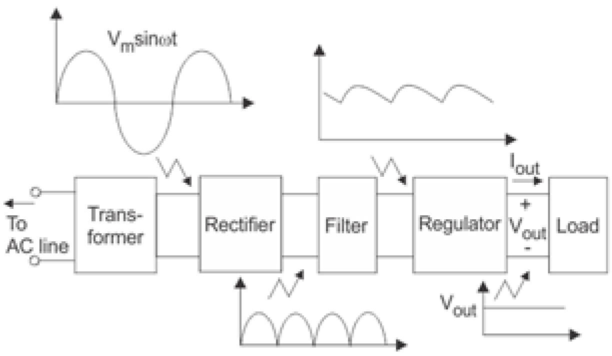
Q.01 A. What is a regulated power supply? With neat block diagram Summarize the working of DC power supply. Also mention the principal components used in each block.

ANS. Today almost every electronic device needs a DC supply for its smooth operation and they need to be operated within certain power supply limits. This required DC voltage or DC supply is derived from single phase ac mains.

A regulated power supply can convert unregulated an AC (alternating current or voltage) to a constant DC (direct current or voltage). A regulated power supply is used to ensure that the output remains constant even if the input changes. A regulated DC power supply is also called as a linear power supply, it is an embedded circuit and consists of various blocks.

The regulated power supply will accept an AC input and give a constant DC output. Figure below shows the block diagram of a typical regulated DC power supply



Components of typical linear power supply

The basic building blocks of a regulated DC power supply are as follows:

1. A step down transformer
2. A rectifier
3. A DC filter
4. A regulator

Step Down Transformer

A step down transformer will step down the voltage from the ac mains to the required voltage level. The turn's ratio of the transformer is so adjusted such as to obtain the required voltage value. The output of the transformer is given as an input to the rectifier circuit.

Rectification

Rectifier is an electronic circuit consisting of diodes which carries out the rectification process. Rectification is the process of converting an alternating voltage or current into corresponding direct (DC) quantity. The input to a rectifier is ac whereas its output is unidirectional pulsating DC. Usually a full wave rectifier or a bridge rectifier is used to rectify both the half cycles of the ac supply (full wave rectification). Figure below shows a full wave bridge rectifier.'

DC Filtration'

The rectified voltage from the rectifier is a pulsating DC voltage having very high ripple content. But this is not we want, we want a pure ripple free DC

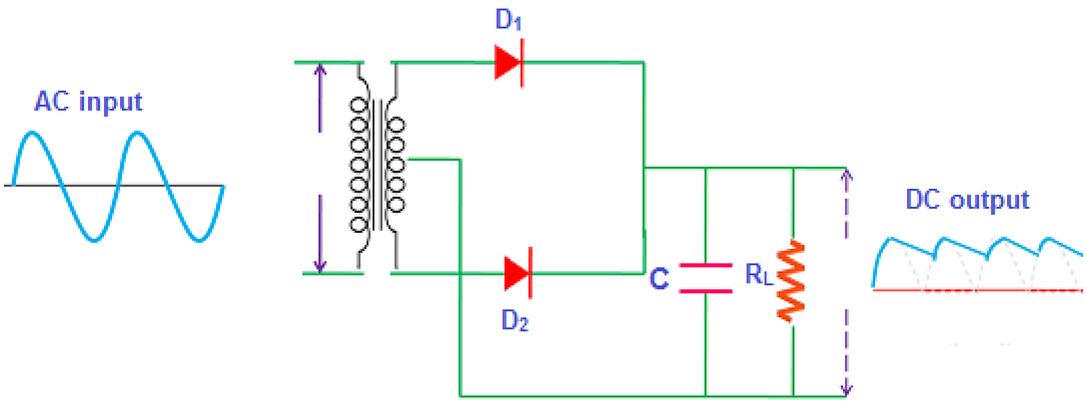
Regulation

This is the last block in a regulated DC power supply. The output voltage or current will change or fluctuate when there is change in the input from ac mains or due to change in load current at the output of the regulated power supply or due to other factors like temperature changes. This problem can be eliminated by using a regulator. A regulator will maintain the output constant even when changes at the input or any other changes occur. Transistor series regulator, Fixed and variable IC regulators or a zener diode operated in the zener region can be used depending on their applications. IC's like 78XX and 79XX are used to obtained fixed values of voltages at the output. waveform. Hence a filter is used. Different types of filters are used such as capacitor filter, LC filter, Choke input filter, π type filter.

B. Discuss the need of filter circuit. With circuit diagram and waveforms brief out the operation of smoothing filter for full wave rectifiers.

ANS. The main duty of the capacitor filter is to short the ripples to the ground and blocks the pure DC (DC components), so that it flows through the alternate path and reaches output load resistor R_L.

When input AC voltage is applied, during the positive half cycle, the diode D_1 is forward biased and allows electric current whereas the diode D_2 is reverse biased and blocks electric current. On the other hand, during the negative half cycle the diode D_2 is forward biased (allows electric current) and the diode D_1 is reverse biased (blocks electric current).

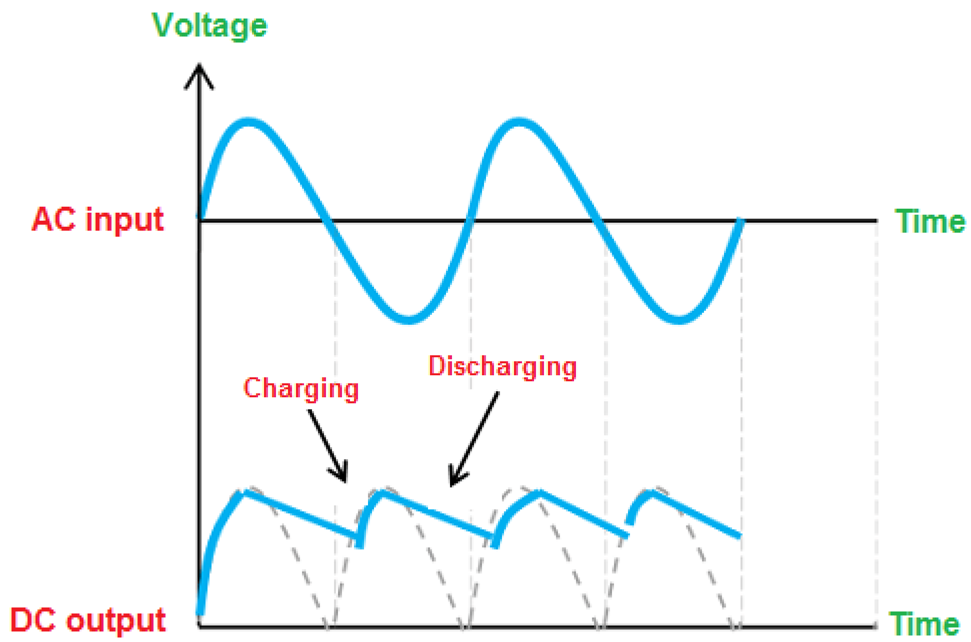


Full wave rectifier with capacitor filter

During the positive half cycle, the diode (D_1) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage.

Initially, the capacitor is uncharged. That means no voltage exists between the plates of the capacitor. So when the voltage is turned on, the charging of the capacitor happens immediately.

During this conduction period, the capacitor charges to the maximum value of the input supply voltage. The capacitor stores a maximum charge exactly at the quarter positive half cycle in the waveform. At this point, the supply voltage is equal to the capacitor voltage.



When the AC voltage starts decreasing and becomes less than the capacitor voltage, then the capacitor starts slowly discharging.

The discharging of the capacitor is very slow as compared to the charging of the capacitor. So the capacitor does not get enough time to completely discharged. Before the complete discharge of the capacitor happens, the charging again takes place. So only half or more than half of the capacitor charge get discharged.

When the input AC supply voltage reaches the negative half cycle, the diode D_1 is reverse biased (blocks electric current) whereas the diode D_2 is forward biased (allows electric current).

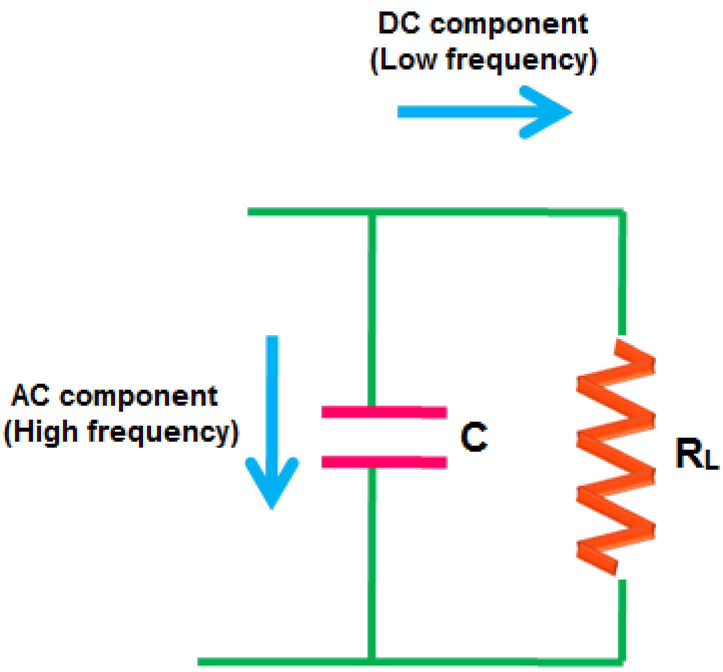
During the negative half cycle, the diode (D_2) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage.

