

Vel Tech

EC8351 - Electronic Circuits- I

II YEAR - III SEMESTER

UNIT-I BIASING OF DISCRETE BJT,FET AND MOSFET

PART - A

1. **Define – Stability Factor** [May/June – 12], [Nov /Dec – 09],
[April/May –10], [May/June – 12]

- i. Stability factor is defined as the rate of change of collector current I_C with respect to the collector base leakage current I_{CBO} keeping both V_{BE} and the current gain β constant.

$$S' = \frac{\partial I_C}{\partial I_{C0}}, \quad \text{with } \beta, V_{BE} \text{ constant}$$

- ii. Stability factor indicate the degree of change in operating point due to variation in temperature.

$$S' = \frac{\partial I_C}{\partial V_{BE}}, \quad \text{with } \beta, I_{C0} \text{ constant}$$

$$S'' = \frac{I_C}{\beta} \quad \text{with } V_{BE}, I_{C0} \text{ constant}$$

2. **Why do you fix the operating point in the middle of the dc load line?** [Nov 05]
In order to get the faithful amplification of the signals, operating point had to be fixed in the middle of the dc load line.
3. **What is Bias? What is the need for biasing?** [Nov-08, May-09,Nov-10, May-11, May-13]

The proper flow of zero signal collector emitter supply voltage during the passage of signal is known as transistor biasing.

Alternatively, the process of giving proper supply voltages and resistances for obtaining the desired Q-point is called biasing.

The need for biasing is

- To prevent thermal runaway
- To achieve stability

4. **Why capacitive coupling is used to connect a signal source to an amplifier?**
[Nov/Dec-07]

Coupling capacitor blocks DC voltage but freely pass signal voltages. Because of this biasing conditions are maintained constant.

Vel Tech

5. Compare bias stabilization and compensation techniques.

[Nov /Dec – 11]

BIAS STABILIZATION	BIAS COMPENSATION
It refers to the use of resistive biasing circuits which allow I_B to vary, so as to keep I_C relatively constant with variations in I_{CO} , β and V_{BE} .	It refers to the use of temperature sensitive devices such as diodes, transistors, thermistors, etc., which provide compensating voltages and currents to maintain the operating point stable.

6. What is Thermal runaway?

The continuous increase in collector current due to poor biasing causes the temperature at collector terminal to increase. If no stabilization is done, the collector leakage current also increases. This further increases the temperature. The action becomes cumulative and ultimately the transistor burns out. The self destruction of an unstabilised transistor is known as thermal runaway.

7. What are the types of transistor biasing?

[Nov /Dec – 11]

The term biasing is defined as the process of giving proper supply voltages and resistances for obtaining the desire Q point. The different methods of biasing are

- i. Fixed Bias
- ii. Voltage divider Bias
- iii. Collector to base Bias
- iv. Emitter feedback bias

8. What is an operating point?

When we bias a transistor, we establish a certain current and voltage conditions for the transistor. These conditions are known as operating condition or dc operating point or quiescent point.

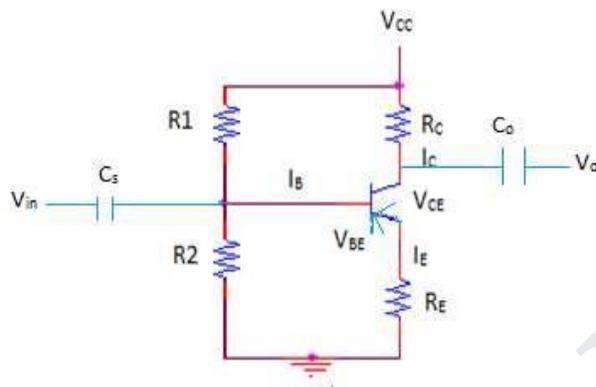
9. What is the condition for thermal stability?

Vel Tech

The required condition to avoid thermal runaway is that the rate at which heat is released at the collector junction must not exceed the rate at which the heat can be dissipated. It is given by

$$\frac{\partial P_c}{\partial T_j} < \frac{\partial P_D}{\partial T_j}$$

10. Draw the single stage self biased circuit using PNP transistor. [April /May – 11]



11. What are the advantages and disadvantages of fixed bias circuit?

Advantages of fixed bias circuit are as follows

- This is a simple circuit which uses very few components
- The operating point can be fixed anywhere in the active region of the characteristics by simply changing the value of R_B . Thus it provides flexibility in design.

Disadvantages of fixed bias circuit are as follows

- This circuit does not provide any check on the collector current which increases with the rise in temperature i.e. thermal stability is not provided by this circuit.
- Since I_C and β and I_B is already fixed; I_C depends on β which changes unit to unit and shifts the operating points.

12. State the advantages and disadvantages of collector to base bias.

Advantages of collector to base bias circuit are as follows

- The biasing arrangements are simple since only one resistor R_B is used.
- The value of base resistance R_B can be easily calculated.

Vel Tech

Disadvantages of collector to base bias circuit are as follows

- Does not provide good stabilization
- The negative feedback of resistance R_B reduces the gain of the amplifier

13. What is the process of instability?

The transistor amplifier fails to provide faithful amplification and drives to instability state due to

- Change in collector current I_C due to temperature changes
- Thermal runaway
- Replacement of transistor of another equivalent transistor.

14. What is the use of compensation technique in electronic circuits?

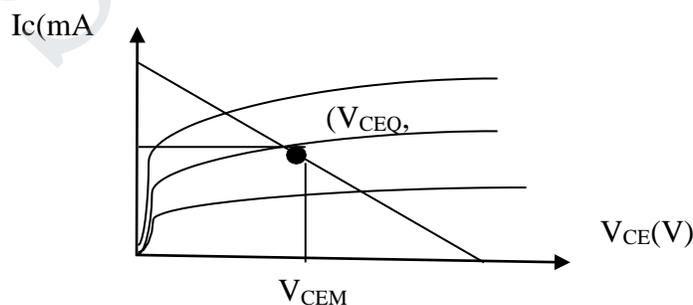
Compensation technique is the use of temperature sensitive devices such as diodes, thermistors, sensistors etc., to stabilize the operating point instead of d.c. biasing circuits.

15. What do you understand by dc load line?

It is the line on the output characteristics of a transistor circuit which gives the values of I_C and V_{CC} corresponding to zero signal.

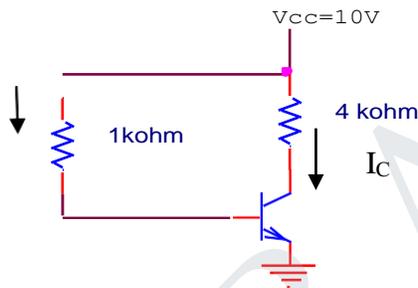
16. What is DC load line? How is Q point plotted on the DC load line? [Nov / Dec – 12]

- The line joining the $I_{C_{MAX}}$ and $V_{CE_{MAX}}$ in the output characteristics of a transistor is called DC load line.
- The optimum Q-point is located at the midpoint of the DC load line between the saturation and cutoff regions. In order to get faithful amplification, the Q point must be within the active region of the transistor.



Vel Tech

17. For the circuit shown in the figure, determine the operating point with $\beta = 100$.
[A/M – 08]



$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{10 - 0.7}{1000}$$

$$= 9.3 \text{ mA}$$

$$I_C = \beta I_B$$

$$= 100 \times 9.3 \times 10^{-3}$$

$$= 0.93 \text{ A}$$

$$V_{CE} = V_{CC} - I_C R_C$$

$$= 10 - (0.93 \times 4 \times 10^{-3})$$

$$= 9.9962 \text{ V}$$

18. What are the factors that affect the Q point of a circuit using BJT? [Nov / Dec 09]

- Reverse saturation current I_{CO} , which doubles for every 10°C increase in temperature.
- Base-emitter voltage V_{BE} , which decreases by 2.5 mV per $^\circ\text{C}$.
- Transistor current gain β , which increases with temperature.
- Variations in transistor parameters such as β .

