

Question: Define (i) an amplifier (ii) Define the gain of an amplifier

Answer: I. an amplifier or simply amp is any device that changes, usually increases, the amplitude of a signal.

ii. The gain of an amplifier is the ratio of output to input power or amplitude, and is usually measured in decibels

Question: List the three basic properties of an amplifier

Question: Name the three main properties of an amplifier.

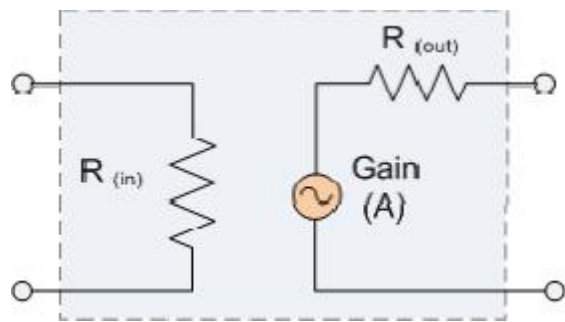
Answer: An amplifier has three main properties,

- i. Input Resistance or (R_{in}),
- ii. Output Resistance or (R_{out})
- iii. Gain or (A).

Question: Draw a simple circuit diagram of an ideal amplifier to show the relationship among these properties.

Question: Sketch a diagram of an Ideal Amplifier Model.

Answer:



The relationship of the input to the output of an amplifier—usually expressed as a function of the input frequency—is called the transfer function of the amplifier, and the magnitude of the transfer function is termed the gain.

Question: What are h-parameters?

Answer: These are four constants which described the behavior of a two-port linear network. A linear network is one in which resistance; inductance and capacitance remain fixed when voltage across them is changed.

Question: List four factors on which the h-parameter depends

Answer: Transistor type • Configuration • Operating point • Temperature • Frequency

Question Briefly explain the term operating point

Answer: The **operating point** defines the characteristics of the region that will be employed for amplification of transistor amplifier's applied signal. Since the operating point is a fixed point on the on the characteristics, it is also called the **quiescent point** (Q-point).

Question: Summarize the operation in the cutoff, saturation, and linear regions of the BJT characteristic.

i. Cut-off Region (Transistor is OFF)

- a) Base-Emitter and Base-Collector junctions are reverse-biased
- b) No current flows (ideally)
- c) Acts like an open switch
- d) $V_{ce} = V_{cc}$

ii. Saturation Region (Transistor is Fully ON)

- a) Both Base-Emitter and Base-Collector junctions are forward-biased
- b) Maximum current flows
- c) Acts like a closed switch
- d) $V_{ce} = 0$

iii. Active (Linear) Region (Amplifier Mode)

- a) Base-Emitter is forward-biased
- b) Base-Collector is reverse-biased
- c) Transistor amplifies current
- d) Used in analog circuits (e.g., amplifiers)

Question: Differentiate between transfer function and gain

Answer: The relationship of the input to the output of an amplifier—usually expressed as a function of the input frequency—is called the **transfer function** of the amplifier, and the magnitude of the transfer function is termed the **gain**.

Question: Give six advantages of negative feedback

Answer:

- i. High input impedance
- ii. Better stabilized voltage gain
- iii. Improved frequency response
- iv. Lower output impedance
- v. Reduced noise
- vi. More linear operation
- vii. Less harmonic distortion
- viii. Less phase distortion
- ix. Less amplitude distortion.

Question: Name four secondary sources of electrical energy.

Answer:

- i. Conversion of one form of electrical power to another desired form and voltage.
E.g AC to DC
- ii. Batteries
- iii. Chemical fuel cells and other forms of energy storage systems
- iv. Solar power
- v. Generators or alternators

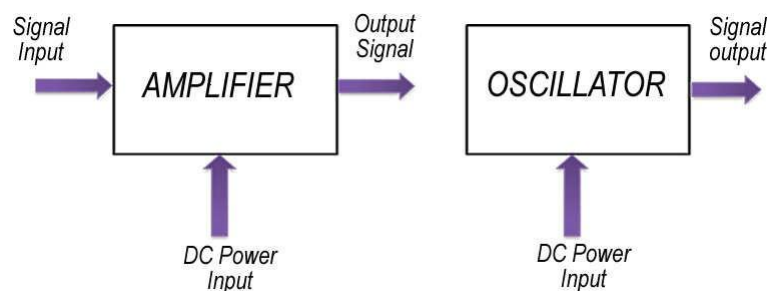
Question: State 3 advantages of the bridge rectifier.

Answer:

- i. No center-tap is required on the transformer
- ii. Much smaller transformers are required
- iii. It is suitable for high-voltage applications
- iv. It has less rating per diode.

Question: What is the difference between an amplifier and an oscillator

Answer: An oscillator can be regarded as an amplifier which provides its own input signal. An oscillator differs from an amplifier in one basic aspect: the oscillator does not require an external signal to start or maintain energy conversion process. It keeps producing an output signal so long as the dc power source is connected.



Question: What are criteria for classifying amplifiers?

Answer: Amplifiers may be classified according to the input (source) they are designed to amplify, the device they are intended to drive, the frequency range of the signals, whether they invert the signal, or the type of device used in the amplification.

Question: What are the types of configuration in transistors?

Question: What are the three basically possible ways to connect a Bipolar Transistor within an electronic circuit?

Answer:

- i. Common Base Configuration - has Voltage Gain but no Current Gain.
- ii. Common Emitter Configuration - has both Current and Voltage Gain.
- iii. Common Collector Configuration - has Current Gain but no Voltage Gain.