The capacitor is not completely uncharged, so the charging of the capacitor does not happens immediately. When the supply voltage becomes greater than the capacitor voltage, the capacitor again starts charging.

In both positive and negative half cycles, the current flows in the same direction across the load resistor R_L. So we get either complete positive half cycles or negative half cycles. In our case, they are complete positive half cycles

The pulsating Direct Current (DC) produced by the full wave rectifier contains both AC and DC components.

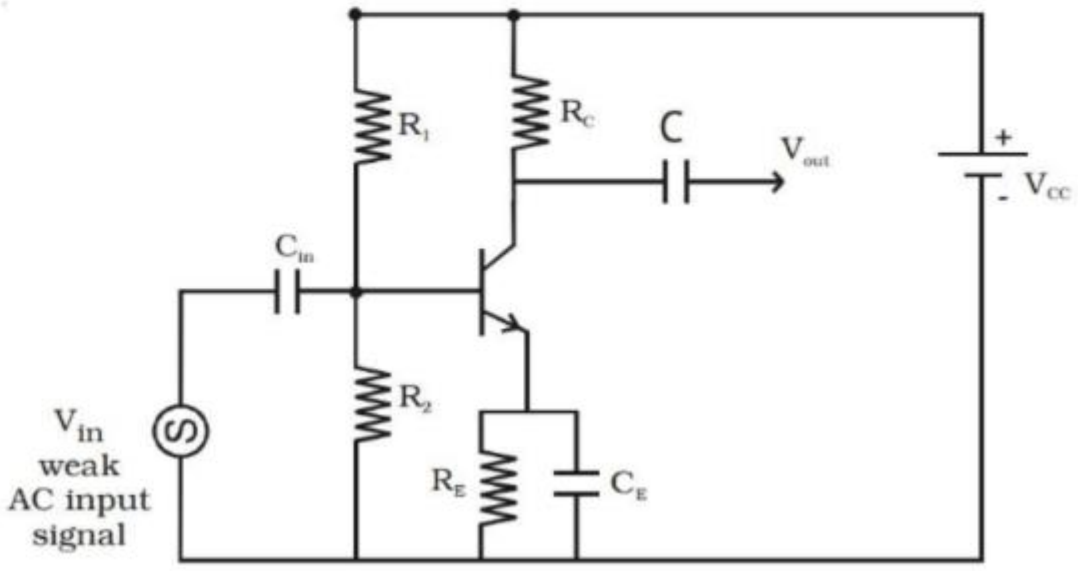
We know that the capacitor allows the AC components and blocks the DC components of the current. When the DC current that contains both DC components and AC components reaches the filter, the DC components experience a high resistance from the capacitor whereas the AC components experience a low resistance from the capacitor.



Electric current always prefers to flow through a low resistance path. So the AC components will flow through the capacitor whereas the DC components are blocked by the capacitor. Therefore, they find an alternate path and reach the output load resistor R_L. The flow of AC components through the capacitor is nothing but the charging of a capacitor.

C. With neat diagram Summarize working principle of the voltage divider bias CE amplifier with feedback.

ANS. When only one transistor associated with the circuit is used for amplification of a weak signal, the circuit is known as a single-stage amplifier. When a common emitter base is used to collect the amplified signal it is known as the single stage CE amplifier.
The diagram of a single stage CE amplifier is given below



A simple stage CE amplifier has different circuit elements and functions. Let us discuss about that,

The resistance R_1,R_2,R_E,shown in the diagram forms the biasing circuit.

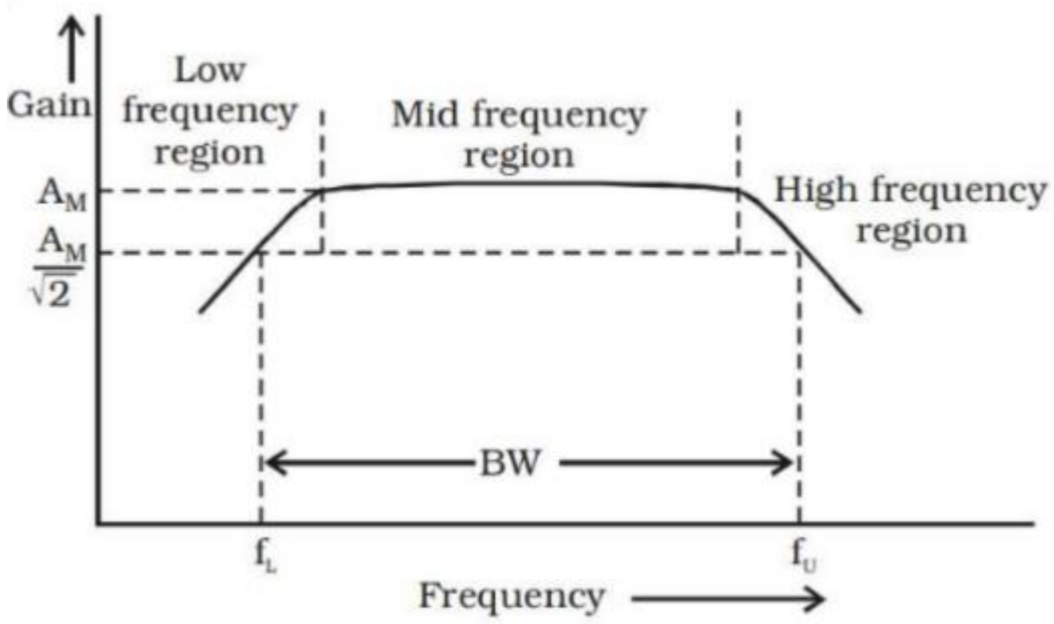
The circuit used to couple the signal to the base of the transistor is known as the input capacitance, C_{in},circuit. The signal source resistance will come across R_2,if this circuit is not used, and thus change the bias. The capacitor C_{in} allows only a.c. signal to flow through it

The capacitor connected in parallel with RE to provide a low reactance path to the amplified AC signal is known as the Emitter bypass capacitor CE. If this capacitor is not used, then the amplified AC signal flowing through RE will cause a voltage drop across it, thereby shifting the output voltage.

The capacitor used to couple the amplified signal to the output device is known as coupling capacitor C. This capacitor C allows only a.c. signal to flow through it

Working:

A small base current flows when a weak input a.c. signal is given to the base of the transistor. A much larger a.c. current flows through collector load RC due to transistor action. A large voltage appears across RC and hence we get a large voltage at the output. Therefore, a weak signal applied to the base came out in amplified form in the collector circuit. The ratio of the amplified output voltage to the input voltage in the amplifier is known as the Voltage gain (Av) of the amplifier.



The above diagram shows the frequency response curve

The voltage gain (Av) of the amplifier for different input frequencies can be determined using the frequency response graph. Taking frequency (f) along X–axis and voltage gain (Av) along Y–axis a graph is drawn. The frequency response curve obtained from the graph it will be like the one which is shown in the diagram above

It is seen that the amplifier gain decreases at very low frequency and at very high frequency, but over a wide range of mid frequency regions it remains constant. The frequency in the low frequency range at which the gain of the amplifier is 12–√12 times the mid frequency gain (AM) is known as the lower cut off frequency.

The frequency in the high frequency range at which the gain of the amplifier is 12–√12 times the mid frequency gain (AM) is known as the upper cut of frequency.

The frequency interval between lower cut off and upper cutoff frequencies is known as the Bandwidth of the single stage CE amplifier.

$BW = f_u - f_l$

Where,

BW is the bandwidth

f_u is the upper cut of frequency.

f_l is the lower cut off frequency.

Q.02 A. A 5V zener diode has a maximum rated power dissipation of 500 mW. If the diode is to be used in a simple regulator circuit to supply a

regulated 5V to a load having a resistance of 500 Ω, determine a suitable value of series resistor for operation in conjunction with a supply of 9V.

ANS. *Determine the voltage across the series resistor: The Zener diode is intended to regulate the voltage at 5V, so the voltage across the series resistor will be 9V (supply voltage) - 5V (Zener diode voltage) = 4V.*

Calculate the current flowing through the load resistor and the Zener diode: The load resistance is given as 500 Ω, and the desired output voltage is 5V. Using Ohm's law, we can calculate the current flowing through the load resistor as I = V/R = 5V / 500 Ω = 10 mA. This current will also flow through the Zener diode, as they are in series.

Calculate the power dissipation in the Zener diode: The maximum rated power dissipation of the Zener diode is given as 500 mW.

Choose a suitable value of the series resistor: The series resistor is used to limit the current flowing through the Zener diode and to dissipate excess power. The power dissipated in the series resistor can be calculated as P = IV, where I is the current flowing through the resistor and V is the voltage across it. In this case, we have V = 4V (from step 1) and I = 10 mA (from step 2). Plugging these values into the formula, we get P = (10 mA) x (4V) = 40 mW.

Verify that the power dissipation in the Zener diode is within the maximum rated power: Subtract the power dissipated in the series resistor (from step 4) from the maximum rated power of the Zener diode (given as 500 mW). In this case, we have 500 mW - 40 mW = 460 mW, which is still within the maximum rated power of the Zener diode.

