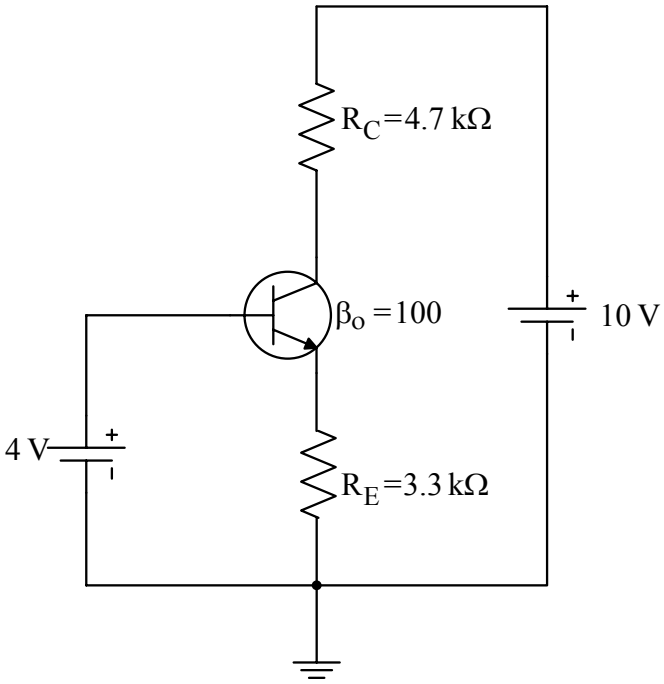
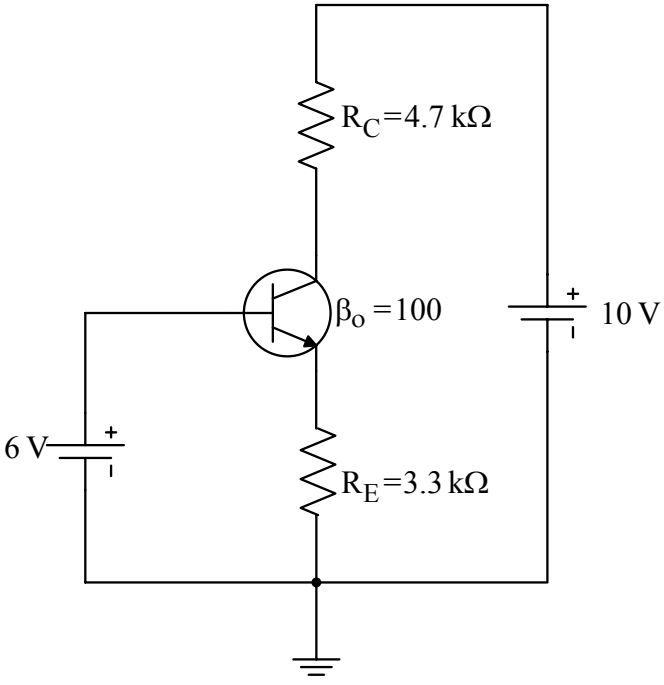
TUTORIAL 6

1. Determine the voltage and current at the terminals B, E and C for each of the following circuit. The transistor is Silicon and V_{BE} = 0.7 V. Determine the mode of operation of each transistor. $V_{CE(sat)}$ = 0.3 V.

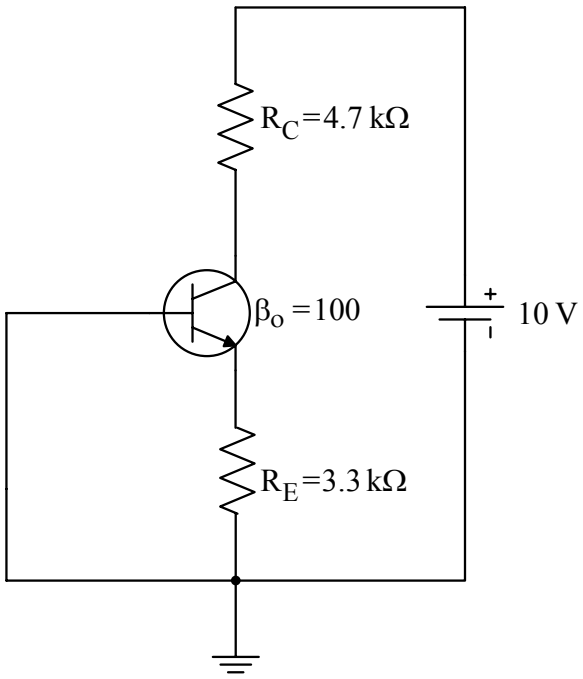
   (a)



