1 UNIT

Diode Circuits and Amplifier Models (2 Marks Questions)

1.1. Draw a neat diagram of a full wave rectifier bridge circuit using diode.

Ans.

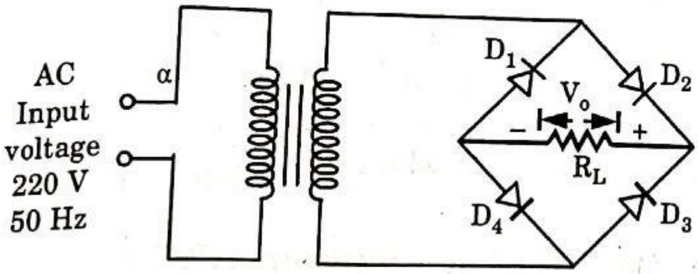


Fig. 1.

1.2. Draw the double ended diode clipper circuit.

AKTU 2015-16, Marks 02

Ans.

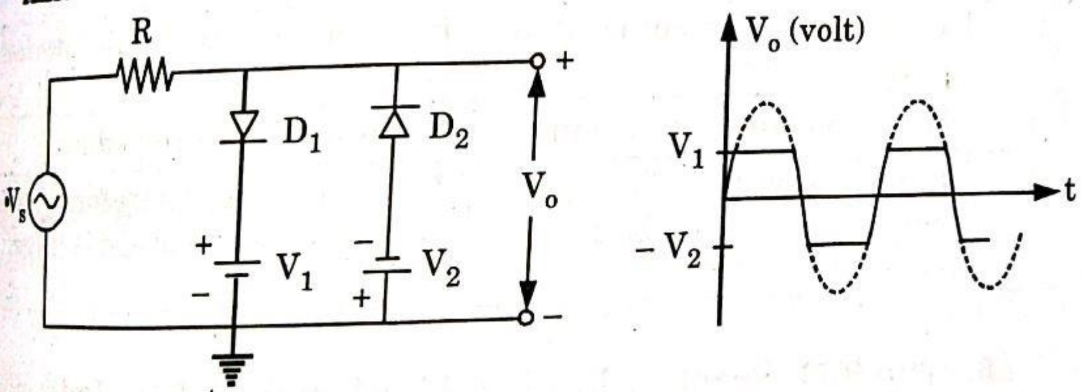


Fig. 2.

1.3. Write gain parameter and ideal characteristics of transconductance amplifier. Also draw the transconductance model.

Ans. **Gain parameter :**

Short circuit transconductance,

$$G_m = \left.\frac{i_o}{v_i}\right|_{v_o = 0} \quad \text{(A/ V)}$$

Ideal characteristics :

$$R_i = \infty, R_o = \infty$$

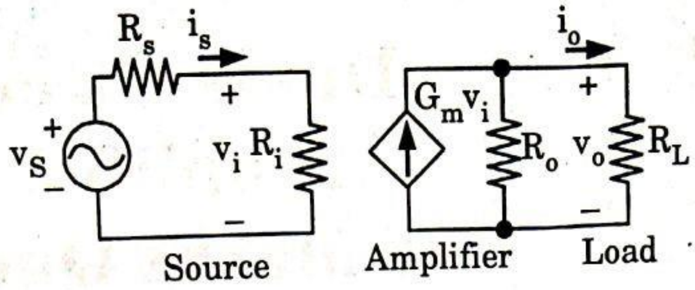


Fig. 3. Transconductance model.

1.4. Establish the relationship between I_{CEO} and I_{CBO} of a BJT.

Ans. The collector current can expressed as

$$I_C = \alpha I_E + I_{CBO}$$

$$I_C = \alpha(I_C + I_B) + I_{CBO}$$

$$I_C (1 - \alpha) = \alpha I_B + I_{CBO}$$

$$I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$$

The collector current when $I_B = 0, I_{CEO} = \frac{I_{CBO}}{1-\alpha}$

1.5. Enlist the difference between JFET and BJT.

Ans.

S. No.	JFET	BJT
1.	Its operation depends only on majority carriers, so it is a unipolar device.	Its operation depends on both majority and minority carriers, so it is a bipolar device.
2.	It is a voltage controlled device.	It is a current controlled device.
3.	It has high input impedance.	It has low input impedance.
4.	Small in size, therefore space requirement on board is small.	Large in size, therefore space requirement on board is large.

1.6. The BJT circuitry has I_C = 10 mA and α = 0.98. Determine the value of I_E.

Ans.