19. What is reverse saturation current?

[May / June – 12]

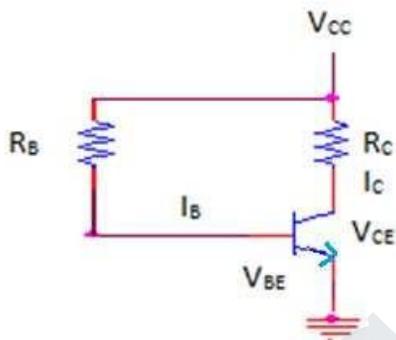
- In the npn BJT transistor, the base collector junction is reverse biased.

Vel Tech

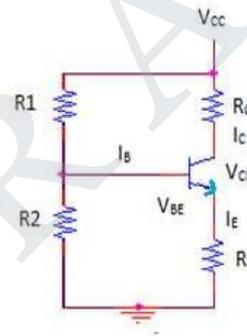
- ii. Under the reverse bias condition, the thermally generated holes in the P-region are attracted towards the negative terminal of the battery and the electrons in the N-region are attracted towards the positive terminal of the battery.
- iii. The minority carriers, electrons in the P- region and holes in the N-region, wander over to the junction and flow towards their majority carrier side giving rise to a current known as reverse saturation current.

20. Draw the fixed bias and the self bias circuits. [Nov /Dec – 09], [May /June – 07]

FIXED BIAS CIRCUIT



SELF BIAS CIRCUIT



21. State the advantages of self-bias over other types of biasing. [Nov /Dec – 10]

- In a fixed bias, the stability factor $S = 1 + \beta$. Since β is a large quantity, the circuit provides poor stability.
- In collector-to-base bias method, when R_C is very small, $S \approx 1 + \beta$, this is equal to that of fixed bias. Hence it is not preferable.
- In self bias method, when $\frac{R_B}{R_E}$ is very small, $S \approx 1$, which provides good stability. Hence self bias method is the best biasing method among the biasing methods.

22. What is the function of the Q-point? [Nov /Dec – 13]

Q- point identifies the transistor collector current and collector-emitter voltage when there is no input signal at the base.

23. Why temperature compensation is required? [Nov /Dec – 12]

- I_{CO} , which doubles for every 10°C increase in temperature.
- Base-emitter voltage V_{BE} , which decreases by $2.5 \text{ mV per } ^\circ\text{C}$.

Vel Tech

- Transistor current gain β varies as temperature raises,

Therefore, the variations of temperature affects I_B , in turn affects I_C . Hence temperature compensation is required.

24. What are the methods to avoid thermal runaway?

- It can be avoided by keeping the collector side large to dissipate heat.
- By using heat sink
- By using proper biasing circuit to provide circuit stable.

25. Why is the input impedance of FET more than that of BJT?

Input impedance of FET is more than that of BJT because the input circuit of FET is reverse bias whereas the input circuit of BJT is forward bias.

26. What are the different methods of biasing JFET?

[May /June – 12]

The different methods of biasing JFET are

- Fixed Bias
- Voltage divider Bias
- Self Bias

27. What are the parameters that the operating point depends upon?

The operating point depends upon

- AC and DC loads
- Available power supply
- Maximum transistor rating
- Peak signal extension to be handled by the stage and the tolerable distortion.

28. What is thermal resistance?

The steady state temperature use at the collector junction is proportional to the power dissipated at the junction.

$$\begin{aligned} \theta T &= T_j - T_A \\ T_j - T_A &= \theta P_D \end{aligned}$$

$$\theta = \frac{T_j - T_A}{P_D}$$

θ Constant proportionality is known as thermal resistance.

Vel Tech

29. Why is the input impedance of FET more than that of BJT?

Input impedance of FET is more than that of BJT because the input circuit of FET is reverse bias whereas the input circuit of BJT is forward bias.

30. What are the different methods of biasing JFET?

[May / June – 12]

The different methods of biasing JFET are

- a) Fixed Bias
- b) Voltage divider Bias
- c) Self Bias

STUCOR APP

Vel Tech

UNIT-II

BJT AMPLIFIERS

1. Define – h-parameters

[M/J – 07]

The h-parameters are hybrid in nature, because the dimensions are not alike. The h-parameters are defined as

- | | | |
|-----|--------------------------------|---|
| i | Input impedance | $h_{11} = \frac{V_1}{I_1}, \text{ with } V_2 = 0$ |
| ii | Reverse voltage transfer ratio | $h_{12} = \frac{V_1}{V_2}, \text{ with } I_1 = 0$ |
| iii | Forward current gain | $h_{21} = \frac{I_2}{I_1}, \text{ with } V_2 = 0$ |
| iv | Output admittance | $h_{22} = \frac{I_2}{V_2}, \text{ with } I_1 = 0$ |

2. Write the voltage gain equation for CE configuration including source resistance.

The voltage gain equation for CE configuration including source resistance is given as

$$A_{VS} = \frac{V_C}{V_S}$$

$$A_{VS} = \frac{A_I Z_L}{Z_{ie} + R_S}$$

Where,

A_{VS} – Voltage gain including source resistance

A_I – Current gain

Z_L – Load impedance

Z_{ie} – Input impedance of CE amplifier

R_S – Source resistance

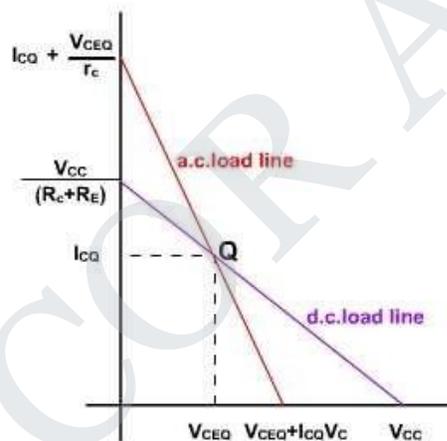
Vel Tech

V_C – Output voltage for CE amplifier

V_S – Source voltage

3. What is AC load line? How is Q point plotted on the AC load line?

The ac load line is a graph that represents all possible combinations of i_c and v_{ce} for a given amplifier. The dc load of an amplifier is different from the ac load. The ac load line is used to give the maximum possible output voltage swing for a given common-emitter amplifier. It will define the maximum possible peak-to-peak output voltage (V_{PP}) from a given amplifier. The ac load line is a straight line drawn from $I_{C(max)}$ and $V_{CE(max)}$, when an ac signal is applied to the amplifier.



4. Why are common emitter amplifiers more popular? [N/D – 11]

The common emitter amplifiers are more popular because

- i The CE configuration provides both voltage gain as well as current gain which is greater than unity.
- i Power gain of the CE amplifier is much greater than the other two configurations.
- i The ratio of output resistance to input resistance is small in the range of 10Ω to 100Ω which makes the configuration an ideal for coupling between the various transistors.

5. What are the benefits of h-parameters?

- Real numbers at audio frequency
- Easy to measure
- Can be obtained from the transistor state characteristics curves
- Convenient to use in circuit analysis and design

Vel Tech

6. What are the techniques employed in improving input impedance?

The input impedance of the circuit can be improved by the following two techniques.

- Using direct coupling (Darlington transistor)
- Using bootstrap technique

7. What are the advantages of Darlington connection?

Darlington connection improves input impedance as well as current gain of the circuit.

8. How does the input impedance increase due to Darlington connection?

[A/M – 08]

- Darlington connection is that the composite of two transistors acts as a single unit with a current gain that is the product of the current gain of the individual transistor.
- Darlington transistor is commonly used in common emitter follower circuit. This gives an equivalent circuit of two emitter followers in cascade, thereby increasing the input impedance.

