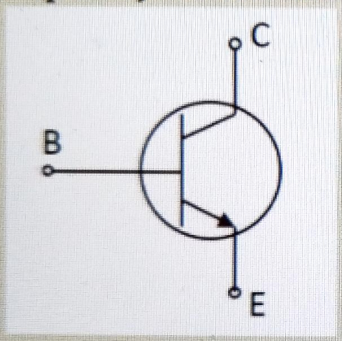
Chapter 3 – Bipolar Junction Transistor

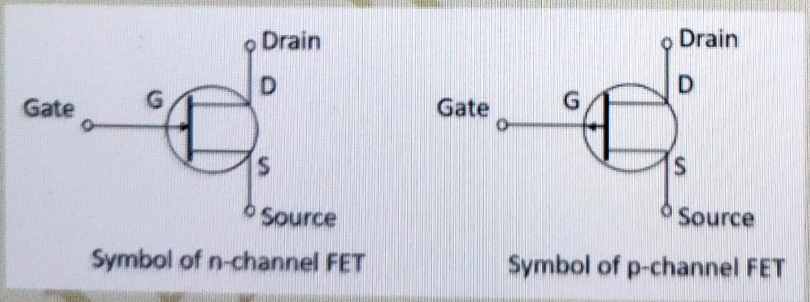
(Weightage – 18 Marks)

2 Marks Questions

1. **List the type of transistor and draw their symbols**
   Answer:
   1) Bipolar Junction Transistor



2) Field Effect Transistor



2. **List specification of BJT.**
   Answer:
   1) Small signal current gain
   2) Maximum collector current
   3) Maximum collector to emitter voltage
   4) Collector to emitter breakdown voltage
3. **Define operating point of the transistor.**
   Answer:
   Operating point: For proper operation of a transistor, in any application, we set a fix level of certain currents and voltages in a transistor. These values of currents

and voltages define the point, at which transistor operates. This point is called operating points or quiscent points or Q points.

4. **Define α and β of transistor.**

Answer:

1) α (Alpha) : It defined as the ratio of collector current (I_C) to emitter current (I_E). This is the Common Base dc current gain.

$$\alpha = \frac{I_C}{I_E}$$

2) β (Beta): It is defined as the ratio of collector current (I_C) to the base current (I_B). This is the Common Emitter dc current gain.

$$\beta = \frac{I_C}{I_B}$$

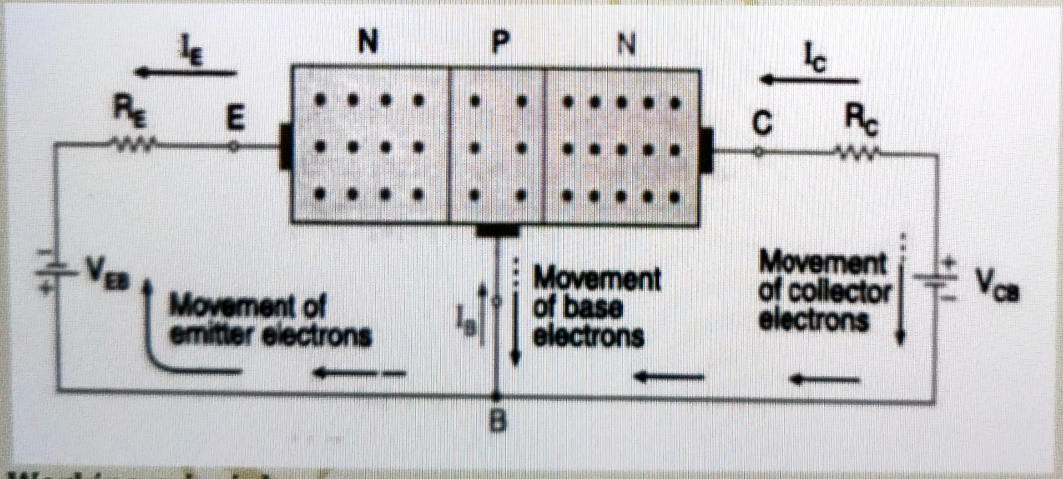
4 Marks Questions

5. **Describe the working principle of npn transistor with the help of diagram.**

Answer:

NPN Transistor:

Diagram:



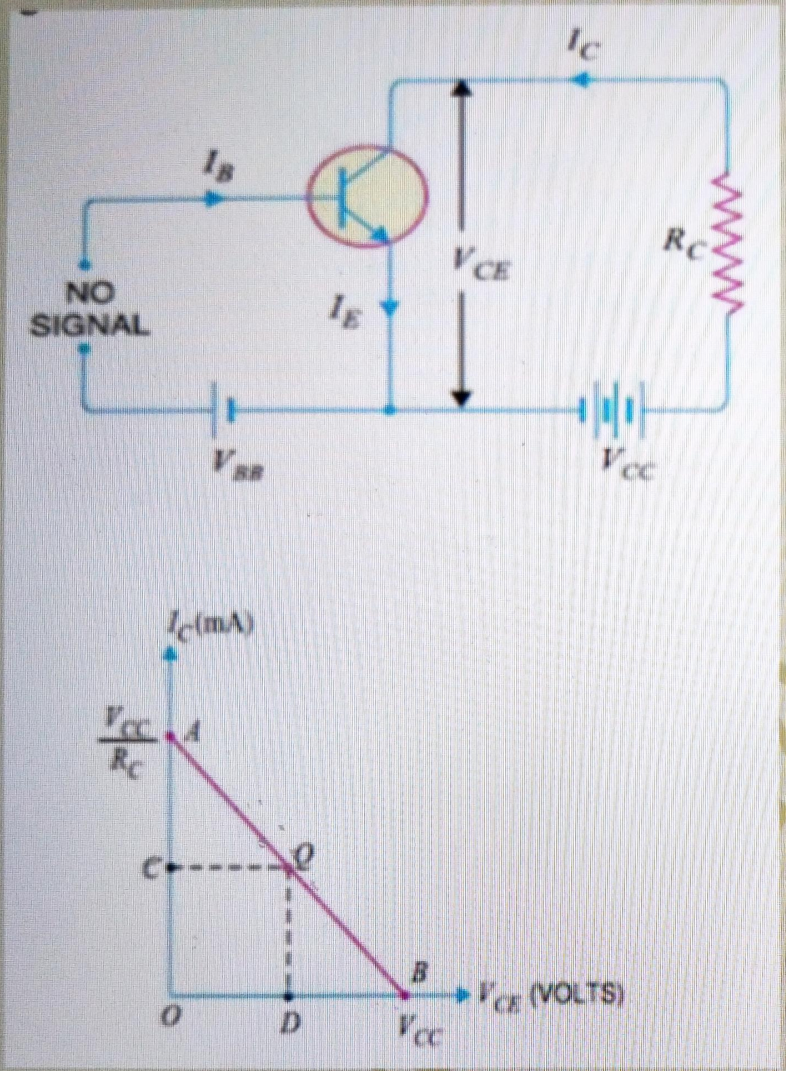
Working principle:

1) Above figure shows NPN transistor with forward biased emitter-base junction and reverse biased collector-base junction.
2) The forward bias causes the electrons in the N-type emitter to flow towards the base. This constitutes the emitter current I_E.
3) As these electrons flow through the P-type they tend to combined with holes.
4) As the base is likely doped and very thin therefore only a few electrons (2%) combine with holes to constitute base current I_B.
5) The remaining electrons (98%) cross over in to the collector region to constitute collector current I_C.
6) In this way almost the entire emitter current flows in the collector circuit. It is clear that emitter current is sum of collector and base current.

