**CBCS SCHEME**

USN 1CR24CS118 **BESCK204C**

# Second Semester B.E./B.Tech. Degree Examination, June/July 2025
## Introduction to Electronics and Communication

Time: 3 hrs. Max. Marks: 100

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.*
*2. M : Marks , L: Bloom's level , C: Course outcomes.*

| | | Module – 1 | M | L | C |
|---|---|---|---|---|---|
| Q.1 | a. | With a neat diagram, explain the working of a DC power supply. Also mention the principal components used in each block. | 10 | L2 | CO1 |
| | b. | With circuit diagram and waveform explain the working of full wave rectifier. | 10 | L2 | CO1 |
| | | **OR** | | | |
| Q.2 | a. | List and describe the main types of amplifiers. | 7 | L2 | CO1 |
| | b. | With circuit diagram explain the following voltage doubler, voltage Tripler. | 6 | L3 | CO1 |
| | c. | Mention the advantage of negative feedback in amplifier circuit with relevant equations and diagram. Explain the concept of negative feedback. | 7 | L2 | CO1 |
| | | **Module – 2** | | | |
| Q.3 | a. | List and explain the conditions to obtain sustained oscillations. Determine the frequency of oscillations of a 3 stage ladder network in which $C = 10$ ηF and $R = 10$ KΩ. | 10 | L3 | CO2 |
| | b. | With circuit diagram and waveform show how operational amplifier can work as a comparator and voltage follower. | 10 | L3 | CO2 |
| | | **OR** | | | |
| Q.4 | a. | With neat circuit diagram explain the working of Wein Bridge oscillator. | 10 | L2 | CO2 |
| | b. | Sketch the circuit of each of the following based on the use of operational amplifier.<br>i) Inverting amplifier<br>ii) Differentiator | 10 | L2 | CO2 |
| | | **Module – 3** | | | |
| Q.5 | a. | Explain with circuit diagram of full adder. | 6 | L2 | CO3 |
| | b. | Given the two binary numbers X = 1010100 and Y = 1000011 perform the subtraction i) X – Y ii) Y – X using 2's complement. | 6 | L3 | CO3 |
| | c. | Convert the following number from the given base to the other bases identified :<br>i) Decimal 225 to binary<br>ii) Binary 11010111 to octal<br>iii) Octal 623 to decimal<br>iv) Hexadecimal 2AC5 to decimal. | 8 | L2 | CO3 |
| | | **OR** | | | |
| Q.6 | a. | Express the Boolean function $F_1 = A + B'C$ in a sum of minterms form and $F_2 = XY + X'Z$ in a product of maxterms form. | 10 | L3 | CO3 |
| | b. | Design a full adder using two half address and on OR gate. | 10 | L3 | CO3 |

| | | | | | |
|---|---|---|---|---|---|
| | | **Module – 4** | | | |
| **Q.7** | **a.** | Compare embedded systems and general computing systems and also provide major application areas of embedded system. | **10** | **L2** | **CO4** |
| | **b.** | Bring out the differennce between RISC and CISC, microprocessor and microcontrollers. | **10** | **L2** | **CO4** |
| | | **OR** | | | |
| **Q.8** | **a.** | Draw the basic block diagram of instrumentation and control system. Also explain feedback based control system. | **10** | **L2** | **CO4** |
| | **b.** | With neat diagram explain the working of LED and 7 segment display. | **10** | **L2** | **CO4** |
| | | **Module – 5** | | | |
| **Q.9** | **a.** | With neat diagram explain the basic blocks used in communication system. | **10** | **L2** | **CO5** |
| | **b.** | Explain the need for modulation and explain briefly the types of modulations used for communication. | **10** | **L2** | **CO5** |
| | | **OR** | | | |
| **Q.10** | **a.** | What are the advantages and disadvantages of digital communication over analog communication? | **10** | **L2** | **CO5** |
| | **b.** | With neat diagram explain the working of time division multiplexing and frequency division multiplexing. | **10** | **L2** | **CO5** |

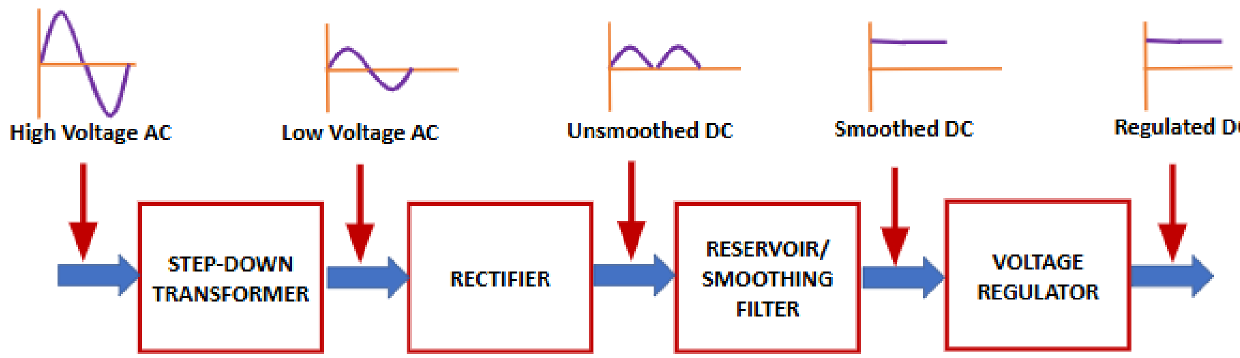
* * * * *

# VTU QP Solution

## Introduction to Electronics (BESCK204C) June/July 2025

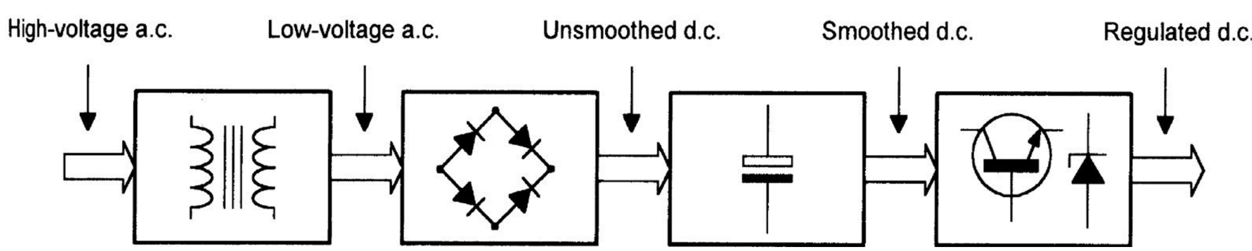
1)a) With a neat diagram explain the working of DC power supply. Also mention the principal components used in each block.

Power supply is a device that ***supplies electric power to a load.*** The following is the block diagram of the power supply.




Block Diagram of Power Supply

The components used in each of the blocks are shown in the diagram below.




Components of Power Supply Blocks

- **Step-Down Transformer** – Steps down the AC main voltage which is usually high (220V) to a lower value (9V, 12V, 15V, 20V, 30V). ***This is achieved by varying the turns ratio on the transformer***.
- **Rectifier –** The AC output from transformer secondary is then rectified using convectional silicon rectifier diodes to produce an ***unsmoothed output (pulsating DC).*** *Rectification* is generally achieved using a bridge rectifier which used four diodes connected in the form of a bridge.
- **Reservoir/Filtering Circuit** – The unsmoothed output from rectifier is smoothened by reservoir/filtering circuit (a ***high value capacitor***). The high value capacitor stores a

considerable charge. The capacitor helps smooth out the voltage pulses produced by the rectifier.

- **Voltage Regulator** – This provides a ***fixed voltage source stabilizes and provides a constant voltage.*** A series transistor regulator using a Zener diode is used for voltage regulation**.**

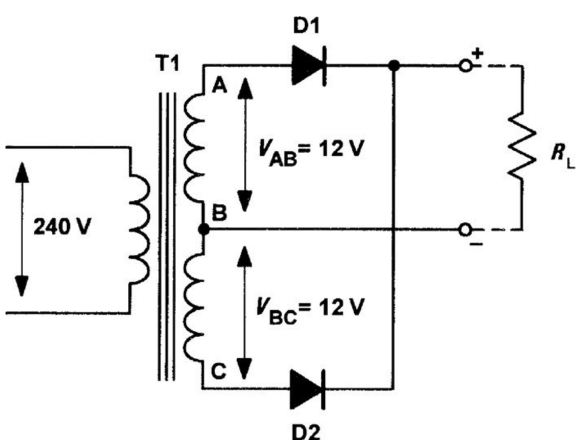
**b) With a neat circuit diagram and waveform explain the working of a full wave rectifier. (10M)**

A full wave rectifier is a type of rectifier that conducts during both the half cycles of the input signal. There are two types of full wave rectifiers.

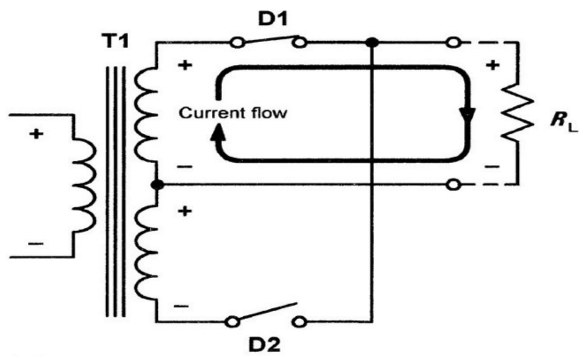
i) Biphase full wave rectifier a
ii) Bridge Rectifier

i) Biphase fullwave rectifier

It is a type of full wave rectifier constructed using two diodes and a centre tap transformer. The following is the circuit of the bi phase full wave rectifier.

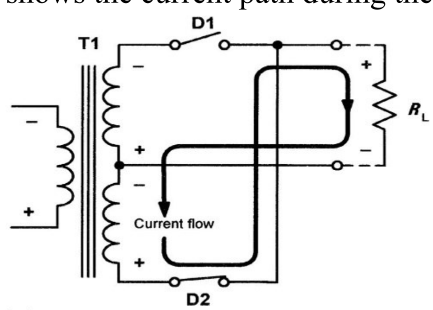



**During the positive half cycle**, for the segment AB, end A is positive and end B is negative and for the segment BC, end B is positive and end C is negative. Hence the diode D1 is forward biased while the diode D2 is reverse biased. The following diagram shows the current path during the positive half cycle.