The input impedance of single stage amplifier: $R_i = (1 + h_{fe}) R_E$

The input impedance of Darlington connection: $R_i = \frac{(1+h_{fe})^2 R_E}{(1+h_o(1+h_{fe}))}$

9. How are amplifiers classified according to the transistor configuration?

[Nov / Dec -15]

Type of signal	Type of configuration	Type of output obtained from the circuit
Small signal	Common emitter amplifier	Class A amplifier
Large signal amplifiers	Common base amplifier	Class B amplifier
	Common collector amplifier	Class C amplifier
		Class AB amplifier

Vel Tech

10. Two identical amplifiers having 10 dB gain each are cascaded. Calculate the output, if the input is of 1 mV (p-p).

[A/M – 11]

Solution:

Given: $A_{V1} = A_{V2} = 10$ dB

$V_i = 1$ mV (p-p)

To find : V_o

Overall gain: $A_V = A_{V1} \cdot A_{V2}$

$$A_V = 10 * 10$$

$$A_V = 100 \text{ dB}$$

$$A_V = 20 \log \frac{V_o}{V_i}$$

$$\log \frac{V_o}{V_i} = \frac{100}{20} = 5$$

$$\frac{V_o}{V_i} = 10^5$$

$$V_o = 10^5 \cdot V_i$$

$$V_o = 10^5 \times 1 \times 10^{-3}$$

$$V_o = 100 \text{ V}$$

11. What is the coupling schemes used in multistage amplifiers? [A/M – 10]

There are three coupling schemes commonly used in multistage amplifiers.

- i Resistance – Capacitance (RC) Coupling
- i Transformer coupling
- i Direct coupling

12. What is a cascade amplifier?

To increase the voltage gain of the amplifier, multiple amplifiers are connected in cascade. The output of one amplifier is the input to another stage. In this way, the overall voltage gain can be increased, when numbers of amplifier stages are used in succession. It is called a multistage amplifier or cascade amplifier.

Vel Tech

13. Two amplifiers having gain 20 dB and 40 dB are cascaded. Find the overall gain in dB?

$$\begin{aligned}\text{Overall gain in dB} &= 20 \text{ dB} + 40 \text{ dB} \\ &= 60 \text{ dB}\end{aligned}$$

14. What are the characteristics of common emitter amplifier?

Common emitter amplifier has

- Large current gain
- Large voltage gain
- Large power gain
- Voltage phase shift is about 180°
- Moderate input and output impedance

15. What are the characteristics of common collector amplifier?

Common collector amplifier has

- High current gain
- Unity voltage gain
- Large power gain
- No phase difference between input and output
- High input impedance
- Low output impedance

16. What are the characteristics of common base amplifier?

Common collector amplifier has

- Low current gain
- High voltage gain
- High power gain
- No phase difference between input and output
- Low input impedance
- High output impedance

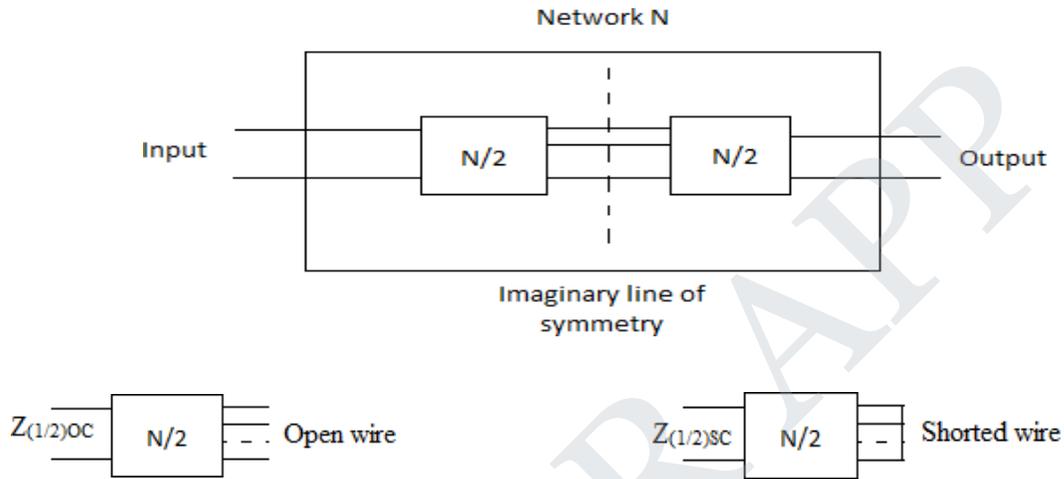
17. State Bisection theorem.

[Nov /D ec – 12]

Bisection Theorem (or) Barlett's bisection theorem states that, if a network N which has a mirror symmetry with respect to the imaginary line is divided into two half networks N/2 about the line of symmetry.

Vel Tech

The two half network can be connected using any number of wires but the wires should not cross. Then for such a bisected network at the imaginary line of symmetry with all the connecting wires open. The input impedance at input and output is $Z_{(1/2)OC}$, while with all the connecting wires shorted, the impedance at input and output is $Z_{(1/2)SC}$.



18. Define – CMRR [Nov /Dec – 09], [Nov /Dec – 07] [May / June – 07]

Common Mode Rejection Ratio/figure of merit is defined as the ability of a differential amplifier to reject a common mode signal.

CMRR is defined as the ratio of the differential mode A_d gain to the common mode gain A_c and is generally expressed in dB.

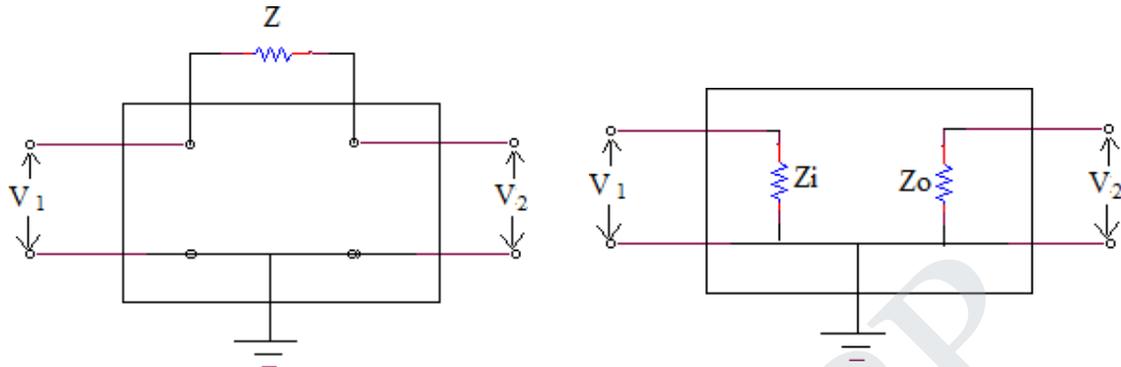
$$CMRR = 20 \log_{10} \frac{A_d}{A_c}$$

19. Define – Miller’s Theorem [M/J – 12], [A/M – 10]

Miller’s theorem states that, if an impedance Z is connected between the input and output terminals of a network which provides a voltage gain A_v , an equivalent circuit that gives the same effect can be drawn by removing Z and connecting an impedance $Z_i = \frac{Z}{(1-A_v)}$

and $Z_o = \frac{ZA}{(A_v-1)}$

Vel Tech

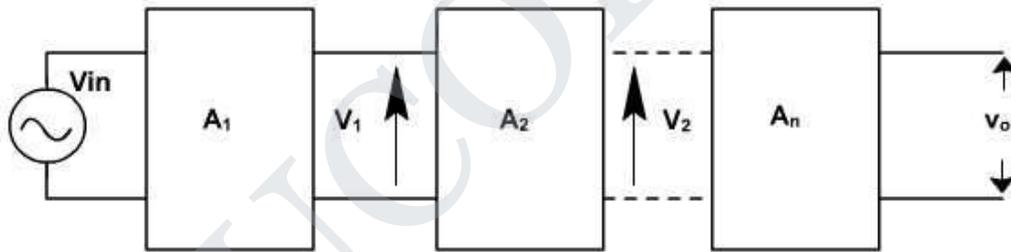


Original Circuit

Equivalent circuit using Miller's theorem

20. What is a cascade amplifier?

To increase the voltage gain of the amplifier, multiple amplifiers are connected in cascade. The output of one amplifier is the input to another stage. In this way, the overall voltage gain can be increased, when numbers of amplifier stages are used in succession. It is called a multistage amplifier or cascade amplifier.