$I_E = I_B + I_C$

6. **Draw DC load line of transistor.**

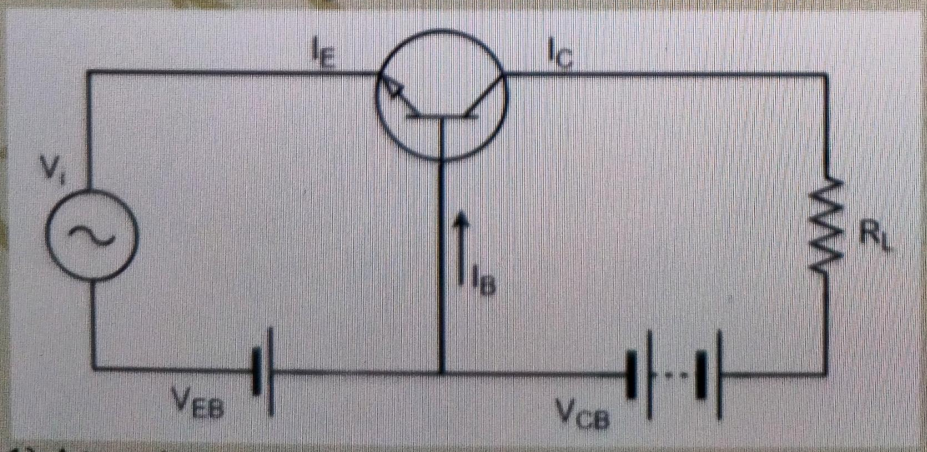
Answer:



7. **With suitable diagram, explain the working of transistor as an amplifier.**

Answer:

Transistor as an amplifier:



1) A transistor acts as an amplifier by raising the strength of a weak signal.
2) The DC bias voltage applied to the emitter base junction, makes it remain in forward biased condition.

3) This forward bias is maintained regardless of the polarity of the signal.
4) The below figure shows how a transistor looks like when connected as an amplifier.
5) The low resistance in input circuit, lets any small change in input signal to result in an appreciable change in the output.
6) The emitter current caused by the input signal contributes the collector current, which when flows through the load resistor R_L, results in a large voltage drop across it.
7) Thus a small input voltage results in a large output voltage, which shows that the transistor works as an amplifier.

8. **Explain working of transistor as a switch.**

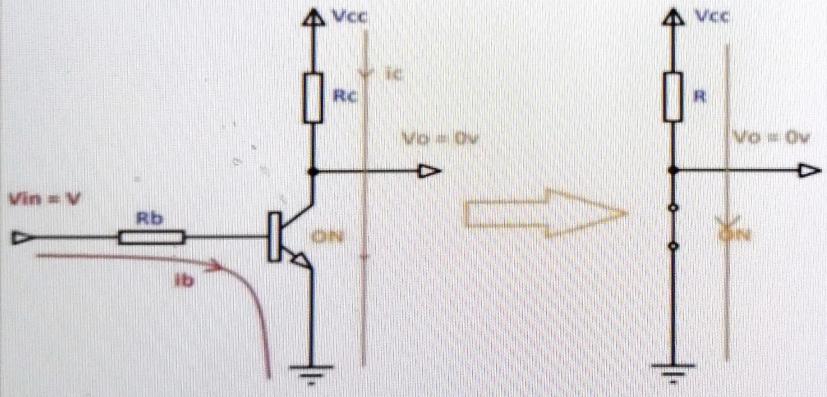
OR

Describe how transistor can be used as a switch and draw waveforms.

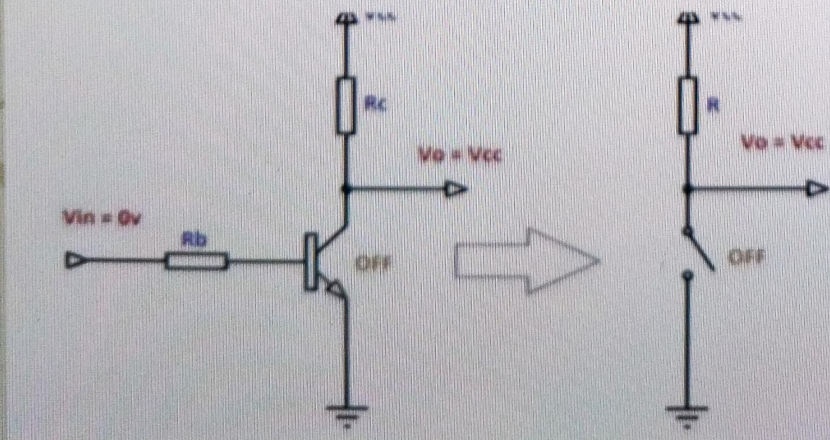
Answer:

Transistor as a switch:

Transistor as a Switch – ON:



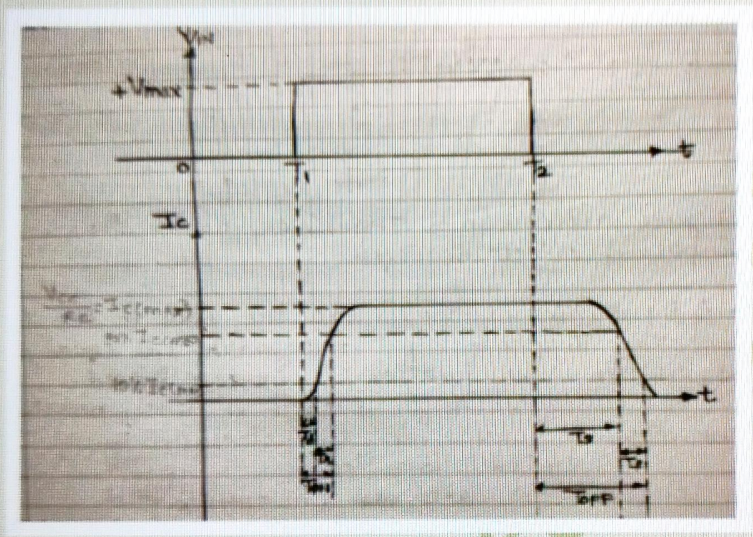
Transistor as a Switch – OFF:



KHARAT ACADEMY

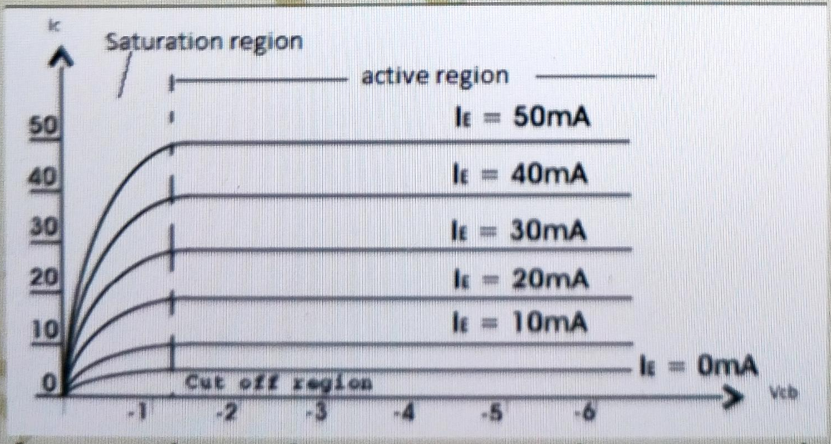
1) When both junctions are forward bias, it works in saturation region & act as closed switch.
2) When both junctions are reverse biased, it works in cutoff region & act as open switch.
3) If input is not given to base, transistor remains off. Diode will be off. $I_C=0$, Acts as open switch.
4) When input is applied to base above 0.7V, transistor becomes ON, Diode is ON. I_C starts flowing, Transistor acts as close switch.

Waveform:



9. Draw O/P characteristics of CB configuration and explain its working.

Answer:



1) In common base configuration, emitter is the input terminal, collector is the output terminal and base terminal is connected as a common terminal for both input and output.
2) The base-emitter junction is forward biased and collector-base junction is reverse biased.
3) Keeping emitter current constant, increase Vcb from zero onward, therefore collector current will be approximately constant as shown.

4) With the increase in emitter current, collector current is also increased as shown above.
5) Depending on the variation of Vcb, ic also varies, based on this the curve is divided into three region i.e. saturation, active and cut off region.
6) Saturation region: In this region Vcb is negative for NPN transistor.
7) A small change in Vcb result in a large value of current
8) Active region: In this region, the collector current is constant and is equal to the emitter current.
9) Cut off region: In this region, a small collector current flows called leakage current when emitter current is zero.