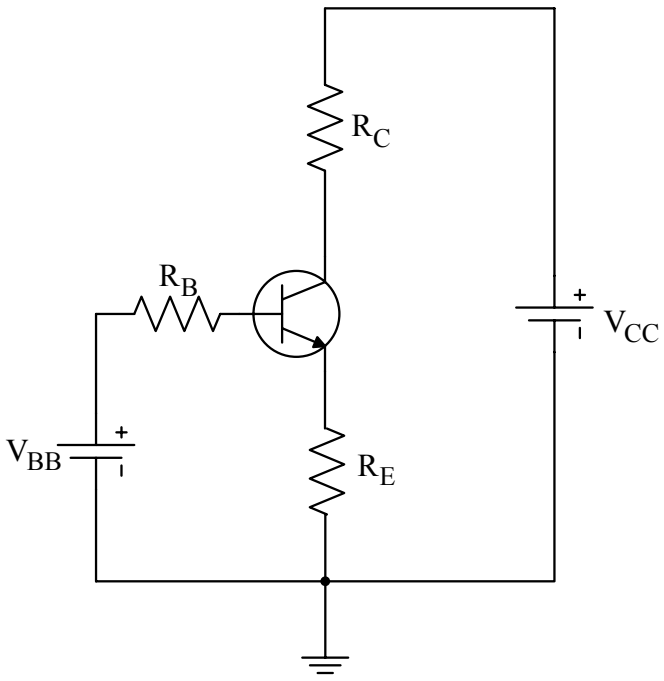
   (b)



(c)



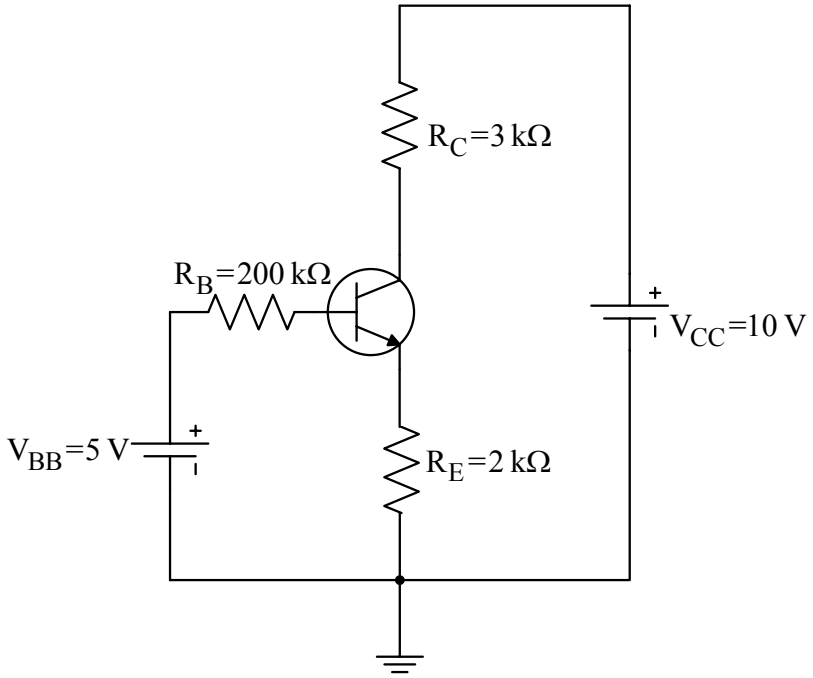
2. The following transistor is a Silicon with V_{BE}=0.7 V, I_B=40 μA and I_{CB0}=0. If V_{BB}=6 V, R_E=1 kΩ and β=80, determine
   (i) I_{EQ} and R_B.
   (ii) V_{CEQ} if V_{CC}=15 V and R_C=3 kΩ.



