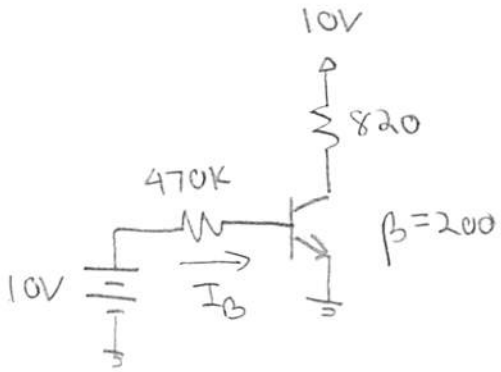
ECE 248
Hw 3 Solutions

Total = 100 pts

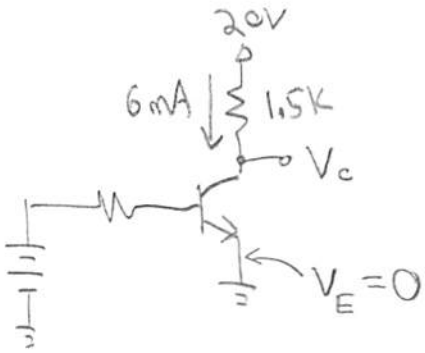
6.5 (+7)

$$I_B = \frac{10 - 0.7}{470K} = \boxed{.0198\,mA} = 19.8\,\mu A$$



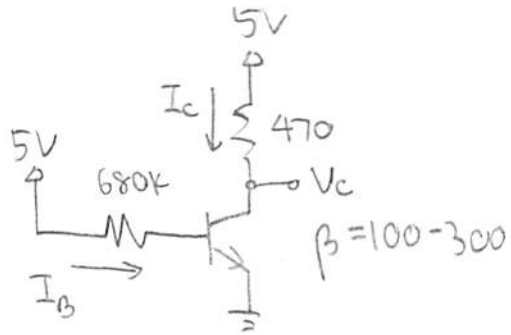
6.8 (+7)

$$V_{CE} = V_C - \cancel{V_E}^{\,0}$$
$$= V_C$$
$$= V_{CC} - I_C R_C$$
$$= 20 - (6mA)(1.5K) = \boxed{11V}$$



6.30 (+8)

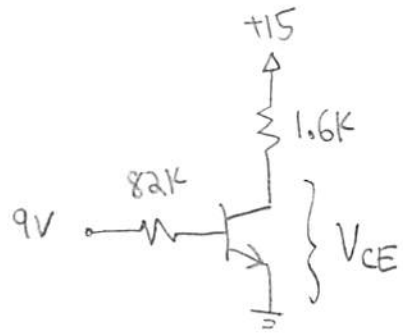
$$V_{CE} = V_C - \cancel{V_E}^{\,0}$$
$$= V_{CC} - I_C R_C$$
$$= V_{CC} - \beta I_B R_C$$
$$I_B = \frac{5 - 0.7}{680K} = .0063\,mA$$



$\beta = 100$: $V_{CE} = 5 - 100 \times .0063mA \times .47K = \boxed{4.7V}$

$\beta = 300$: $V_{CE} = 5 - 300 \times .0063mA \times .47K = \boxed{4.11V}$

7.XX Need to find V_{CE}



(+7) $V_{CE} = V_C - V_E$ (≈ 0)

$= V_{CC} - I_C R_C$

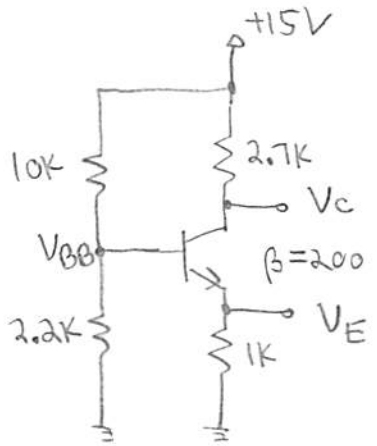
$= V_{CC} - \beta I_B R_C$

$I_B = \frac{9-0.7}{82K} = 0.101mA$

$= 15 - 100 \times .1mA \times 1.6K = -1.2V < 0$

NOT in active mode!

7.44 (+16)



(a) stiff divider?