Question: What is a bipolar junction transistor?

Answer: A bipolar junction transistor (BJT) is a three-layer electronic device made of either NPN or PNP semiconductor material, with three terminals: emitter, base, and collector. It controls current flow by using the base to regulate the movement of charge carriers from the emitter to the collector, allowing it to act as a switch or amplifier in circuits.

Question: What are the four possible combinations of bias condition of a BJT with two junctions

Answer

- i. both junctions reverse-biased
- ii. both junctions forward-biased
- iii. BE junction forward-biased
- iv. BC junction reverse-biased.
- v. BE junction reverse-biased,
- vi. BC junction forward-biased.

Question: Explain the terms Digital and analogue IC's

Question: List the two classes of Integrated Circuits (ICs) based on the function

Answer:

- i. **Digital ICs:** contain circuits whose input and output voltages are limited to two possible levels – high or low.
- ii. **Linear ICs (LICs):** also referred to as analog ICs because their inputs and outputs can take on a continuous range of values and the outputs are generally proportional to the inputs.

Question: What is meant by the term Integrated Circuit

Answer: An IC is a complete electronic circuit in which both the **active** and **passive** components are fabricated on a tiny single chip of silicon. **Active** components are those which have the ability to produce gain. Examples are: transistors and FETs. **Passive** components or devices are those which do not have this ability. Examples are: resistors, capacitors and inductors.

Question: Enumerate some of the uses of Linear Integrated Circuit.

Answer:

- i. Operational amplifiers
- ii. Small-signal amplifiers
- iii. **Power amplifiers:** A power amplifier is an electronic device that increases the power level of a signal, making it strong enough to drive loads
- iv. RF and IF amplifiers
- v. Microwave amplifiers
- vi. Multipliers
- vii. Voltage comparators
- viii. Voltage regulators etc.

Question: Explain the workings of an Operational Amplifier Shunt Voltage Regulator.

Answer: An Operational Amplifier Shunt Voltage Regulator works by using an op-amp to maintain a constant output voltage across the load by controlling a shunt element (transistor or a Zener diode).

Question: The input and output voltages of a filter network are 16 mV and 8 mV respectively.

Answer:

Question: What are the determining factors in judging the stability of a feedback amplifier as a function of frequency?

Answer:

- i. The product of the amplifier's gain and feedback factor (βA)
- ii. The phase shift between the input and output signals

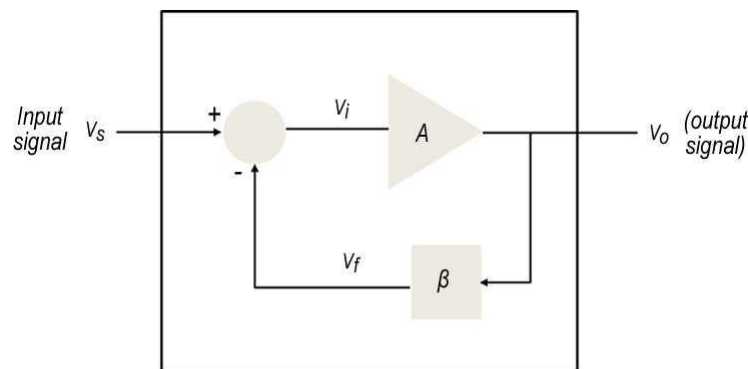
Question: How does a feedback amplifier function?

Answer: A feedback amplifier works by taking a portion of its output signal and feeding it back to the input. This feedback can be:

- a. **Positive Feedback:** The feedback adds to the input signal.
- b. **Negative Feedback** (Most Common): The feedback reduces the input signal.

Question: Sketch a feedback circuit

Answer:



Question: Differentiate between gain margin and phase margin

Question: Differentiate between the gain margin and phase margin of an amplifier

Answer:

- i. **Gain margin (GM)** is defined as the negative value of $|\beta A|$ in decibels at the frequency at which the phase angle is 180° . Thus 0 dB, equal to a value of $\beta A = 1$, is on the border of stability and any negative decibel value is stable,
- ii. **Phase margin (PM)** is defined as the angle of 180° minus the magnitude of the angle at which the value of $|\beta A|$ is unity (0dB)

Question: Describe the Nyquist and Barkhausen criteria?

Question: State the Nyquist criterion.

Answer:

- i. Nyquist criterion states that The amplifier is unstable if the Nyquist curve encloses the point, and it is stable otherwise. A Nyquist plot is used to quickly show whether an amplifier is stable for all frequencies and how stable the amplifier is relative to some gain or phase-shift criteria.

ii. If the condition $\beta A = 1$ is met. This is known as Barkhausen criterion for oscillation

Question: What is a Choke Input or L-C Filter?

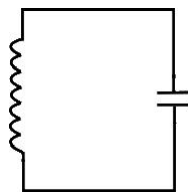
Answer: A Choke Input Filter, also known as an L-C Filter, is a type of power supply filter used to smooth out the output of a rectifier and reduce the ripple in DC voltage.

Question: When is the resonance effect said to occur in an LC circuit?

Answer: The resonance effect occurs when inductive and capacitive reactance are equal in absolute value.

Question: Sketch LC-oscillator

Answer:



An LC oscillator is a type of electronic oscillator circuit that uses an inductor (L) and a capacitor (C) to produce continuous oscillating signals (AC voltage) at a specific frequency.

Question: State the typical maximum efficiencies for class A, class B and class AB amplifiers.

