accepted.

- **Hard Real-Time Embedded Systems** – In these types of embedded systems time/deadline of task is strictly followed. Task must be completed in between time frame (defined time interval) otherwise result/output may not be accepted.

5. List Out The Important Application Area Of IOT.

- Wearables. Wearable technology is the hallmark of IoT applications and one of the earliest industries to deploy IoT.
- Smart Home Applications.
- Health care.
- Smart Cities.
- Agriculture.
- Industrial Automation.
- Hacked Car.
- Healthcare.

6. What are the application of IOT in smart homes?

- Lighting. Today, home lighting can automatically adjust to personal needs. ...
- Bathrooms. IoT technologies in the bathroom can make your home routine more entertaining and convenient. ...
- Gardens. ...
- Kitchen. ...
- Security Systems. ...
- Safety Sensors. ...
- Temperature Control.
- Doors.

7. what are the requirements and specifications of embedded system?

An embedded system's functionality is usually fixed and is primarily determined by the system's interactions with its environment. Embedded systems also usually have numerous modes of operation, must respond rapidly to exceptions, and possess a great deal of concurrency. Design metrics is a measure of an implementation's features such as its cost, size, power, and performance. It must be of a size to fit on a single chip, must perform fast enough to process data in real time and consume minimum power to extend battery life.

8. what is the water model of embedded system?

The waterfall development model consists of five major phases: requirements analysis determines the basic characteristics of the system; architecture design decomposes the functionality into major components; coding implements the pieces and integrates them; testing uncovers bugs; and maintenance entails deployment in.

9. what is the concept of smart homes?

A smart home allows home owners to control appliances, thermostats, lights, and other devices remotely using a smart phone or tablet through an internet connection. Smart homes can be set up through wireless or hardwired systems. Smart home technology provides homeowners with convenience and cost savings.

10. what is smart lightning?

Smart lights are lighting fixtures and light bulbs that can sense and interact automatically with their environments and with users and other smart devices. Unlike regular light bulbs

which require manual operation, smart lights can be controlled remotely or through voice commands

11. what is smart agriculture?

Smart agriculture is a rising area bringing the benefits of digitalization through big data, artificial intelligence and linked data into the agricultural domain. This chapter motivates the use and describes the rise of smart agriculture.

12.what is smart cities?

Smart cities use IoT devices such as connected sensors, lights, and meters to collect and analyze data. The cities then use this data to improve infrastructure, public utilities and services, and more.

13. List Out The Important Application of Smart Cities.

- Smart Waste Management.
- Smart Parking.
- Smart Street Lighting.
- Environmental Monitoring.
- Safety And Security.
- Traffic & Fleet Control.

14 what is the purpose of home automation?

Home automation makes it possible to automate tasks related to security, well-being, and comfort through a smart system installed in a home or building. In other words, it integrates technology into the design of a space. One of the main advantages of home automation systems is energy efficiency.

15.what is the difference between home automation and iot?

Home automation and IoT also differ in the degree of data protection: a home automation system is closed, i.e. all the connected systems communicate only with each other and store the data in a more protected and difficult to violate environment, while the Internet of Things devices, by their nature, must communicate.

16. what are the common economic impact of iot in smart cities?

One of the key areas where IoT is expected to have a major impact in Indian smart cities is in transportation. Smart traffic management systems can use IoT sensors to gather real-time data on traffic flow, congestion, and accidents, allowing for more efficient routing of vehicles and better use of limited road space.

17.Why Smart Cities Are Important To Our Economy?

The main goal of a smart city is to optimise city functions and promote economic growth while also improving the quality of life for citizens by using smart technologies and data analysis

18. what are the benefits of smart economy?

Smart Economy is an economy based on technological innovation, resource efficiency, sustainability, and high social welfare. Smart Economy adopts innovations, new entrepreneurial initiatives, increases productivity and competitiveness, with the overall goal of improving the quality of life of all citizens.

19. what is the home healthcare?

Smart health is about putting the patient at the heart of health services design, and reimagining models of care to realize personalized health at scale.

- ➢ Connected hearing aids.
- ➢ Fall detection.
- ➢ Food safety refrigeration.
- ➢ Medical refrigeration.
- ➢ Patient monitoring of chronic health conditions, activity, vitals, etc.
- ➢ Safety monitoring.
- ➢ Tracking Staff, Patients, Inventory.

20. What Are The Objectives Of Smart Healthcare Monitoring System?

This system helps the doctor to analyze patient data and provide right intervention at the right time to the right patient. The main aim is to develop smart healthcare system which provides high quality and low cost healthcare services to the patients.

s

UNIT V

PART B &C

1. Describe The Structural And Behavioral Description Of Methods Used For Designing An Embedded System.

In embedded system design, a microcontroller plays a vital role. Micro-controller is based on Harvard architecture, it is an important component of an embedded system. External processor, internal memory and i/o components are interfaced with the microcontroller. It occupies less area, less power consumption.