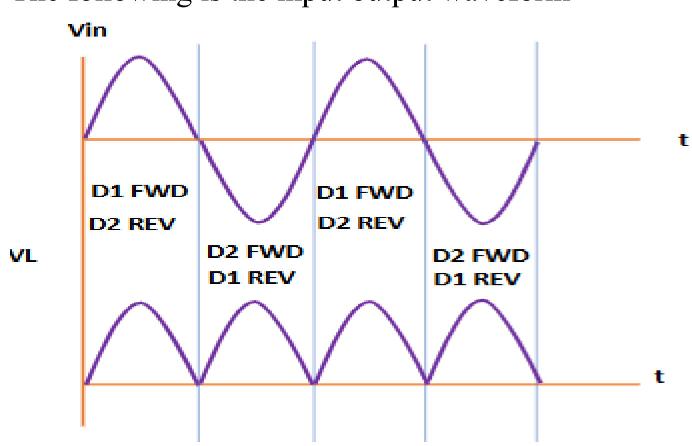

(a)

**During the negative half cycle**, for the segment AB, end A is negative and end B is positive and for the segment BC, end B is negative and end C is positive. Hence the diode D2 is forward biased while the diode D1 is reverse biased. The following diagram shows the current path during the positive half cycle.




(b)

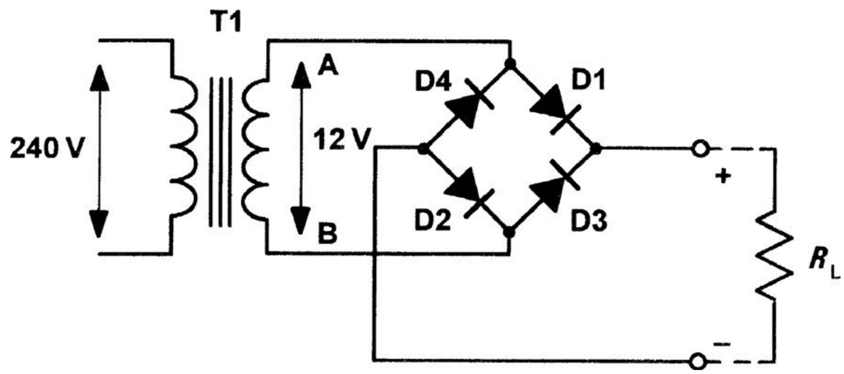
The following is the input output waveform




Pulsating Output Voltage

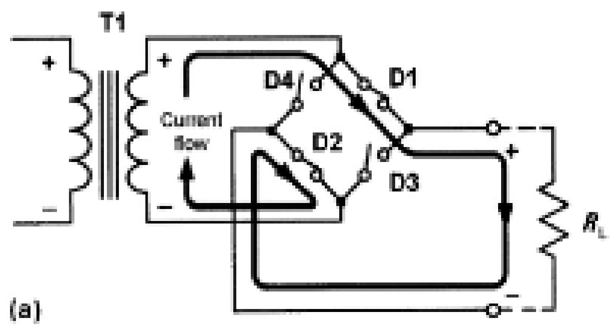
**ii) Bridge rectifier**

It is a type of full wave rectifier constructed using four diodes connected in the form of the bridge. The following is the circuit of the bi phase full wave rectifier.

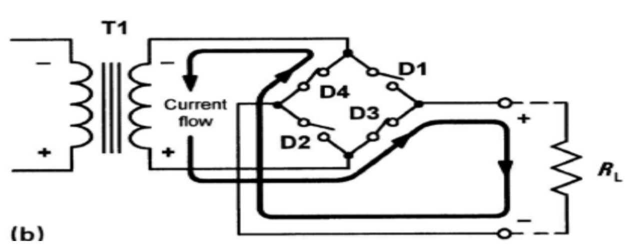



**Bridge Rectifier Circuit**

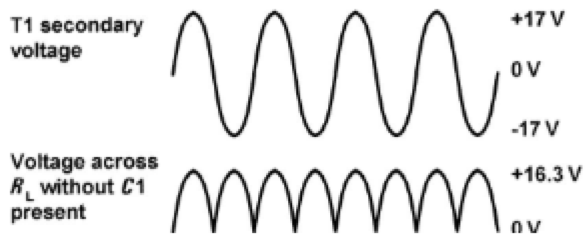
**During the positive half cycle,** end A is positive and end B is negative. Hence the diodes D1, D2 are forward biased while the diodes D3 and D4 are reverse biased. The following diagram shows the current path during the positive half cycle.




**During the negative half cycle**, end A is negative and end B is positive and for the segment BC, end B is negative and end C is positive. Hence the diode D3 and D4 are forward biased while the diode D3, D3 are reverse biased. The following diagram shows the current path during the positive half cycle.




The following is the input output waveform of the bridge rectifier.




OR

**2)a) List and describe the maintains types of amplifiers.**

**AC coupled Amplifier**

- *Stages are coupled together in such a way that dc levels are isolated* and only the *AC components of a signal are transferred from stage to stage.*

**DC(Direct) coupled Amplifier**

- *Stages are coupled together in such a way that stages are not isolated to d.c. potentials.*
- *Both a.c. and d.c. signal components are transferred from stage to stage.*

**Large Signal Amplifiers**

- Designed to cater for 1V – 100V or more

**Small signal amplifier**

- Designed to cater for low-level signals (normally *less than 1 V* and often much smaller).
- Specially designed to combat the effects of noise.

**Audio frequency amplifiers**

- Operate in the band of frequencies that is normally associated with audio signals (e.g. *20 Hz to 20 kHz*).

**Radio Frequency amplifiers**

- Operate in the band of frequencies that is normally associated with radio(100kHz-1GHz).

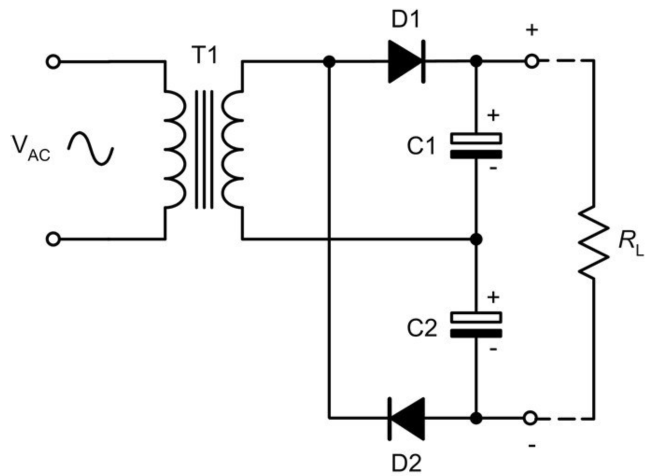
**Low noise amplifiers**

- Designed so that they contribute negligible noise (signal disturbance) to the signal being amplified.
- Designed for use with very small signal levels (usually less than 10 mV) or so).

**b) With a block diagram, explain the working of voltage doubler and voltage tripler.**

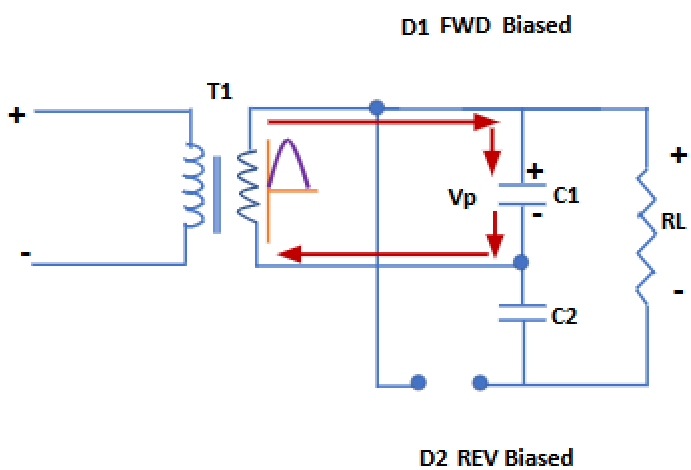
**Voltage doubler**

Voltage doubler is a type of voltage multiplier circuit in which the output voltage is double the input voltage. The following is the circuit diagram of a voltage doubler.

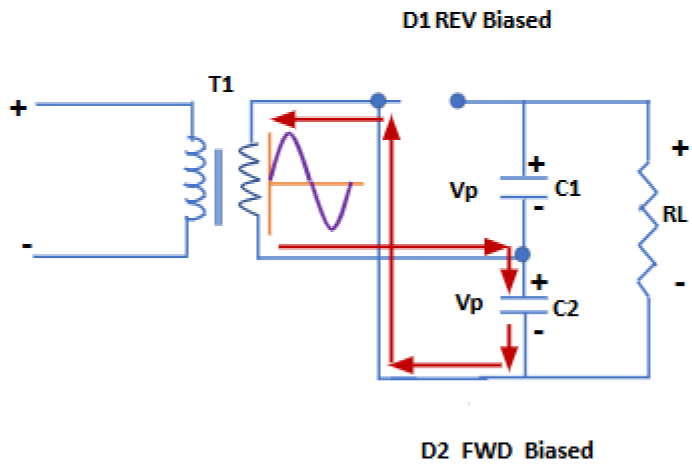



**Voltage Doubler circuit**

During the positive half cycle the upper end of the transformer secondary is positive and the lower end is negative. Hence the diode D1 is forward biased while the diode D2 is reverse biased. The current flows in the circuit as shown in the figure below.




During the negative half cycle the upper end of the transformer secondary is negative and the lower end is positive. Hence the diode D1 is reverse biased while the diode D2 is forward biased. The current flows in the circuit as shown in the figure below.




Hence, C1 will charge to positive peak of secondary and C2 will charge to negative peak of secondary voltage.

*Since the output is taken from C1 and C2 connected in series the resulting output voltage is twice that produced by one diode alone.*

**Voltage Tripler**

Voltage tripler is a type of voltage multiplier circuit in which the output voltage is double the input voltage. The following is the circuit diagram of a voltage tripler.