Answer:

- i. Class A - a maximum theoretical efficiency of less than 40%
- ii. Class B - with a maximum theoretical efficiency of about 70%
- iii. Class AB - which an efficiency rating between that of Class A and Class B (40-70)%

Question: Briefly describe the operation of a Class A amplifier

Question: What are the five (5) types of Amplifier Class? Explain any one of them

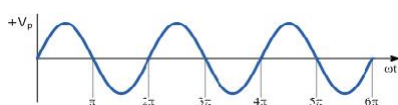
Question: Using perfect circuit diagrams describe the following classes of amplifiers:

- i. Class A ii. Class B iii. Class AB and iv. Class C.

Question: List the different classes of amplifier operations

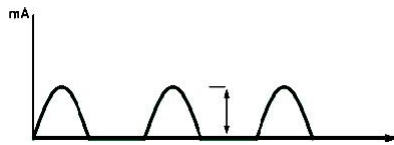
Answer:

- i. Class A
 - a) Works for the full cycle (100% of the time) of the input signal.
 - b) Very clean and low distortion, but not power-efficient.
 - c) The amplifier is always on, even when there's no signal.



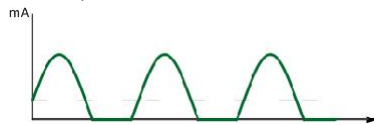
- ii. Class B

- a) Works for half of the signal cycle (only 50%).
- b) More efficient than Class A but creates distortion if used alone.



iii. Class AB

- a) A mix between Class A and Class B.
- b) Each part of the amp works a bit more than half the cycle.
- c) Gives better sound quality than Class B and better efficiency than Class A.
- d) Often used in audio amplifiers.



iv. Class C

- a) Works for less than half of the signal cycle.
- b) Not suitable for audio—used in radio transmitters and RF circuits.
- c) Needs a tuned circuit to recreate the full signal.

v. Class D

- a) Uses digital (on/off) signals to amplify.
- b) Very efficient (uses power only in short bursts).
- c) Common in modern audio systems and portable devices.

Question : State three advantages and one disadvantage of class A amplifier.

Answer:

- i. Simpler than other classes
- ii. Can use either single-ended or push-pull and bias is usually less critical.
- iii. Gives the least audio distortion.
- iv. Because the device is never shut off completely there is no "turn on" time, little problem with charge storage, and generally better high frequency performance and feedback loop stability
- v. The problem of crossover distortion associated with Class AB and B designs is avoided

Disadvantage of Class A Amplifiers

- i. They are very inefficient

Question Draw a Series-fed Class A large Signal Amplifier and explain its AC operation.

Answer: Class A Operation Class A Amplifier operation is where the entire input signal waveform is faithfully reproduced at the amplifiers output as the transistor is perfectly biased within its active region, thereby never reaching either of its Cut-off or Saturation regions.

Question: What is an operational amplifier?

Question: What is an operational amplifier (op-amp)?

Answer: An operational amplifier, or op-amp is a very high gain, high input impedance directly coupled positive feedback amplifier with low output impedance.

Question: State any two characteristics of an ideal Op-amp

Answer:

- i. The two input terminals are directly shorted internally
- ii. The input impedance of the OP-AMP is infinity
- iii. Common-mode rejection ratio is infinity
- iv. The open-loop gain of the OP-AMP is infinity

Question: What is Peak Inverse Voltage?

Answer: It is the maximum voltage that occurs across the rectifying diode in the reverse direction

Question: State three uses of op-amp

Answer:

- i. perform mathematical operations like summation, subtraction, multiplication, differentiation and integration
- ii. Amplification – Used to amplify weak signals in audio devices, sensors, and instrumentation.
- iii. Filtering – Used in active filters (low-pass, high-pass, band-pass) for signal processing.

Question: What are active filters

Answer: Active filters are electronic circuits that use active components like operational amplifiers (op-amps), along with resistors and capacitors, to filter specific frequency ranges from signals. Unlike passive filters, they can provide gain, have better performance at low frequencies, and don't require inductors.

Question: Briefly describe the following: i. low pass filter ii. High pass filter iii. Band pass filter. Iv. Notch filter

Answer:

- i. **Low Pass Filter:** Allows low-frequency signals to pass through while blocking high-frequency signals.
- ii. **High Pass Filter:** Allows high-frequency signals to pass through while blocking low-frequency signals.
- iii. **Band Pass Filter:** Allows signals within a certain frequency range (band) to pass through, while blocking frequencies outside that range.
- iv. **Notch Filter (Band Stop Filter):** Blocks or attenuates signals within a specific narrow frequency range and allows all others to pass.

Question: Differentiate between an integrator and a differentiator

Answer:

- i. An integrator uses a capacitor as a feedback component to produce an output which is the integral of the input signal over time.
- ii. A differentiator uses a capacitor at the input and a resistor as the feedback component to produce an output which is the derivative of the input signal over time.

Question: What are electronic oscillators and state 4 applications of square wave

Answer:

- i. An electronic oscillator may be defined as a circuit which converts dc energy into ac energy at a very high frequency
- ii. It is an electronic source of alternating current or voltage having sine, square or saw-tooth or pulse shapes
- iii. It is a circuit which generates an ac output signal without requiring any externally applied input signal
- iv. It is an unstable amplifier

Question: Define (i) an oscillator (ii) a noninverting amplifier

Question: What is an oscillator?