$10K // 2.2K = 1.8K$

$\frac{200+1}{100} \times 1K = 2.01K$

✓ YES

(b) $V_{BB} = 15 \frac{2.2K}{2.2K+10K} = 2.7V$

$\alpha = \frac{200}{201} = .995$

(c) $V_{CQ} = V_{CC} - I_{CQ} R_C = V_{CC} - \alpha I_{EQ} R_C$

$I_{EQ} = \frac{2.7-0.7}{1K} = 2mA$

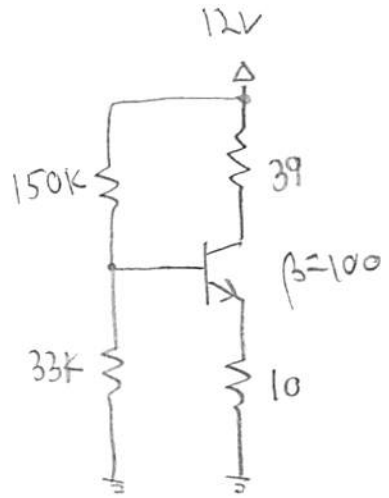
$= 15 - .995 \times 2mA \times 2.7K$

$= 9.63V$

(d) $V_{CEQ} = V_{CQ} - V_{EQ} = 9.63 - 2 = 7.63V$

$V_{EQ} = 2.7 - 0.7 = 2V$

7.22 (+16)



(a) Thevenize the divider!

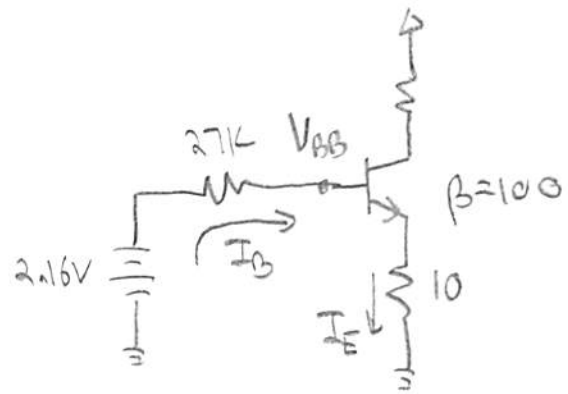
$$V_{TH} = 12 \cdot \frac{33K}{33K + 150K} = \boxed{2.16V}$$

(b) $R_{TH} = 150K \,//\, 33K = \underline{\underline{27K}}$

$$\frac{\beta+1}{100} \times .010K = \frac{101}{100} \times .010K = \underline{\underline{.01K}}$$

$27K > .01K$! Divider is no where close to being stiff!

(c)



Method 1

KVL:

$$2.16 - I_B \cdot 27K - 0.7 - I_E \cdot 10 = 0$$

$I_E = (\beta+1) I_B$

$$I_B = \frac{2.16 - 0.7}{27K + 101 \cdot .010K} = .052mA$$

$$V_{BB} = 2.16 - I_B \cdot 27K = 2.16 - .052mA \cdot 27K$$

$$= \boxed{0.75V}$$

Method 2

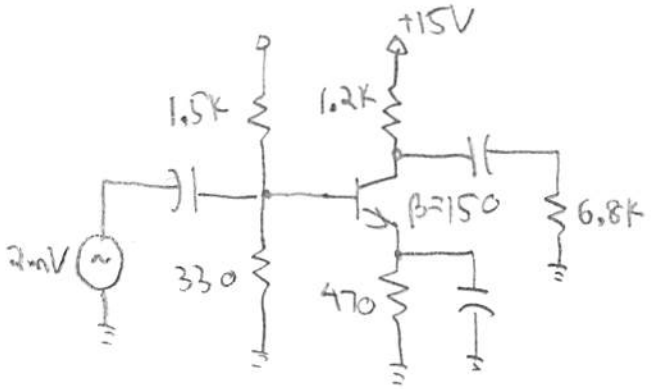
Base current:

$$I_B = \frac{2.16 - V_{BB}}{27K} = \frac{1}{\beta+1} I_E = \frac{V_{BB} - 0.7}{(101)\,.010K}$$

$$.081 - .037 V_{BB} = V_{BB} - 0.7$$

$$V_{BB} = \underline{\underline{0.75V}}$$

8.19 (+16)



For AC equivalent circuit:

① All DC voltages become AC grounds

② $R_C // R_L = r_c = 1.2K // 6.8K = \underline{1.02K}$

$R_1 // R_2 = 1.5K // .33K = \underline{.271K}$

③ Use T-model ⇐ need r_e'