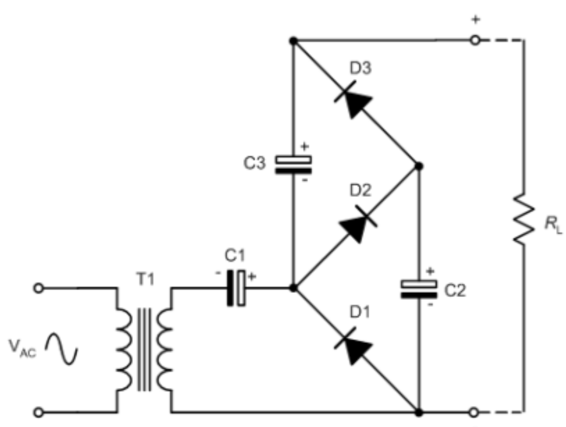



**Figure 6.26** A voltage tripler

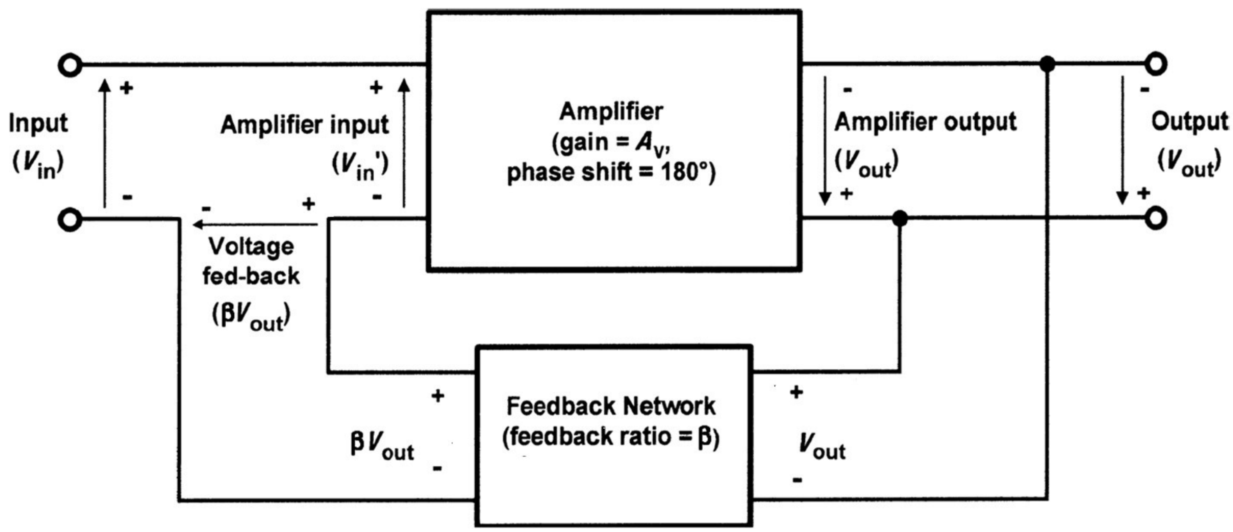
In the above circuit C1 charges to the positive peak secondary voltage, while C2 and C3 charge to twice the positive peak secondary voltage. The result is that the output voltage is the sum of the voltages across C1 and C3 which is three times the voltage that would be produced by a single diode. The ladder arrangement shown above can be easily extended to provide even higher voltages but the efficiency of the circuit becomes increasingly impaired and high-order voltage multipliers of this type are only suitable for providing relatively small currents.

2)c) Mention the advantage of negative feedback in amplifier circuit with relevant equations and diagram. Explain the concept of negative feedback.

Negative feedback refers to the case when the output is fed back to the input in such a way that it subtracts from the input and reduces the overall gain of the circuit. The following are the advantages of negative feed back.

(i) ***Precisely control the gain***
(ii) ***Reduce distortion***
(iii) ***Improve bandwidth***.

Following is the representation of an amplifier circuit with negative feedback, with the feedback factor equal to β.




Applying KVL,

$$V_{in} = V_{in}' + \beta V_{out} \qquad \text{---------------} \quad (1)$$

$$V_{in}' = V_{in} - \beta V_{out} \qquad \text{----------------------} \ (2)$$

Where,

$$V_{out} = A_v \times V_{in} \qquad \text{-------------------------} \ (3)$$

Gain is defined as the ratio of output to input.

$$\text{Gain} = G = \frac{V_{out}}{V_{in}}$$

$$G = \frac{A_v V_{in}'}{V_{in}' + \beta V_{out}}$$

$$G = \frac{A_v V_{in}'}{V_{in}' + \beta(A_v V_{in}')}$$

$$\boxed{G = \frac{A_v}{1+\beta A_v}}$$

Hence overall gain with negative feedback is less than the gain without feedback.

<u>Module 2</u>

3) a) List and explain the conditions to obtain sustained oscillations. Determine the frequency of oscillations of a 3 stage ladder network in which C= 10 nF and R= 10 KΩ.

The following are the conditions for sustained oscillations.

**i) The feedback must be positive (zero degree phase shift),** i.e. the signal fed back must arrive back in-phase with the signal at the input.

The amplifier provides 180° phase shift, while the feedback network provides another 180° phase shift. Hence the overall phase shift is $0^0$ or $360^0$.

**ii) The overall loop voltage gain must be greater than 1,** i.e. the amplifier's gain must be sufficient to overcome the losses associated with any frequency selective feedback network.

Given, C = 10nF,

R = 10KΩ

f = ?

$$f = \frac{1}{2\pi \times \sqrt{6}CR}$$

$$f = \frac{1}{2\pi\sqrt{6} * (10 * 10^{-9}) * 10 * 10^{3}})$$

f = 244.948 Hz

3) b) With circuit diagram and waveform show how operational amplifier can work as a comparator and voltage follower.

Comparator

---

* Comparators:

A comparator is an electronic circuit, which compare the two inputs that are applied to it and produces the result of comparison as output.

The output value of the comparator indicates which of the input is greater or lesser.

Types of comparators:

1) Inverting comparator
2) Non-inverting comparator

1) Inverting comparator:

It is an opamp based comparator, for which a reference voltage is applied to its noninverting terminal and the input voltage is applied to its inverting terminal.

The circuit diagram is shown below.

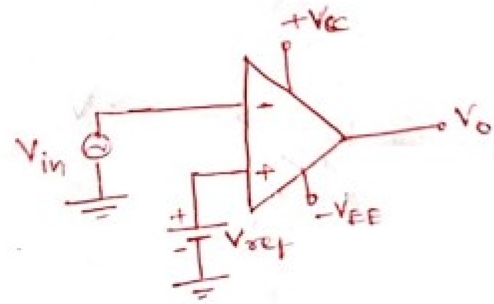
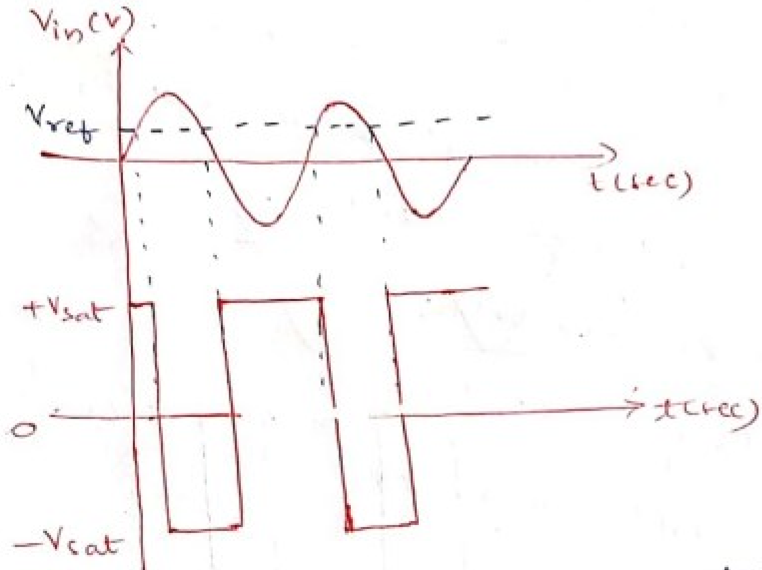



Fig: Inverting opamp.

If $V_{in} > V_{ref}$ then $V_o = -V_{sat}$ and

if $V_{in} < V_{ref}$ then $V_o = +V_{sat}$.




Waveform of Inverting comparator.

* **Non-inverting comparator:**

Here the reference voltage is applied to opamp's inverting terminal and the input voltage is applied to non-inverting terminal.

The circuit diagram is shown below.

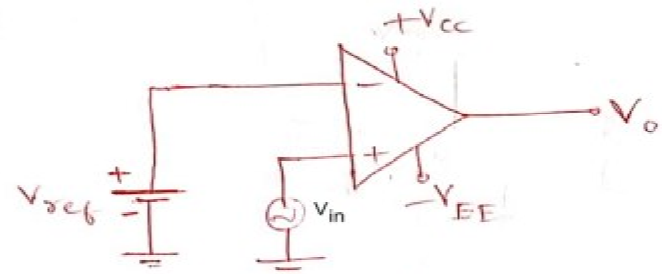
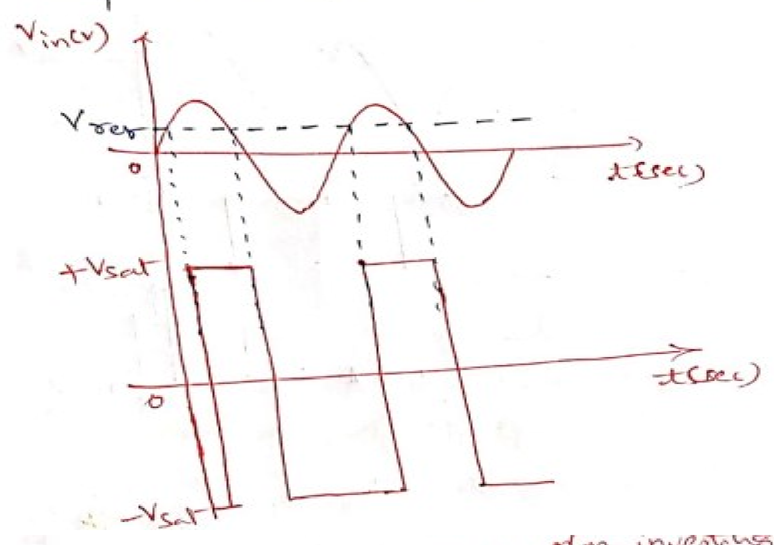



Fig. Non-inverting opamp

If $V_{in} > V_{ref}$ then $V_o = +V_{sat}$ and

if $V_{in} < V_{ref}$ then $V_o = -V_{sat}$.