Answer:

- i. Oscillators are circuits that produce periodic waveforms. An oscillator can be thought of as an amplifier that provides itself (through feedback) with an input signal.
- iii. A non-inverting operational amplifier (op-amp) is a type of op-amp where the output voltage is in phase with the input voltage.

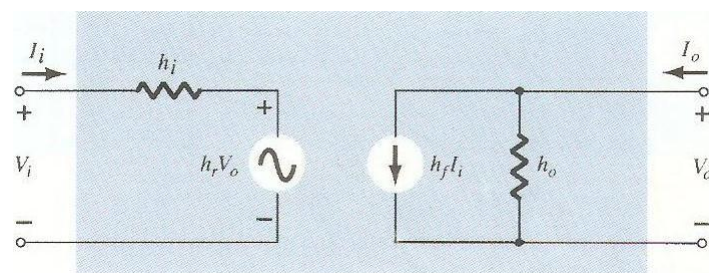
Question: State two classifications of the oscillator

Answer:

- i. **Sinusoidal (or harmonic) oscillators**—which produce an output having sine waveform
- ii. **Non-sinusoidal (or relaxation) oscillators**—they produce an output which has square, rectangular or saw-tooth waveform or is of pulse shape.

Question: Draw and describe the complete hybrid equivalent circuit

Answer:



A hybrid equivalent circuit is a simplified model used to represent a transistor's behavior in AC analysis using four parameters (h-parameters). It shows how the transistor responds to input signals in terms of voltage gain, current gain, input

impedance, and output impedance. A hybrid equivalent circuit uses a mix of different units—such as ohms (impedance), unitless gain, and siemens (admittance)—to describe the transistor's electrical characteristics.

Question: List the available types of multivibrators (MV).

Answer:

They are basically two-stage amplifiers with positive feedback from the output of one amplifier to the input of the other.

- i. **Astable multivibrator (AVM):** has no stable state; it continuously switches between two states on its own, producing a square wave output without any external trigger.
- ii. **Monostable multivibrator (MMV):** has one stable state and one unstable state; it requires an external trigger to temporarily switch to the unstable state before returning to the stable one.
- iii. **Bistable multivibrator (BMV):** has two stable states and remains in one state until an external trigger switches it to the other, making it useful for storing binary data (flip-flop behavior)

Question: State three uses of multivibrator.

Answer: These devices are very useful as pulse generating, storing and counting circuits.

Uses of Multivibrators Some of their uses are:

- i. as frequency dividers
- ii. as sawtooth generators
- iii. as square wave and pulse generators
- iv. as a standard frequency source when synchronized by an external crystal oscillator
- v. for many specialized uses in radar and TV circuits
- vi. as memory elements in computers.

Question: List the difference(s) between fixed negative voltage regulator and adjustable voltage regulator. Give one example of each.

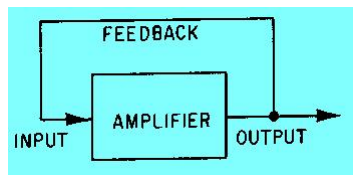
Answer:

The change in voltage from no-load to full-load condition is called voltage regulation.

- i. Fixed Negative Voltage Regulator:
 - a) Has a constant negative voltage
 - b) Not flexible – output is fixed
 - c) Requires few or no external component
 - d) Simple circuits needing a standard voltage
- ii. Adjustable Voltage Regulator
 - a) User can set the desired output voltage using external components
 - b) Flexible – output can be adjusted within a range
 - c) Flexible – output can be adjusted within a range
 - d) Circuits needing custom voltage levels

Question: Draw the block diagram of the oscillator

Answer:



Question: Differentiate between negative feedback and positive feedback

Answer: If the output feedback signal opposes the input signal, the signal is DEGENERATIVE or NEGATIVE FEEDBACK. However, if the feedback aids the input signal, the feedback is REGENERATIVE or POSITIVE FEEDBACK. Negative feedback results in decreased voltage gain

Question: State four advantages of degenerative feedback

Answer:

- i. High input impedance
- ii. Better stabilized voltage gain
- iii. Improved frequency response
- iv. Lower output impedance
- v. Reduced noise
- vi. More linear operation
- vii. Less harmonic distortion
- viii. Less phase distortion
- ix. Less amplitude distortion.

Question: Draw the circuit diagram for closed-loop non-inverting operational amplifier.

Question: Complete the following table of h-parameter

Parameter	Meaning	Relation	Condition	Unit
h_{11}	Input impedance	$\frac{V_i}{i_o}$	Output shorted V_{out}	Ohm(Ω)
h_{12}	Reverse voltage gain	$\frac{V_i}{V_o}$	Input open I_{in}	dimensionless
h_{21}	Current gain	$\frac{I_o}{I_i}$	Output short-circuited V_{out}	Dimensionless
h_{22}	Output admittance	$\frac{I_o}{V_o}$	Input open	Siemens (S) or $1/\Omega$

Question: With the aid of diagram, describe a half wave rectifier circuit.

Answer: half-wave rectifier is a circuit that converts AC (alternating current) into DC (direct current) by allowing only one half (positive or negative) of the AC signal to pass through.

Question: Write short notes to explain the following rectification process: i. half-wave ii. Full-wave

Answer: A Full-Wave Rectifier is a circuit that converts the entire input AC (alternating current) signal into a pulsating DC (direct current) signal. It uses either two diodes with a center-tapped transformer or four diodes in a bridge configuration, allowing both halves of the AC waveform to contribute to the output, resulting in higher efficiency and smoother output than a half-wave rectifier.