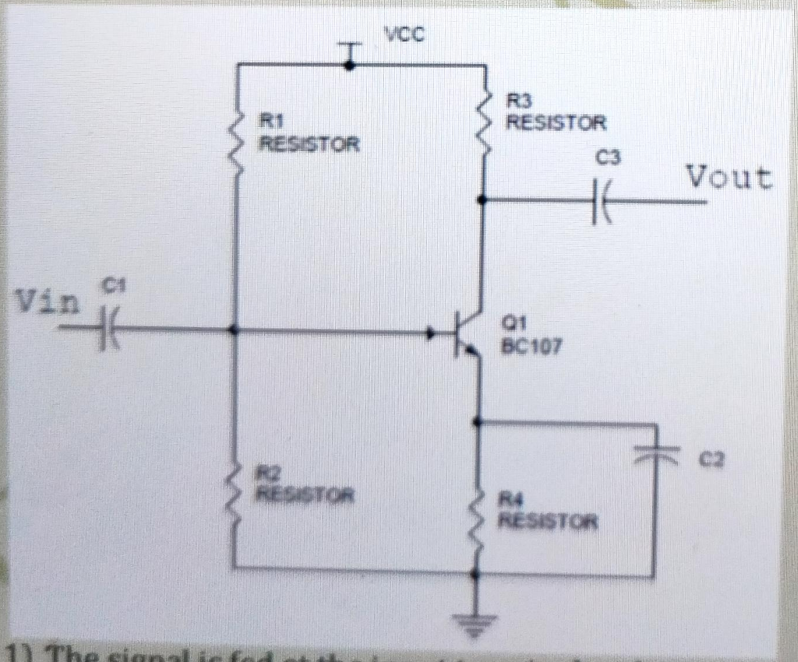
10. Compare CB, CE and CC configuration of BJT.

Answer:

Factor	CB	CE	CC
Input impedance	Low	Medium	High
Output impedance	High	Medium	Low
Current gain	Less than or equal to 1	High	High
Voltage gain	High	High	Less than unit

11. Draw circuit diagram of single stage RC coupled CE amplifier and describe with the help of input and output waveform

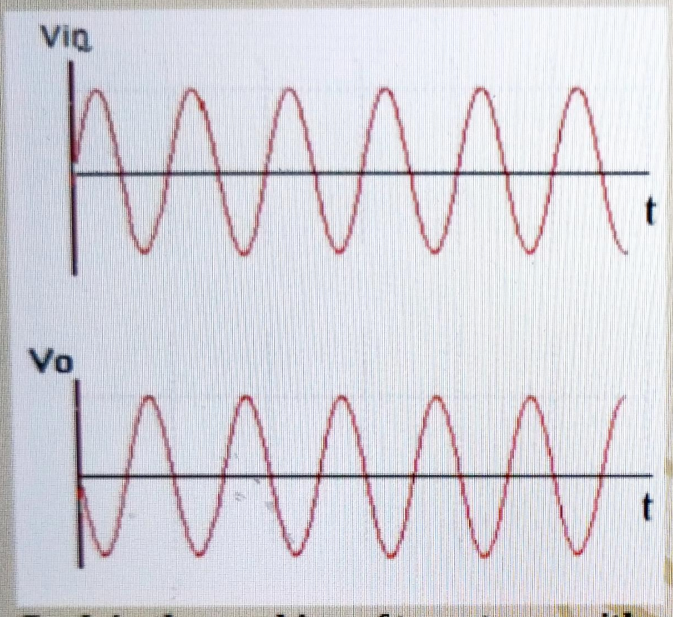
Answer:



1) The signal is fed at the input terminal and output is taken from collector and emitter end of supply.
2) The total instantaneous output voltage Vce is given by
Vce=Vcc-Ic Rc ----- (1)
3) When the signal voltage increases in the positive half cycle, the base current also increases.