Input & Output waveforms are shown below.




Input and output waveforms of Non-inverting comparator

★ Voltage follower:

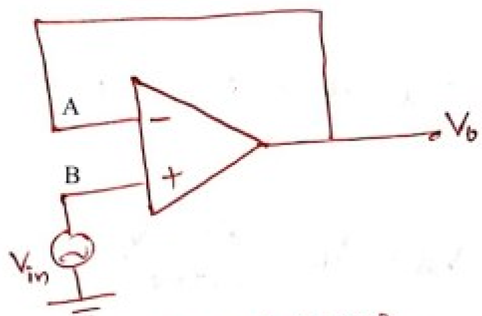



Fig: Voltage follower

- A circuit in which output voltage follows the input voltage is called voltage follower.
- Voltage follower circuit using opamp is shown in above figure.
- The node B is at potential $V_{in}$.
- The node A is also at the same potential as B i.e. $V_{in}$ according to concept of virtual ground.

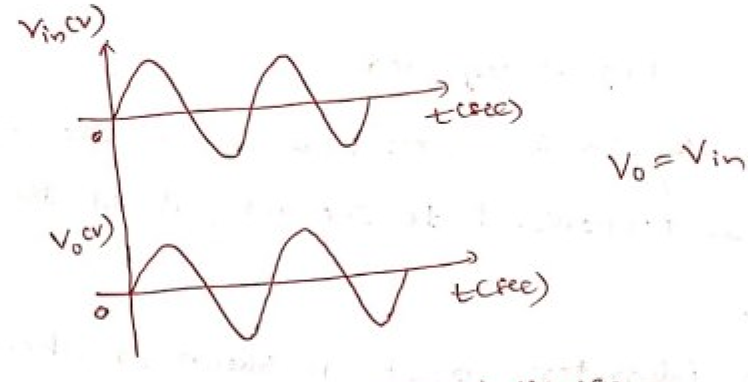
$$\therefore \quad V_A = V_B = V_{in}$$

- Now node A is directly connected to the output. Hence we can write.

$$V_0 = V_A = V_{in}$$

$$\therefore V_0 = V_{in}$$

- For this circuit, voltage gain is unity. Thus output voltage is equal to input voltage $V_{in}$.
- It is also called as source follower, unity gain amplifier, buffer amplifier.

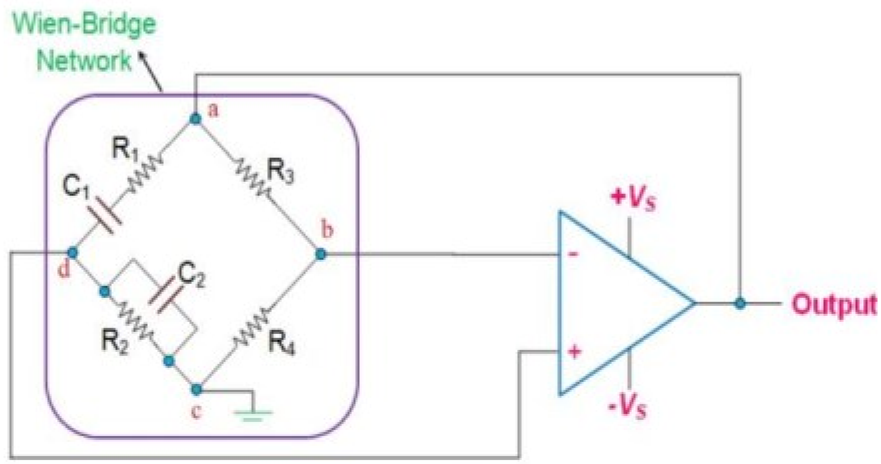



Waveforms of voltage follower

4)a) With neat circuit diagram explain the working of Wein Bridge oscillator.

Wein bridge oscillator is an RC oscillator and is used to generate sinusoidal oscillations in the audio frequency range.

The name wein bridge is due to the fact that, the network consists of four arms connected in bridge fashion as shown in below figure.




Wien-Bridge Oscillator Using an Op-Amp

- ***The input signal is applied to b and d*** while the ***output is taken from a and c***.
- ***At one particular frequency, the phase shift produced by the network will be exactly zero (i.e. the input and output signals will be in-phase).***
- If we connect the network to an amplifier producing 0° phase shift which has sufficient gain to overcome the losses of the Wien bridge, oscillation will result.
- The minimum amplifier gain required to sustain oscillation is given by: $$A_v = 1 + \frac{C1}{C2} + \frac{R2}{R1}$$
- When C1 = C2 and R1 = R2, the frequency at which the phase shift will be zero is given by: $$f = \frac{1}{2\pi \times \sqrt{C1C2R1R2}}$$
- When R1 = R2 = R and C1 = C2 = C the frequency at which the phase shift will be zero will be given by:

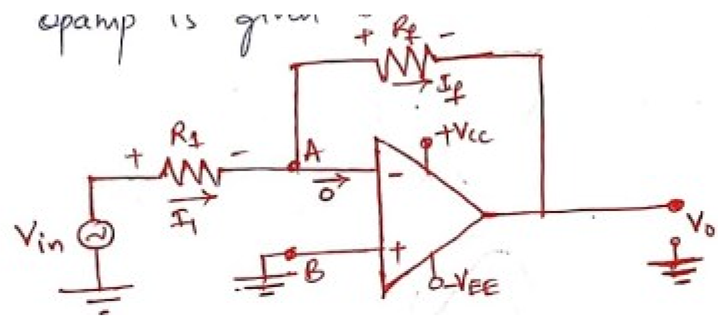
$$f = \frac{1}{2\pi \times \sqrt{C^2R^2}} = \frac{1}{2\pi CR}$$

4)b) Sketch the circuit of each of the following based on the use of operational amplifier

i) Inverting amplifier

In an inverting amplifier as the name implies, the o/p of the amplifier is inverted wrt the input signal. ie the output signal has 180° phase shift as compared to input signal.

In an inverting amplifier, the input is applied to the inverting terminal while the non-inverting i/p terminal is connected to ground.



Let $V_{in}$ be the i/p voltage and I be the current flowing through $R_1$.

Since input resistance of the opamp is very high, no current flows into the opamp and the entire current flows into the feedback resistance.

Current flowing through $R_1$ = $I = \frac{V_{in} - V_A}{R_1} \rightarrow ①$

Current flowing through $R_f$ = $I = \frac{V_A - V_0}{R_f} \rightarrow ②$

Since node B is grounded, node A is also equal to ground potential

$\therefore V_A = 0$

→ Equating ① & ②

$$\frac{V_{in} - V_A}{R_1} = \frac{V_A - V_0}{R_f}$$

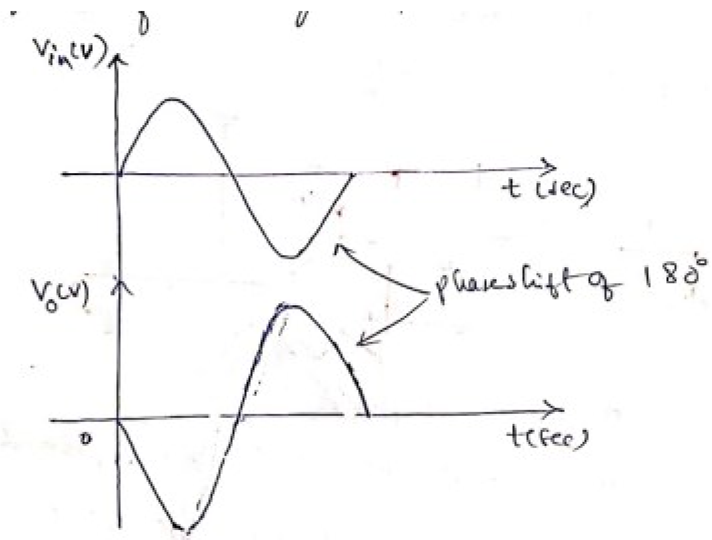
$$\frac{V_{in}}{R_1} = \frac{-V_0}{R_f}$$

$$\therefore \frac{V_0}{V_{in}} = -\frac{R_f}{R_1}$$

∴ Voltage gain

$$\therefore \boxed{A_{VF} = \frac{V_0}{V_{in}} = -\frac{R_f}{R_1}}$$

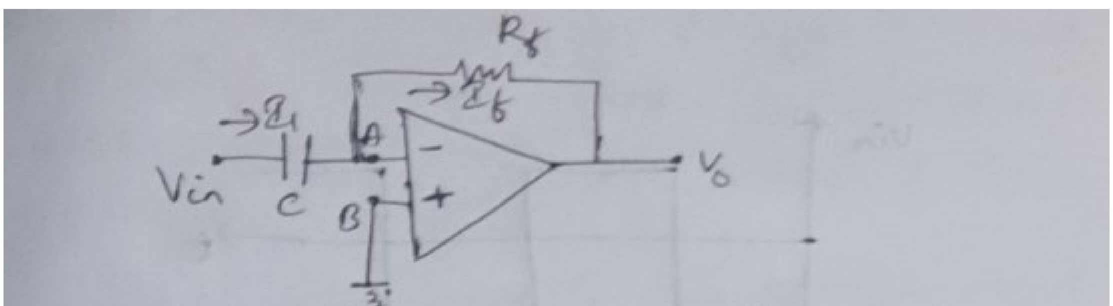
Here, Rf/R1 represents the gain of the amplifier, while the negative sign indicates that the output is inverted with respect to the input. Hence it is called as inverting amplifier.




Waveforms of inverting amplifier.

ii) Differentiator

A differentiator porduces an output that is equal to the rate of change of input. The faster the input changes, greater will the output be.