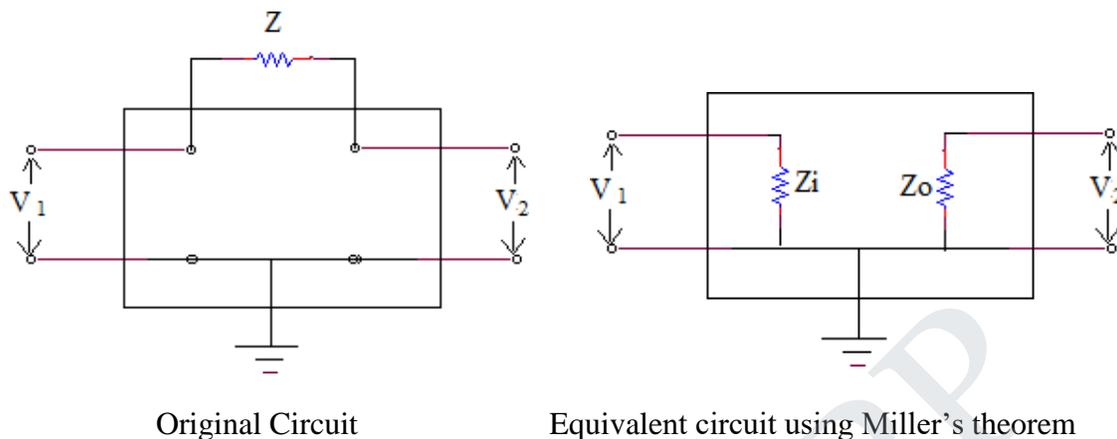
21. Define – Miller's Theorem

[May / June – 12], [April / May – 10]

Miller's theorem states that, if an impedance Z is connected between the input and output terminals of a network which provides a voltage gain A_v , an equivalent circuit that gives the same effect can be drawn by removing Z and connecting an impedance $Z = \frac{Z}{1 - A_v}$

and $Z_o = \frac{ZA}{(A_v - 1)}$

Vel Tech



22. What does bootstrapping mean?

The name bootstrap arises from the fact that, if one end of the resistor changes in voltage, the other end of the resistor moves through potential difference, it is as if resistor is pulling itself by bootstrap. The effective load on the bootstrap emitter follower can be given as

$$R_{Leff} = R_1 \parallel R_2 \parallel R_E \parallel \frac{R^3 A_V}{A_V - 1}$$

23. What are multistage amplifiers? (April / May 2009)

We need amplifier which can amplify a signal from a very weak source such as microphone to a level which is suitable for the operation of another transducer such as loudspeaker. This is achieved by cascading number of amplifier stages known as multistage amplifier.

24. Why transformer coupling is not used in the initial stages of a multistage amplifier?

The transformer coupled amplifiers are not used in the initial stages of a multistage amplifier because it produces unwanted noise. Once these signals are amplified, it cannot be eliminated by other stages. Hence the amplifier performance deteriorates.

25. Mention two advantages which are specific to Darlington connection. (Dec. 2004)

- The input impedance can be improved with the help of Darlington connection (cascaded connection of two emitter followers)
- Current gain of the circuit can be improved by ten times.

Vel Tech

26. Why capacitive coupling is used to connect a signal source to an amplifier?

(Dec. 2007)

The input capacitor couples the signal to the base of the transistor. It blocks any d.c. component present in the signal and passes only a.c. signal for amplification. Because of this input capacitor, biasing conditions are maintained constant.

27. What is meant by unity gain frequency?

The frequency at which the gain approaches unity is known as unity gain frequency.

28. Define dynamic range of an amplifier.

Dynamic range of an amplifier is defined as the range over which an active electronic device can produce a suitable output signal in response to an input signal.

29. Compare the performance of RC coupled amplifier and transformer coupled amplifier (May / June 2009)

Parameter	RC coupled amplifier	Transformer coupled amplifier
Coupling components	Resistor and capacitor	Impedance matching transformer
Block d.c.	Yes	Yes
Frequency response	Flat at middle frequencies	Not uniform, high at resonant frequency and low at other frequencies
Impedance matching	Not achieved	Achieved
Applications	<ul style="list-style-type: none"> Used in all audio small signal amplifiers , Used in tape recorders 	<ul style="list-style-type: none"> Used in amplifier where impedance matching is an important criteria. Used in the output stage of the public address systems

30. What are the salient features of hybrid parameters?

The salient features of hybrid parameters are

- H-parameters are real numbers
- They are easy to measure
- They are convenient to use in circuit analysis and design
- Readily supplied by manufactures
- Easily convertible from one configuration to other

Vel Tech

31. What is conversion efficiency in a power amplifier?

It is the ratio of the ac power delivered to the load to the dc input power applied is referred to as conversion efficiency.

$$\eta = \frac{\text{signal power delivered to the load}}{\text{dc power supplied at the input circuit}} \times 100$$

STUCOR APP

Vel Tech

32. What is class AB operation? (Dec 2002)

The power amplifier is said to be class AB amplifier if the Q-point and the input signal are selected such that, the output signal is obtained for more than 180° but less than 360° for a full input cycle.

33. Define class C operation of power amplifier (Dec 2005)

The power amplifiers is said to be class C amplifier, if the Q-point and the input signal are selected such that, the output signal is obtained for less than a half cycle for a full input cycle.

34. What is the drawback of class B amplifier? How it is minimized? (Dec 2004)

The drawback of class B amplifier is cross-over distortion. To overcome this cross over distortion, a small forward bias is kept applied to the transistors, so that when input is zero, this additional forward bias can make the transistor ON immediately, eliminating cross-over distortion.

35. What is a heat sink? Give its advantages.(Dec 2006, May 2008)

A heat sink is a mechanical device which is connected or press fit to the case of the transistor that provides a large surface area, to dissipate the developed heat, the heat sink carries the heat to the surroundings. The advantages of heat sink are:

- The temperature of the case gets lowered
- The power handling capacity of the transistors can approach the rated maximum value.

36. What is meant by harmonic distortion? (May 2004)

At the top of power amplifiers, along with the fundamental frequency component, additional frequency components are also present whose frequencies are integral multiples of fundamental frequency such as $2f, 3f, 4f, \dots$. These are called harmonics. The output gets distorted due to these components. This is called this the harmonic component.

37. How is crossover distortion caused? (May / June 2009)

For making transistor ON, it is necessary that V_{BE} must exceed $0.7V$. Due to this, in class B amplifier, while crossing over from one half cycle to other, as long as input is below $0.7V$, none of the transistor is ON and the output is zero. Due to this, there is distortion in the output which is called crossover distortion.

38. Why is power amplifiers provided with heat sink? (April / May 2010)

The maximum power handled by a particular power transistor and the temperature of the transistor junctions are closely related. This is because of the fact that the junction temperature increases due to the power dissipation. The hat sink draws heat from the power transistor via thermal condition expels the heat into the ambient air via, thermal convection and heat radiation.

39. What are the different types of distortion in amplifiers? (April / May 2009)

The different types of distortion in amplifier are frequency distortion, amplitude distortion, and phase distortion.