Given : $\alpha = 0.98, I_C = 10$ mA
To Find : I_E

We know that, $\alpha = I_C/I_E$

$$\therefore \quad I_E = \frac{10 \times 10^{-3}}{0.98} = 10.2 \text{ mA}$$

1.7. Derive the relation between α and β for BJT.

AKTU 2017-18, Marks 02

AKTU 2016-17, Marks 02

Ans. We know that, $I_E = I_C + I_B$ ...(1.7.1)

Dividing eq. (1.7.1) both sides by I_C, we get

$$\frac{I_E}{I_C} = \frac{I_C}{I_C} + \frac{I_B}{I_C}$$

But we know that $\beta = I_C/I_B$ and $\alpha = I_C/I_E$

$$\frac{1}{\alpha} = 1 + \frac{1}{\beta} = \frac{\beta + 1}{\beta}$$

$$\alpha = \frac{\beta}{\beta + 1}$$

1.8. If α of a transistor changes from 0.981 to 0.987, find the percentage change in β.

AKTU 2015-16, Marks 02

Ans. Here,

$$\beta_1 = \frac{\alpha_1}{1-\alpha_1} = \frac{0.981}{1-0.981} = 51.632$$

$$\beta_2 = \frac{\alpha_2}{1-\alpha_2} = \frac{0.987}{1-0.987} = 75.92$$

$$\% \text{ change in } \beta = \frac{\beta_2 - \beta_1}{\beta_1} = \frac{75.92 - 51.632}{51.632} = 47.04\ \%$$

1.9. Explain with proper reason the use of Emitter Follower.

AKTU 2015-16, Marks 02

Ans. The Emitter Follower is used as a voltage buffer for connecting a high resistance source to a low resistance load.

1.10. What is transconductance in FET ? What is the relationship between g_m and g_{mo} ?

AKTU 2017-18, Marks 02

Ans. The control that the gate voltage has over drain current is measured by transconductance g_m. It is simply the slope of transfer characteristics.

$$g_m = \left(\frac{\Delta I_D}{\Delta V_{GS}}\right), \text{ when } V_{DS} \text{ held constant}$$

The unit of g_m is siemens (mho).

1.11. Draw the small signal π-model of BJT.

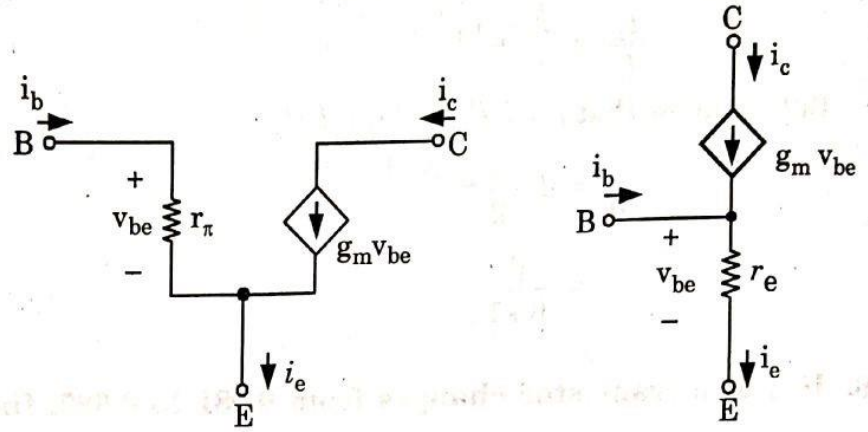
AKTU 2015-16, Marks 02

OR

Draw hybrid - π model and T-model equivalent of *npn* transistor.

AKTU 2016-17, Marks 02

Ans.



(*a*) Hybrid-π model (*b*) *T*-model

Fig. 4.

1.12. A *CE* amplifier is having I_C = 1 mA, β_o = 100, V_A = 100 V. Calculate g_m, r_π, r_o.

Ans.

$$g_m = \frac{I_C}{V_T} = \frac{1 \times 10^{-3}}{25 \times 10^{-3}} = 40 \text{ mA/V}$$

$$r_\pi = \frac{\beta_o}{g_m} = \frac{100}{40 \times 10^{-3}} = 2.5 \text{ k}\Omega$$

$$r_o = \frac{V_A}{I_C} = \frac{100}{1 \times 10^{-3}} = 100 \text{ k}\Omega$$

1.13. Draw small signal model of FET.

Ans.

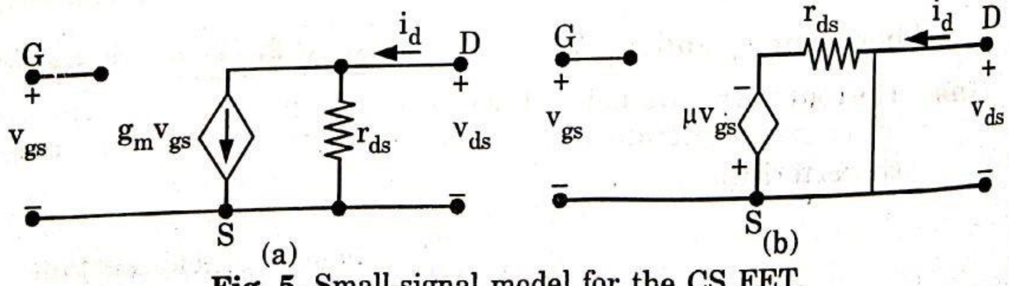


Fig. 5. Small-signal model for the CS FET.

☺☺☺

2 UNIT

Multistage Amplifiers and Feedback Topologies (2 Marks Questions)

2.1. Define frequency response.

Ans. The curve drawn between voltage gain and frequency of an amplifier is known as frequency response.