So, a suitable value of the series resistor for the given scenario would be one that limits the current flowing through the Zener diode to 10 mA and dissipates 40 mW of power. Using Ohm's law, we can calculate the resistance as R = V/I = 4V / 10 mA = 400 Ω. Therefore, a 400 Ω resistor would be a suitable choice as a *series resistor in conjunction with a 9V supply and a 5V Zener diode to regulate the voltage to 5V for a load resistance of 500 Ω.*

B. What is voltage multiplier and mention its applications? With circuit diagram brief out the operation of voltage Tripler circuit.

ANS. *A voltage multiplier is an electronic circuit that generates a higher DC voltage from a lower DC voltage. It uses a combination of diodes and capacitors to multiply the input voltage to a higher level. Voltage multipliers are commonly used in various applications where high voltages are required, such as in high-voltage power supplies, CRT displays, electrostatic precipitators, and X-ray generators.*

One common type of voltage multiplier is the Voltage Tripler circuit. The voltage tripler circuit is a type of voltage multiplier that triples the input voltage. It consists of a combination of diodes and capacitors connected in a ladder-like configuration.

The circuit diagram of a voltage tripler is shown below:

```
      +V_in
    |
    C1
    |
 D1 ---|--- C2
    |
 D2 ---|--- C3
    |
 D3 ---|--- V_out
    |
   GND
```

Operation of Voltage Tripler Circuit:

During the first half-cycle of the input AC voltage (or the positive half-cycle of a DC voltage), capacitor C1 charges to the peak voltage of the input voltage through diode D1.

During the second half-cycle of the input AC voltage (or the negative half-cycle of a DC voltage), capacitor C2 charges to the peak voltage of the input voltage through diode D2.

During the third half-cycle of the input AC voltage (or the second positive half-cycle of a DC voltage), capacitor C3 charges to the peak voltage of the input voltage through diode D3.

At the end of this charging process, the voltage across capacitor C3 is three times the peak voltage of the input voltage, hence the name "voltage tripler".

The output voltage is taken across capacitor C3, which can be significantly higher than the input voltage, depending on the value of the capacitors and the characteristics of the diodes used.

The voltage tripler circuit can generate a higher DC voltage from a lower DC or AC voltage, making it useful in applications where a higher voltage level is required, such as in high-voltage power supplies for electronic equipment or in high-voltage testing and measurement applications. However, it should be noted that voltage multipliers, including voltage triplers, can be sensitive to component tolerances and have limitations in terms of voltage rating, power dissipation, and efficiency, and should be designed and used carefully to ensure safe and reliable operation.

C. Illustrate how BJT is used as a switch.

A Bipolar Junction Transistor (BJT) can be used as a switch in electronic circuits to control the flow of current through a load. BJTs can operate in either an "ON" state (saturated) or an "OFF" state (cutoff) depending on the biasing conditions applied to their base terminal. Here's a basic illustration of how a BJT can be used as a switch:

In this configuration, an NPN transistor is used as a switch to control the current through a load connected between the collector and the emitter terminals. When the base-emitter junction is forward-biased with a sufficient voltage, the transistor enters the ON state and allows current to flow from the collector to the emitter, thereby turning the load ON. When the base-emitter junction is reverse-biased or has an insufficient voltage, the transistor enters the OFF state and prevents current flow, thereby turning the load OFF.

To use the BJT as a switch, the base-emitter junction is typically driven with a digital signal, such as a voltage or a current, to control the ON/OFF state of the transistor. When the base-emitter voltage exceeds the threshold voltage (Vbe) of the transistor, it turns ON and allows current to flow through the load. When the base-emitter voltage is below the threshold voltage, it turns OFF and stops the current flow through the load.

Q. 03 A. Sketch the circuits of each of the following based on use of Operational Amplifier a) Differentiator. b) Integrator .

ANS.

a) Differentiator Circuit:

lua

Copy code

```
 Vin ----| Rf

      |

      |

      +--| C
```

|

|

Vout ----|

In a differentiator circuit, the output voltage (Vout) is proportional to the rate of change (derivative) of the input voltage (Vin). The resistor (Rf) and capacitor (C) form a feedback network connected to the inverting terminal of the Op-Amp. The input voltage is applied to the non-inverting terminal of the Op-Amp. The output voltage is taken from the output terminal of the Op-Amp. The input voltage is differentiated by the capacitor, and the resulting output voltage is amplified by the Op-Amp and fed back through the resistor.

b) Integrator Circuit:

lua

Copy code

```
   Vin ----| R
           |
           |
           +--| C
           |
           |
   Vout ----|
```

In an integrator circuit, the output voltage (Vout) is proportional to the integral of the input voltage (Vin). The resistor (R) and capacitor (C) form a feedback network connected to the inverting terminal of the Op-Amp. The input voltage is applied to the non-inverting terminal of the Op-Amp. The input voltage is integrated by the capacitor, and the resulting output voltage is amplified by the Op-Amp and fed back through the resistor.

Note: In both the differentiator and integrator circuits, the values of the resistor (R) and capacitor (C) should be carefully chosen to achieve the desired frequency response and avoid instability or distortion in the output signal. Additionally, appropriate biasing and supply voltage should be provided to the Op-Amp for proper operation.

B. Write a note on Ideal characteristics of Op-Amp.

ANS*. An operational amplifier (Op-Amp) is a versatile electronic component widely used in analog electronic circuits due to its unique characteristics. The ideal characteristics of an Op-Amp are often assumed in circuit analysis for simplification and idealized performance. These ideal characteristics are:*

Infinite Open-Loop Gain (Aol): An ideal Op-Amp has an infinite open-loop gain, meaning it can amplify input signals to an arbitrary level without any limitations. This allows the Op-Amp to provide precise amplification of small input signals.

Infinite Input Impedance: An ideal Op-Amp has an infinite input impedance, which means that it draws no current from the input source. This allows the Op-Amp to have minimal impact on the input signal and not load down the source.

Zero Input Offset Voltage: An ideal Op-Amp has zero input offset voltage, which means that there is no voltage difference between the inverting and non-inverting input terminals when the Op-Amp is in the ideal state.

Zero Input Bias Current: An ideal Op-Amp has zero input bias current, which means that no current flows into or out of the input terminals of the Op-Amp.

Infinite Bandwidth: An ideal Op-Amp has an infinite bandwidth, allowing it to amplify signals of any frequency without any limitations.

Infinite Slew Rate: An ideal Op-Amp has an infinite slew rate, which means it can respond to changes in input voltage instantly without any delay.

Zero Output Impedance: An ideal Op-Amp has zero output impedance, allowing it to drive any load without any loss of signal quality.

Infinite Common Mode Rejection Ratio (CMRR): An ideal Op-Amp has an infinite CMRR, meaning that it perfectly rejects any common-mode signals (i.e., signals that are present at both input terminals) and amplifies only the differential mode signals (i.e., signals that are present at the input terminals with respect to each other).

It's important to note that while these ideal characteristics are useful for analysis and understanding of Op-Amp circuits, real-world Op-Amps may not fully meet these ideal specifications due to limitations in the manufacturing process, temperature, and other factors. Therefore, it's essential to consider the actual specifications of a specific Op-Amp when designing and analyzing circuits to ensure reliable and accurate performance.

C. Explain the operation of Single stage Astable Oscillator with its circuit diagram.

ANS. *A single-stage astable oscillator is a type of electronic oscillator that generates a continuous square or rectangular wave output without the need for external triggering. It typically consists of an operational amplifier (Op-Amp) circuit along with passive components such as resistors and capacitors. Here is a basic circuit diagram and an explanation of the operation of a single-stage astable oscillator:*

lua

Copy code

```
      +------+
```

```
Vin -----|      |
         |      |
         |  Op-Amp
         |      |
Vout -----|      |
         +--+--+
            |
            |
            |
            |
            |
            C
            |
            |
            |
           GND
```

In the above circuit diagram, the Op-Amp is represented by a triangle symbol, and the inputs are denoted by the (+) and (-) signs. The output is denoted as Vout, and the input voltage is Vin. A capacitor (C) is connected in parallel with the feedback resistor (Rf) between the output and the inverting input terminal of the Op-Amp.

The operation of the single-stage astable oscillator can be explained as follows:

Initial State: Initially, assume the output of the Op-Amp is low (Vout = 0V). The inverting input terminal of the Op-Amp is also at 0V, and the non-inverting input terminal is at the input voltage (Vin).

Charging Phase: As the input voltage (Vin) increases, the voltage at the non-inverting input terminal of the Op-Amp also increases. This causes the output of the Op-Amp to swing to a high voltage (Vout = Vcc, where Vcc is the supply voltage), charging the capacitor (C) through the resistor (Rf).

Discharging Phase: As the capacitor (C) charges, the voltage at the inverting input terminal of the Op-Amp also increases. Once it reaches a certain threshold (typically, the threshold is set by the reference voltage of the Op-Amp), the output of the Op-Amp switches to a low voltage (Vout = 0V), discharging the capacitor (C) through the resistor (Rf).

Repeat Cycle: The capacitor (C) discharges until the voltage at the inverting input terminal of the Op-Amp drops below the threshold, causing the output of the Op-Amp to switch back to a high voltage (Vout = Vcc) and starting the charging phase again. This cycle repeats, generating a continuous square or rectangular wave output at the Vout terminal.

