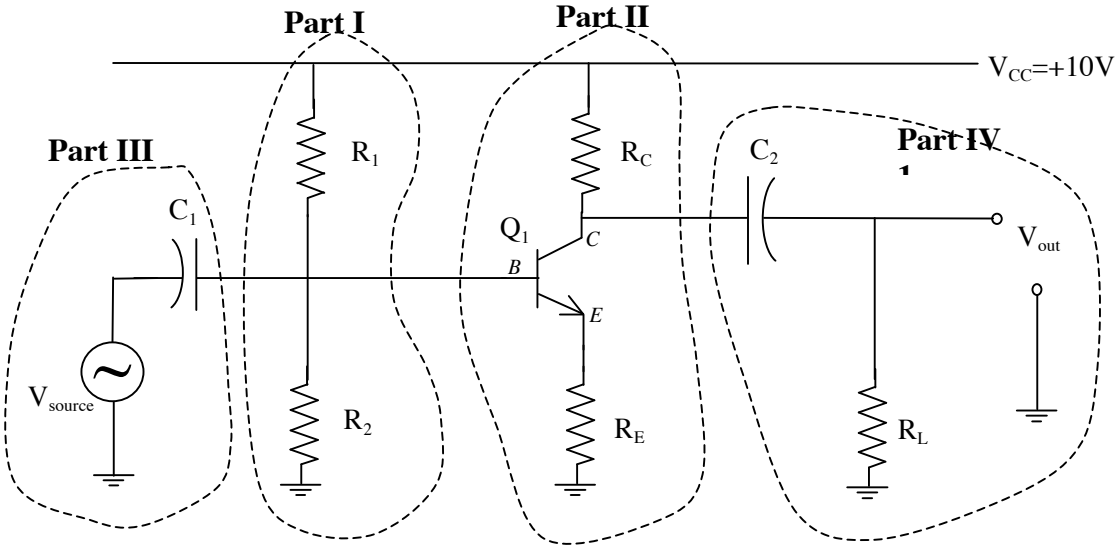
PHY2250 - HW 8 Answers

1. (1 point) In a given transistor circuit, the emitter current is 25mA and the collector current is 24.6mA. What is the base current? **Answer: 0.4 mA**

2. (4 points) In the following amplifier schematic, R_1=5kΩ, R_2=2kΩ, R_C=1kΩ and R_E=500Ω.



   a. Referring to "Part I", what is V_B, the DC voltage at the transistor's base?
   Answer: $V_B = V_{CC} * R_2 / (R_1 + R_2) = 10 * 2/7 = 2.86$ V
   b. What is V_E, the voltage at the emitter?
   Answer: $V_E = V_B - 0.7V = 2.16$ V
   c. Given V_E, what are I_E and I_C? (Use β_{DC}=100.)
   Answer: $I_E = V_E / R_E = 2.16 / 500 = 4.32$ mA
   $I_C = I_E * \beta_{DC} / (\beta_{DC} + 1) = 3.42 * 100/101 = 4.28$ mA
   d. What are the role of the capacitors C_1 and C_2? i.e. why might you want them there?
   Answer: They "block" any DC bias from flowing between Parts I and III, and Parts II and IV, respectively.

3. In the text, Chapter 28, *Question* 5. Derive the equation $\alpha_{DC} = \beta_{DC} / (\beta_{DC} + 1)$

$$I_E = I_B + I_C = \left(\frac{I_C}{\beta_{DC}}\right) + I_C = I_C\left(\frac{1}{\beta_{DC}} + 1\right) = I_C\left(\frac{1}{\beta_{DC}} + \frac{\beta_{DC}}{\beta_{DC}}\right)$$

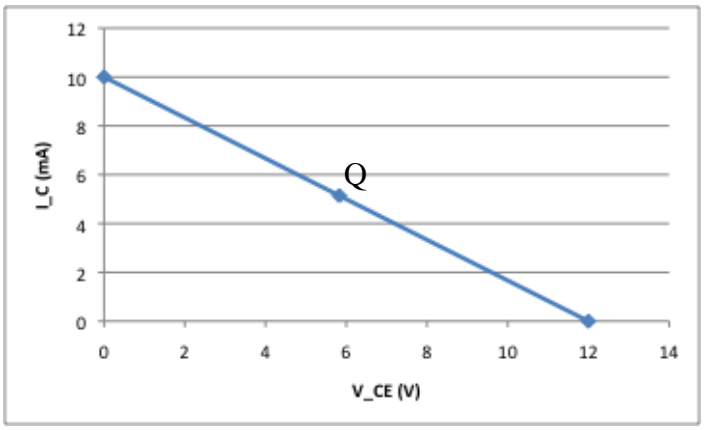
$$I_E = I_C\left(\frac{1+\beta_{DC}}{\beta_{DC}}\right)$$

$$I_E\left(\frac{\beta_{DC}}{1+\beta_{DC}}\right) = I_C$$

$$\therefore \alpha_{DC} \equiv \frac{I_C}{I_E} = \frac{\beta_{DC}}{1+\beta_{DC}}.$$

4. Problem 28-30

Answer: $I_{C(sat)} = V_{CC} / R_C = 12/1200 = 10$ mA
$V_{CE(off)} = V_{CC} = 12$ V
$I_{BQ} = (V_{CC} - 0.7V) / R_B = 11.3 / 220000 = 51.4\ \mu A$
$I_{CQ} = I_{BQ} * \beta_{DC} = 5.14$ mA
$V_{CEQ} = V_{CC} - I_{CQ}R_C = 5.83$ V



5. Problem 28-38

Answer:

a. $V_B = V_{CC} R_2 / (R_1 + R_2) = 10 * 3.3 / (3.3+8.2) = 2.87$ V
b. $V_E = V_B - 0.7V = 2.17$ V
c. $I_E = V_E / R_E = 2.17 / 750 = 2.89$ mA
$I_{CQ} = I_E \beta / (\beta+1) = 2.87$ mA
d. $V_{CQ} = V_{CC} - I_C R_C = 10 - 2.87V = 7.13V$
e. $V_{CEQ} = V_C - V_E = 4.96$ V
f. $I_{C(sat)} = V_{CC} / (R_C + R_E) = 10 / 1750 = 5.71$ mA
e. $V_{CE(off)} = 10V$

6. What is the function of capacitor C_E in the circuit shown in Figure 29-3?
Answer: This provides the AC part of the signal with "a low impedance path to ground," meaning it allows AC signals to *bypass* R_E -- thereby increasing the AC gain of the amplifier -- without changing the DC part or "Q point."