2.2. Draw the frequency response of *RC* coupled amplifier.

Ans.

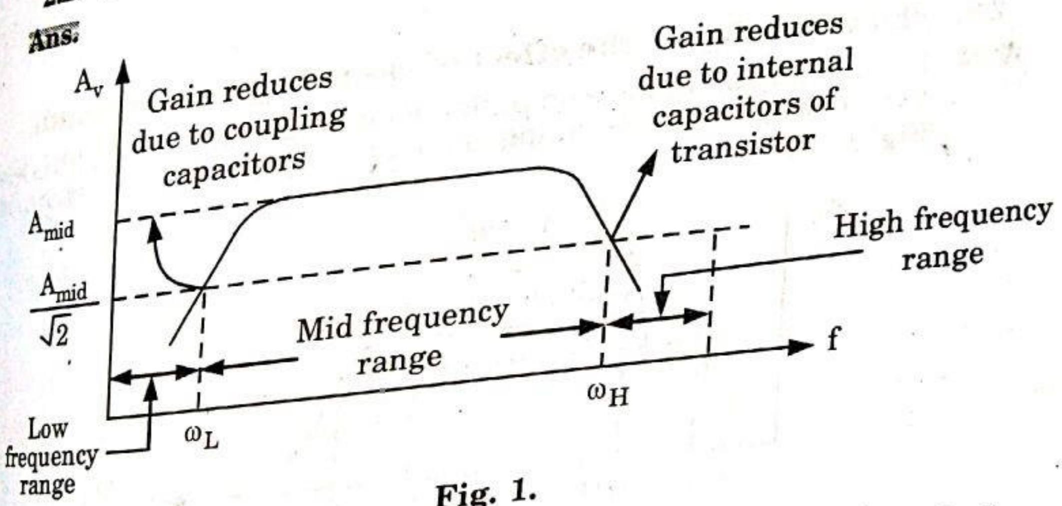


Fig. 1.

2.3. What is the necessity of frequency response analysis ?

AKTU 2016-17, Marks 02

Ans. Frequency response directly led to the idea of filtering of signals using LTI systems. One important application involves the idea of frequency selective filtering.

2.4. What are the requirements of a multistage amplifier ?

Ans.

1. Gain should be sufficiently large.
2. Input impedance should match with source impedance.
3. Output impedance should match with load impedance.
4. Bandwidth should be adequately large.

2.5. What is *RC* coupled amplifier ?

Ans. In *RC* coupling, a resistor and a capacitor are used as coupling device. The capacitor connects the output of one stage to the input of next stage to pass AC signal and to block the DC bias voltages. The amplifier using *RC* coupling is called the *RC* coupled amplifier.

2.6. What are the advantages of *RC* coupled amplifier ?

Ans.
1. Wide frequency response (large bandwidth).
2. It is the most convenient coupling.
3. Due to the coupling capacitor C_c, Q point is unchanged.
4. The distortion in the output is low.

2.7. What are the disadvantages of *RC* coupled amplifier ?

Ans.
1. Gain reduces at low frequencies due to coupling capacitors.
2. Ageing can make these amplifiers noisy.
3. No impedance matching.
4. Overall voltage gain is less.

2.8. Show with figure the effect of cascading on bandwidth.

Ans. In cascading multistage amplifier, gain is high and bandwidth is less as compare to non-cascading or single stage amplifier, as shown in Fig. 2.

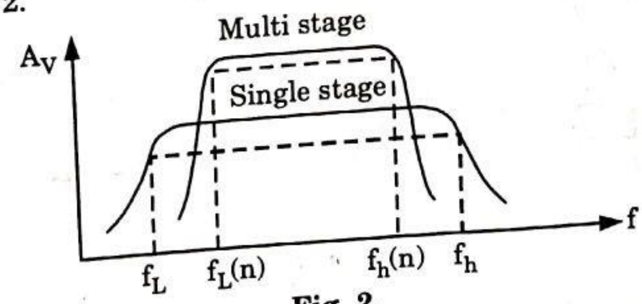


Fig. 2.

2.9. What is cascode amplifier ?

Ans. A common gate (common-base) amplifier stage in cascade with a common-source (common-emitter) amplifier stage is known as the cascode configuration.

2.10. Compare different amplifier classes.

Ans.

S.No.	Class	Class-A	Class-B	Class-C	Class-AB
1.	Operating cycle	360°	180°	Less than 180°	180° to 360°
2.	Position of Q	Centre	on x-axis	Below x-axis	Above x-axis
3.	Efficiency	25% or 50%	78.5%	High (almost 100%)	50% to 78.5%
4.	Distortion	Absent	Present more than Class-A	Highest	Present less than Class-B

2.11. Name the four basic feedback topologies used in amplifiers ?

Ans. The four basic feedback topologies are as follows :

1. Series-shunt feedback (voltage amplifier)
2. Shunt-series feedback (current amplifier)
3. Series-series feedback (transconductance amplifier)
4. Shunt-shunt feedback (transresistance amplifier)

2.12. Compare different types of feedback network based on input and output resistance.

Ans.