Vel Tech

STUCOR APP

Vel Tech

STUCOR APP

Vel Tech

UNIT – III

SINGLE STAGE FET, MOSFET AMPLIFIERS

1. What is an amplifier

An amplifier is a circuit; it can be used to increase the magnitude of the input current or voltage at the output by means of energy drawn from an external source.

1. Write the expression for basic current equation in MOSFET?

The region for which $v_{ds} < v_{ds}(\text{sat})$ is known as Non saturation

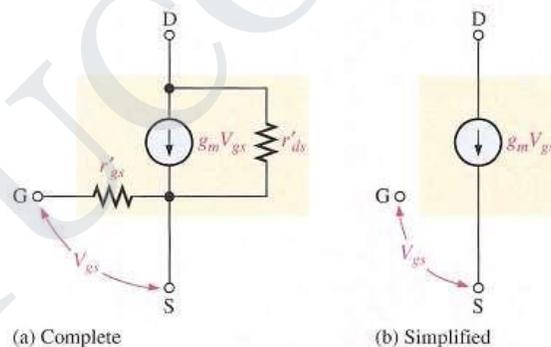
region, $i_d = k_n[2(v_{gs} - v_{tn})v_{ds} - v_{ds}^2]$.

In the saturation region, the ideal current - voltage characteristics for $v_{gs} > v_{tn}$ are given by the equation, $i_d = k_n(v_{gs} - v_{tn})^2$

2. Why FET is called as a voltage control device.

In FET the voltage applied between gate and source v_{gs} controls the drain current i_d . Therefore, FET is a voltage control device. In FET, current is carried by only one type of charge particles, either electrons or holes.

3. Draw the equivalent circuit of FET



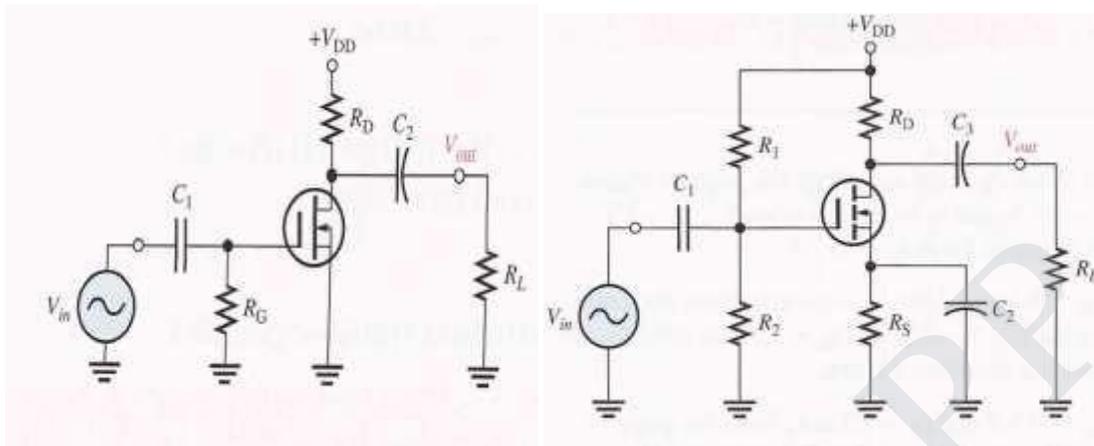
Here r'_{gs} appears between the gate and source, and a current source equal to $g_m v_{gs}$ appears between the drain and source. Also, the internal drain to source resistance r'_{ds} is included.

4. Write two reasons why a hybrid parameter model is used in small signal analysis.

- i. The h parameters are determined by short circuiting the output and open circuiting the input. This method of analyzing transistor circuits makes easier for designing a circuit.
- ii. The hybrid parameters are more popular in transistor circuit analysis, because it has mixed dimensions.

Vel Tech

5. Sketch the simple common source amplifier circuit of MOSFET?



D-MOSFET

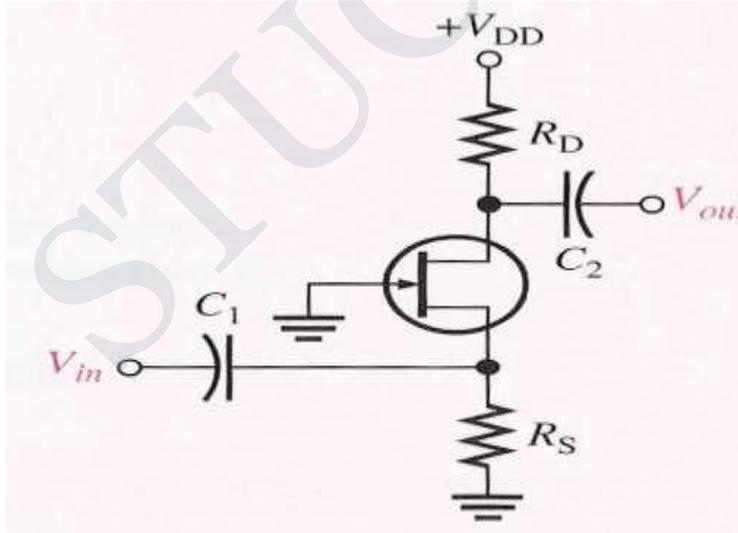
E-MOSFET

6. What are the basic circuit configurations used in MOSFET?

There are 3 basic MOSFET circuit configurations, they are

- i. Common Source(CS)
- ii. Common Gate(CG)
- iii. Common Drain (CD)

7. Sketch the simple common gate amplifier circuit of JFET?



Vel Tech

8. Compare the characteristic of small signal amplifier with large signal amplifier.

Small signal amplifier	Large signal amplifier
Input signal is so weak as to produce small fluctuations in the collector current compared to its quiescent value, the amplifier is known as small signal amplifier.	When fluctuation in collector current is large i.e., beyond the linear portion of characteristics of the amplifier, is called as large signal amplifier.

9. Compare the AC circuit characteristics of the CS, CG and (source follower) CD.

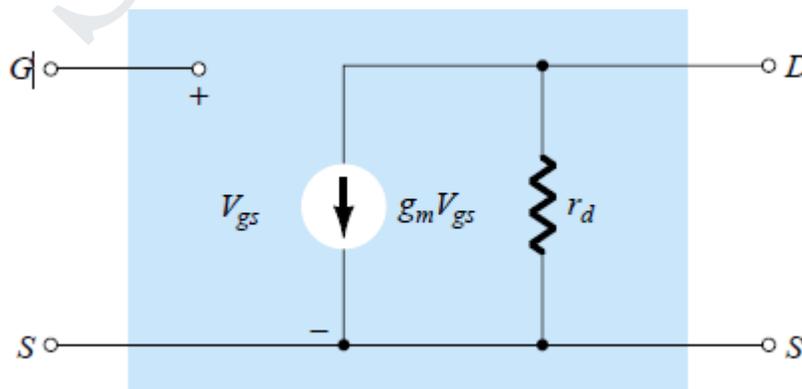
Characteristics of the three MOSFET amplifier configurations.

Configuration	Voltage gain	Current gain	Input resistance	Output resistance
Common source	$A_v > 1$	-	R_{TH}	Moderate to high
Source follower	$A_v \approx 1$	-	R_{TH}	Low
Common gate	$A_v > 1$	$A_i \approx 1$	Low	Moderate to high

10. State the general advantage of using JEFET rather than BJT?

- i. FETs require less space than that for BJTs, hence they are preferred in integrated circuits.
- ii. FETs have higher input impedance than BJT they are preferred in amplifiers where high input impedance is required.