(iii) Draw the current components and the direction of their flow in an NPN BJT operating as an amplifier.

4(a).Sketch the output characteristic of a CE NPN transistor. Label the saturation, active and cut-off regions.

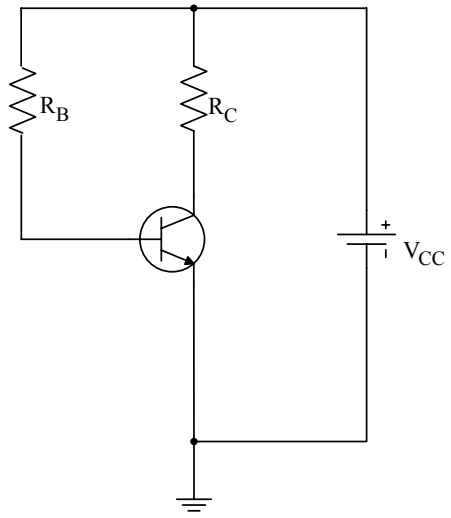
(b). Calculate the transistor's currents shown in the following diagram. Determine the Silicon transistor's operating region. Given β_0=120 and I_{CB0}=20 nA.



5(a).For the CB and CE Silicon NPN BJT amplifier, sketch:

(i) the transistor's biasing diagram
(ii) the input characteristic with the axis labeled
(iii) the output characteristic with the axis and the typical input and leakage currents labeled

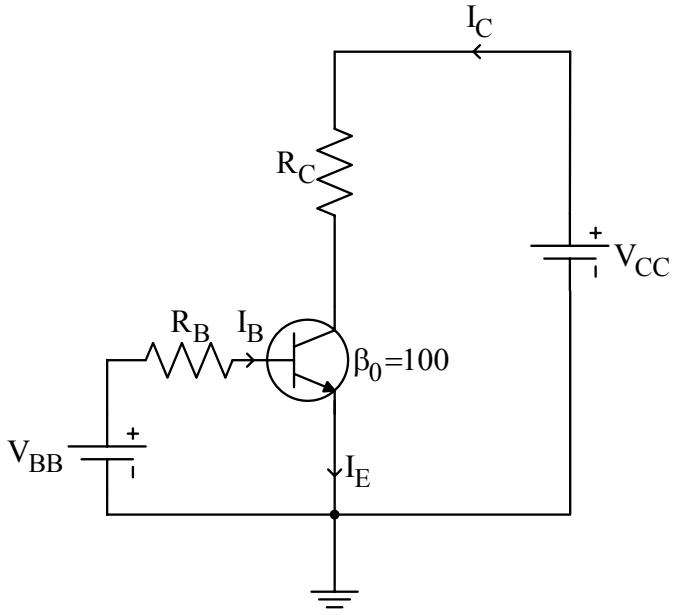
(b).A transistor is connected as a CE amplifier. If R_C=2.2 kΩ, V_{CC}=18 V and I_B=40 μA, determine the biasing condition of the device and estimate the undistorted maximum output. Assume that the transistor is Silicon and V_{BE}=0.7 V.



6(a). A Germanium transistor is operating as an amplifier (in its forward active mode). It has a leakage current I_{CB0} = 5 μA that has to be considered and β = 100. If the transistor is connected to operate as a CE, determine the collector current if:

(i) $I_B = 0$
(ii) $I_B = 40$ μA

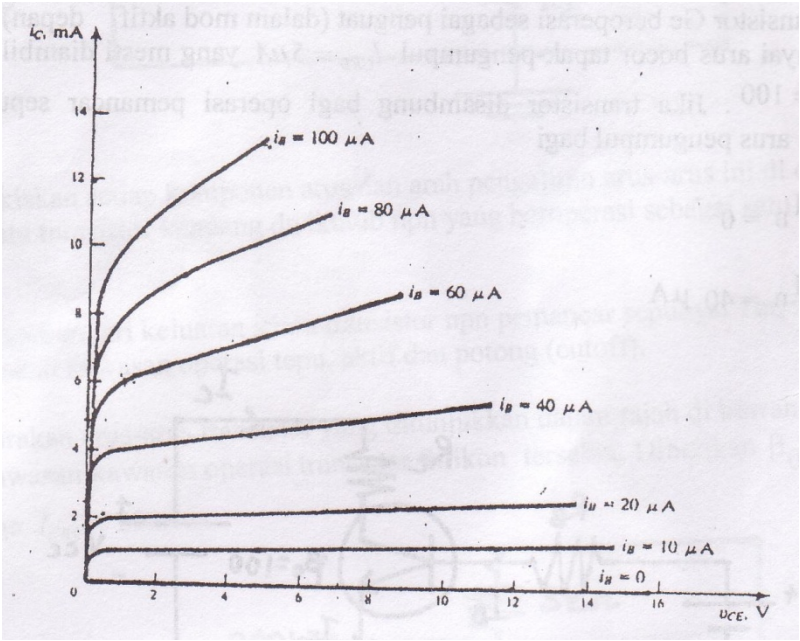
(b). For the circuit below, β_0 = 100, I_{BQ} = 20 μA, V_{CC}=15 V and R_C=3 kΩ. If I_{CB0} = 0, determine



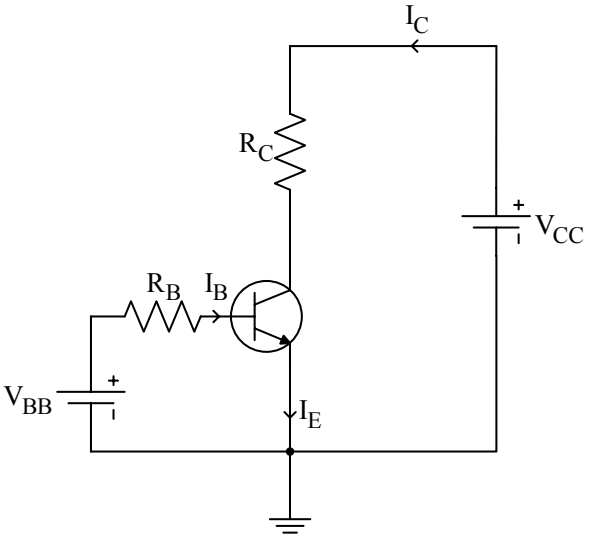
(i) I_{EQ}
(ii) V_{CEQ}
(iii) V_{CEQ} if R_C is increased to 6 kΩ

(c) Assume that the collector characteristic below is for the transistor in the circuit shown in (b). If I_{BQ} = 20 μA, V_{CEQ}=9 V, V_{CC}=14 V and the leakage current can be neglected, determine from the graph

(i) I_{CQ}
(ii) R_C
(iii) I_{EQ}
(iv) β_0



7. Draw the transistor characteristic for the following circuit. Draw the load line of the circuit on the characteristic. What is the purpose of drawing the load line? If the circuit is to function as a switch, explain in detail the changes in I_E.