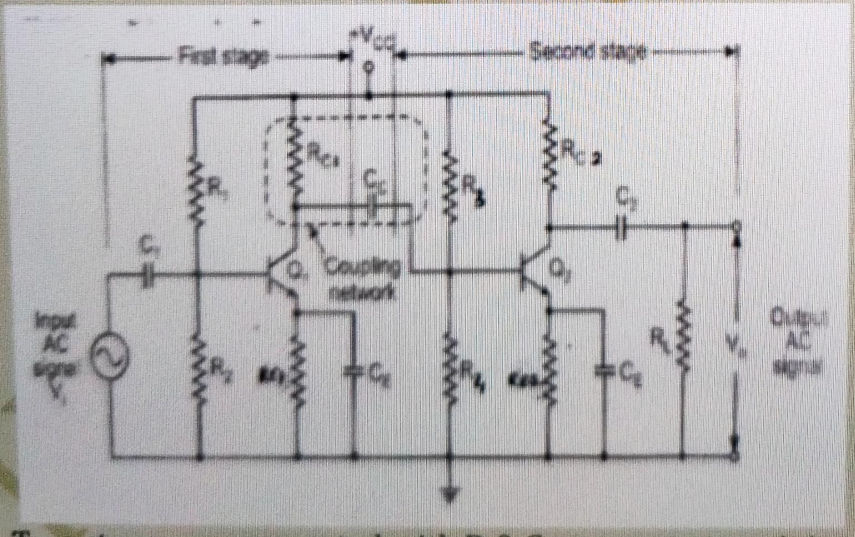
4) The result is that collector current and hence voltage drop IcRc increases.
5) As Vcc is constant, therefore output voltage Vce decreases.
6) As the signal voltage is increasing in the positive half cycle, the output voltage is increasing in the negative sense i.e. output is 180 degree out of phase with input as shown below.
7) Therefore in a CE amplifier the positive half cycle of the signal appears as amplified negative half cycle in the output and vice versa.

Waveform:



12. Explain the working of two stages with neat circuit diagram.

Answer:



Two stages are connected with R & C components so it is called as RC Coupled amplifier.

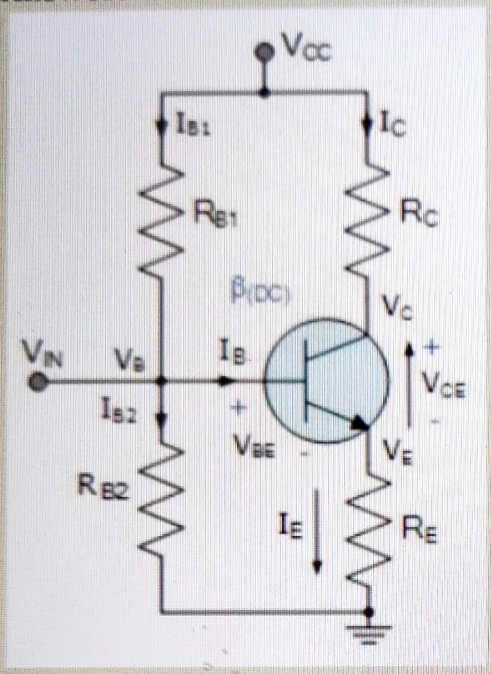
a) Resistor RC1, R3 & Capacitor CC form the coupling network.
b) R1, R2 , R3, R4 provide voltage divider bias to Q1 & Q2.
c) RC1& RC2 provide VCE to Q1 & Q2.
d) RE1 & RE2 provide bias stabilization.

Applications of RC Coupled Amplifier:

Excellent frequency response from 50 Hz to 20 KHz so it is very useful in the initial stage of all public address systems

13. Draw and explain voltage divider bias network.

Answer:

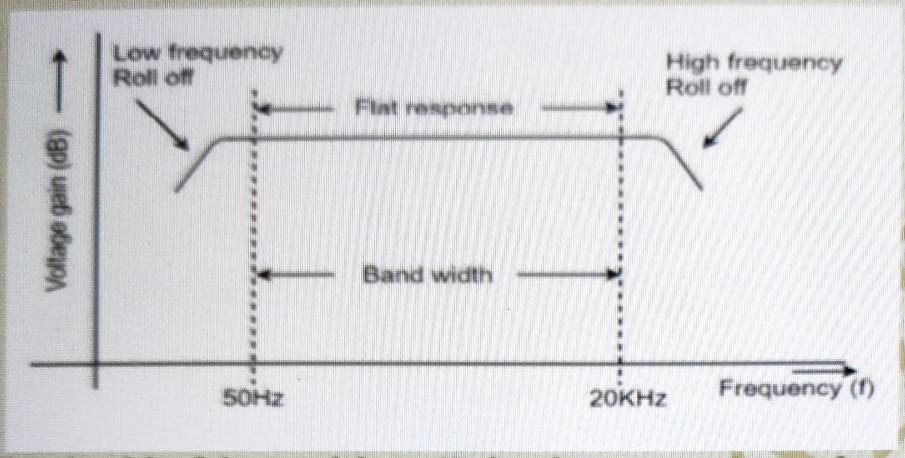


1) Voltage Divider Circuit using Transistor is shown in Fig.
2) Note that the positions of the collector and emitter resistors are reversed compared to the npn transistor circuit. A
3) lso, note that the base voltage (V_B) in Fig. is the voltage drop across resistor R_{B1}, not that across R_{B2}.
4) As in the case of other circuits using pnp transistors, the current directions and voltage polarities are the reverse of those in npn transistor circuits.
5) Apart from these differences, a pnp transistor Voltage Divider Bias Circuit is analysed in exactly the same way as an npn transistor circuit.

14. Draw frequency response of RC coupled two stage amplifier. Write formula to calculate bandwidth and state any two methods to improve bandwidth.

Answer:

Frequency response of RC coupled two stage amplifier:



Bandwidth of the amplifier = Higher frequency – Lower frequency

$= f_H - f_L$

Two methods to improve bandwidth:

1) Direct coupled Amplifier
2) The basic bootstrapping principle is to use an additional buffer amplifier to actively charge and discharge to input capacitance as required. By doing so the effective source capacitance is reduced, enabling the overall bandwidth of the circuit to be increased.

15. Observe the given frequency response of RC coupled amplifier in Fig. 3 Calculate:

(i) Lower cut-off frequency (FL)

(ii) Higher cut-off frequency (FH)

(iii) Bandwidth (BW)

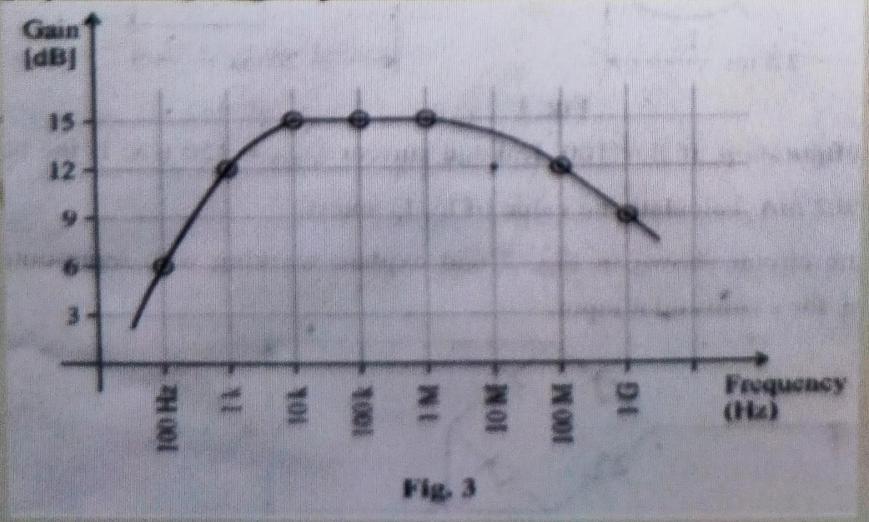


Fig. 3

Answer:

As maximum gain is 15 dB, 3 dB down gain is 12 dB.

So,

(i) The lower cut-off frequency F_L= 1KHz

(ii) Higher cut-off frequency F_H =100 MHz

(iii) Bandwidth (BW) = F_H - F_L = (100000 -1)KHz = 99999 KHz

16.

In CE configuration, if β = 100, leakage current I_{CEO} = 150 μA. If the base current is 0.2 mA, calculate the value of I_C, I_E and α.

(Note: Marks should be given for correct formula)

Given data:-β =100, I_{CEO} = 150 μA. I_B is 0.2mA ,

To find I_C, I_E and α.

Solution :-

We know

1) $\alpha = \beta / (\beta + 1)$

$= 100/(100+1) = 0.99$

2) I_C is given as,

$I_C = \beta * I_B + I_{CEO}$

$= (100*0.2*10^{-3}) + 150*10^{-6} = 20.150$ mA.

3) I_E is given as,

$I_E = I_C + I_B = (20.150 + 0.2)$ mA $= 20.35$ mA