Elements of Embedded Systems

- Processor
- Microprocessor
- Microcontroller
- Digital signal processor.

Challenges in Embedded System Design

While designing any embedded system, designers face lots of challenges like as follows,

- Environment adaptability
- Power consumption
- Area occupied
- Packaging and integration
- Updating in hardware and software
- Security
- There are various challenges the designers face while testing the design like Embedded hardware testing, Verification stage, Validation Maintainability.

The design steps mainly include the following.

1. Requirements
2. Specifications
3. Hardware and software functioning.
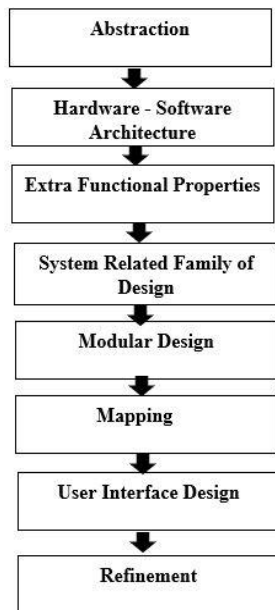
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Hardware

ACVM hardware architecture has the following hardware specifications

- Microcontroller 8051
- 64 KB RAM and 8MB ROM
- 64 KB Flash memory
- Keypad
- Mechanical coin sorter
- Coin channel
- USB wireless modem
- Power supply

2. **Discuss About Development Of Iot Applications**

- ❖ IoT app development refers to creating software applications that leverage the Internet of Things (IoT) technology to enhance functionality and user experience for IoT devices.
- ❖ These apps can connect with devices through sensors and internet connectivity to offer features such as remote monitoring, battery status updates, and even predictive maintenance alerts.
- ❖ By developing IoT apps, we can improve the efficiency, convenience, and sustainability of device usage, ultimately benefiting both manufacturers and users.

Step 1: Define the requirements for the application

Step 2: Choosing the right hardware

Step 3: Find the right connectivity protocols

Step 4: Ensure the firmware is well-equipped

Step 5: Pick the right cloud platform

**3. Explain In Detail The Home Automation System With Suitable Diagram.**

- In the present scenario, the automation industry plays a very major role in human day-to-day living.

- The word automation means making the use of machinery instead of human efforts as well as it may be defined as the technique of making an apparatus, a process, or a system that operates automatically.

- *Home Automation* is a system that allows users to control various appliances of varying kinds and also makes controlling of home appliances easier and saves energy.
- Nowadays, home automation is used more and more. On the other hand, it provides increased comfort especially when everyone is busy with their work.

- Home automation installed in houses does not only increase comfort but also allows centralized control of heating, ventilation, air-condition, and lighting.

- Hence, they contribute to an overall cost reduction and also useful in energy saving which is certainly the main problem today.

- In present years, wireless systems like Wi-Fi, Bluetooth have become more and more common in home networking.

- Also in home automation, the use of wireless technologies gives several advantages that could not be achieved using a wired network only.

Smart Devices: These are the real powerhouse of any home automation system. These are the main parts that actually implement the whole system commands. Examples of the smart devices which can be added to any home automation to complete the whole system are as follows:

- **Access Control**
- **Security Devices:** This includes security cameras, smart locks.
- **Home Appliances:** Smart refrigerators, washing machines, dishwashers, and ovens already exist.

- **Smaller Appliances:** As automatic coffee pots and electric kettle have been also around for a while too
- **Climate Controls:** Climate control system with energy management systems
- **Smart Thermostats.**
- **Entertainment Pieces:** Entertainment includes smart TVs, wireless speakers, and film projectors
- **Health Care Devices:** Smart humidifiers and smart scales are two common examples of health care devices.
- **Lighting Controls:** They include dimmers, light bulbs, light strips, and switches, etc.