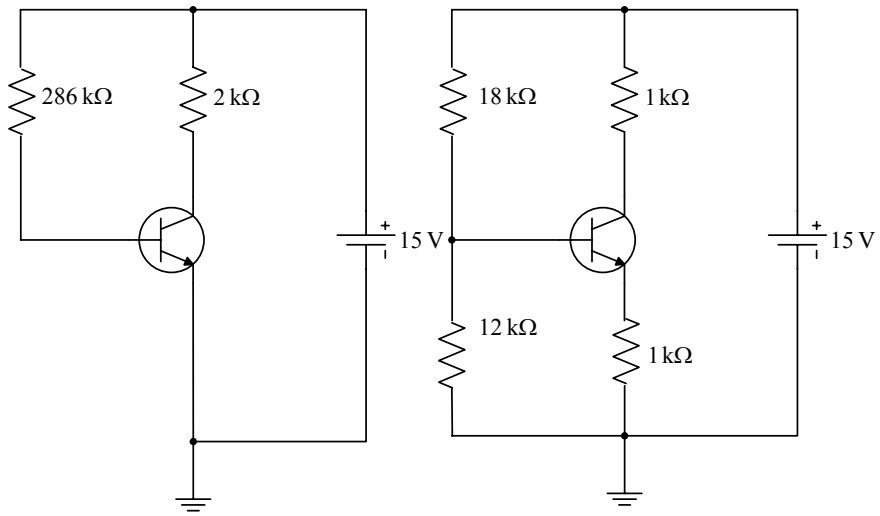


8. For the following 2 biasing BJT circuits, determine I_C and V_{CE} for

(i) $h_{FE} = 50$

(ii) $h_{FE} = 150$

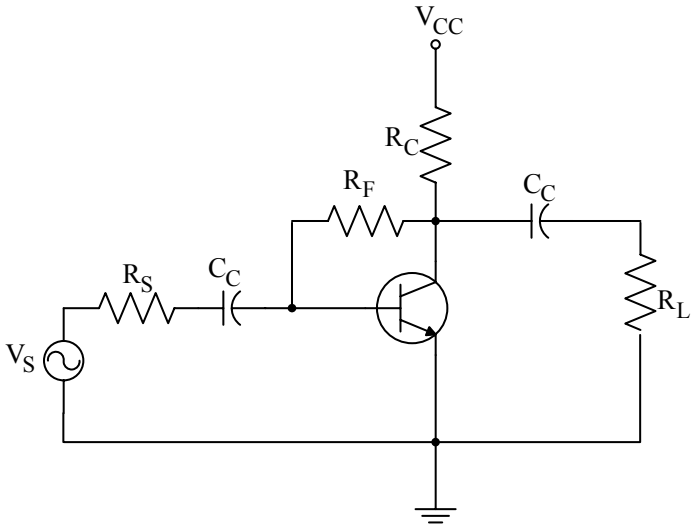
V_{BE} for the transistors is 0.7 V. Reverse leakage current can be neglected. Comment on the performance (i.e. stability of the biasing point) for each circuit based on the results from (i) and (ii).



9. The Silicon transistor in the following circuit has $I_{CB0} = 0$, $h_{FE} = 100$ and $V_{BE} = 0.7$ V.

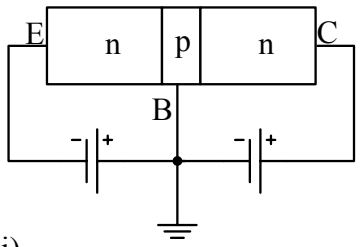
(a) If $R_C = 2$ kΩ and $V_{CC} = 12$ V, determine R_F to obtain the maximum output signal swing.

(b) Determine the emitter resistance, R_E, which when added to the following Silicon transistor circuit will cause the circuit to operate with the following condition: $V_{CEQ} = 5$ V, $\beta_0 = 80$, $I_{CB0} = 0$, $V_{BE} = 0.7$ V, $R_F = 220$ kΩ, $R_C = 2$ kΩ and $V_{CC} = 12$ V.

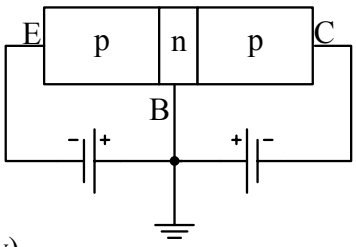


10. State whether the transistor in each circuit below is biased in the active, saturation or cut-off region. Give reasons for your answer.

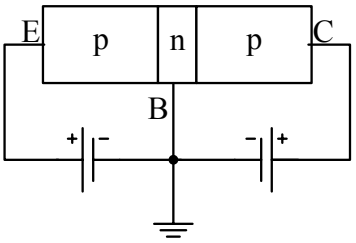
(i)



(ii)



(iii)



(iv)