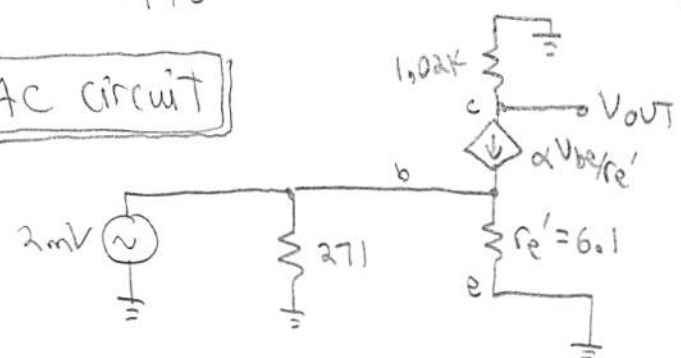
Stiff divider? $1.5K // .33K = .271K$

$\frac{150+1}{100} \times .47K = .71K$ ✓

$\Rightarrow V_{BB} = 15 \frac{330}{330+1500} = 2.71V$

$\Rightarrow I_{EQ} = \frac{2.71 - 0.7}{470} = .0043\,A \Rightarrow r_e' = \frac{.026}{.0043A} = \underline{6.1\,\Omega}$

AC circuit

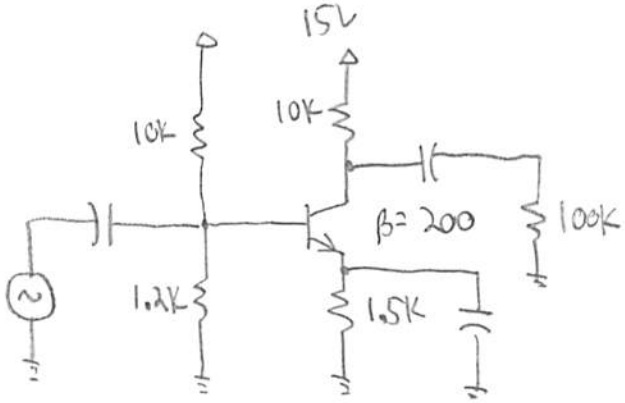


8.XX (+7)

$\frac{V_{OUT}}{V_{IN}} = -\alpha \frac{r_c}{r_e'} = -.995 \frac{1020}{6.1} = \boxed{-166.4}$

$\alpha = \frac{200}{201} = .995$

8.44 (16)



(a) • $r_c = R_c // R_L$

$= 10K // 100K = \underline{9.1K}$

• $R_1 // R_2 = 10K // 1.2K = \underline{1.07K}$

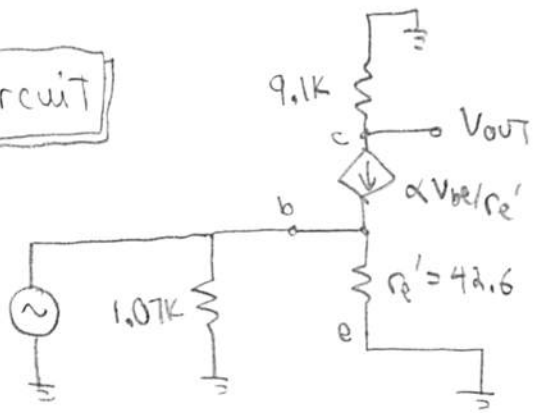
• stiff divider? $10K // 1.2K = 1.07K$ ✓

$\frac{201}{100} \cdot 1.5K = 3K$ ✓

$\rightarrow V_{BB} = 15 \frac{1.2K}{1.2K + 10K} = 1.61V$

$\Rightarrow I_{EQ} = \frac{1.61 - 0.7}{1.5K} = 0.61mA \Rightarrow r_e' = \frac{.026}{.61 \times 10^{-3} A} = \underline{42.6\Omega}$

AC circuit



(b) $\frac{V_{OUT}}{V_{IN}} = -\alpha \frac{r_c}{r_e'} = -.995 \frac{9.1K}{.0426K} = \boxed{-212.6}$

(c) $r_c = 10K // 1K = \underline{0.91K}$

$\Rightarrow \frac{V_{OUT}}{V_{IN}} = -.995 \frac{.91K}{.0426K} = \boxed{-21.3}$