Question: Briefly explain the operating conditions of the transistor when used as a switch for both "Fully-OFF" and "Fully-ON"

Answer:

- i. Fully-OFF - Cut-off Region - Both junctions are **Reverse-biased**, Base current is zero or very small resulting in zero Collector current flowing, the device is switched fully "OFF".
- ii. Fully-ON - Saturation Region - Both junctions are **Forward-biased**, Base current is high enough to give a Collector-Emitter voltage of 0 Volts resulting in maximum Collector current flowing, the device is switched fully "ON".

Question: What do you understand by Windmill?

Question: What is meant by power supply? ii. Enumerate the sources of electricity.

Answer:

- i. Power supply is a supply of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU
- ii. Sources of energy
 - a) **Steams as an Energy Source**
 - b) **Fossil Fuels and Nuclear Fuel**
 - c) **Oil and Natural Gas**
 - d) **Coal**
 - e) **Solar Energy**
 - f) **Windmills:** Windmills, once widely used for pumping water. Windmills generate electricity by converting the kinetic energy of wind into mechanical energy, which drives a generator to produce electrical power. Modern windmill farms use multiple turbines in windy areas, but inconsistent wind patterns limit large-scale reliability.

Question: Highlight four types of power supply.

Answer:

- i. **Battery Power Supply:** A battery consists of several electrochemical cells

connected in series to provide the voltage desired. Batteries may be primary or secondary

ii. **Unregulated Power Supply:** An Unregulated Power Supply converts AC to DC without stabilizing the output voltage, so the voltage can vary with changes in load or input. It is simple and low-cost but not suitable for sensitive electronic devices.

iii. **Regulated Power Supply:** A Regulated Power Supply provides a constant and stable output voltage regardless of changes in input voltage or load conditions.

iv. **AC/DC Supply:** An AC/DC Power Supply converts alternating current (AC) from the mains into direct current (DC) used by most electronic devices. It typically includes a transformer, rectifier, filter, and voltage regulator to produce a smooth DC output.

v. **Switched-Mode Power Supply**

vi. **Programmable Power Supply:** A Programmable Power Supply is an electronic device that allows the user to set and control output voltage and current digitally. It is often used in automated testing and development environments where precise and repeatable power settings are needed

vii. **Uninterruptible Power Supply:** An Uninterruptible Power Supply (UPS) is a device that provides backup power by switching instantly to a battery when the main AC power fails.

viii. **High-Voltage Power Supply:** A High-Voltage Power Supply is designed to deliver output voltages much higher than standard supplies, typically in the range of hundreds or thousands of volts. It is used in applications such as X-ray machines, particle accelerators, and scientific research that require high-voltage energy.

Question: Describe linear and switched mode power supplies

Answer: A Linear Power Supply converts AC to DC using a transformer and regulator, providing a smooth output but with low efficiency and more heat. A Switched-Mode Power Supply (SMPS) Converts AC to DC using high-frequency switching and components like inductors and capacitors to convert power efficiently, making it compact and suitable for high-power applications.

Question: Explain an Uninterruptible Power Supply (UPS)?

Answer: An Uninterruptible Power Supply (UPS) is a device that provides backup power by switching instantly to a battery when the main AC power fails, ensuring continuous power to connected equipment. It is commonly used in systems like computers, hospitals, or telecoms to prevent data loss or service disruption during outages.

Question: Explain the Piezoelectric Effect.

Answer: The piezoelectric effect is the ability of crystals like quartz to generate voltage when stressed, and to vibrate when an alternating voltage is applied. At its resonant frequency, the crystal vibrates with maximum amplitude, producing a precise and stable frequency used to control timing and signal processing in devices like

computers, watches, and communication systems.

Question: Give the two reasons for the loss of energy during the oscillations of the capacitor in an oscillatory circuit.

Answer:

- i. Some energy is lost in the form of heat produced in the resistance of the coil and connecting wires
- ii. and some energy is lost in the form of electromagnetic (EM) waves that are radiated out from the circuit through which an oscillatory current is passing.

Question: Determine the Voltage, Current and Power Gain of an amplifier that has an input signal of 1mA at 10mV and a corresponding output signal of 10mA at 1V. Also, express all three gains in decibels

Answer:

Input Voltage (V_{in}) = 10 mV = 0.01 V

Input Current (I_{in}) = 1 mA = 0.001 A

Output Voltage (V_{out}) = 1 V

Output Current (I_{out}) = 10 mA = 0.01 A

$$A_v = \frac{V_{out}}{V_{in}} = \frac{1}{0.01} = 100$$

In decibels (dB):

$$A_{v(dB)} = 20\log_{10}(100) = 20 * 2 = 40\text{dB}$$

Current gain

$$A_i = \frac{I_{out}}{I_{in}} = \frac{0.01}{0.001} = 10$$

$$A_{i(dB)} = 20\log_{10}(10) = 20 * 1 = 20\text{dB}$$

Power Gain (Input power)

$$P_{in} = V_{in} * I_{in} = 0.01 * 0.001 = 10^{-5}$$

$$P_{out} = V_{out} * I_{in} = 1 * 0.01 = 10^{-3}$$

$$A_p = \frac{P_{out}}{P_{in}} = \frac{0.01}{0.00001} = 1000$$

$$A_{p(dB)} = 10\log_{10}(1000) = 10 * 3 = 30\text{dB}$$

Question: Explain the function of a rectifier circuit in a dc supply unit

Answer: It is a circuit which employs one or more diodes to convert ac voltage into pulsating dc voltage. Such a voltage could be used in, say, a battery charger.