S. No.	Characteristics	Types of feedback network			
		voltage series	voltage shunt	current series	current shunt
1.	Input resistance	increases by a factor of $(1 + A\beta)$	decreases by a factor of $(1 + A\beta)$	increases by a factor of $(1 + A\beta)$	decreases by a factor of $(1 + A\beta)$
2.	Output resistance	decreases by a factor of $(1 + A\beta)$	decreases by a factor of $(1 + A\beta)$	increases by a factor of $(1 + A\beta)$	increases by a factor of $(1 + A\beta)$

2.13. Mention few properties of series-shunt and shunt-series feedback amplifiers.

AKTU 2015-16, Marks 02

Ans. Properties of series-shunt feedback amplifier :

1. Increase the input resistance with feedback.
2. Decrease the output resistance with feedback.

Properties of shunt-series feedback amplifier :

1. Decrease the input resistance with feedback.
2. Increase the output resistance with feedback.

2.14. An amplifier has a midband gain of 125 and a bandwidth of 250 kHz. If 4 % negative feedback is introduced, find the new bandwidth.

Ans:
$$BW_f = (1 + A\beta)\ BW$$
$$= (1 + 125 \times 0.04) \times 250 \times 10^3 \text{ Hz} = 262.5 \text{ kHz}$$

2.15. An amplifier with voltage gain of 60 dB uses $\frac{1}{20}$ of its output in negative feedback. Calculate the gain with feedback in dB.

Ans: Given, $A_{dB} = 60 \text{ dB} \Rightarrow A = 1000$

$$A_f = \frac{A}{1+A\beta} = \frac{1000}{1+\frac{1}{20}\times 1000} = \frac{60}{4} = 19.6$$

$$|A_f|_{dB} = 20 \log 19.6 = 25.84 \text{ dB}$$

2.16. Draw the waveforms for class *A*, *B*, *AB* and *C* amplifier.

Ans:

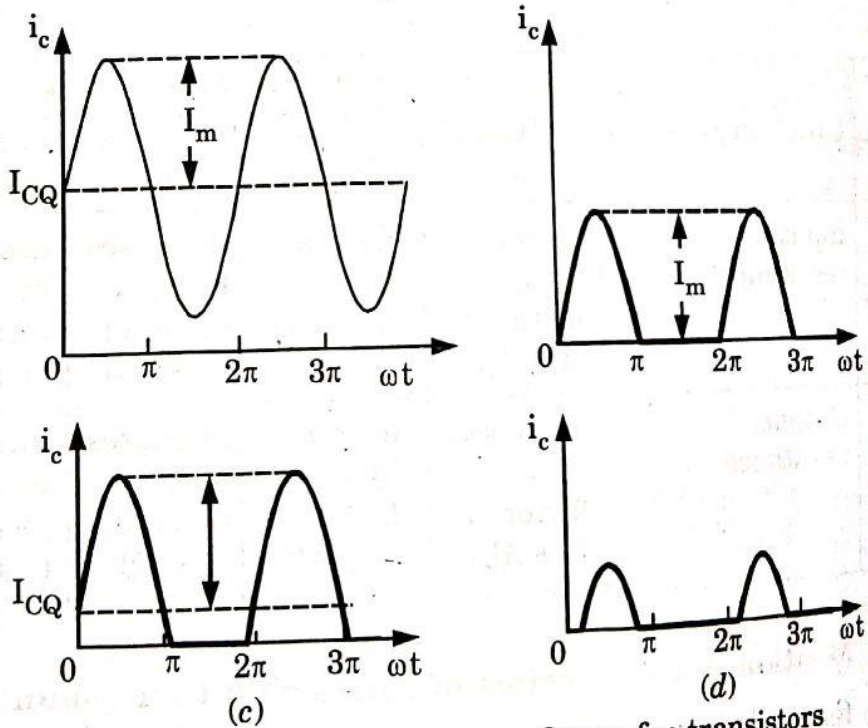


Fig. 3. Collector current waveforms for transistors operating in (a) Class A (b) Class B, (c) Class AB, and (d) Class C amplifier stages.

☺☺☺

3 UNIT

Oscillators (2 Marks Questions)

3.1. What is an oscillator ?

Ans. An oscillator is a device which generates an alternating voltage. It generates an AC output signal without requiring any externally applied input signal. The oscillator converts DC energy into AC energy. Feedback used in oscillator is positive feedback.

3.2. Explain Barkhausen criterion. **AKTU 2016-17, Marks 02**

Ans. Barkhausen criterion defines two basic requirements for oscillations :

1. Total phase shift in the closed loop is 0° or 360°.
2. The magnitude of loop gain *i.e.*, $|A\beta| = 1$.

3.3. Draw the circuit of a Wien bridge oscillator and give condition for sustained oscillations.

Ans.

