PROBLEMS

Example-1

Determine the Q-point for the CE amplifier given in fig. 1, if R_1 = 1.5K W and R_s = 7K W . A 2N3904 transistor is used with β = 180, R_E = 100W and $R_C = R_{load}$ = 1K W . Also determine the P_{out}(ac) and the dc power delivered to the circuit by the source.

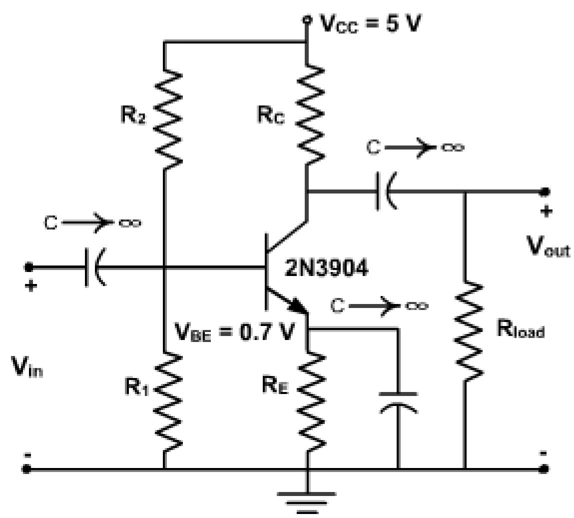

Fig. 1

Solution:

We first obtain the Thevenin equivalent.

$$V_{BB} = \frac{R_1}{R_1 + R_2} V_{CC} = \frac{1500}{1500 + 7000} .5 = 0.882 \ \text{V}$$

and
$$R_B = \frac{R_1 R_2}{R_1 + R_2} = 1.24 \ \text{K}\Omega$$

$$I_{CQ} = \frac{V_{BB} - V_{BE}}{R_B / \beta + R_E} = \frac{0.882 - 0.7}{1240/180 + 100} = 1.70 \ \text{mA}$$

Note that this is not a desirable Q-point location since V_{BB} is very close to V_{BE}. Variation in V_{BE} therefore significantly change I_C.We find $R_{ac} = R_C \parallel R_{load}$= 500 W and $R_{dc} = R_C + R_E$ =1.1KW. The value of V_{CE} representing the quiescent value associated with I_{CQ} is found as follows,

$$V_{CEQ} = V_{CC} - I_{CQ} R_{dc} = 5 - (1.70 \times 10^{-3})(1.1 \times 10^{-3}) = 3.13 \text{ V}$$

Then

$$V_{CC} = V_{CEQ} + I_{CQ} R_{ac} = 3.13 + (1.7 \times 10^{-3})(500) = 3.98 \text{ V}$$

Since the Q-point is on the lower half of the ac load line, the maximum possible symmetrical output voltage swing is

$$2(I_{CQ} - 0)(R_C \parallel R_{load}) = 2(1.70 \times 10^{-3})(500) = 1.70 \; V_{peak\text{-}peak}$$

The ac power output can be calculated as

$$P_{out}(ac) = \frac{1}{2} i_{load}^2 R_{load} = \frac{1}{2}\left(1.70 \times 10^{-3} \times \frac{1000}{2000}\right)^2 \times 1000 = 0.361 \text{ mW}$$

The power drawn from the dc source is given by

$$P_{Vcc}(dc) = I_{CQ} V_{CC} + \frac{V_{CC}^2}{R_1 + R_2} = 11.4 \text{ mW}$$

The power loss in the transistor is given by

$$P_{transistor} = V_{CEQ} I_{CQ} = 3.13 \text{ V} \times 1.70 \text{ mA} = 5.32 \text{ mW}$$

The Q-point in this example is not in the middle of the load line so that output swing is not as great as possible. However, if the input signal is small and maximum output is not required, a small I_C can be used to reduce the power dissipated in the circuit.

Biasing a pnp Transistor:

The biasing of pnp transistor is done similar to npn transistor except that supply is of opposite polarity The various biasing circuits of pnp transistor are shown in fig. 3.

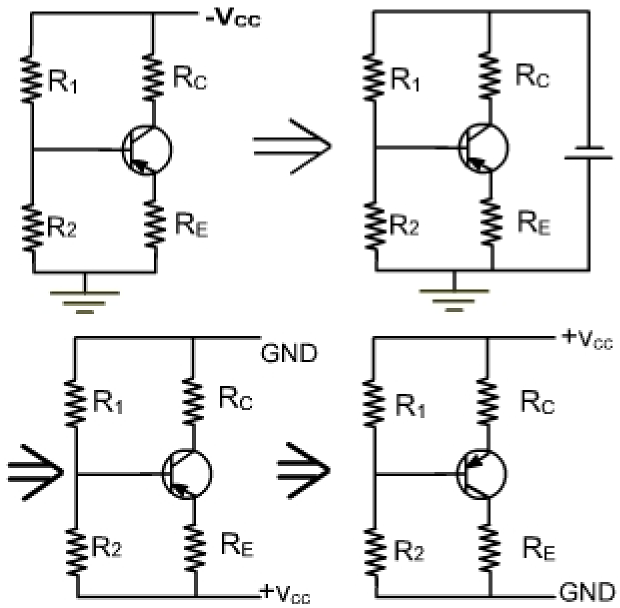

Fig. 3

Example 2:

For the circuit shown in fig. 4, calculate I_C and V_{CE}

Solution:

Voltage across 1K ohm resistor $= \frac{1}{3} \times 30 = 10V$

Therefore,

$$I_C \approx I_E = \frac{10-0.7}{2K} = \frac{9.3}{2K} = 4.65mA$$

Therefore, $V_C = 465 \times 3K = 13.95V$

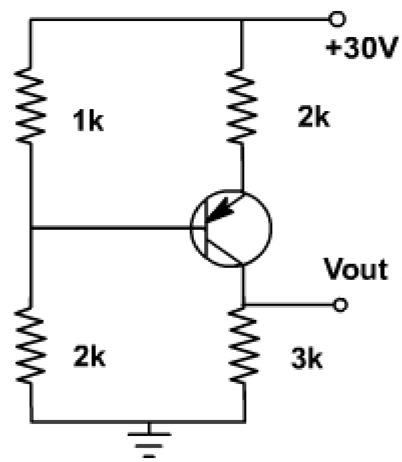

Fig. 4