Since B is grounded, point A is also at zero potential i.e $V_A = 0$

As current through opamp is zero, the entire current $I_1$ flows through $R_f$.

$$I_1 = C \frac{d(V_{in}-V_A)}{dt}$$

Since $V_A = 0$

$$i_1 = C\frac{dV_{in}}{dt} \rightarrow (1)$$

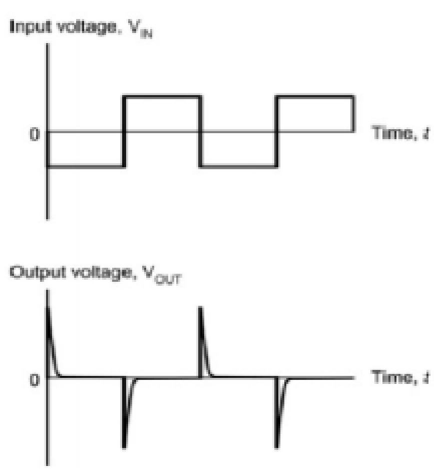
$$i_f = \frac{V_A - V_o}{R_f} = \frac{-V_o}{R_f} \rightarrow (2)$$

Equating (1) and (2)

$$C\frac{dV_{in}}{dt} = \frac{-V_o}{R_f}$$

$$\boxed{V_o = -CR_f\frac{dV_{in}}{dt}}$$

Hence the output is the derivative of the input signal and the negative sign indicates that the output is inverted with respect to the input.
The waveform of the differentiator circuit is shown below.




Typical input and output of a differentiator circuit

Module-3

**Q .5 a) Explain with circuit Diagram Full adder. ---- 6 Marks**

# Full Adder

Half adder does not takes the carry-in value into account.

Full adder is developed to overcome this drawback of Half Adder circuit. It can add two one-bit numbers A and B, along with carry $C_{in}$.

The full adder is a three input and two output combinational circuit.


Block diagram

| Inputs | | | Output | |
|---|---|---|---|---|
| A | B | Cin | S | Co |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |

From truth table, Logic expression for sum is given by

$$S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

$$S = \bar{A}(\bar{B}C_{in} + B\bar{C}_{in}) + A(\bar{B}\bar{C}_{in} + BC_{in})$$

$$= \bar{A}(B \oplus C_{in}) + A(\overline{B \oplus C_{in}})$$

$$\boxed{S = A \oplus B \oplus C_{in}}$$

$\because$ $A \oplus B = A\bar{B} + \bar{A}B$ and $A \odot B = \bar{A}\bar{B} + AB$

and $A \odot B = \overline{A \oplus B}$

$$C_o = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$

$$C_o = (\bar{A}B + A\bar{B})C_{in} + AB(\bar{C}_{in} + C_{in})$$

$$C_o = \bar{A}BC_{in} + A\bar{B}C_{in} + AB$$

$$= \bar{A}BC_{in} + A(\bar{B}C_{in} + B) \qquad \because A + \bar{A}B = A + B$$

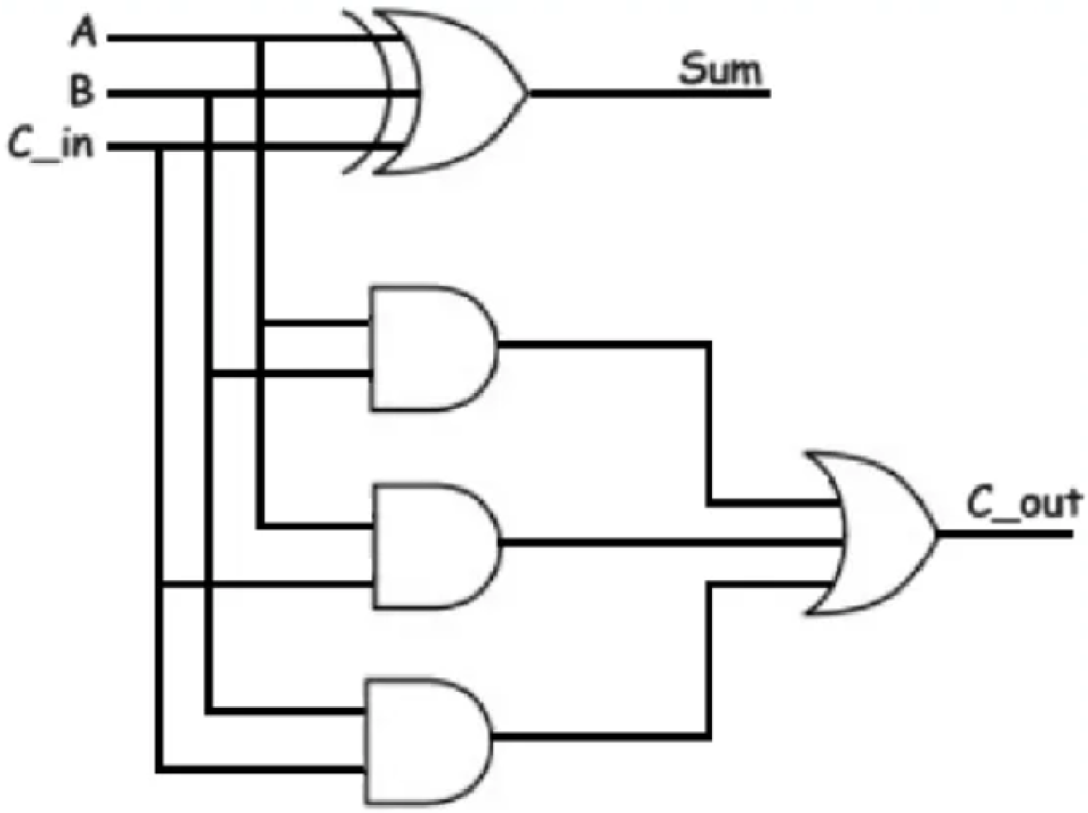
$$= \bar{A}BC_{in} + A(B + C_{in})$$

$$= \bar{A}BC_{in} + AB + AC_{in}$$

$$= B(\bar{A}C_{in} + A) + AC_{in}$$

$$= B(A + C_{in}) + AC_{in}$$

$$C_o = AB + BC_{in} + AC_{in}$$



**Q.5 b) Given two binary numbers X=1010100 and Y=1000011 perform the subtraction**

**i) X – Y and ii) Y – X using 2's complement. ---- 6 Marks**

X = 1010100 and ~~y=~~ Y = 1000011

(i) X − Y

1's complement of Y = 0111100

$+ \quad 1$

0111101

2's complement of Y

X = 1010100

+2's Y = 0111101

$\boxed{CY=1}$ 0010001

Carry out of MSB
Result is positive

discard carry

$X - Y = (0010001)_2 = (17)_{10}$

(ii) Y − X

1's complement of X = 0101011

$+ \quad 1$

0101100

2's complement of X =

Y = 1000011

+ 2's X = + 0101100

result = 1101111

No carryout of MSB
Result is negative

Take 2's complement of result

1's comp. of result = 0010000

$+ \quad 1$

2's comp. of result = − 0010001 $= (-17)_{10}$

Q.5 c) Convert

i) Decimal 225 to binary.

ii) Binary 11010111 to octal

iii) Octal 623 to decimal

iv) Hexadecimal 2AC5 to decimal. ------- 8 Marks

(i) $(225)_{10} = (\ ?\ )_2$

| | | |
|---|---|---|
| 2 | 225 | |
| 2 | 112 | 1 (LSB) |
| 2 | 56 | 0 |
| 2 | 28 | 0 |
| 2 | 14 | 0 |
| 2 | 7 | 0 |
| 2 | 3 | 1 |
| | 1 | 1 |

(MSB)

$(225)_{10} = (11100001)_2$

(ii) $(11010111)_2 = (\ ?\ )_8$

Add leading zero

$\underbrace{011}_{3}\ \underbrace{010}_{2}\ \underbrace{111}_{7}$

$\therefore (11010111)_2 = (327)_8$

(iii) $(623)_8 = (\ ?\ )_{10}$

$= 6 \times 8^2 + 2 \times 8^1 + 3 \times 8^0$

$= 6 \times 64 + 16 + 3$

$= 403$

$\therefore (623)_8 = (403)_{10}$

(iv) $(2AC5)_{16} = ( ? )_{10}$

$= 2\times16^3 + A\times16^2 + C\times16^1 + 5\times16^0$

$= 2\times16^3 + 10\times16^2 + 12\times16 + 5\times1$

$= 8192 + 2560 + 192 + 5$

$= 10949$

$\therefore (2AC5)_{16} = (10949)_{10}$

**Q6. A) Express the Boolean function F1=A+B'C in a sum of minterms form and F2=XY+X'Z in a product of maxterms form. ------- 10 Marks**

$F_1 = A + B'C$

$= A(B+B') + B'C(A+A')$

$= AB + AB' + AB'C + A'B'C$

$= AB(C+C') + AB'(C+C') + AB'C + A'B'C$

$= ABC + ABC' + \underline{AB'C} + AB'C' + AB'C + A'B'C$

$= \underset{1}{A'B'C} + \underset{4}{AB'C'} + \underset{5}{AB'C} + \underset{6}{ABC'} + \underset{7}{ABC}$

$F_1 = \Sigma m(1,4,5,6,7)$

$$F_2 = xy + \bar{x}z \qquad [\because A+BC = (A+B)\cdot(A+C)]$$

$$= (xy + \bar{x})(xy + z)$$

$$= (\bar{x} + x)(\bar{x} + y)(x + z)(y + z)$$

$$= (\bar{x} + y)(x + z)(y + z)$$

$$= (\bar{x} + y + z\bar{z})(x + z + y\bar{y})(y + z + x\bar{x})$$

$$= (\bar{x} + y + z)(\bar{x} + y + \bar{z})\boxed{(x + y + z)}(x + \bar{y} + z)\boxed{(x + y + z)}(\bar{x} + y + z)$$

$$F_2 = (\underset{1}{\bar{x}} + \underset{0}{y} + \underset{0}{z})(\underset{1}{\bar{x}} + \underset{0}{y} + \underset{1}{\bar{z}})(\underset{0}{x} + \underset{0}{y} + \underset{0}{z})(\underset{0}{x} + \underset{1}{\bar{y}} + \underset{0}{z})$$

$$F_2 = \prod M(0, 2, 4, 5)$$

**Q.6 b) Design full adder using 2two half adders and an OR gate. -------- 10 Marks**

Full adder:

| Inputs | | | Output | |
|---|---|---|---|---|
| A | B | Cin | S | Co |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |

From truth table, Logic expression for sum is given by

$$S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

$$S = \bar{A}(\bar{B}C_{in} + B\bar{C}_{in}) + A(\bar{B}\bar{C}_{in} + BC_{in})$$

$$= \bar{A}(B \oplus C_{in}) + A(\overline{B \oplus C_{in}})$$

$$\boxed{S = A \oplus B \oplus C_{in}}$$

$\because A \oplus B = A\bar{B} + \bar{A}B$ and $A \odot B = \bar{A}\bar{B} + AB$

and $A \odot B = \overline{A \oplus B}$

$$\text{Carry} = \underbrace{\bar{a} b c_{in} + a \bar{b} c_{in}} + a b \bar{c}_{in} + a b c_{in}$$

$$= ab(\bar{c}_{in} + c_{in}) + c_{in}(\bar{a}b + a\bar{b})$$

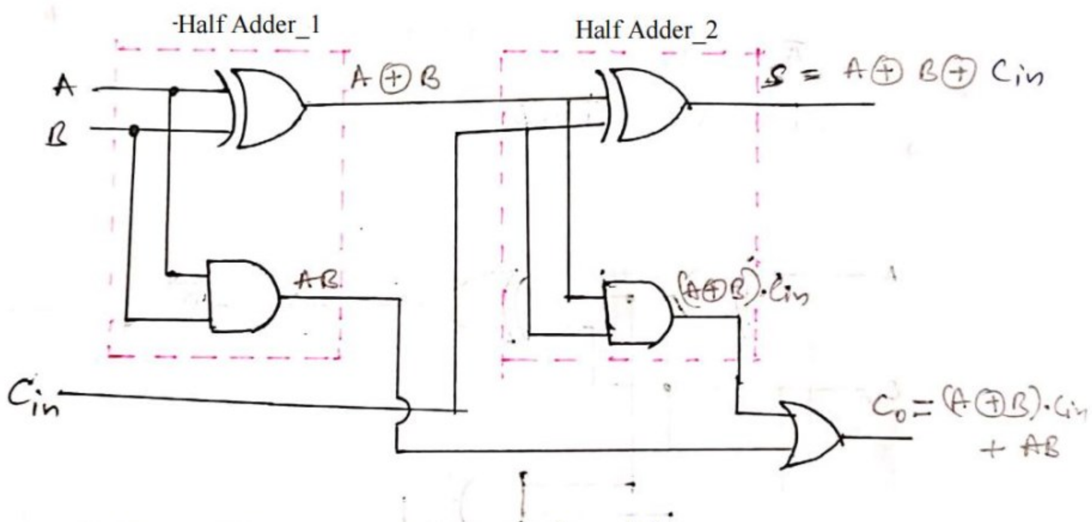
$$= ab + c_{in}(\bar{a}b + a\bar{b})$$

$$= ab + c_{in}(a \oplus b)$$

★ Realization of Full adder using two half adders.

$$S = A \oplus B \oplus C_{in}$$

$$C_o = (A \oplus B) C_{in} + AB$$




Full adder using two half adders.

Module-4

**Q.7 a) Compare embedded system and general-purpose computing system and also provide major application areas of embedded system. ------- 10 Marks**

An embedded system is an electronic/electro-mechanical system designed to perform a specific function and is a combination of both hardware and software.

| General Purpose Computing System | Embedded System |
|---|---|
| Contains a General Purpose Operating System (GPOS) | May or may not contain an operating system for functioning |
| Applications are alterable (programmable) by the user (It is possible for the end user to re-install the operating system, and also add or remove user applications) | The firmware of the embedded system is pre-programmed and it is non-alterable by the end-user (There may be exceptions for systems supporting OS kernel image flashing through special hardware settings) |
| Performance is the key deciding factor in the selection of the system. Always, 'Faster is Better' | Application-specific requirements (like performance, power requirements, memory usage, etc.) are the key deciding factors |
| Less/not at all tailored towards reduced operating power requirements, options for different levels of power management. | Highly tailored to take advantage of the power saving modes supported by the hardware and the operating system |
| Response requirements are not time-critical | For certain category of embedded systems like mission critical systems, the response time requirement is highly critical |
| Need not be deterministic in execution behaviour | Execution behaviour is deterministic for certain types of embedded systems like 'Hard Real Time' systems |

Major application areas of embedded system are listed as follows:

(1) *Consumer electronics:* Camcorders, cameras, etc.
(2) *Household appliances:* Television, DVD players, washing machine, fridge, microwave oven, etc.
(3) *Home automation and security systems:* Air conditioners, sprinklers, intruder detection alarms, closed circuit television cameras, fire alarms, etc.
(4) *Automotive industry:* Anti-lock breaking systems (ABS), engine control, ignition systems, automatic navigation systems, etc.
(5) *Telecom:* Cellular telephones, telephone switches, handset multimedia applications, etc.
(6) *Computer peripherals:* Printers, scanners, fax machines, etc.
(7) *Computer networking systems:* Network routers, switches, hubs, firewalls, etc.
(8) *Healthcare:* Different kinds of scanners, EEG, ECG machines etc.
(9) *Measurement & Instrumentation:* Digital multimeters, digital CROs, logic analysers PLC systems, etc.
(10) *Banking & Retail:* Automatic teller machines (ATM) and currency counters, point of sales (POS)
(11) *Card Readers:* Barcode, smart card readers, hand held devices, etc.
(12) *Wearable Devices:* Health and Fitness Trackers, Smartphone Screen extension for notifications, etc.
(13) Cloud Computing and Internet of Things (IOT)

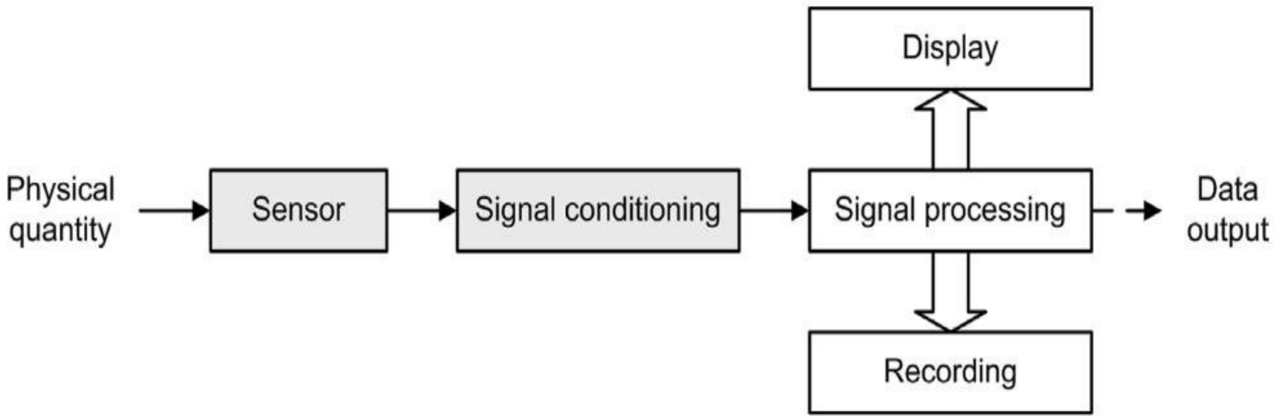
**Q.7 b) Bring out the difference between RISC and CISC, microprocessor and microcontroller. ---------- 10 Marks**

| RISC | CISC |
|---|---|
| Lesser number of instructions | Greater number of Instructions |
| Instruction pipelining and increased execution speed | Generally no instruction pipelining feature |
| Orthogonal instruction set (Allows each instruction to operate on any register and use any addressing mode) | Non-orthogonal instruction set (All instructions are not allowed to operate on any register and use any addressing mode. It is instruction-specific) |
| Operations are performed on registers only, the only memory operations are load and store | Operations are performed on registers or memory depending on the instruction |
| A large number of registers are available | Limited number of general purpose registers |
| Programmer needs to write more code to execute a task since the instructions are simpler ones | Instructions are like macros in C language. A programmer can achieve the desired functionality with a single instruction which in turn provides the effect of using more simpler single instructions in RISC |
| Single, fixed length instructions | Variable length instructions |
| Less silicon usage and pin count | More silicon usage since more additional decoder logic is required to implement the complex instruction decoding. |
| With Harvard Architecture | Can be Harvard or Von-Neumann Architecture |

| Microprocessor | Microcontroller |
|---|---|
| A silicon chip representing a central processing unit (CPU), which is capable of performing arithmetic as well as logical operations according to a predefined set of instructions | A microcontroller is a highly integrated chip that contains a CPU, RAM, special and general purpose register arrays, on chip ROM/FLASH memory for program storage, timer and interrupt control units and dedicated I/O ports. |
| It is a dependent unit. It requires the combination of other chips like timers, program and data memory chips, interrupt controllers etc., for functioning | It is a self contained unit and it doesn't require external interrupt controllers, timer etc., for its functioning |
| Most of the time general purpose in design and operation | Mostly application-oriented or domain-specific |
| Doesn't contain a built in I/O port. The I/O port functionality needs to be implemented with the help of external programmable peripheral interface chips like 8255 | Most of the controllers contain multiple built-in I/O ports which can be operated at a single 8 or 16 or 32 bit port or as individual port pins |
| Targeted for high end market where performance is important | Targeted for embedded market where performance is not so critical (At present this demarcation is invalid) |
| Limited power saving options compared to microcontrollers | Includes lot of power saving features |

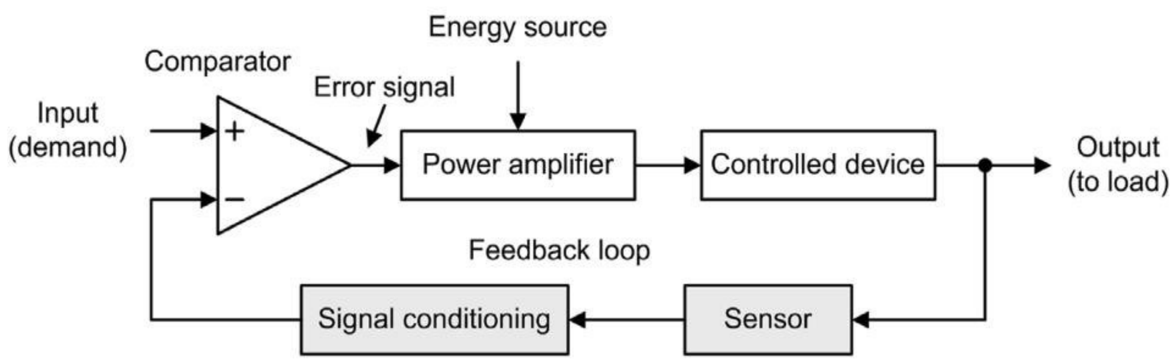
**Q. 8 a) Draw the basic block diagram of instrumentation and control system. Also explain the feedback-based control system. --------------- 10 Marks**

An instrument is a device that measures or manipulates or process physical variables such as temperature, pressure etc.