The frequency of the output waveform can be controlled by adjusting the values of the resistor (Rf) and the capacitor (C) in the circuit. The duty cycle of the output waveform (i.e., the ratio of time the output is high to the total period of the waveform) can also be adjusted by changing the values of Rf and C. Additionally, the supply voltage (Vcc) and the reference voltage of the Op-Amp can also affect the operation of the single-stage astable oscillator. It's important to choose suitable component values and supply voltages to ensure proper operation and desired output waveform characteristics.

Q.04 A. Mention the condition of sustained oscillations. Determine the frequency of oscillations of a three stage ladder network in which C=10nF and R=10KΩ.

***ANS.** The condition for sustained oscillations in an oscillator circuit is that the total phase shift around the loop of the feedback path must be exactly 360 degrees, and the loop gain (product of voltage gain and current gain) must be equal to or greater than unity (1).*

For a three-stage ladder network, such as a three-stage RC (Resistor-Capacitor) network, the phase shift contributed by each stage depends on the values of the resistors and capacitors used. In the case of a ladder network with identical resistors (R) and capacitors (C), the phase shift contributed by each stage is 60 degrees.

Given that C = 10 nF and R = 10 KΩ in the ladder network, we can determine the frequency of oscillations as follows:

Calculate the total phase shift contributed by the three stages:

Total Phase Shift = Phase Shift per Stage × Number of Stages

Total Phase Shift = 60 degrees × 3

Total Phase Shift = 180 degrees

Since the ladder network has a total phase shift of 180 degrees, we need to introduce additional phase shift in the feedback path to make the total phase shift 360 degrees for sustained oscillations. This can be done by adding an additional phase shift element, such as an inverting amplifier or an RC phase shift network, in the feedback path of the oscillator circuit.

Once the total phase shift around the feedback loop is 360 degrees, we can determine the frequency of oscillations using the formula:

Frequency of Oscillations = 1 / (2π × RC)

Frequency of Oscillations = 1 / (2π × 10 nF × 10 KΩ)

Frequency of Oscillations ≈ 1591.55 Hz (rounded to two decimal places)

So, the frequency of oscillations of the three-stage ladder network with C = 10 nF and R = 10 KΩ is approximately 1591.55 Hz.

B. With a neat circuit diagram and Waveforms, describe the operation of Crystal controlled Oscillator.

ANS*.* *+Vcc*

```
          |
          |
   +-----|-----+-----+
   |    |    |    |
 C1 |    |    |    |
   |    |    |    |
   +-----|-----+-----+
          |
          |
   +-----|-----+-----+
   |    |    |    |
 C2 |    |    |    |
   |    |    |    |
   +-----|-----+-----+
          |
          |
   +-----|-----+-----+
   |    |    |    |
 C3 |    |    |    |
   |    |    |    |
   +-----|-----+-----+
          |
          |
   +-----------+
```

```
|  Crystal  |
| Resonator |
+-----------+
      |
      |
      |
     GND
```

Waveforms:

The waveform at different points in the circuit would typically show a stable and precise sinusoidal waveform at the output, with the frequency determined by the resonant frequency of the quartz crystal. The amplitude of the waveform depends on the gain of the amplifier circuit and the level of input power.

Operation:

The circuit consists of a series of capacitors (C1, C2, C3) connected in parallel with a quartz crystal resonator. The resonator is the frequency-determining element, and it is connected between the output and the input of the amplifier.

When power is applied to the circuit, the amplifier starts to oscillate at its natural frequency determined by the resonant frequency of the quartz crystal.

The resonant frequency of the quartz crystal is highly stable and precise, and it determines the frequency of the output signal.

The capacitors (C1, C2, C3) are used to provide the necessary load capacitance for the quartz crystal resonator, which is required for proper oscillation.

The output signal from the oscillator is typically a sinusoidal waveform with an amplitude determined by the gain of the amplifier circuit.

It's important to note that crystal controlled oscillators require precise matching of the load capacitance (C1, C2, C3) with the specifications of the quartz crystal resonator for proper operation. The load capacitance is typically specified by the manufacturer of the quartz crystal and must be chosen carefully to ensure stable and reliable oscillation.

Crystal controlled oscillators are widely used in many electronic applications that require highly stable and precise frequency signals, such as in communication systems, frequency synthesizers, clocks, and timers, among others. The use of quartz crystals as the frequency-determining element provides excellent frequency stability, temperature stability, and long-term reliability, making crystal controlled oscillators essential in many electronic devices and systems.

C. With a neat circuit diagram explain single stage Multivibrators.

ANS. *A multivibrator is a type of electronic circuit that produces a square wave or rectangular waveform output. It can operate in different states, typically referred to as "high" and "low" states, and can switch between these states periodically to generate a square wave output. A single-stage multivibrator, also known as a monostable multivibrator or a one-shot multivibrator, consists of a single active component, typically a transistor or an operational amplifier, and passive components such as resistors and capacitors.*

Here's a circuit diagram of a single-stage multivibrator using a transistor:

When the circuit is initially powered on, the transistor Q1 is in an off state, and the output (at the collector) is at a high level, close to Vcc.

Capacitor C1 charges through resistor R1, and the time constant (R1 x C1) determines the duration of the high state of the output pulse.

Once the voltage at the base of Q1 reaches the threshold voltage (typically around 0.7V for a standard NPN transistor), Q1 turns on, and the collector voltage drops rapidly to a low level, close to ground.

Capacitors C2 and C3 quickly discharge through the transistor, and the duration of the low state of the output pulse is determined by the values of C2 and C3.

After the time determined by the values of R1 and C1 has passed, capacitor C1 discharges through resistor R1, and the transistor Q1 turns off, returning the output to a high level.

The output pulse width is determined by the values of R1 and C1, and can be adjusted by changing the values of these components.

Single-stage multivibrators are widely used in many electronic applications, such as timing circuits, pulse generators, and pulse width modulators, among others. They can be used to generate precise and adjustable pulses with well-defined widths and frequencies, making them useful in a variety of electronic systems and devices.

Q. 05 A. With the help of truth table explain the operation of Full Adder with its circuit diagram and reduce the expression for Sum and carry.

***ANS**. A full adder is a combinational logic circuit that performs the addition of three binary inputs, typically labeled as A, B, and Cin (carry-in), and produces two outputs, Sum and Cout (carry-out). The truth table of a full adder is as follows:*

A	*B*	*Cin*	*Sum*	*Cout*
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*

Based on the truth table, we can derive the logic equations for Sum and Cout as follows:

Sum = A $\oplus$ B $\oplus$ Cin, where $\oplus$ represents the XOR (exclusive OR) operation.

Cout = (A $\wedge$ B) $\vee$ ((A $\oplus$ B) $\wedge$ Cin), where $\wedge$ represents the AND operation, and $\vee$ represents the OR operation.

The circuit consists of XOR gates, AND gates, and OR gates, which are connected according to the logic equations derived from the truth table. The inputs A, B, and Cin are applied to the appropriate gates, and the outputs Sum and Cout are obtained from the corresponding gates.

By simplifying the expressions for Sum and Cout, we can reduce the circuit complexity and minimize the number of gates required for implementation, which can lead to more efficient and optimized circuit designs.

B. Mention the different theorems and Postulates of Boolean Algebra and Prove each of them with truth table.

ANS. *There are several important theorems and postulates in Boolean algebra that are used for simplifying and manipulating logic expressions. Some of the commonly used theorems and postulates are:*

Identity Theorem:

The identity theorem states that any Boolean variable (A) OR'ed with 0 is equal to the original variable (A).

Truth table:

A	0	A OR 0
0	0	0
1	0	1

Proof:

The truth table shows that for any value of A, the result of A OR 0 is equal to A. This proves the identity theorem.

Null (Annulment) Theorem:

The null theorem states that any Boolean variable (A) AND'ed with 0 is always equal to 0.

Truth table:

A	0	A AND 0
0	0	0
1	0	0

Proof:

The truth table shows that for any value of A, the result of A AND 0 is always 0. This proves the null theorem.

Domination Theorem:

The domination theorem states that any Boolean variable (A) OR'ed with 1 is always equal to 1.

Truth table:

A	1	A OR 1
0	1	1

1 1 1

Proof:

The truth table shows that for any value of A, the result of A OR 1 is always 1. This proves the domination theorem.

Negation (Complement) Theorem:

The negation theorem states that any Boolean variable (A) OR'ed with its complement (~A) is always equal to 1.

Truth table:

A	*~A*	*A OR ~A*
0	*1*	*1*
1	*0*	*1*

Proof:

The truth table shows that for any value of A, the result of A OR ~A is always 1. This proves the negation theorem.

Idempotent Theorem:

The idempotent theorem states that any Boolean variable (A) OR'ed or AND'ed with itself is always equal to the original variable (A).

Truth table for OR:

A	*A*	*A OR A*
0	*0*	*0*
1	*1*	*1*

Truth table for AND:

A	*A*	*A AND A*
0	*0*	*0*

1 1 1

Proof:

The truth tables show that for any value of A, the result of A OR A and A AND A is always equal to A. This proves the idempotent theorem.

These are just a few examples of the theorems and postulates of Boolean algebra. There are many other theorems and postulates that can be used to simplify and manipulate logic expressions, and their proofs can be established using truth tables. Truth tables are a powerful tool for verifying and understanding the behavior of Boolean algebra expressions and logic circuits.