Question: What is rectification?

Answer: The process of converting ac voltage into dc voltage is called rectification and is accomplished with the help of a: 1. Rectifier 2. Filter and 3. Voltage regulator circuit. These elements put together constitute dc power supply.

Question: State and briefly explain the factors upon which the frequency of time-period of the oscillatory current depends.

Answer:

- i. **Capacitance of the Capacitor:** Larger the capacitor, greater the time required for the reversal of the discharge current i.e. lower its frequency
- ii. **Self-inductance of the Coil:** Larger the self-inductance, greater the internal effect and hence longer the time required by the current to stop flowing during discharge of the capacitor.

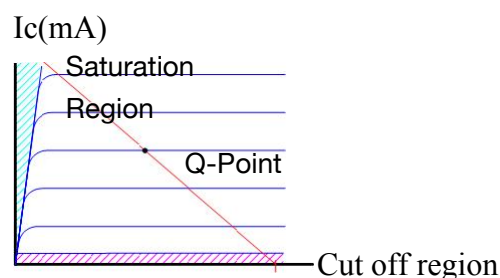
Question: Give any four (4) examples of Non sinusoidal wave forms and state the use of each

Answer: Any waveform whose shape is different from that of a standard sine wave is called non-sinusoidal waveform. Examples are: square, rectangular, saw-tooth, triangular waveforms and pulses

- i. **Pulses:** A pulse may be defined as a voltage or current that changes rapidly from one level of amplitude to another they are used in digital electronics.
- ii. **Square Wave:** a pulse waveform with a mark-to-space ratio of 1:1 used in
 - a) audio frequency note generation
 - b) digital electronic switching as in computers
 - c) Radars
 - d) synchronizing pulses in TV
 - e) switching of high-power electronic circuits such as thyristor circuits
- iii. **Saw-tooth Wave:**
 - a) scanning circuits of cathode-ray tubes (CRT),
 - b) timing circuits where the time for the wave to proceed from one level to another is measured, such as that produced in an integrating circuit
- iv. **Triangular Wave**
 - a) in scanning circuits where a uniform left-to-right scan is required as in computer displays
 - b) audio frequency note generation
 - c) timing circuits for electronic applications.

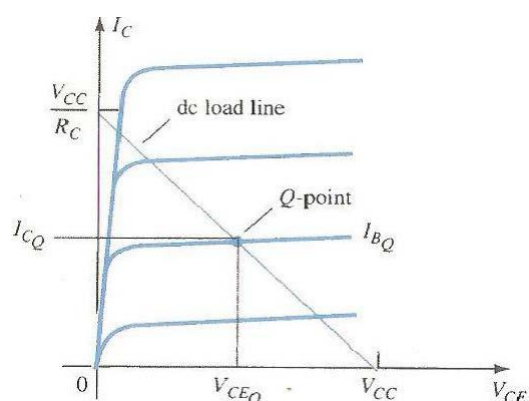
Question: Sketch the CE-configuration transistor output characteristics of a transistor and indicate the active, cut-off and saturation regions.

Answer:



Question: Draw a complete Transistor Characteristics showing Load Line and Q-

Point



Question: Explain any four (4) factors that affect frequency stability of an oscillator

Question: Briefly explain the term “frequency stability of an oscillator” and name any six factors responsible for it.

Answer

The ability of an oscillator to maintain a constant frequency of oscillation is called its frequency stability. Following factors affect the frequency stability:

Factors responsible for frequency stability of an oscillator

- i. **Operating Point of the Active Device:** Operation on non-linear portion of a transistor varies the parameters of the transistor which, in turn, affects the frequency stability of the oscillator. To stabilize this frequency, a q-point is chosen as to confine the circuit operation on the linear portion of its characteristics.
- ii. **Inter-element Capacitances:** Any changes in the inter-element capacitances of a transistor particularly the collector- to emitter capacitance cause changes in the oscillator output frequency, thus affecting its frequency stability. The effect of changes in inter-element capacitances can be neutralized by adding a swamping capacitor across the offending elements leading
- iii. **Power Supply:** Changes in the dc operating voltages applied to the active device shift the oscillator frequency. This problem can be avoided by using regulated power supply.
- iv. **Temperature Variations:** Variations in temperature cause changes in transistor parameters and also change the values of resistors, capacitors and inductors used in the circuit. Since such changes take place slowly, they cause a slow change (called drift) in the oscillator output frequency.
- v. **Output Load:** A change in the output load may cause a change in the Q-factor of the LC tuned circuit thereby affecting the oscillator output frequency
- vi. **Mechanical Vibrations:** Vibrations change the values of circuit elements, they result in changes of oscillator frequency. This instability factor can be eliminated by isolating the oscillator from the source of mechanical vibrations.

Question: State any four (3) applications of resonance effect.

Answer:

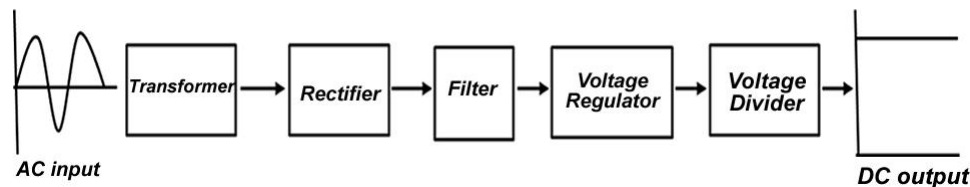
- i. Most common application is tuning. For example, when we tune a radio to a particular station, the LC circuits are set at resonance for that particular carrier frequency.
- ii. A series resonant circuit provides voltage magnification.
- iii. A parallel resonant circuit provides current magnification.
- iv. A parallel resonant circuit can be used as load impedance due to high impedance, the gain of amplifier is maximum at resonant frequency
- v. Both parallel and series resonant circuits are used in induction heating.