11. Draw the small signal equivalent circuit of JFET.



Vel Tech

12. How does the body effect change the small signal equivalent circuit of the MOSFET?

The body effect occurs in a MOSFET in which the substrate, or body, is not connected to the source. For an NMOS device, the body is connected to the most negative potential in the circuit and will be at signal ground for the four-terminal MOSFET

13. List out the applications of MOSFET?

- i. Heat sink and cooling within a computer most MOSFETs are located on the microprocessor chip, mounted on the motherboard and conspicuously cooled by its own heat sink and cooling fan.
- ii. Microprocessor chip The microprocessor chip itself is mounted in an electronic package with hundreds of interconnecting pins and connected to the chip by hundreds of tiny bond wires.
- iii. Chip cross-section A cross-section of the chip reveals multiple layers of tiny wires above the MOSFETs which are embedded in the silicon substrate.

14. Write the expressions of small signal voltage gain and output resistance of the common gate circuit?

The voltage gain from source to drain is developed as follows:

$$A_v = \frac{V_{out}}{V_{in}} = \frac{V_d}{V_{gs}} = \frac{I_d R_d}{V_{gs}} = \frac{g_m V_{gs} R_d}{V_{gs}}$$

$$A_v = g_m R_d$$

$$R_{in(source)} = \frac{V_{in}}{I_{in}} = \frac{V_{gs}}{g_m V_{gs}}$$

$$R_{in(source)} = \frac{1}{g_m}$$

Vel Tech

15. What is the difference between a MOSFET and PN junction FET?

S.No.	Parameter	JFET	MOSFET
1	Types	N – channel P– channel	N – channel depletion type MOSFET. P – channel depletion type MOSFET N – channel enhancement type MOSFET. P – channel enhancement type MOSFET.
2	Operation mode	Operated in depletion mode.	Operated in depletion and enhancement mode
3	Gate	Gate is not insulated from channel.	Gate is insulated from channel by a layer of SiO ₂

UNIT-IV

FREQUENCY RESPONSE OF AMPLIFIERS

GENERAL INTRODUCTION:

1. Why are h-parameters not used at high frequencies? [M/J – 12]

The h-parameters are not used at high frequencies, because the values of h-parameters are not constant at high frequencies. Therefore, it is necessary to analyze the transistor at each and every frequency, which is impracticable. At high frequencies, h-parameters become complex in nature.

2. Write the expressions for gain bandwidth product for voltage and current. [A/M – 10]

The gain bandwidth product for voltage gain is,

$$|A_{vs} bw f_H| = |A_{vso} f_H| = \frac{-h_{fe}R_L}{R_s + h_{ie}} * \frac{1}{2\pi R_{eq}C_{eq}}$$

The gain bandwidth product for current gain is,

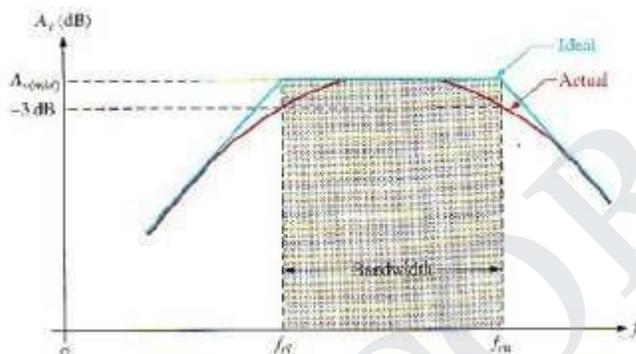
Vel Tech

$$|A_{is\ bw\ f_H}| = |A_{iso\ f_H}| = \frac{-h_{fe}R_s}{R_s + h_{ie}} * \frac{1}{2\pi R_{eq}C_{eq}}$$

3. How is the high frequency gain of an amplifier limited? [M/J – 12]

At high frequencies, the coupling and bypass capacitors act as short circuit and does not affect the amplifier frequency. However, at high frequencies, the internal capacitances commonly known as junction capacitances reduce the current gain. At higher frequencies, the reactance of the junction capacitances is low. As frequency increases, the reactance of junction capacitances falls. When these reactance become small enough, they provide shunting effect as they are in parallel with junctions. This reduces the circuit gain and hence the output voltage.

4. Draw general frequency response curve of an amplifier. [M/J – 12]



5. What is bandwidth of an amplifier? [N/D – 09], [M/J – 07]

Bandwidth of the amplifier is defined as the difference between upper cut-off frequency (f_2) and lower cut-off frequency (f_1). That is bandwidth of the amplifier = $f_2 - f_1$. f_2 lies in the high frequency region and f_1 lies in the low frequency region.

FREQUERNCY RESPONSE BJT

6. What is the effect of coupling capacitors on the bandwidth of the amplifier? [M/J – 12]

The reactance of a capacitor is $X_c = 1/2\pi f_c$. At medium and high frequencies, the factor f makes X_c very small, so that all coupling capacitors behave as short circuits. At low frequencies, X_c increases. This increase in X_c drops the signal voltage across the capacitor and reduces the circuit gain. As signal frequencies decrease, the capacitor's reactance increase, and circuit gain continues to fall, reducing the output voltage.

7. Short circuit common emitter current gain of transistor is 25 at a frequency of 2 MHz, if $f_\beta = 200$ kHz, calculate f_T and h_{fe} . What is the bandwidth that can be obtained using BJT, if the rise time of a BJT is 40 ns? [N/D – 11]

Solution: Given $A_i = 25$, $f = 2\text{MHz}$, $f_\beta = 200\text{kHz}$ and $t_r = 40$ ns

Vel Tech

$$i) |A_i| = \frac{h_{fe}}{\sqrt{1 + \left(\frac{f}{f_{\beta}}\right)^2}}$$

$$h_{fe} = |A_i| * \sqrt{1 + \left(\frac{f}{f_{\beta}}\right)^2} = 25 * \sqrt{1 + \left(\frac{2\text{MHz}}{200\text{kHz}}\right)^2}$$

$$= 25 * \sqrt{1 + 10^2} = 25 * 10 = 250$$

$$ii) f_T = h_{fe} * f_{\beta} = 250 * 200\text{kHz} = 50\text{MHz}$$

$$iii) B = \frac{0.35}{t_r} = \frac{0.35}{40 * 10^{-9}} = \frac{0.35}{40 * 10^{-9}} = 8.75 \text{ MHz}$$

STUCOR APP

Vel Tech

8. What are the effects of emitter bypass capacitor on high frequency response? [N/D – 12]

At lower frequencies, the bypass capacitor C_E is not a short. So, the emitter is not at ground. X_c in parallel with R_E (R_S in case of FET) creates an impedance. The signal voltage drops across this impedance reducing the current gain.

9. What is meant by gain-bandwidth product? [N/D – 12], [A/M – 08]

The gain bandwidth product f_T is an important parameter of high frequency characteristics of a transistor. The parameter is the product of short-circuit current gain and the bandwidth lower 3 dB frequency, which is so small that it can be assumed to be zero.

FREQUENCY RESPONSE - FET

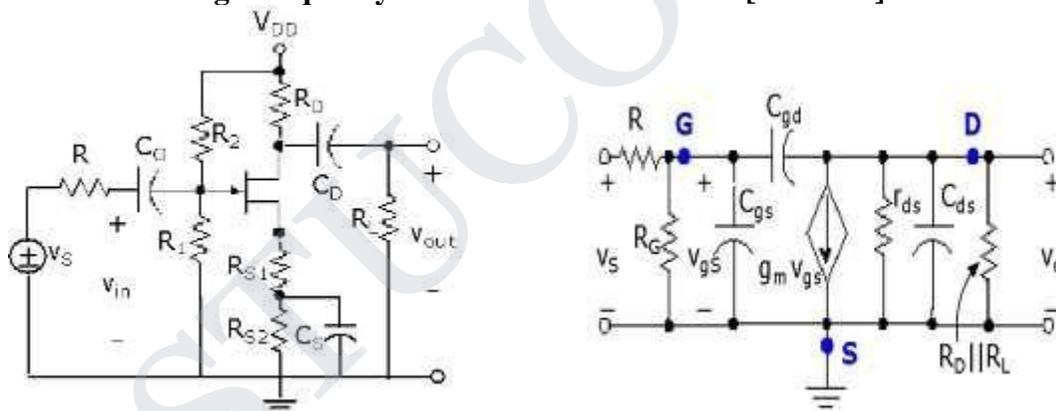
10. Calculate the amplification factor μ of FET, if $r_d = 4 \text{ K}\Omega$ and $g_m = 4 \text{ mA/V}$. [A/M – 11]

Given: $r_d = 4 \text{ K}\Omega$

$g_m = 4 \text{ mA/V}$

$\mu = g_m * r_d = (4 * 10^{-3}) * (4 * 10^3) = 16$

11. Draw the high frequency model of FET. [M/J – 12]



FREQUENCY RESPONSE-MULTISTAGE AMPLIFIER

12. Two amplifiers having gain 20 dB and 40 dB are cascaded. Find the overall gain in dB.

[N/D – 09]

Overall gain in dB = sum of decibel voltage gains of the individual stages.