C. Subtract using (r-1)'s compliment method a)4456(10)-34234(10) Subtract using r's compliment method a)1010100(2)-1000100(2)

ANS. *a) 4456 (10) - 34234 (10)*

Step 1: Find the (r-1)'s complement of the subtrahend (34234) by subtracting each digit from (r-1), where r is the radix (10 in this case).

Subtrahend: 34234

(r-1) = 10-1 = 9

Complement of 2: 9-2 = 7

Complement of 4: 9-4 = 5

Complement of 2: 9-2 = 7

Complement of 3: 9-3 = 6

Complement of 4: 9-4 = 5

So, the (r-1)'s complement of 34234 is 65766.

Step 2: Add the (r-1)'s complement obtained in Step 1 to the minuend (4456).

Minuend: 4456

(r-1)'s complement of subtrahend: 65766

4456 + 65766 = 70222

Step 3: Discard the carry, if any, from the result obtained in Step 2.

In this case, there is no carry.

So, the result of the subtraction 4456 - 34234 using (r-1)'s complement method is 70222.

b) Now, let's perform subtraction using r's complement method for binary numbers.

a) 1010100 (2) - 1000100 (2)

Step 1: Find the 1's complement of the subtrahend (1000100) by changing 0s to 1s and 1s to 0s.

Subtrahend: 1000100

1's complement of 1000100: 0111011

Step 2: Add 1 to the 1's complement obtained in Step 1 to get the 2's complement of the subtrahend.

1's complement of subtrahend: 0111011

Add 1: 1

2's complement of subtrahend: 0111100

Step 3: Add the 2's complement obtained in Step 2 to the minuend (1010100).

Minuend: 1010100

2's complement of subtrahend: 0111100

1010100 + 0111100 = 10010000 (carry over 1)

Step 4: Discard the carry, if any, from the result obtained in Step 3.

In this case, there is a carry of 1.

So, the result of the subtraction 1010100 - 1000100 using r's complement method is 0010000 in binary.

Q. 06 A. Convert the following a) 3A6.C58D(16) = ? (8) b) 0.6875(10) = ? (2)

***ANS.** a) To convert the hexadecimal number 3A6.C58D to octal (base 8), we can follow these steps:*

Step 1: Convert the hexadecimal number to binary (base 2).

3A6.C58D (16) = 0011 1010 0110.1100 0101 1000 1101 (2)

Step 2: Group the binary digits in sets of three, starting from the decimal point.

001 110 101 001 101 101 000 101 (2)

Step 3: Convert each group of three binary digits to its octal equivalent.

001 110 101 001 101 101 000 101 (2) = 3 6 5 1 5 5 0 5 (8)

So, the octal equivalent of the hexadecimal number 3A6.C58D is 36515505 in base 8.

b) To convert the decimal number 0.6875 to binary (base 2), we can follow these steps:

Step 1: Multiply the decimal number by 2, and keep track of the whole number part and the fraction part at each step.

*0.6875 * 2 = 1.375 (1 as whole number part, 0.375 as new fraction part)*

*0.375 * 2 = 0.75 (0 as whole number part, 0.75 as new fraction part)*

*0.75 * 2 = 1.5 (1 as whole number part, 0.5 as new fraction part)*

*0.5 * 2 = 1 (1 as whole number part, 0 as new fraction part)*

Step 2: Write down the whole number parts obtained at each step.

0.1011 (2)

Step 3: Stop when the fraction part becomes zero or when the desired number of binary digits is obtained.

So, the binary equivalent of the decimal number 0.6875 is 0.1011 in base 2.

B. State and prove De-morgan's Theorem with its truth table.

ANS. *De Morgan's Theorem states that the complement of a logical expression (AND or OR) involving multiple variables is equivalent to the logical expression with the variables complemented (negated), and the logical operation changed to its opposite (i.e., changing AND to OR, or OR to AND). Mathematically, De Morgan's Theorem can be expressed as follows:*

De Morgan's Theorem for AND operation:

$\neg(A \cap B) = \neg A \cup \neg B$

De Morgan's Theorem for OR operation:

$\neg(A \cup B) = \neg A \cap \neg B$

Where ¬ represents the negation (complement) operation, ∩ represents the AND operation, and ∪ represents the OR operation.

Proof of De Morgan's Theorem for AND operation:

Truth Table for $A \cap B$:

A	*B*	*$A \cap B$*
0	*0*	*0*
0	*1*	*0*
1	*0*	*0*
1	*1*	*1*

Truth Table for $\neg A \cup \neg B$:

A	*B*	*$\neg A$*	*$\neg B$*	*$\neg A \cup \neg B$*

0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

As we can see from the truth tables, the results of A ∩ B and ¬A ∪¬B are the same for all possible combinations of A and B. This proves that ¬(A ∩ B) is equivalent to ¬A ∪¬B, which is De Morgan's Theorem for AND operation.

Proof of De Morgan's Theorem for OR operation:

Truth Table for A ∪B:

A	B	A ∪B
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table for ¬A ∩ ¬B:

A	B	¬A	¬B	¬A ∩ ¬B
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

As we can see from the truth tables, the results of A ∪B and ¬A ∩ ¬B are the same for all possible combinations of A and B. This proves that ¬(A ∪B) is equivalent to ¬A ∩ ¬B, which is De Morgan's Theorem for OR operation.

C. Minimize the following function a)F(x,y,z) = xy+x'z+yz Find the compliment of the function F1 and F2 F1(x,y,z) = x'yz'+x'y'z F2(x,y,z)=x(y'z'+yz').

ANS. *To minimize the function F(x, y, z) = xy + x'z + yz, we can use Boolean algebraic simplification techniques such as factoring, distribution, and complementation.*

Step 1: Apply Distribution Law

F(x, y, z) = xy + x'z + yz

= xy + x'z + yz + x'z' + x'z' // Adding x'z' + x'z' to the expression, which does not change its value (identity law)

= xy + x'z + yz + x'z'(1+1) // Applying distributive law: a + ab = a(1+b)

= xy + x'z + yz + x'z'(1) // Applying the law a + 1 = 1

= xy + x'z + yz + x'z' // Applying the law a.1 = a

Step 2: Apply Complementation Law

F(x, y, z) = xy + x'z + yz + x'z' // Original expression

= xy + x'z + yz + x'z' // Applying the law a + a' = 1

= xy + x'z + yz + x'z'(xy+xy') // Applying the law a.a' = 0 and a+a' = 1

Step 3: Apply Factoring and Grouping

F(x, y, z) = xy + x'z + yz + x'z'(xy+xy')

= xy(1 + x'z') + yz(1 + x'z') // Factoring out common terms

= xy(1 + x'z') + yz(1 + x'z') // Applying the law a + a = a

Step 4: Apply Distribution Law

F(x, y, z) = xy(1 + x'z') + yz(1 + x'z')

= xy + x'z' + yz // Applying the law a(1 + b) = a + ab

So, the minimized form of the function $F(x, y, z)$ *is:* $F(x, y, z) = xy + x'z' + yz$

Now, to find the complement of $F1(x, y, z) = x'yz' + x'y'z$*, we can apply the complementation law, which states that* $\neg(a \cdot b \cdot c) = \neg a + \neg b + \neg c$*.*

$F1(x, y, z) = x'yz' + x'y'z$

$\neg F1(x, y, z) = \neg(x'yz' + x'y'z)$

$= \neg x' + \neg y + \neg z' + \neg x' + \neg y' + \neg z$ *// Applying De Morgan's Theorem*

$= \neg x' + \neg x' + \neg y + \neg y' + \neg z + \neg z'$ *// Grouping similar terms*

$= \neg x' + \neg y + \neg y' + \neg z + \neg z'$ *// Applying the law* $a + a = a$

So, the complement of $F1(x, y, z)$ *is:* $\neg F1(x, y, z) = \neg x' + \neg y + \neg y' + \neg z + \neg z'$

Similarly, to find the complement of $F2(x, y, z) = x(y'z' + yz')$*, we can apply the complementation law.*

$F2(x, y, z) = x$

Q. 07 A. Compare Embedded Systems and General Computing Systems, also provide the applications of Embedded systems.

ANS*. Embedded systems and general computing systems are two different types of computing systems with distinct characteristics and applications.*

Comparison between Embedded Systems and General Computing Systems:

Definition: Embedded systems are specialized computing systems that are designed to perform dedicated tasks with specific functionalities. They are *typically integrated into other devices or systems to control or monitor their operations. General computing systems, on the other hand, are more generic and versatile systems designed to perform a wide range of tasks with varying functionalities.*

Design and Purpose: Embedded systems are purpose-built and optimized for specific applications or tasks, often with limited resources such as processing power, memory, and energy. General computing systems, on the other hand, are designed to handle a wide range of tasks and applications with higher processing power, memory, and flexibility.

Form Factor: Embedded systems are usually small and compact, designed to be integrated into other devices or systems, often with custom form factors. General computing systems, on the other hand, come in various form factors such as desktop computers, laptops, servers, etc.

Operating System: Embedded systems often use specialized operating systems or real-time operating systems (RTOS) that are designed to be lightweight and optimized for specific applications. General computing systems typically use general-purpose operating systems such as Windows, macOS, Linux, etc.

