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ECE 2280

Homework #4

1. 1) partially on because $V_{BE} \approx 0.7v$; $V_{CE} \geq 0.7v$

2) none $V_{BE} = 0.8v$, $V_{CE} = 0.1v$

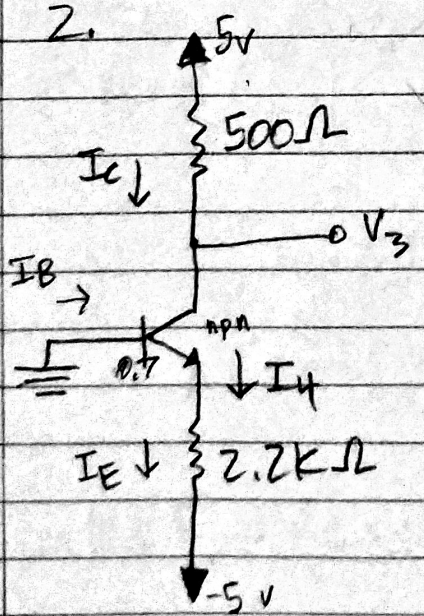
3) partially on $V_{BE} = 0.7v$, $V_{CE} = 0.14v$

4) none $V_{BE} = 0.7v$, V_{CE} $0.1v$

5) partially on $V_{BE} = 0.7v$, $V_{CE} = 2.7v$

6) off $V_{BE} = 0$

2.



$V_{BE} = 0.7$, $\beta = 100$ $I_B, I_C, I_E, V_B, V_C, V_E$

$-0.7 + 5 - I_E(2.2k) = 0$

$I_E = \frac{4.3}{2.2k} = 1.95mA$

$I_B = \frac{I_E}{101} = 19.3\mu A$

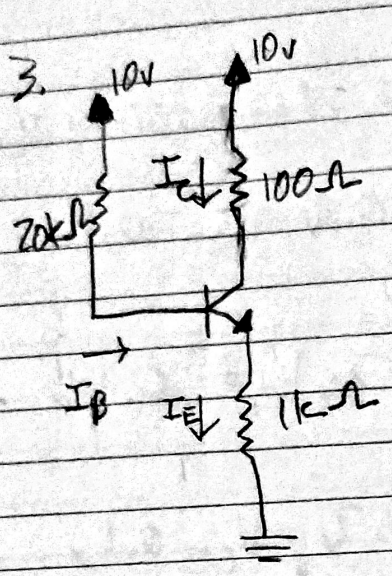
$I_C = 100 \cdot 19.3\mu A = 1.93mA$

$V_B = 0$

$V_E = V_B - 0.7$
$= -0.7v$

$V_C = -5 - 500I_C = 4.03v$

3.



$V_{BE} = 0.7$ $\beta = 100$

$10V - I_B(20k\Omega) - 0.7V - I_E(1k\Omega) = 0$

$I_B = \frac{I_E}{101}$

$10V - \frac{I_E}{101}(20k\Omega) - 0.7V - I_E(1k\Omega) = 0$

$V_B = 10 - 77\mu A(20k\Omega)$
$= 8.5V$

$V_E = 8.5 - 0.7 = 7.8V$

$-\frac{I_E}{101}(20k\Omega) - I_E(1k\Omega) = -9.3$

$V_C = 10 - 7.69mA(100)$
$= 9.2V$

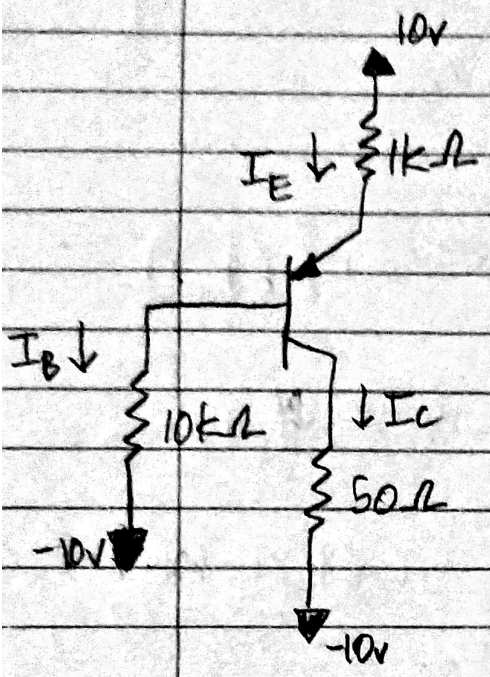
$I_E\left(\frac{20k\Omega}{101} - 1k\Omega\right) = -9.3$

$I_E = 7.76mA$

$I_B = \frac{7.76mA}{101} = 77\mu A$

$I_C = 100(77\mu A) = 7.69mA$

4.