$A_v \text{ (dB)} = 20 + 40 = 60 \text{ dB}$

Vel Tech

13. Write the equation of overall upper and lower cutoff frequencies of multistage amplifier
[A/M – 12]

Overall lower cutoff frequency of multistage amplifier

$$\frac{1}{\sqrt{1 + (f_c)^2}} = \frac{1}{\sqrt{2}}$$

STUCOR APP

Vel Tech

$$[\overline{f_L^n}]$$

$$f(n) = \frac{f_L^n}{\sqrt{(2^{1/n}) - 1}}$$

$f(n)$ - Lower 3dB frequency of identical cascaded stages

f_L - Lower 3dB frequency of single stage

n - Number of stages

Overall lower cutoff frequency of Multistage amplifier

$$\frac{1}{\sqrt{[1 + (\frac{f_L}{f_H})^2]^n}} = \frac{1}{\sqrt{2}}$$

$$f(n) = f_H \sqrt{(2^{1/n}) - 1}$$

$f(n)$ - Higher 3dB frequency of identical cascaded stages

f_H - Higher 3dB frequency of single stage

n - Number of stages

SIGNAL CHARACTERISTICS

14. What is the bandwidth that can be obtained using BJT, if the rise time of a BJT is 40ns?
[M/J – 12]

Given $t_r = 40$ nsec

$$t_r = \frac{0.35}{f_2} = \frac{0.35}{BW}$$

$$\text{Therefore bandwidth} = \frac{0.35}{t_r} = \frac{0.35}{40 \times 10^{-9}} = 8.75 \text{ MHz.}$$

15. What is meant by amplifier rise time?

[N/D – 07],

[A/M – 10]

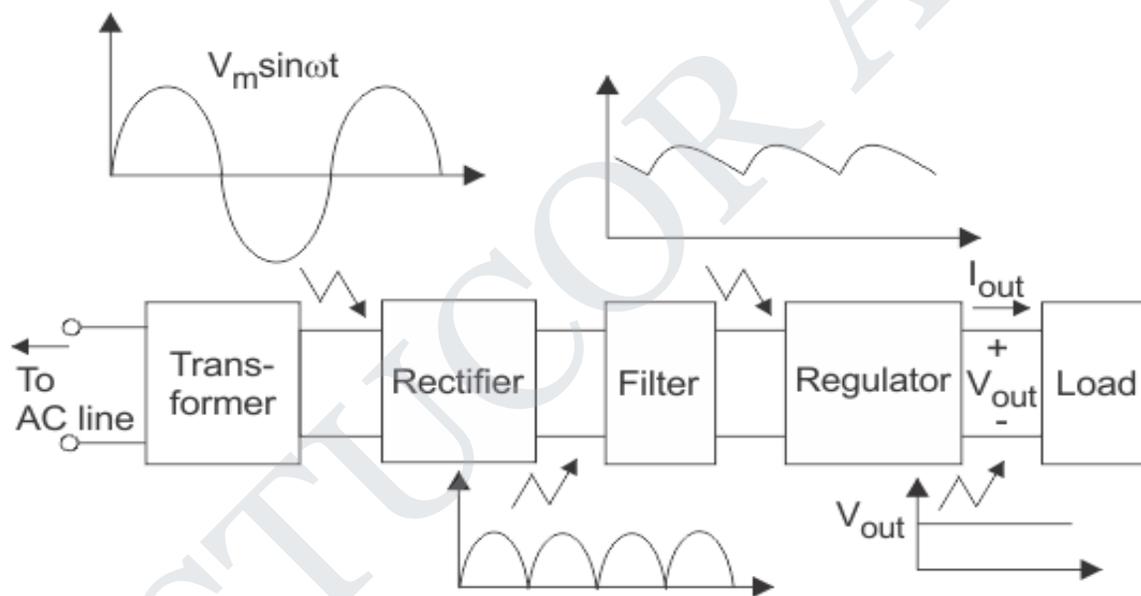
The difference between t_2 and t_1 is called the rise time t_r , where, t_2 is the time required for V_O to reach nine tenth of its final value, and t_1 is the time required for V_O to reach one tenth of its final value.

$$t_r = t_2 - t_1$$

UNIT-V

**POWER SUPPLY AND ELECTRONIC
DEVICES TESTING****1. What are the requirements of linear mode power supply?**

- The ac Ripple should be low.
- It should be able to furnish the maximum current needed for the unit, maintaining the voltage constant.
- Over voltage (spike and surges) protection must be incorporated.

2. Draw the block diagram of linear mode power supply.

Components of typical linear power supply

3. What is rectifier? Mention the types.

Rectifier is defined as an electronic device used for converting ac voltage into dc voltage

- Half wave rectifier
- Full wave rectifier
- Bridge rectifier

4. Define Ripple Factor.

The ratio of rms value of ac component to the dc component in the output is known as ripple factor(R_T)

$r = \text{rms value of component} / \text{dc value of component}$

$$r = V_{r,rms} / V_{dc}$$

5. What is Peak Inverse Voltage?

It is defined as the maximum reverse voltage that a diode can withstand without destroying the junction. The peak inverse voltage across a diode is the peak of the negative half cycle. For a half wave rectifier, PIV is V_m

6. What is Transformer Utilisation Factor(TUF).

TUF = dc power delivered to the load / ac rating of the transformer secondary

$$= P_{dc} / P_{ac \text{ rated}}$$

7. What is Form Factor?

Form Factor = rms value / average value

8. Define rectifier efficiency.

It is defined as the ratio of dc output power to the ac input power.

$$\eta\% = \text{DC output power} / \text{AC input power}$$

9. What is meant by Regulation?

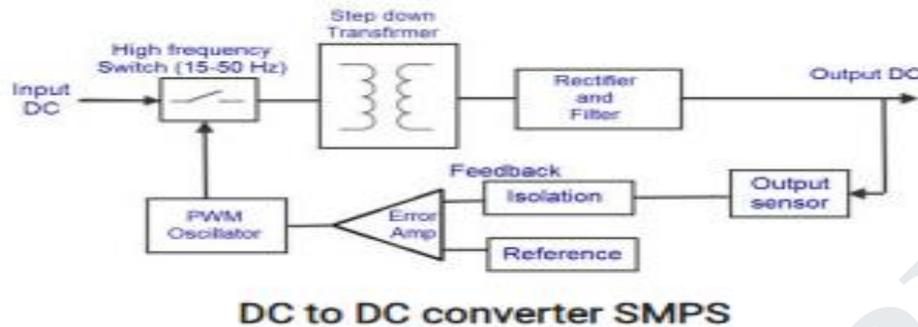
Regulation is defined as change in DC output voltage as load changes from no load to full load.

$$\% \text{ Regulation} = \frac{(V_{dc})_{NL} - (V_{dc})_{FL}}{(V_{dc})_{FL}} * 100$$

10. State the principles of SMPS.

The pulse width modulation is the basic principle of the switching regulator. The average value of repetitive waveform is proportional to the area under the waveform so the switching regulators use the fact that of duty cycle of the pulse waveform is varied, the average value of the voltage also changes proportionally.