Connectivity: Embedded systems are often designed to operate in connected environments, where they can communicate with other devices or systems. General computing systems are typically used in a connected environment as well, but they may not have the same level of optimized connectivity features as embedded systems.

Applications of Embedded Systems:

Automotive: Embedded systems are widely used in the automotive industry for applications such as engine control units (ECUs), anti-lock braking systems (ABS), airbag control systems, etc.

Consumer Electronics: Embedded systems are used in various consumer electronics devices such as smart TVs, home appliances, wearables, digital cameras, etc.

Industrial Automation: Embedded systems are used in industrial automation applications such as process control systems, robotics, factory automation, etc.

Medical: Embedded systems are used in medical devices such as pacemakers, insulin pumps, patient monitoring systems, etc.

Aerospace and Defense: Embedded systems are used in aerospace and defense applications such as avionics systems, guided missiles, radar systems, etc.

Internet of Things (IoT): Embedded systems are at the heart of IoT devices, enabling connectivity, data collection, and control in various IoT applications such as smart cities, smart homes, industrial IoT, etc.

Smart Grids and Energy Management: Embedded systems are used in smart grids and energy management systems for monitoring and controlling energy generation, distribution, and consumption.

In summary, embedded systems and general computing systems are distinct in their design, purpose, and applications. Embedded systems are specialized computing systems optimized for specific applications, often with limited resources, and find applications in diverse industries such as automotive, consumer electronics, industrial automation, medical, aerospace and defense, IoT, and energy management, among others.

B. Write a note on core of an Embedded systems with its block diagram.

ANS. *The core of an embedded system refers to the central processing unit (CPU) or microprocessor that serves as the brain of the system. It is responsible for executing instructions, performing calculations, and controlling the overall operation of the embedded system. The core is a crucial component of embedded systems, as it determines the processing power, performance, and capabilities of the system.*

Block Diagram of an Embedded System Core:

The block diagram of an embedded system core typically consists of the following components:

CPU/Microprocessor: This is the central processing unit of the embedded system, responsible for executing instructions and performing calculations. It can be a general-purpose microprocessor or a specialized microprocessor optimized for embedded systems.

Memory: This includes different types of memory such as RAM (Random Access Memory) for temporary data storage, ROM (Read-Only Memory) for storing firmware or other permanent data, and non-volatile memory for storing data even when the power is turned off, such as Flash memory or EEPROM (Electrically Erasable Programmable Read-Only Memory).

Peripherals: These are external devices or interfaces that connect to the core for input/output operations. Examples of peripherals include sensors, actuators, displays, communication interfaces (such as UART, SPI, I2C, etc.), timers, and interrupts, which enable communication and interaction with the external environment.

System Bus: This is a communication pathway that allows data and instructions to be transferred between the CPU, memory, and peripherals. It typically includes address lines, data lines, and control lines, and may use different *protocols and standards depending on the specific embedded system architecture.*

Power Management: This includes components such as voltage regulators, power switches, and battery management circuits, which are responsible for managing the power supply and optimizing power consumption in the embedded system.

Clock and Timing: This includes components such as crystal oscillators, clock generators, and timers, which provide the necessary clock signals and timing references for the operation of the embedded system.

System Control: This includes components such as reset circuits, watchdog timers, and system control logic, which ensure proper initialization, operation, and fault detection of the embedded system.

The block diagram of an embedded system core may vary depending on the specific requirements and functionalities of the embedded system, and the components may be integrated into a single chip or distributed across multiple chips or modules.

In summary, the core of an embedded system is the central processing unit (CPU) or microprocessor that forms the heart of the system. It is responsible for executing instructions, performing calculations, and controlling the overall operation of the embedded system. The block diagram of an embedded system core typically includes components such as CPU/microprocessor, memory, peripherals, system bus, power management, clock and timing, and system control. These components work together to enable the proper functioning of the embedded system and its interaction with the external environment.

C. Write a note on Transducers? Explain one type of Sensor and Actuator with its operation.

ANS. *Transducers are devices that convert one form of energy into another. They are commonly used in embedded systems to interface with the physical world by converting physical quantities such as temperature, pressure, humidity, or motion into electrical signals that can be processed by the system.*

One type of transducer commonly used in embedded systems is a sensor. Sensors are devices that detect and measure physical quantities and convert them into electrical signals that can be processed by the embedded system. Sensors play a crucial role in enabling embedded systems to sense and respond to changes in the physical environment.

One example of a sensor is a temperature sensor. Temperature sensors are used to measure the temperature of an object or environment and convert it into an electrical signal that can be processed by the embedded system. There are different types of temperature sensors, such as thermocouples, resistance temperature detectors (RTDs), thermistors, and integrated circuit (IC) temperature sensors, each with its own principles of operation.

Let's take an example of an IC temperature sensor, which is a commonly used type of temperature sensor in embedded systems. The operation of an IC temperature sensor typically involves the following steps:

Sensing: The temperature sensor detects the temperature of the object or environment through a physical change in its properties. For example, an IC temperature sensor may use the change in the electrical resistance of a temperature-sensitive material to measure temperature.

Signal Conditioning: The electrical signal generated by the temperature sensor is often weak and needs to be conditioned to be suitable for processing by the embedded system. This may involve amplifying the signal, filtering out noise, and converting the signal to a digital form, depending on the requirements of the embedded system.

Conversion: The conditioned electrical signal is then converted into a digital value that represents the temperature measurement. This may involve using analog-to-digital converters (ADCs) to convert the analog signal into a digital value that can be processed by the embedded system.

Processing: The digital temperature value is then processed by the embedded system to perform various operations, such as calibration, data analysis, and decision-making, based on the temperature measurement.

Actuators, on the other hand, are devices that convert electrical signals from the embedded system into physical actions or movements. They are used to control and manipulate the physical environment based on the processed data from sensors. Examples of actuators include motors, servos, solenoids, relays, and LEDs, among others.

In summary, sensors and actuators are important types of transducers used in embedded systems to enable the system to interact with the physical environment. Sensors detect and measure physical quantities and convert them into electrical signals, while actuators convert electrical signals into physical actions or movements. An example of a sensor is an IC temperature sensor, which measures temperature and converts it into an electrical signal that can be processed by the embedded system.

Q. 08 A. Explain how 7 seg Display can be used to Display the data and write a brief note on operation of LED.

***ANS**. A 7-segment display is a type of electronic display device that can be used to display numerical digits from 0 to 9, as well as some other characters such as letters and symbols. It consists of seven individual LED (Light Emitting Diode) segments arranged in the shape of the number "8", with one additional LED segment in the center. By selectively turning ON or OFF these segments, different numbers or characters can be displayed.*

To display data using a 7-segment display, the segments corresponding to the desired digits or characters need to be illuminated or turned ON, while the other segments remain OFF. This is typically achieved by providing suitable electrical signals to the individual segments of the 7-segment display from an embedded system or a microcontroller.

The operation of a 7-segment display involves driving the individual LED segments with appropriate current and voltage levels to achieve the desired illumination. Each segment of the 7-segment display is typically connected in a common cathode or common anode configuration. In a common cathode configuration, the cathodes of all the LED segments are connected together and connected to a common ground, while in a common anode configuration, the anodes of all the LED segments are connected together and connected to a common positive voltage source.

To display a specific digit or character on the 7-segment display, the corresponding segment needs to be illuminated by providing a suitable voltage level to its respective cathode or anode, while keeping the other segments turned OFF. This is typically achieved by using a combination of transistors, shift registers, and other digital logic components to control the individual segments of the 7-segment display.

The operation of a LED (Light Emitting Diode) is based on the principle of electroluminescence, where a semiconductor material emits light when an electric current is passed through it. LEDs are commonly used in various applications, including displays, indicators, lighting, and more. LEDs are available in different colors, sizes, and shapes, and can be used in combination to create different types of displays, such as alphanumeric displays and dot matrix displays.

The operation of an LED involves forward biasing the semiconductor junction to allow current to flow through it, which causes the LED to emit light. The color of the emitted light depends on the type of semiconductor material used in the LED. For example, a red LED typically uses gallium arsenide (GaAs) as the *semiconductor material, while a green LED uses gallium phosphide (GaP), and a blue LED uses gallium nitride (GaN).*

LEDs are commonly used in embedded systems and other electronic devices as indicators, status indicators, and displays due to their low power consumption, small size, fast response time, and long operational lifespan. They can be easily controlled by microcontrollers and other digital logic components to provide visual feedback, display information, or indicate the status of a system or a device.

B. What is an Embedded system and brief about the different elements of an Embedded systems.

ANS.

An embedded system is a specialized computer system designed to perform specific tasks or functions as part of a larger system or product. It is typically designed to be integrated into a larger system or product and is dedicated to performing specific functions, often with real-time requirements, and operates with specific constraints on size, power, and performance.

The different elements of an embedded system typically include:

Hardware: The hardware of an embedded system refers to the physical components of the system, including the microprocessor or microcontroller, memory (RAM and ROM), input/output (I/O) interfaces, sensors, actuators, communication interfaces, and other peripheral devices. The hardware is designed to meet the specific requirements of the embedded system, such as size, power consumption, and performance.