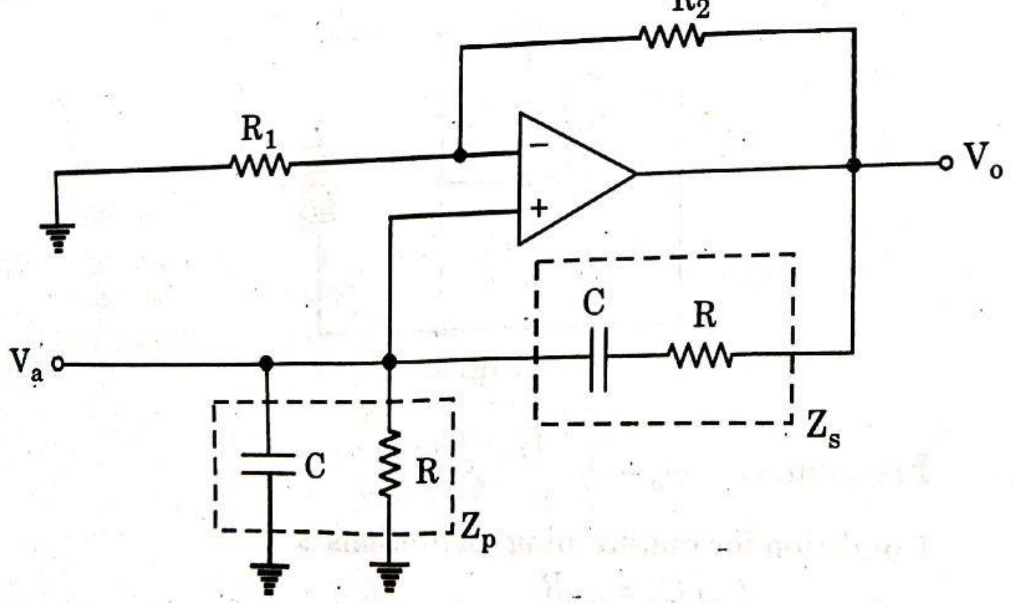


Fig. 1. Wien bridge oscillator.

To obtain sustained oscillation at $\omega_o = 1/RC$, we should set the magnitude of the loop gain to unity. This can be achieved by selecting,

$$R_2/R_1 = 2$$

3.4. List some advantages and disadvantages of Wien bridge oscillator.

Ans. **Advantages :**

1. Good frequency stability.
2. Frequency of oscillations can be changed.
3. A very good quality of sine wave can be obtained at the oscillator output.

Disadvantages :

Oscillation frequency is dependent only on the values of R and C components.

3.5. Write the advantages and disadvantages of phase-shift oscillator.

Ans. **Advantages :**

1. It does not require transformers or inductors.
2. It can be used to produce very low frequencies.
3. The circuit provides good frequency stability.

Disadvantages :

1. It is difficult for the circuit to start oscillations as feedback is generally small.
2. The circuit gives small output.

3.6. Draw the circuit of Colpitts oscillators and also write its frequency and condition of maintaining oscillations.

AKTU 2016-17, Marks 02

Ans.

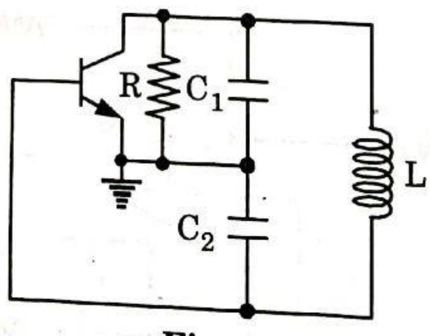


Fig. 2.

Frequency, $\omega_o = 1\Big/\sqrt{L\left(\dfrac{C_1C_2}{C_1 + C_2}\right)}$

Condition for maintaining oscillations is

$$C_2 / C_1 = g_m R$$

3.7. What is the drawback of Colpitts oscillator ? Name the oscillator to remove this drawback.

Ans. The drawback of Colpitts oscillator is that its frequency stability is very poor.
Clapp oscillator is used to removes this drawback.

3.8. What do you mean by self-limiting oscillators ?

Ans. *LC* tuned oscillators utilize the non-linear $i_C - v_{BE}$ characteristics of the BJT for amplitude control. Thus, these LC tuned oscillators are known as self-limiting oscillators.

3.9. Which oscillator is well suited for the generation of wide range audio frequency sine waves ?

Ans. Wien bridge oscillator is well suited for the generation of wide range audio frequency sine waves.

3.10. How monostable multivibrator is used ?

Ans. Monostable multivibrator has one stable state and the other is quasi-stable state. The circuit is useful for generating single output pulse of adjustable time duration in response to a triggering signal.

3.11. Draw the circuit diagram of triangular waveform generator.

Ans.