11. Draw the Block diagram of SMPS.



12. Compare Rectifier and Regulator

Rectifier	Regulator
<ol style="list-style-type: none"> 1. Rectifier converts pure sinusoidal input into pulsating dc output. 2. The output contains rippler 3. Output voltage changes with respect to load current, input voltage and temperature. 4. Eg: Half wave, Full wave and Bridge rectifier 5. Uses: Diode 	<ol style="list-style-type: none"> 1. Regulator converts the pulsating dc input input into constant dc output 2. The output is ripple free 3. Output voltage does not change with respect to load current, input voltage and temperature. 4. Eg: Zener regulator, transistorized regulator etc., 5. Uses: Transistor, op-amps etc.,

13. What are the advantages of Boost Regulator.

- The output voltage is higher than input voltage.
- The efficiency is high, greater than 90%.
- Low input ripple current.
- Simple to design

14. Compare shunt and series Regulator.

Shunt Regulator	Series Regulator
<ol style="list-style-type: none"> 1. Control element is in parallel with the load 2. Only small current passes through the control element which is required to be diverted to keep output constant. 3. Any change in output is compensated by changing the current through the control element as per the control signal. 4. The regulation is poor. 5. Simple to design. 	<ol style="list-style-type: none"> 1. The control element is in series with the load 2. The entire load current I_L always passes through the control element. 3. Any change in output voltage is compensated by adjusting the voltage across the control element as per the control signal. 4. The regulation is good 5. Complicated to design as compared to shunt regulators.

15. What are the different types of Switching regulator.

- Step down (or) Bulk switching regulator
- Step up (or) Boost switching regulator
- Inverting type switching regulator

STUCOR APP

Vel Tech

2. What is the relation between I_o and I_{ref} ?

$$\frac{I_o}{I_{REF}} = \frac{(W/L)_2}{(W/L)_1}$$

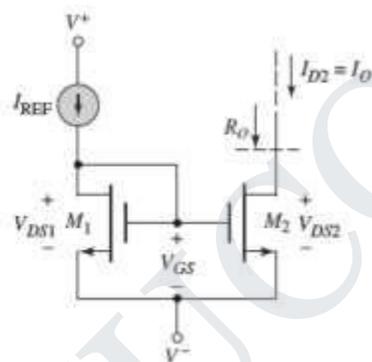
The special connection of Q_1 and Q_2 provides an output current I_o that is related to the reference current I_{REF} by the ratio of the aspect ratios of the transistors. The relationship between I_o and I_{REF} is determined

by the geometries of the transistors.

3. What is meant by current mirror?

In the special case of identical transistors, $I_o = I_{REF}$, and the circuit replicates or mirrors the reference current in the output terminal. This has given the circuit composed of Q_1 and Q_2 the name current mirror.

4. Draw the two transistor MOSFET current source.

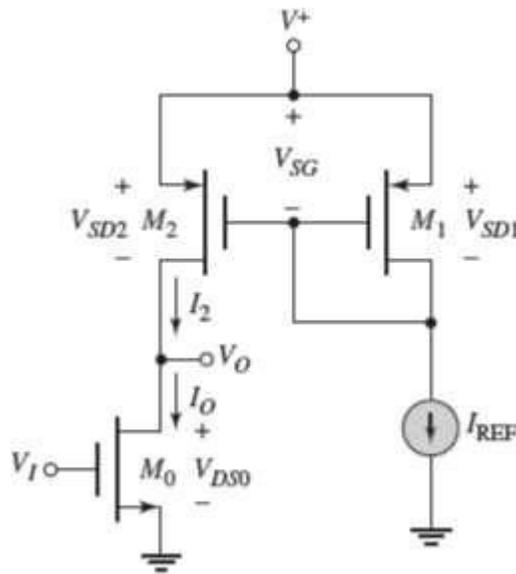


5. What are active loads?

Active loads are essentially “upside down” current-source circuits that replace the discrete collector and drain resistors. The active loads produce a much larger small-signal voltage gain compared to discrete resistor circuits.

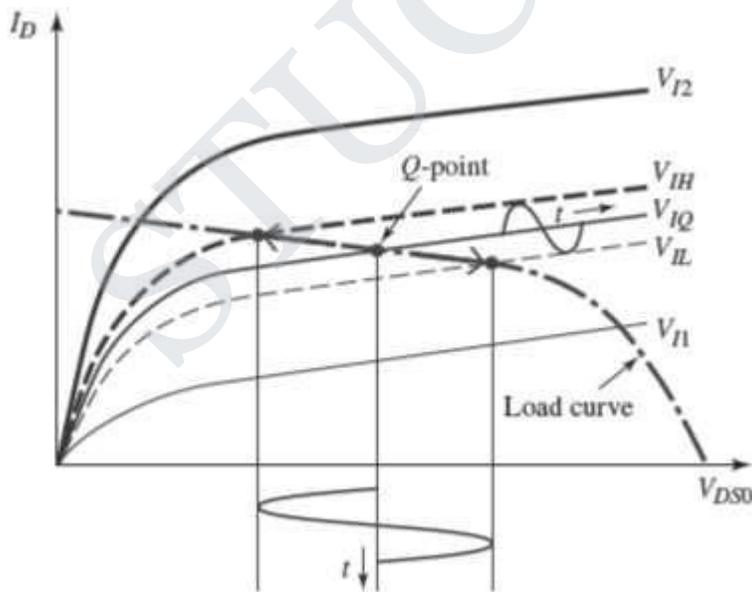
6. Draw the MOSFET amplifier with active load

Vel Tech



7. Give the driver characteristics and load curve for MOSFET circuit with active load.

The figure shows the transistor characteristics of the driver transistor M_0 for several values of gate-to-source or V_I voltages. Superimposed on these curves is the load curve, which essentially is the I_D versus V_{SD} characteristic of the active load M_2 at a constant V_{SG} voltage.



Vel Tech

The Q -point moves up and down the load curve producing a change in output voltage. Also, as V_{I1} increases to V_{I2} , the driver transistor M_0 is driven into the non-saturation region; as V_{I1} decreases

to V_{I1} , the load transistor M_2 is driven into the non-saturation region.

8. Define – CMRR

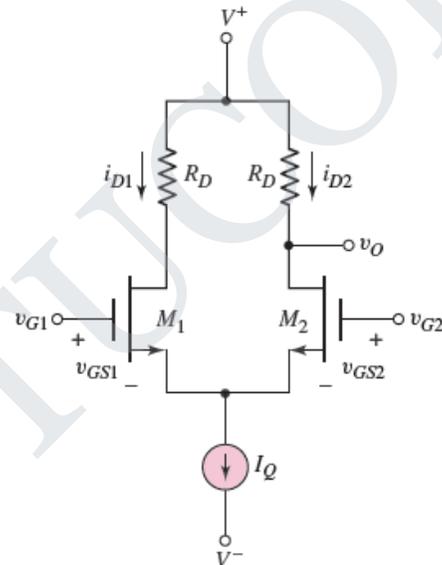
The ability of a differential amplifier to reject a common-mode signal is given in terms of the common-mode rejection ratio (CMRR). The CMRR is a figure of merit for the differential amplifier and is defined as

$$\text{CMRR} = \left| \frac{A_d}{A_{cm}} \right|$$

A_d – differential gain

A_{cm} – common mode gain

9. Draw the basic MOSFET differential pair configuration



10. Give the expression of CMRR for MOSFET differential amplifier.

Vel Tech

$$\text{CMRR} = \frac{1}{2} [1 + 2\sqrt{2K_n I_Q} \cdot R_o]$$

I_Q – bias current

R_o – output resistance

STUCOR APP