(a) Instrumentation system

Fig. a shows the arrangement of an instrumentation system. The physical quantity to be measured (e.g. temperature) acts upon a sensor that produces an electrical output signal. The output produced by the sensor may be small or may suffer from the presence of noise (i.e. unwanted signals) further signal conditioning will be required before the signal will be in an acceptable form for signal processing, display and recording. the signal processing may use digital rather than analogue signals an additional stage of analog to digital conversion is required.




(b) A control system

Fig.b shows the arrangement of a control system. This uses negative feedback in order to regulate and stabilize the output.

It thus becomes possible to set the input or demand (i.e. what we desire the output to be) & leave the system to regulate itself by comparing it with a signal derived from the output (via a sensor and appropriate signal conditioning). A comparator is used to sense the difference in these two signals and where any discrepancy is detected the input to the power amplifier is adjusted accordingly. This signal is referred to as an error signal (it should be zero when the output exactly matches the demand). The controlled device can take many forms (e.g. a d.c. motor, heater, etc.).

**Q.8 b) With a neat diagram explain the working of LED and 7 segment display. ---- 10 marks**

## LED

- Light Emitting Diode (LED) is an important output device for visual indication in any embedded system.
- Light Emitting Diode is a p-n junction diode and it contains an anode and a cathode.
- For proper functioning of the LED, the anode of it should be connected to +ve terminal of the supply voltage and cathode to the –ve terminal of supply voltage.

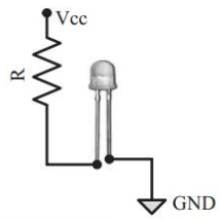
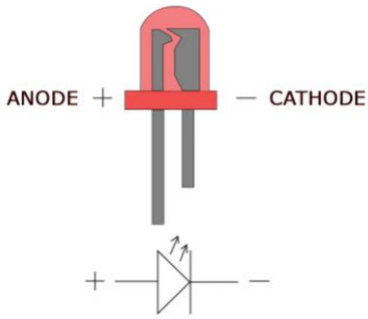
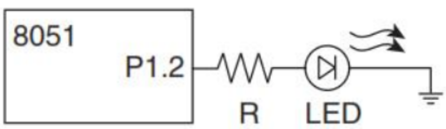


Fig. 2.13 LED interfacing




## Interfacing a LED

- Light Emitting Diode (LED) emits light when **forward biased**.
- When the **port pin** P1.2 goes **high** in Fig., the **LED is forward biased** and **emits light**.
- When the **pin** P1.2 goes **low**, **LED is off.**



LED interfaced to 8051

# 7-Segment LED Display

The 7 – segment LED display is an **output device** for displaying alpha numeric characters

✓It contains 8 light-emitting diode (LED) segments arranged in a special form.

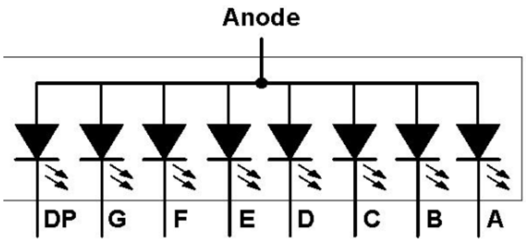
✓Out of the 8 LED segments, 7 are used for displaying alpha numeric characters and 1 is used for representing decimal point.

✓The LED segments are named A to G and the decimal point LED segment is named as DP

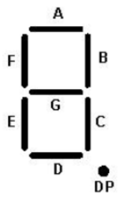
✓The LED Segments A to G and DP should be lit accordingly to display numbers and characters

✓The 7 – segment LED displays are available in two different configurations, namely; **Common anode and Common cathode**

In the Common anode configuration,
the anodes of the 8 segments are connected commonly
To display ‘0’, the inputs a, b, c, d, e, f should be made “low” to forward bias the corresponding LEDs, as the anodes are already connected to $V_{cc}$.

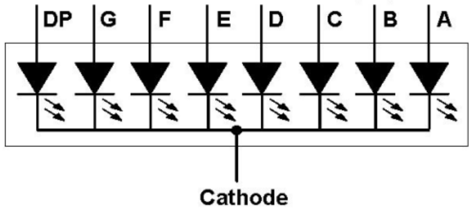



Common Anode LED Display




In the Common cathode configuration,
the 8 LED segments share a common cathode line (connected to ground).
To display the number 0 (zero),
LEDs A, B, C, D, E, F should be switched “on” and LEDs G and DP should be made “off” in the 7-segment display.

Common Cathode LED Display

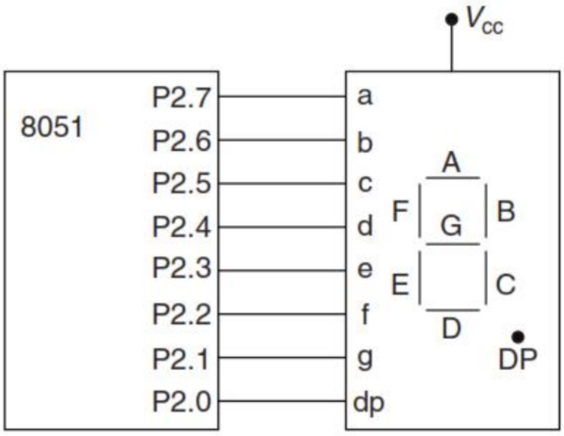


## 7-Segment LED Display

✓Based on the configuration of the 7 – segment LED unit,

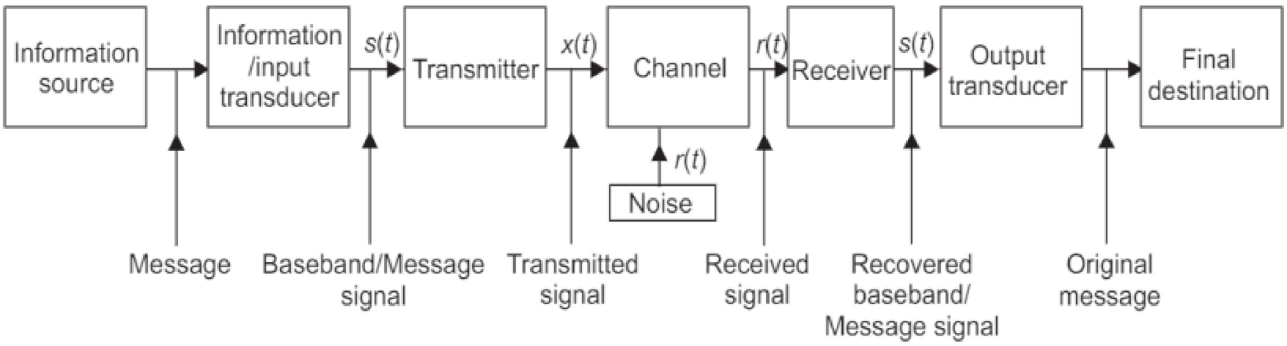
- ✓the LED segment anode or cathode is connected to the
- ✓Port of the processor/ controller in the order
- ✓ 'A' segment to the Least significant port Pin and
- ✓DP segment to the most significant Port Pin.

✓OR vice versa




Module-5

**Q.9 a) With a neat diagram explain the basic blocks used in communication system. ----- 10 Marks**




Schematic diagram of a Basic Communication System

**Information source**: A communication system transmits information from an information source (message) to a destination.

Examples: Voice, Live scenes(video), music, written text, and e-mail.

**Input Transducer**: A input transducer is a device that converts a non-electrical energy into its corresponding electrical energy called baseband signal s(t).

Example Transducers: Sound: Microphone, Picture: Camera, Text: Keyboard, Temperature/Pressure: Sensor with transducer

**Transmitter:**

- Baseband signal s(t) which is the output of the input transducer is input the transmitter. Transmitter processes the signal prior to transmission. Nature of processing depends on the type of communication system. Two options are available for processing

i) Baseband signal which lies in low frequency spectrum is translated to the high frequency spectrum. – Carrier Communication system

ii) The baseband signal is transmitted without translating to a higher frequency spectrum – Baseband communication system

For example, in Carrier Communication system baseband signal is translated from low frequency baseband signal to a higher frequency spectrum called Modulation. The modulated signal is denoted as x(t).

**Channel:**

The transmission medium between the transmitter and the receiver is called a channel. The transmitted signal should have adequate power to withstand the channel noise. Depending on the physical implementations, one can classify the channels in the following two groups:

a) Hardwired channels: Ex: Transmission lines, Waveguides and OFC

b) Soft-wired channels. EX: Air or Open space and Sea water

**Noise:**

Noise is an unwanted signal and does not contain any information denoted as n(t). When noise is mixed with the transmitted signal, it rides over it and deteriorates its waveform. This results in alteration of the original signal and wrong information is received. The signal power should be sufficiently increased so that it can withstand the noise.

**Receiver:**

The task of the receiver is to provide the original information to the user. The information is altered due to the processing at the transmitter. The signal received by the receiver is r(t). This signal contains both the transmitted signal x(t) and the noise n(t) added to it during transmission. The receiver performs the opposite operation, demodulation which brings the signal from high frequency spectrum to low frequency spectrum. Demodulation removes the high frequency carrier signal from the received signal and recovers the original baseband signal s(t).

**Output transducer**:

Converts the electrical baseband signal s(t) back to non-electrical original signal and delivered to destination.

**Q.9b) Explain the need for modulation and explain briefly the types of modulation used for communication. --------- 10 Marks**

Modulation is the process of varying characteristics such as, amplitude, frequency, or phase of the carrier signal, in accordance with the amplitude of modulating signal (message signal) that typically contains information to be transmitted. For example, the modulation signal might be an audio signal representing sound from a microphone, a video signal representing moving images from a video camera, or a digital signal representing a sequence of binary digits, a bitstream from a computer.