Question: With the aid of a block diagram, list and explain the components of a dc supply unit.

Question: With the aid of a perfect block diagram describe the DC power supply unit.

Answer:

A typical DC power supply consist of 5 stages.



- i. **Transformer:** Its job is either to step up or (mostly) step down the ac supply voltage to suit the requirement of the solid- state electronic devices and circuits fed by the dc power supply
- ii. **Rectifier:** It is a circuit which employs one or more diodes to convert ac voltage into pulsating dc voltage.
- iii. **Filter:** The function of this circuit element is to remove the fluctuations or pulsations (called ripples) present in the output voltage supplied by the rectifier.
- iv. **Voltage Regulator:** Its main function is to keep the terminal voltage of the dc supply constant even when
 - a) ac input voltage to the transformer varies
 - b) the load varies.
- v. **Voltage Divider:** Its function is to provide different dc-voltages needed by different electronic circuits.

Question: Draw the circuit diagram of the Half-wave, Full-wave and Full-wave Bridge rectifier circuits and indicate the respective input and output waveforms.

Question: Define the following: Mark-to-Space Ratio (MSR), Pulse Repetition Time (PRT), and Pulse Repetition Frequency (PRF)

Answer:

- i. Mark-to-Space Ratio (MSR)

This name has come from early Morse-code transmission systems where a pulse was used to cause a pen to mark the paper.

$$\text{MRS} = \frac{\text{pulse width}}{\text{time between pulse}} = \frac{1\mu\text{s}}{4\mu\text{s}} = 0.25$$

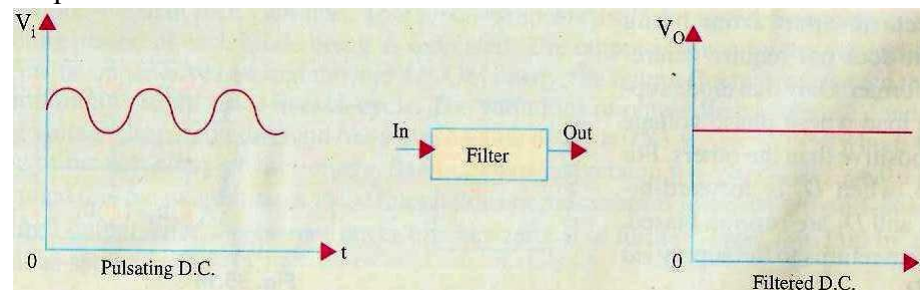
ii. Pulse Repetition Time (PRT): It may be defined as the time between the beginning of one pulse and that of the other.

iii. Pulse Repetition Frequency (PRF): It is given by the number of pulses per second.

$$\text{iv. } \text{PRT} = \frac{1}{\text{PRF}} = \frac{1}{5\mu\text{s}} = \frac{10^6}{5} = 200,000\text{Hz}$$

Question: What is a Filter circuit? Draw a block diagram of a filter circuit.

Answer: A circuit that converts a pulsating output from a rectifier into a very steady dc level is known as filter because it filters out or smoothens out the pulsations in the output.



Question: What is common-mode rejection ratio

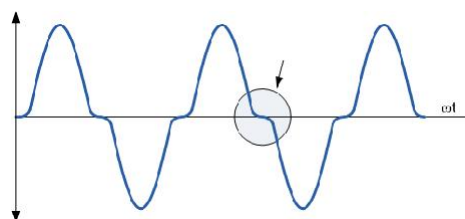
$$\text{Answer: CMRR} = \frac{A_d}{A_c}$$

Question: The value of CMRR can also be expressed in logarithm term as?

$$\text{Answer: CMRR(log)} = 20\log \frac{A_d}{A_c} (dB)$$

Question: Discuss cross over distortion.

Answer: Crossover Distortion produces a zero voltage "flat spot" or "dead band" on the output wave shape as it crosses over from one half of the waveform to the other. The reason for this is that the transition period when the transistors are switching over from one to the other, does not stop or start exactly at the zero crossover point thus causing a small delay between the first transistor turning "OFF" and the second transistor turning "ON". This delay results in both transistors being switched "OFF" at the same instant in time producing an output wave shape as shown below.



Question: How is the effect of cross distortion reduced?

Answer: by applying a slight forward base bias voltage to the bases of the two transistors via the center-tap of the input transformer, thus the transistors are no longer biased at the zero cut-off point but instead are "Pre-biased" at a level determined by this new biasing voltage.

Question: Write notes on the common collector amplifier circuit

Answer: In the common collector configuration the load resistance is situated in series with the emitter so its current is equal to that of the emitter current. The load resistance in this type of amplifier configuration also have both the collector current and the input current of the base flowing through it giving a large current gain therefore, providing good current amplification with very little voltage gain.

Question: Write the equation for amplifier efficiency

Answer: Efficiency(η) = (power delivered to the load) / (d.c. power taken from the supply) = P_{out}/P_{in}

Question: What are transistors?