$V_{BE} = 0.7 \quad \beta = 100$

$10 + I_B(10k\Omega) + 0.7 + I_E(1k\Omega) - 10 = 0$

$I_B = \frac{I_E}{101}$

$-10 - \frac{I_E}{101}(10k\Omega) + 0.7 - I_E(1k\Omega) - 10 = 0$

$-\frac{I_E}{101}(10k\Omega) - I_E(1k\Omega) = 19.3$

$I_E\left(\frac{10k\Omega}{101} - 1k\Omega\right) = 19.3$

$I_E = 17.6mA$

$I_B = \frac{17.6mA}{101} = 176\mu A$

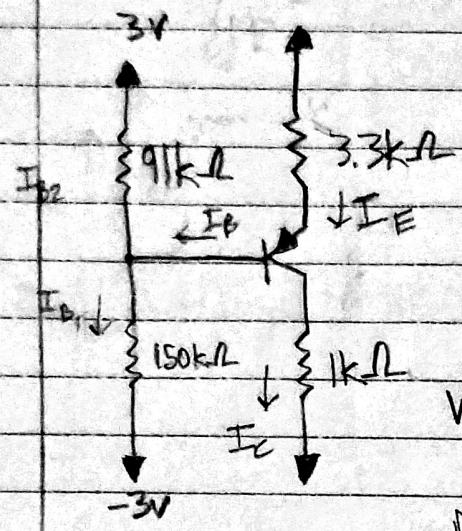
$I_C = 100(176\mu A) = 17.4mA$

$V_B = -10 + I_B(10k\Omega) = -8.26V$

$V_C = 10 - I_E(1k\Omega) = -9.13$

$V_E = V_B + 0.7 = -7.6V$

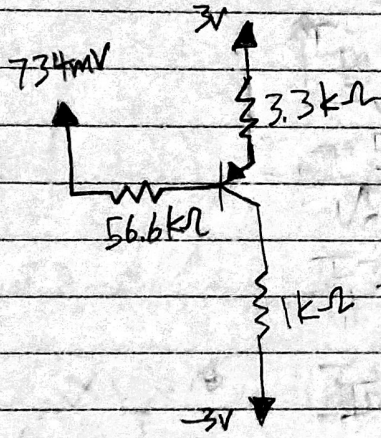
5.