A high-speed internet plays an important role in smooth connectivity and also plays an important reliable performance between Wi-Fi-enabled devices.
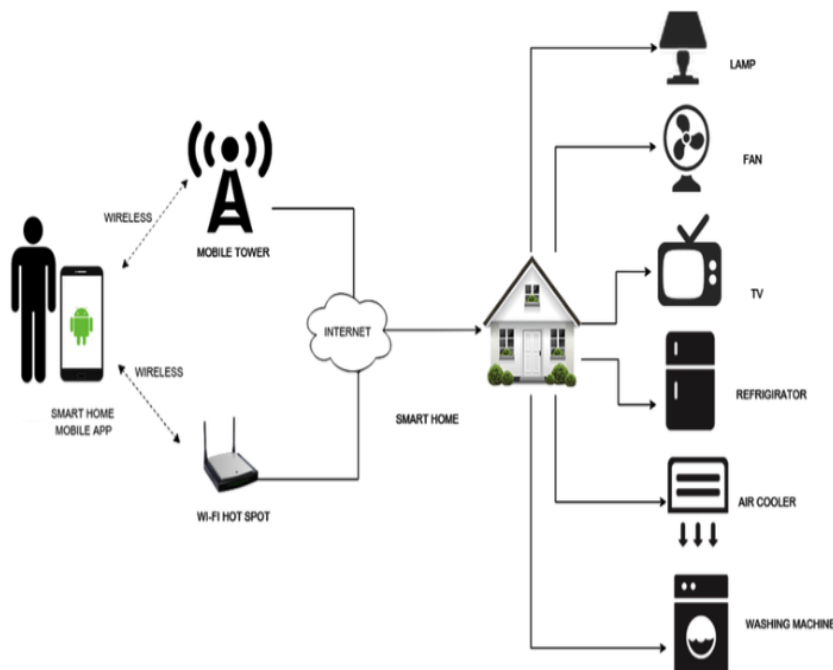

4.Describe The Functions Of Iot In Smart Agriculture.
- As a result, farmers and associated brands can easily monitor the field conditions from anywhere without any hassle.
- Smart farming refers to managing farms using modern Information and communication technologies to increase the quantity and quality of products while optimizing the human labor required.
- Among the technologies available for present-day farmers are: Sensors: soil, water, light, humidity, temperature management.
- It can help farmers avoid accidental deforestation and soil erosion.
- In addition, smart irrigation systems can help farmers reduce water usage, and some smart farming technologies helps generate renewable energy. Moreover, many smart farming solutions are designed to be carbon-neutral or even carbon-negative.

IoT use cases in agriculture (with examples)
- Monitoring of climate conditions.
- Greenhouse automation.
- Crop management.
- Cattle monitoring and management.
- Precision farming.
- Agricultural drones.
- Predictive analytics for smart farming.
- End-to-end farm management systems.
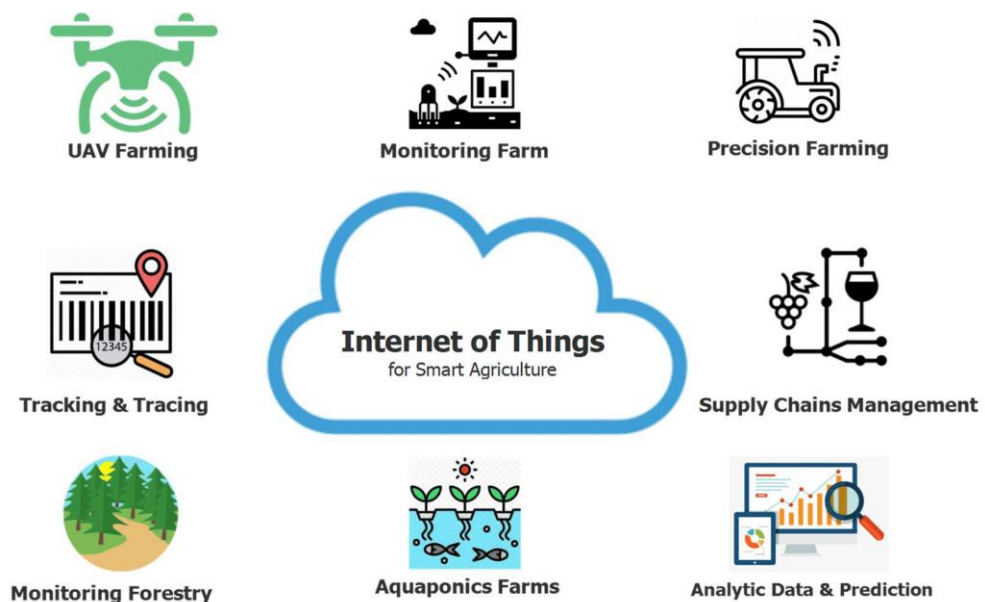
4. **Discuss About The Development Of Smart Cities In Detail.**

- Smart cities leverage technologies to provide services to the citizens. Various electronic methods and sensors are used for collecting data.
- The insights of the data received help the operational improvement of garbage collection, utility supply, traffic movement, environmental management, and managing social services.
- A smart city uses information and communication technology (ICT) to improve operational efficiency, share information with the public and provide a better quality of government service and citizen welfare.

  - A smart city is a technologically modern urban area that uses different types of electronic methods and sensors to collect specific data.

o Information gained from that data is used to manage assets, resources and services efficiently; in return, that data is used to improve operations across the city.

o The Smart Cities Mission is an innovative and new initiative by the Government of India to drive economic growth and improve the quality of life of people by enabling local development and harnessing technology as a means to create smart outcomes for citizens.

- **Use of information and communication technologies**. Building and control automation. Efficient urban planning. Urban mobility and sustainable public transport.