Software: The software of an embedded system includes the programs or code that is written to control and operate the hardware. This can include the operating system (OS), device drivers, firmware, middleware, and application *software. The software is typically designed to be efficient, compact, and optimized for the specific hardware platform of the embedded system.*

Real-time Operating System (RTOS): An RTOS is a specialized operating system designed for use in embedded systems with real-time requirements. It provides features such as task scheduling, interrupt handling, and inter-task communication to ensure that tasks or functions are performed in a timely and deterministic manner.

Sensors: Sensors are devices that are used to detect and measure physical or environmental conditions, such as temperature, pressure, humidity, light, sound, motion, etc. Sensors are an important element of many embedded systems as they provide input data for decision-making and control.

Actuators: Actuators are devices that are used to control physical actions or movements based on the output of the embedded system. Examples of actuators include motors, servos, valves, solenoids, and relays. Actuators are used to convert digital or analog signals from the embedded system into physical actions in the external environment.

Communication Interfaces: Communication interfaces are used to enable communication between the embedded system and other systems or devices. This can include wired or wireless interfaces such as UART (Universal Asynchronous Receiver/Transmitter), SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit), Ethernet, Wi-Fi, Bluetooth, etc.

Power Management: Power management is an important element of embedded systems as they often operate on limited power sources, such as batteries or power supplies with specific power requirements. Power management techniques are used to optimize power consumption, extend battery life, and ensure reliable operation of the embedded system.

User Interface: The user interface of an embedded system is the interface through which users interact with the system. This can include displays, buttons, touchscreens, keypads, and other input/output devices that allow users to provide input to the system, receive output or feedback, and control the operation of the embedded system.

C. Write a note on classification of Embedded systems.

***ANS**. Embedded systems can be classified based on various criteria, including their functionality, performance, complexity, and application domain. Here are some common classifications of embedded systems:*

Standalone Embedded Systems: Standalone embedded systems are independent systems that perform specific functions or tasks without the need for external connections or interactions. They operate in isolation and are typically designed for dedicated applications. Examples of standalone embedded systems include home appliances, industrial control systems, consumer electronics, and automotive systems.

Networked Embedded Systems: Networked embedded systems are connected to a network, either wired or wireless, and can communicate with other systems or devices. They may have multiple nodes or devices connected to a network, and can exchange data, share resources, and collaborate with other systems. Examples of networked embedded systems include smart home systems, industrial automation systems, IoT (Internet of Things) devices, and communication systems.

Real-time Embedded Systems: Real-time embedded systems are designed to respond to events or inputs within specific time constraints. They are used in applications where timely and deterministic processing is critical, such as in control systems, robotics, aerospace, and medical devices. Real-time embedded systems can be classified as hard real-time (strict deadlines must be met) or soft real-time (some deadlines can be missed).

Mobile Embedded Systems: Mobile embedded systems are designed to be portable and can be carried or worn by users. They may have wireless communication capabilities and are often used in applications such as smartphones, tablets, wearable devices, and mobile medical devices.

Embedded Systems on Chip (SoC): Embedded systems on chip, or SoCs, are integrated systems that combine the functionality of a microprocessor or microcontroller with other system components, such as memory, I/O interfaces, sensors, and actuators, on a single chip. SoCs are commonly used in applications where space, power, and cost constraints are critical, such as in consumer electronics, automotive systems, and IoT devices.

Safety-critical Embedded Systems: Safety-critical embedded systems are used in applications where the safety and reliability of the system are of utmost importance. Examples of safety-critical embedded systems include systems used in aerospace, automotive, medical, and nuclear industries, where failure can have severe consequences.

Embedded Systems for Control and Automation: Embedded systems used for control and automation are designed to monitor, control, and automate processes or systems. Examples of such embedded systems include industrial control systems, building automation systems, and process control systems.

Embedded Systems for Medical Applications: Embedded systems are widely used in medical applications, such as medical devices, monitoring systems, and telemedicine systems. These embedded systems require compliance with strict regulations and standards, such as FDA regulations, and must be reliable, secure, and accurate to ensure patient safety.

Q. 09 A. Write a note on different types of modulations and briefly describe each in detail.

***ANS**. Modulation is the process of modifying a carrier signal with a modulating signal in order to transmit information. There are several different types of* *modulation techniques used in communication systems, each with its own advantages, disadvantages, and applications. Here are some common types of modulations:*

Amplitude Modulation (AM): Amplitude modulation (AM) is a modulation technique where the amplitude of the carrier signal is varied in proportion to the modulating signal. The modulating signal contains the information to be transmitted. In AM, the carrier signal is a high-frequency signal, and the modulating signal is a low-frequency signal. AM is widely used in broadcast radio and television systems.

Frequency Modulation (FM): Frequency modulation (FM) is a modulation technique where the frequency of the carrier signal is varied in proportion to the modulating signal. Unlike AM, in FM, the amplitude of the carrier signal remains constant, and only the frequency changes. FM is commonly used in broadcast radio, television, and mobile communication systems.

Phase Modulation (PM): Phase modulation (PM) is a modulation technique where the phase of the carrier signal is varied in proportion to the modulating signal. The amplitude and frequency of the carrier signal remain constant, and only the phase changes. PM is used in various communication systems, including digital communication systems, satellite communication, and radar systems.

Amplitude Shift Keying (ASK): Amplitude shift keying (ASK) is a digital modulation technique where the amplitude of the carrier signal is switched between two or more levels to represent digital data. ASK is simple to implement and is used in various communication systems, such as optical communication, wireless communication, and digital broadcasting.

Frequency Shift Keying (FSK): Frequency shift keying (FSK) is a digital modulation technique where the frequency of the carrier signal is switched between two or more values to represent digital data. FSK is used in various *communication systems, including wireless communication, satellite communication, and digital data communication.*

Phase Shift Keying (PSK): Phase shift keying (PSK) is a digital modulation technique where the phase of the carrier signal is switched between two or more values to represent digital data. PSK is commonly used in digital communication systems, including satellite communication, wireless communication, and optical communication.

Quadrature Amplitude Modulation (QAM): Quadrature amplitude modulation (QAM) is a digital modulation technique that combines both amplitude modulation (AM) and phase modulation (PM). In QAM, both the amplitude and phase of the carrier signal are modulated to represent digital data. QAM is widely used in modern communication systems, including digital television, digital radio, and wireless communication.

B. Brief about Modern Communication System with its block diagram.

ANS. *A modern communication system is a complex system that involves the transmission, reception, and processing of information in various forms such as voice, data, images, and video. It typically consists of several components that work together to enable efficient communication between users or devices. Here is a brief overview of the main elements of a modern communication system along with a simple block diagram:*

Transmitter: The transmitter is responsible for converting the information to be transmitted into a suitable form for transmission. It may include components such as a microphone, camera, data encoder, and modulator. The modulator modulates the carrier signal with the modulating signal, which contains the information to be transmitted.

Channel: The channel is the medium through which the modulated signal is transmitted from the transmitter to the receiver. It could be a physical medium *such as a wired or wireless channel, or it could be a virtual channel in case of digital communication systems.*

Receiver: The receiver is responsible for receiving the modulated signal from the channel and demodulating it to extract the original information. It may include components such as a demodulator, filter, decoder, and audio or video output devices, depending on the type of information being transmitted.

Medium: The medium refers to the physical medium through which the communication signal is transmitted. It could be wired medium such as copper cables or optical fibers, or wireless medium such as air for radio waves or space for satellite communication.

Control Unit: The control unit manages the overall operation of the communication system, including coordinating the flow of information between the transmitter and receiver, error correction, synchronization, and protocol management.

Terminal Equipment: The terminal equipment refers to the devices used by users to access and utilize the communication system. It could include devices such as telephones, computers, cameras, or other end-user devices.

Network: The network is the infrastructure that connects multiple communication systems together, allowing for communication between different users or devices. It may include components such as switches, routers, and gateways, as well as various network protocols for routing, addressing, and managing data flow.

C. List out the advantages of Digital Communication over Analog Communications.

***ANS.** There are several advantages of digital communication over analog communication. Here are some key advantages:*

Better Signal Quality: Digital signals are less susceptible to noise and interference compared to analog signals. Digital communication systems use error correction techniques to ensure accurate and reliable transmission of data, resulting in improved signal quality and higher overall system performance.

Greater Signal Capacity: Digital communication systems can transmit more information in a given bandwidth compared to analog systems. Digital signals can be compressed, multiplexed, and modulated using various techniques to efficiently utilize the available bandwidth and transmit multiple channels of data simultaneously.

Flexibility and Versatility: Digital communication systems offer greater flexibility and versatility in terms of signal processing and modulation techniques. Digital signals can be easily manipulated, processed, and encoded, allowing for a wide range of applications such as data communication, voice communication, video communication, and multimedia transmission.

Improved Noise Immunity: Digital communication systems can use error correction codes and encryption techniques to enhance noise immunity and ensure secure communication. Digital signals can be easily regenerated, filtered, and equalized to compensate for signal degradation and interference, resulting in improved performance in noisy environments.

Ease of Integration: Digital communication systems can be easily integrated with other digital systems, such as computers, microprocessors, and digital signal processors (DSPs), for seamless data processing, storage, and transmission. Digital communication systems can also be easily upgraded or expanded to accommodate changing communication requirements.

Lower Transmission Costs: Digital communication systems can offer cost-effective solutions for long-distance communication. Digital signals can be *transmitted over long distances without significant signal degradation, and digital communication systems can utilize various modulation and coding techniques to optimize bandwidth utilization and minimize transmission costs.*

Better Scalability: Digital communication systems can be easily scaled up or down to meet different communication requirements. Digital signals can be easily converted to different data rates, formats, and protocols, making them highly scalable and adaptable to changing communication needs.