$V_{BE} = 0.7 \quad \beta = 100$

$$V_{Th} = \frac{3(150k) - 3(91k)}{150k + 91k} = 0.734V$$

$$R_{Th} = \frac{(91k)(150k)}{91k + 150k} = 56.6k\Omega$$



$$734mV + I_B(56.6k) + \overset{+0.7}{I_E}(1k) - 3 = 0$$

$$734mV + \frac{I_E(56.6k)}{101} + \overset{+0.7}{I_E}(1k) - 3 = 0$$

$$I_E\left(\frac{56.6k}{101} + 1k\right) = 2.26$$

$V_B = 734mV + I_B(56.6k) = .96V$

$V_E = V_B + 0.7 = 1.66V$

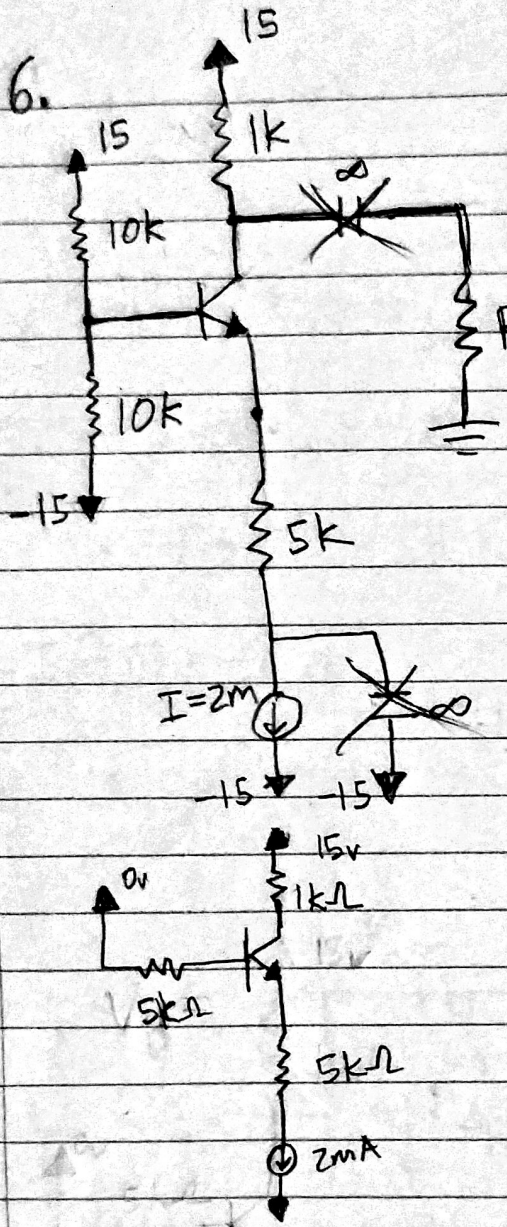
$V_C = 3 - .396(3.3k) = -2.6V$

$I_E = 4mA$

$I_B = \frac{4mA}{101} = 4\mu A$

$I_C = 101(4\mu A) = 396mA$

6.