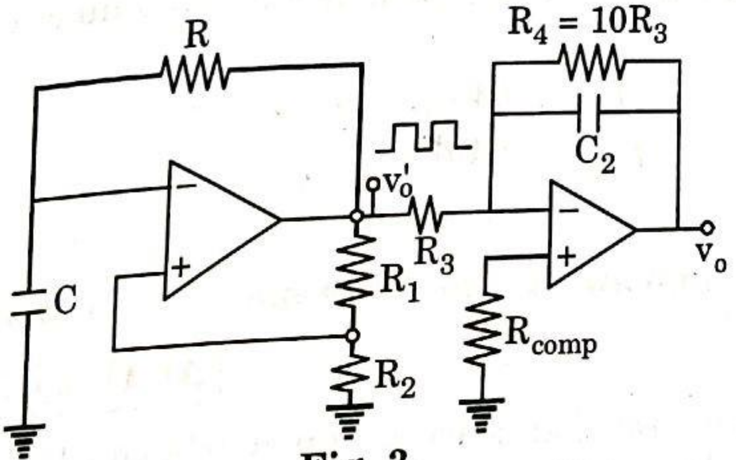


Fig. 3.

3.12. Why the monostable multivibrator also called as gating circuit ?

Ans. The monostable multivibrator is called as gating circuit as it generates a rectangular waveform at definite time and thus could be used to gate parts of a system.

☺☺☺

UNIT 4

Current Mirror and Op-Amp Design (2 Marks Questions)

4.1. What is current steering ?

Ans. On a IC chip with a number of amplifier stages, a constant DC current (called a reference current) is generated at one location and then replicated at various other locations for biasing the various amplifier stages through a process is known as current steering.

4.2. What is current transfer ratio ?

Ans. The relationship between the I_o and I_{REF} by the ratio of the aspect ratio of transistor is known as current gain or current transfer ratio.

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

4.3. What is meant by the term matched transistors ?

AKTU 2017-18, Marks 02

Ans. If the two transistors are designed to be equal *i.e.*, same size, same orientation, same surrounding and have identical values of saturation current, current gain and early voltage, then this pair of transistor is referred as matched transistors.

4.4. What is the advantage of Widlar current source over Wilson current source ?

AKTU 2016-17, Marks 02

Ans.

1. It requires less chip area.
2. The output resistance R_o is higher than basic current source, this is due to the emitter resistance R_E.

4.5. What are the requirements of good current source ?

Ans.

1. The output current I_o should not depend upon β.
2. The output resistance of the current source should be high.

4.6. What is the minimum output voltage for proper operation of MOSFET current mirror ?

Ans: The current source will operate properly with an output voltage V_o greater than V_{OV}, which is a few tenths of a volt.

$$V_o \geq V_{GS} - V_t$$

$$V_o \geq V_{OV}$$

4.7. Draw the output characteristics of MOS current source.

Ans:

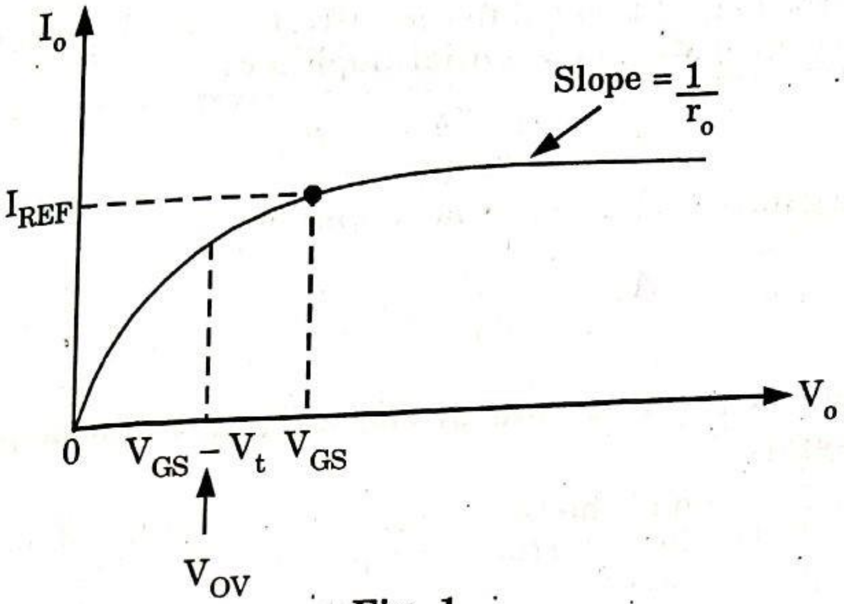


Fig. 1.

4.8. Define ICMR (input common-mode range). What is the value of $v_{CM\,max}$ and $v_{CM\,min}$ of MOS amplifier ?

Ans: ICMR is the range of v_{CM} over which the differential pair operates properly.