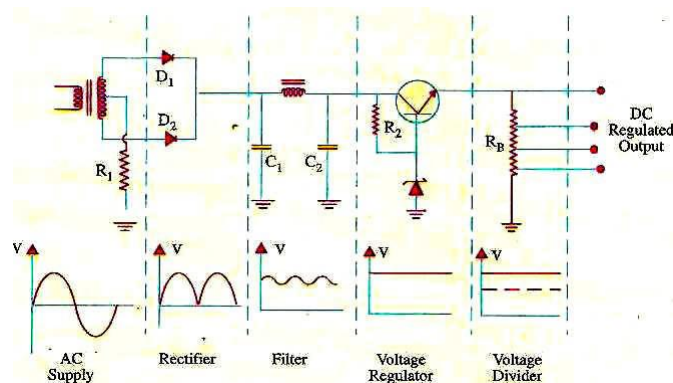
Answer: The term transistor was derived from the words TRANSfer and resISTOR. A transistor is a solid-state device that transfers an input signal current from a low-resistance circuit to a high-resistance circuit.

Question: What do you understand by the term biasing?

Answer: The term **biasing** is an all-inclusive term for the application of **dc** voltages to establish a fixed level of current and voltage. For transistor amplifiers the resulting dc current and voltage establish a region that will be employed for amplification of the applied signal.

Question: Draw a diagram to represent a complete solid state power supply .

Answer:



Question: What is voltage gain in dB?

Answer: Voltage gain A_v = Output Voltage/Input Voltage = V_{out}/V_{in}

Voltage Gain in dB = $20\log A_v$

Current Gain in dB = $20\log A_i$

Power Gain in dB = $10\log A_p$

Question: What do you understand by Amplifier efficiency?

Answer: The efficiency of an amplifier refers to the ratio of output-signal power compared to the total input power. Efficiency is a measure of how much of the power source is usefully applied to the amplifier's output.

Question: List 4 uses of diodes

Answer: Diodes are made up from two pieces of semiconductor material, either Silicon or Germanium to form a simple PN-junction.

- i. Rectification – Converting AC to DC in power supplies (used in rectifiers).
- ii. Voltage Regulation – Using Zener diodes to maintain a constant voltage.
- iii. Signal Demodulation – Extracting audio or data from modulated radio signals.
- iv. Protection Circuits – Preventing damage by blocking reverse voltage or voltage spikes

Question: List the 3 terminals in the FET transistor

Answer:

- i. Gate (G) – Controls the flow of current.
- ii. Source (S) – The terminal through which carriers enter the channel.
- iii. Drain (D) – The terminal through which carriers leave the channel.

Question: State the functions of the following terminals: Base, Emitter, and Collector

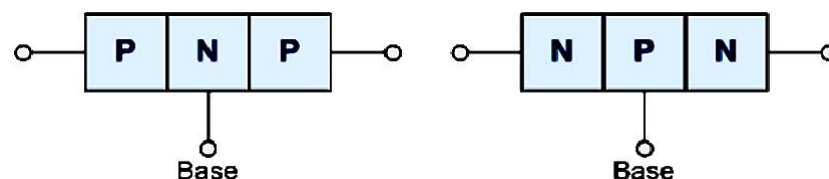
Question: List the three elements of the two-junction transistor

Answer:

- i. The EMITTER, which gives off, or emits, " current carriers (electrons or holes)
- ii. The BASE, which controls the flow of current carriers and
- iii. The COLLECTOR, which collects the current carriers.

Question: Sketch the symbol of a PNP and NPN.

Answer:



Question: Show the diagrammatic representation of the: (i) construction (ii) two-diode analogy and (iii) symbols of a PNP and NPN transistors.

Question: Define the following terms: i. Resonance effect ii. Impedance?

Answer:

- i. The resonance effect occurs when inductive and capacitive reactance are equal in absolute value. The word resonance refers to a class of phenomena in which a small

driving perturbation gives rise to a large effect in the system.

iii. Impedance is the total opposition that a circuit offers to the flow of alternating current (AC).

Question: A tuned collector has a fixed inductance of 100uf and has to be tunable over the freq band of 500khz to 1500khz find the range variable capacitor to be used

Answer:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$C = \frac{1}{2\pi f^2 L}$$

$$C_{\max} \approx 1.013 \times 10^{-9} \text{F} = 1013 \text{ pF}$$

$$C_{\min} \approx 113 \text{ pF}$$

Question: Calculate the output voltage of a non-inverting amplifier with the following values $R_i = 100 \text{ kohms}$ $R_f = 500 \text{ kohms}$ with voltage $V_i = 2 \text{ v}$

$$V_{\text{out}} = V_{\text{in}} \left(1 + \frac{R_f}{R_i}\right) = 12 \text{ v}$$

Question: Determine the input power, output power and circuit efficiency of a Class B amplifier providing a 30V peak signal to a 20Ω (speaker) and a power supply of $V_{cc} = 35 \text{ V}$.

$$P_{\text{out}} = \frac{V^2}{2R}$$

$$P_{\text{out}} = 22.5 \text{ W}$$

$$P_{\text{in}} = \frac{P_{\text{out}}}{(\text{nb}) \text{ Efficiency}} =$$

$$\text{nb} = \frac{\pi}{4} = 0.785$$

$$P_{\text{in}} = \frac{P_{\text{out}}}{0.785} = 28.6 \text{ w}$$

$$\eta = \frac{P_{\text{out}}}{P_{\text{in}}} \times 100 = 78.5\%$$