$V_{BE} = 0.7V$

$\beta = 100$

$V_T = 25mV$

$I_{B4}, I_{C4}, I_{E4}, V_{B4}, V_{C4}, V_{E4}$

$I_E = 2mA$

$I_B = \frac{2mA}{101} = 19.8\mu A$

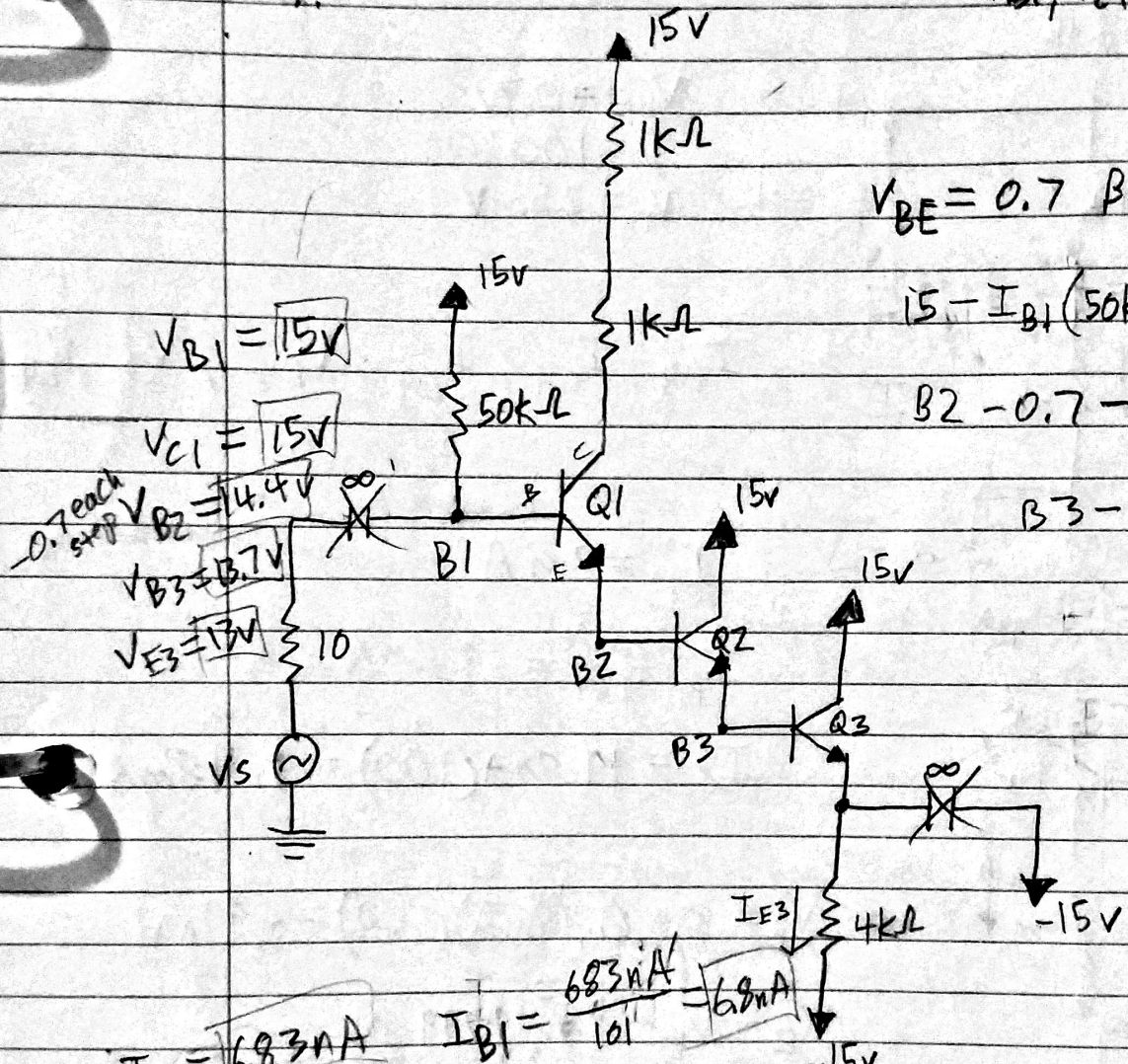
$I_C = 19.8\mu A(100) = 1.98mA$

$V_B = 0 - (1.98mA)(5k\Omega) = -99mV$

$V_E = V_B - 0.7 = -799mV$

$V_C = 15 - (1.98mA \cdot 1k) = 13.02V$

7. $V_{B1}, V_{C1}, V_{B2}, V_{B3}, V_{E3}$



$V_{BE} = 0.7 \quad \beta = 100 \quad V_T = 25mV$

$15 - I_{B1}(50k\Omega) - 0.7 - B2 = 0$

$B2 - 0.7 - B3 = 0$

$B3 - 0.7 - I_{E3}(4k\Omega) + 15 = 0$

$V_{B1} = 15V$

$V_{C1} = 15V$

$V_{B2} = 14.4V$ (0.7 each step)