Q. 10 A. Explain with a neat diagram the concept of Radio wave Propagation and its different types.

***ANS**. Radio wave propagation refers to the way in which radio waves travel from a transmitting antenna to a receiving antenna. There are several types of radio wave propagation, which can be classified into three main categories: ground wave propagation, sky wave propagation, and space wave propagation.*

Ground Wave Propagation: In ground wave propagation, radio waves follow the curvature of the Earth's surface and travel along the ground. Ground wave propagation is most effective at lower frequencies (typically up to a few MHz) and is commonly used for local radio broadcasting and communication over short distances. Ground wave propagation is affected by factors such as the terrain, ground conductivity, and frequency of the radio waves.

Sky Wave Propagation: In sky wave propagation, radio waves are reflected back to the Earth's surface by the ionosphere, a layer of charged particles in the Earth's upper atmosphere. Sky wave propagation allows radio waves to travel long distances, even over the horizon, and is commonly used for long-range communication, such as in AM (amplitude modulation) broadcasting and shortwave communication. Sky wave propagation is affected by factors such as the height and density of the ionosphere, time of day, and solar activity.

Space Wave Propagation: In space wave propagation, radio waves travel in a straight line from the transmitting antenna to the receiving antenna without being reflected or refracted. Space wave propagation is commonly used for line-of-sight communication, such as in FM (frequency modulation) broadcasting, television broadcasting, and microwave communication. Space wave propagation is affected by factors such as the height and type of antennas, height of obstacles, and frequency of the radio waves.

Here is a diagram illustrating the concept of radio wave propagation:

lua

Copy code

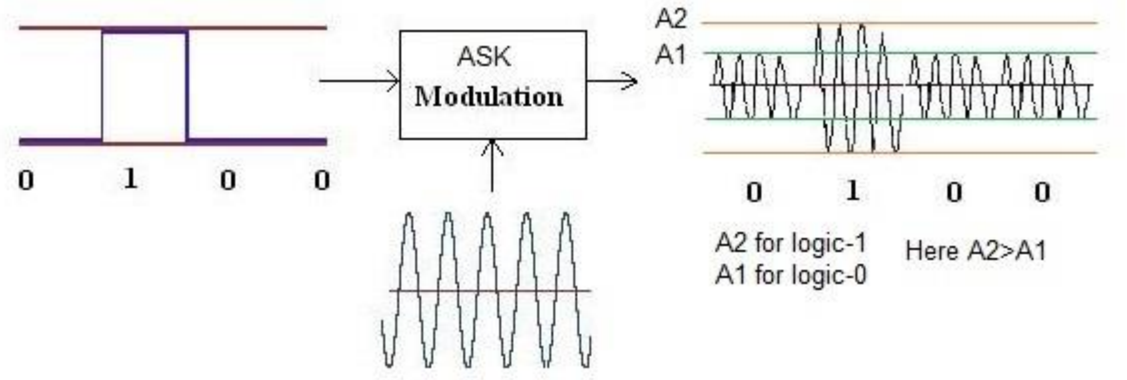
```
         Transmitting Antenna      Radio Waves       Receiving Antenna
                  +              +              +
                  |              |              |
                  |              |              |
                  |              |              |
                  |              |              |
                  |              |              |
                  |              |              |
                  |              |              |
                  +-----------------------------------+
                               Earth's Surface
```

In ground wave propagation, radio waves follow the curvature of the Earth's surface and travel along the ground. In sky wave propagation, radio waves are reflected back to the Earth's surface by the ionosphere, allowing for long-distance communication. In space wave propagation, radio waves travel in a straight line from the transmitting antenna to the receiving antenna without being reflected or refracted, suitable for line-of-sight communication.

Different types of radio wave propagation have their advantages and limitations, and the choice of propagation type depends on the specific communication requirements, frequency bands, and environmental conditions.

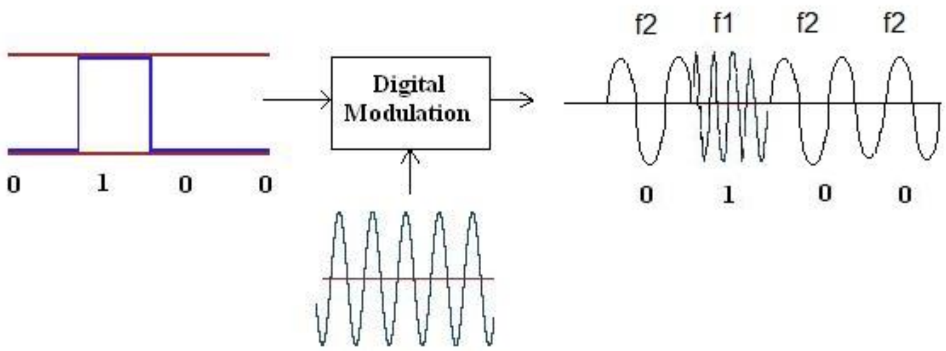
B. Consider the following binary data and sketch the ASK, FSK & PSK modulated waveforms.

ANS.



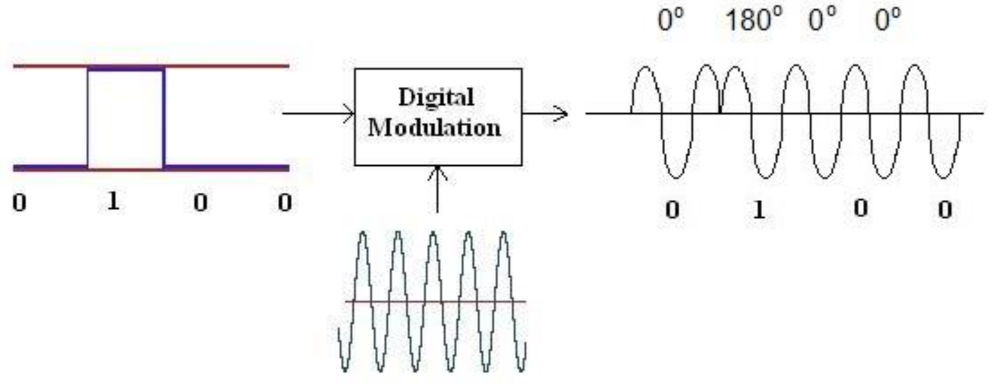
FSK

The short form of Frequency Shift Keying is referred as **FSK**. It is also digital modulation technique. In this technique, frequency of the RF carrier is varied in accodance with baseband digital input. The figure depicts the FSK modulation. As shown, binary 1 and 0 is represented by two different carrier frequencies. Figure depicts that binary 1 is represented by high frequency 'f1' and binary 0 is represented by low frequency 'f2'.



PSK

The short form of Phase Shift Keying is referred as **PSK**. It is digital modulation technique where in phase of the RF carrier is changed based on digital input. Figure depicts Binary Phase Shift Keying modulation type of PSK. As shown in the figure, Binary 1 is represented by 180 degree phase of the carrier and binary 0 is represented by 0 degree phase of the RF carrier.



C. Describe about Radio signal transmission and Multiple access techniques.

ANS. *Radio signal transmission refers to the process of sending information, such as voice, data, or video, through radio waves from a transmitter to a receiver. Radio waves are electromagnetic waves that propagate through the air or other medium and can carry information in the form of varying amplitude, frequency, or phase.*

The process of radio signal transmission typically involves the following steps:

Modulation: In this step, the information to be transmitted, such as voice or data, is impressed onto a carrier signal by varying its amplitude, frequency, or phase. This process is known as modulation, and it allows the information to be carried by the carrier signal.

Amplification: The modulated carrier signal is then amplified to an appropriate level to ensure that it can propagate over the desired distance without significant loss of signal strength.

Transmission: The amplified modulated signal is then transmitted through an antenna, which converts the electrical signal into radio waves that propagate through the air or other medium.

Reception: The radio waves are received by a compatible receiver antenna, which converts them back into an electrical signal.

Demodulation: The received electrical signal is then demodulated to extract the original information, such as voice or data, from the carrier signal.

Multiple access techniques are used to allow multiple users to share the same radio frequency spectrum for communication without interfering with each other. Some commonly used multiple access techniques include:

Frequency Division Multiple Access (FDMA): In FDMA, different users are assigned different frequency bands to transmit their signals. Each user is allocated a separate frequency band, and their signals are transmitted simultaneously without overlapping.

Time Division Multiple Access (TDMA): In TDMA, different users are assigned different time slots within a fixed time frame to transmit their signals. Each user is allocated a specific time slot during which they can transmit their signals.

Code Division Multiple Access (CDMA): In CDMA, different users are assigned different unique codes to modulate their signals. The modulated signals are then transmitted simultaneously over the same frequency band, and the receiver uses the corresponding code to demodulate the desired signal.

Orthogonal Frequency Division Multiple Access (OFDMA): OFDMA is a combination of FDMA and TDMA, where different users are assigned different orthogonal frequency subcarriers within a time frame to transmit their signals. Each user can transmit their signals simultaneously using multiple subcarriers.

These multiple access techniques allow efficient utilization of the limited radio frequency spectrum by enabling multiple users to share the same frequency band or time frame for communication without interfering with each other.