The maximum value of v_{CM} is,

$$v_{CM\,max} = V_t + V_{DD} - \frac{I}{2} R_{DD}$$

The minimum value of v_{CM} is,

$$v_{CM\,min} = -V_{SS} + V_{CS} + V_t + V_{OV}$$

4.9. What is meant by common-mode rejection ratio (CMMR) ?

Ans: The ability of a differential amplifier to reject a common mode signal is expressed by its common mode rejection ratio CMRR. CMRR is defined as the ratio of the differential voltage gain A_d to the common mode voltage gain A_{cm} *i.e.*,

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

4.10. What is the ICMR range of BJT differential amplifier ?

Ans.
1. The maximum value of $v_{CM\,max}$ is,

$$v_{CM\,max} = V_C + 0.4 = V_{CC} - \frac{\alpha I}{2} R_C + 0.4$$

2. The minimum value of $v_{CM\,min}$ is,

$$v_{CM\,min} = -V_{EE} + V_{CS} + V_{BE}$$

4.11. Write the differential voltage gain of MOS and BJT differential amplifier.

Ans. For the output taken differentially, the gain becomes,
1. The gain of MOS differential amplifier is,

$$A_d = \frac{v_{o2} - v_{o1}}{v_{id}} = g_m R_D$$

2. The gain of BJT differential amplifier

$$A_d = \frac{v_{c2} - v_{c1}}{v_{id}} = g_m R_C$$

4.12. What is the function of the output stage or last stage of op-amp ?

Ans. The function of the last stage or output stage of an op-amp is to supply the load current and provide low output impedance. It should also provide a large output voltage saving ideally the total supply voltage *i.e.*, $V_{CC} + V_{EE}$.

4.13. What is the role of coupling capacitor (C_c) in IC-741 internal circuit ? **AKTU 2015-16, Marks 02**

Ans. The role of coupling capacitor (C_c) in IC- 741 internal circuit is to compensate frequency using the Miller compensation techniques. Coupling capacitor (C_c) is connected at the stage-II feedback path.

4.14. How the effect of input bias current in non-inverting amplifier is compensated ?

Ans. The effect of input bias current in a non-inverting amplifier is compensated by placing a compensating resistor R_{comp} in series with the input signal V_i.

4.15. Why the bias circuit is used ?

Ans. The bias circuit is used to provide proportional current in the collector of transistor.

☺☺☺

5 UNIT

Op-amp Applications (2 Marks Questions)

5.1. Define operational amplifier.

Ans. An operational amplifier or op-amp is a high gain, direct coupled amplifier. It is designed to perform mathematical operations (addition, subtraction, integration, differentiation etc.).

5.2. List of ideal characteristics of op-amp.

AKTU 2017-18, Marks 02

OR

Write the characteristics of an ideal op-amp.

AKTU 2016-17, Marks 02

Ans.

1. Input impedance is infinite.
2. Output impedance is zero.
3. Infinite CMRR.
4. Bandwidth is infinite.
5. Open loop gain is infinite.

5.3. Sketch the circuit of op-amp as an integrator and differentiator.

AKTU 2017-18, Marks 02

OR

Derive the circuit of integrator using an ideal op-amp.

AKTU 2016-17, Marks 02

Ans. **Integrator :**

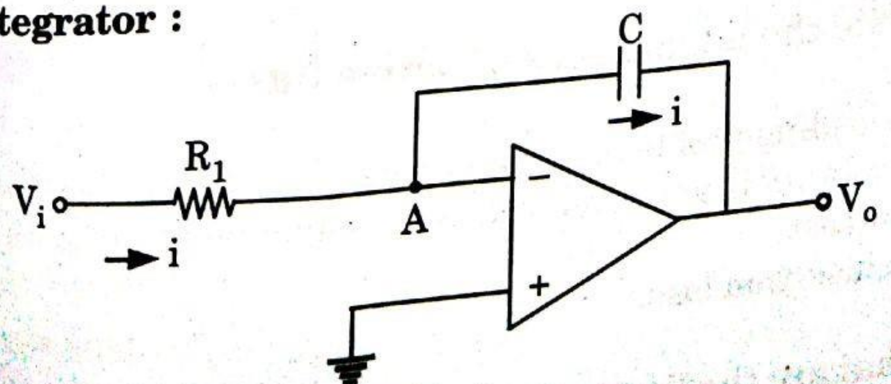


Fig. 1.

Differentiator :

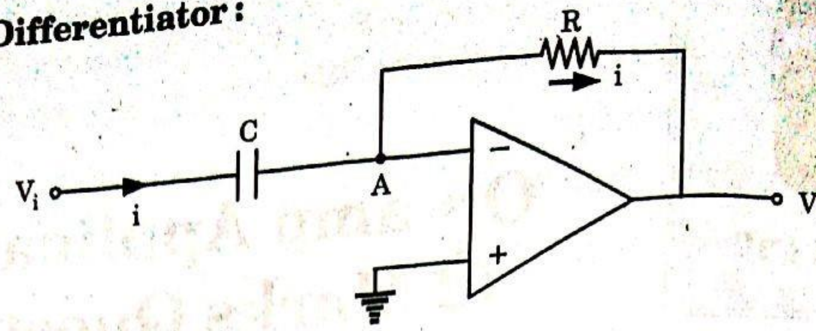


Fig. 2.

5.4. Why is integrator preferred over differentiator ?

Ans. Integrator is preferred over differentiator for analog computers as the gain of integrator decreases with increase in frequency and hence signal to noise ratio of integrator is higher than that of differentiator.