Need for modulation is explained in following points:

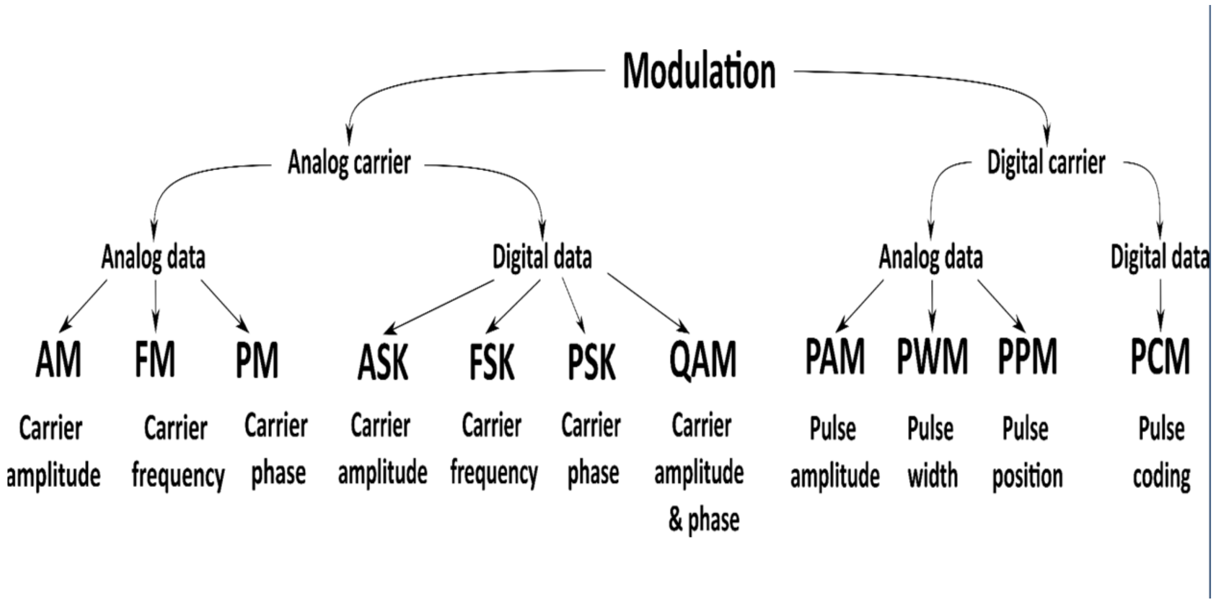
1. **Height of the antenna is reduced**: When we transmit a radio signal antenna height must be a **multiple of λ/4** where λ is the wavelength whose value is λ = c/f.λ is directly proportional to the speed of light and inversely proportional to the signal frequency. This means that higher the frequency lesser will be the value of λ that result in the shorter height of antenna which can be practically installed. Thus we can say modulation reduces the antenna height.
2. **Avoid mixing of signals**: It avoids the mixing of various signals. Suppose we have transmitted some baseband signals by multiple transmitters then all the signal will be in between the same frequency band i.e., in between 0 to 20KHZ which result in mixing of signals and receiver will not be able to separate them. But if we modulate all the signals with different carriers then the signals will have different frequency range so that they can be easily separated at the destination.
3. **Increase in the range**: The low-frequency message signal has another drawback that it cannot travel much longer distance during transmission as the signal gets attenuated. However, if we increase frequency then attenuation gets reduced thereby increasing the range of data transmission.
4. **Multiplexing can be done**: Modulation makes multiplexing possible. Through multiplexing, we can use the same channel to transmit various signal at the same time. But it gets successful only when the signal is modulated because modulation provides different frequency range to the signals. Due to which they can be transmitted through the same channel at the same time.

5. Improves Quality of reception

6. Bandwidth Extension

7. Reduced noise and interference

Types of Modulation:




**Analog modulation schemes:**

1. **Amplitude modulation (AM)** -modulation technique in which the instantaneous amplitude of the carrier signal is varied in accordance with the instantaneous amplitude of the analog modulating signal to be transmitted, keeping frequency and phase of the carrier constant.
2. **Frequency Modulation**: Process of changing the frequency of the carrier signal in accordance with the instantaneous amplitude of the modulating signal while keeping the amplitude and phase of the carrier constant.
3. **Phase modulation**: Process in which the instantaneous phase of the carrier signal is varied in accordance with the instantaneous amplitude of the of the modulating signal, while keeping amplitude and frequency of the carrier constant.

**Digital Modulation Schemes:**

1. **Amplitude shift Keying (ASK):** Represents digital data as variations in the amplitude of a carrier wave.
2. **Frequency shift keying (FSK):** Digital information is transmitted through discrete frequency changes of a carrier signal.
3. **Phase shift keying (PSK):** Conveys the digital data by changing the phase of the constant frequency carrier.

**Q. 10a) What are the advantages and disadvantages of digital communication over analog communication? ------------- 10 Marks**

Advantages of digital communication over analog communication:

1. Less sensitive to noise.
2. Digital circuits are easy to design and cheaper than analog circuits.
3. It is easier to integrate different services: video and the accompanying soundtrack, into the same transmission scheme.
4. The transmission scheme can be relatively independent of the source.
5. Signal processing functions such as encryption and compression are employed in digital circuits to maintain the secrecy of the information.
6. Digital circuits are less sensitive to physical effects such as vibration and temperature.
7. Digital signals are simpler to characterize, this makes the associated hardware easier to design.
8. Easy to Implement techniques like Multiplexing, Equalization, Error correction
9. There are techniques for removing redundancy from a digital transmission, so as to minimize the amount of information that has to be transmitted.

Disadvantages of digital communication over analog communication:

1. Higher Bandwidth Requirement: Digital signals usually need more bandwidth than analog for the same information.
2. Complex Equipment: Requires analog-to-digital converters, digital signal processors, and more complex circuitry.
3. Quantization Errors: Signal is approximated during digitization, leading to loss of detail.
4. Latency: Processing, encoding, and error correction introduce delay.
5. Higher Power Consumption: Digital circuits and processing units consume more power.
6. Complete Signal Loss: Digital signals may fail entirely if the signal quality drops below a certain threshold.
7. High Initial Cost: More expensive to set up digital systems, especially in analog-dominated environments.

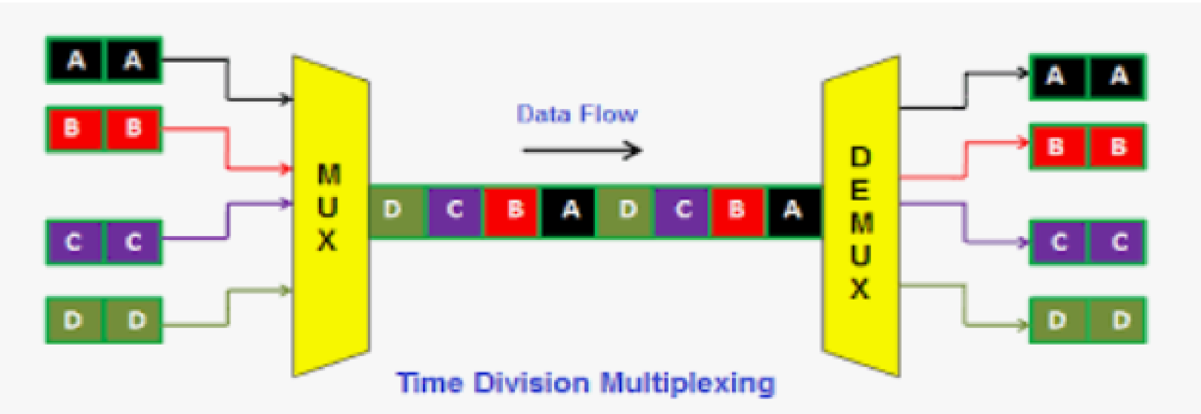
- Compatibility Issues: Difficult to interface with older analog systems without converters.

**Q.10b) With neat diagram explain the working of time division multiplexing and frequency division multiplexing? ----------- 10 Marks**

Multiplexing is the process that allows transmission of more than one signal on a single channel. Multiplexing allows maximum utilization of the available bandwidth. Multiplexing is possible only due to modulation.

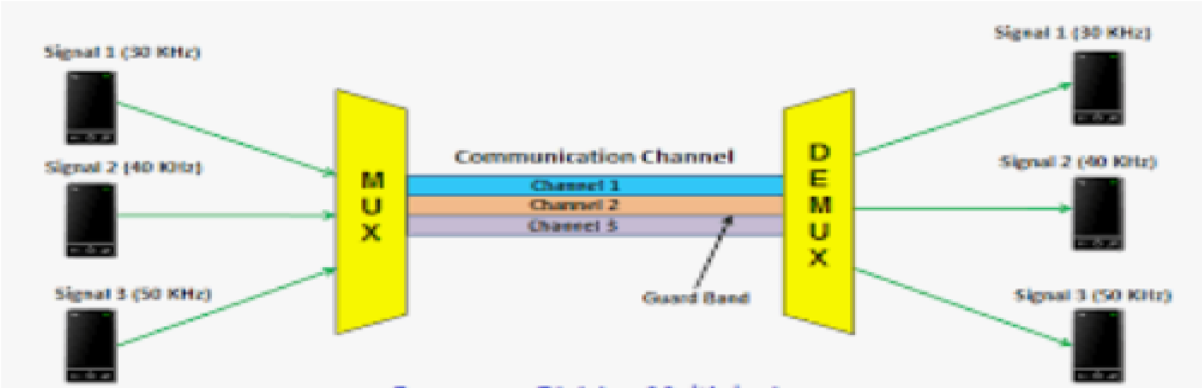
**Time division multiplexing:**

Time Division Multiplexing (TDM) is a technique used in digital and analog communication systems to transmit multiple signals over a single communication channel by dividing time into distinct slots. Each signal is allocated a specific time slot in which it can transmit its data. These time slots are assigned in a round-robin fashion, and the signals take turns using the channel. TDM operates so rapidly that multiple transmissions appear to occur simultaneously. TDM is widely used in applications such as telephone networks, digital audio and video transmission, and satellite communication.




**Frequency division multiplexing:**

Frequency Division Multiplexing (FDM) is a technique used in analog communication to transmit multiple signals simultaneously over a single communication channel by dividing the available bandwidth into multiple frequency bands. Each signal is assigned a unique frequency range (band), and all signals are transmitted at the same time, but at different frequencies. To prevent overlapping and interference, guard bands are placed between adjacent frequency bands. FDM is commonly used in traditional radio and television broadcasting, cable TV, and early telephone systems.




Frequency Division Multiplexing