5.5. A non-inverting amplifier circuit is capable of providing a voltage gain of 15. Assuming ideal op-amp and R_1 as 1.3 kΩ, calculate the feedback resistance.

Ans.

Given : $A_V = 15$, $R_1 = 1.3$ kΩ

To Find : R_f.

$$A_V = \left(1 + \frac{R_f}{R_1}\right)$$

$$15 = 1 + \frac{R_f}{1.3 \times 10^3}$$

$$\frac{R_f}{1.3 \times 10^3} = 14$$

$$R_f = 14 \times 1.3 \times 10^3 = 18.2 \text{ k}\Omega$$

5.6. What are the applications of precision diode ?

Ans.

i. Half-wave rectifier
ii. Full-wave rectifier
iii. Peak value detector
iv. Clipper
v. Clamper

5.7. Write the advantages of active filters.

Ans.

i. No loading problem.
ii. Flexibility in gain and frequency adjustment.
iii. Low cost.
iv. No insertion loss.

5.8. What are the limitations of active filters over passive filters ?

Ans.
1. The design of active filter becomes costly for high frequencies.
2. Active filters require dual polarity DC power supply where as passive filters do not.

5.9. Design a multiple feedback narrow bandpass filter with $f_c = 1$ kHz, $Q = 3$ and $A = 10$.

AKTU 2016-17, Marks 02

Ans.

Given : $f_c = 1$ kHz, $Q = 3$ and $A = 10$

To Design : Multiple feedback narrow bandpass filter.

Let $C_1 = C_2 = C = 0.01\ \mu F$.

$$R_1 = \frac{Q}{2\pi f_c C A} = \frac{3}{(2\pi)(10^3)(10^{-8})(10)} = 4.77\ k\Omega$$

$$R_2 = \frac{Q}{2\pi f_c C(2Q^2 - A)} = \frac{3}{(2\pi)(10^3)(10^{-8})[2(3)^2 - 10]}$$

$$= 5.97\ k\Omega$$

$$R_3 = \frac{Q}{\pi f_c C} = \frac{3}{(\pi)(10^3)(10^{-8})} = 95.5\ k\Omega$$

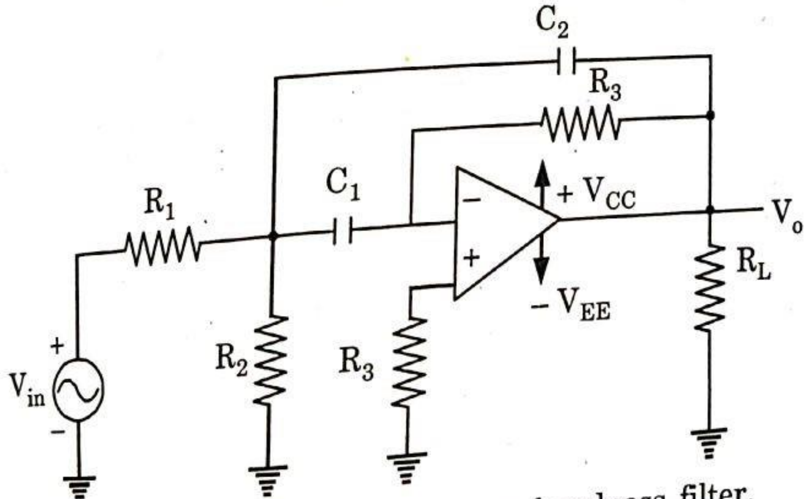


Fig. 3. Multiple feedback narrow bandpass filter.

5.10. For a first order Butterworth high pass filter, evaluate the value of R if $C = 0.0047\ \mu F$ and $f_c = 10$ kHz.

AKTU 2016-17, Marks 02

Ans.

Given : $C = 0.0047\ \mu F$, $f_c = 10$ kHz

To Find : R.

We know that, $f_c = \dfrac{1}{2\pi RC}$

Therefore, $R = \dfrac{1}{2\pi f_c C} = \dfrac{1}{2\pi(10 \times 10^3) \times 47 \times 10^{-10}} = 3.39\ \text{k}\Omega$

5.11. Show the relationship between *K*, *Q* and bandwidth in the twin-*T* notch filter.

Ans. $$Q = \frac{f_o}{\text{BW}} = \frac{1}{4(1-K)}$$

As K approaches unity, Q-Factor becomes very large and BW approaches 0.

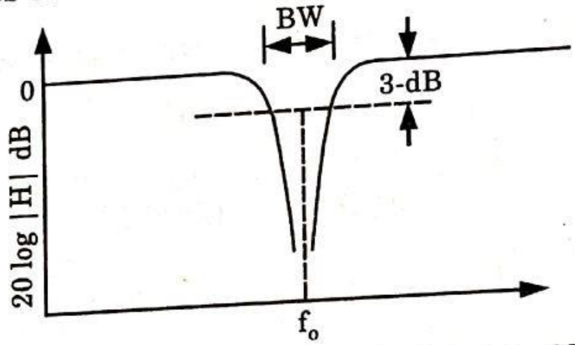


Fig. 4. Frequency response of notch filter.

☺☺☺