$V_{B3} = 13.7V$

$V_{E3} = 13V$

$I_{E1} = 683nA \quad I_{B1} = \frac{683nA}{101} = 6.8nA$

$I_{B2} = \frac{69\mu A}{101} = 683nA$

$I_{E2} = 69\mu A$

$B3 = B2 - 0.7$

$B2 = 15 - I_{B1}(50k\Omega) - 0.7$

$B3 = 15 - I_{B1}(50k\Omega) - 0.7 - 0.7$

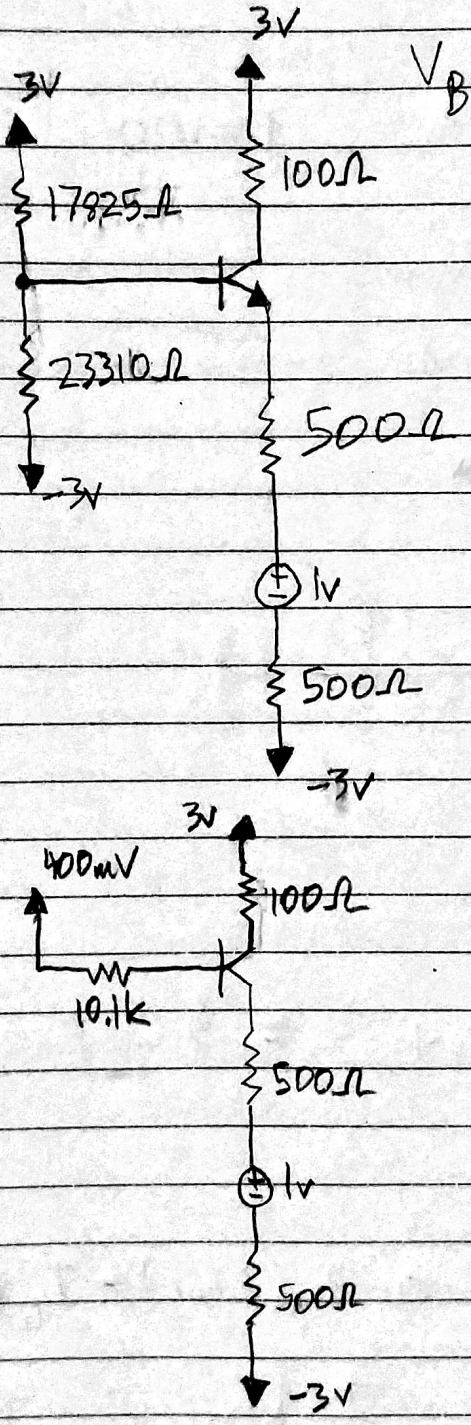
$I_{B3} = \frac{7mA}{101} = 69\mu A$

$I_{C3} = 101 \cdot 69\mu A = 7mA$

$15 - I_{B1}(50k\Omega) - 0.7 - 0.7 - 0.7 - I_{E3}(4k\Omega) + 15 = 0$

$I_{E3}\left(\frac{50k\Omega}{101} - 4k\Omega\right) = -27.9 = 7mA$

8.



$V_{BE} = 0.7 \quad \beta = 100$

$I_B, I_C, I_E, V_B, V_C, V_E$

$$V_{Th} = \frac{3(23310) - 3(17825)}{23310 + 17825} = 400mV$$

$$R_{Th} = \frac{(23310)(17825)}{23310 + 17825} = 10.1k$$

$400mV - I_B(10.1k) - 0.7 - I_E(500) - 1$

$-I_E(500) + 3 = 0$

$$I_E\left(\frac{10.1k}{101} - 500 - 500\right) = -1.7$$

$$I_E = 1.55mA$$

$$I_B = \frac{1.55mA}{101} = 15.35\mu A$$

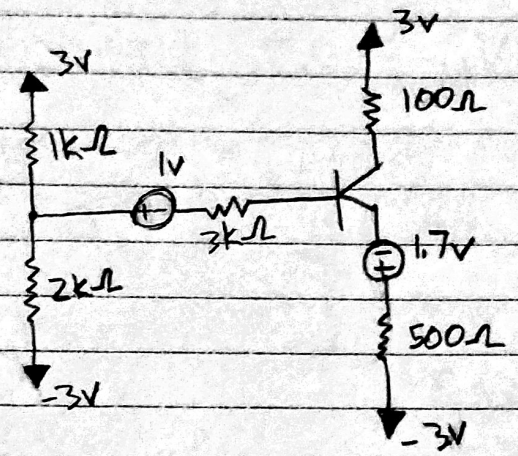
$$I_C = 100(15.35\mu A) = 1.53mA$$

$V_B = (15.35\mu)(10.1k) = .25V$

$V_E = 0.25 - 0.7 = -0.45V$

$V_C = 2.85V$

9.

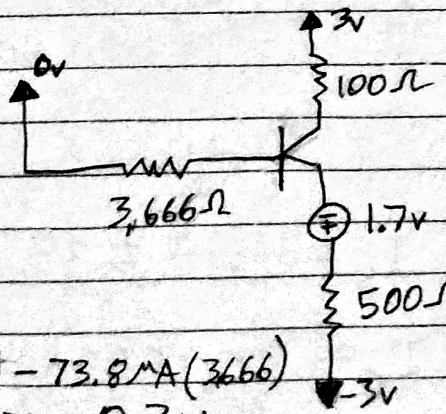


$\beta = 100$

$$V_{Th} = \frac{3(2k) - 3(1k)}{1k + 2k}$$

$$V_{Th} = 0V$$

$$R_{Th} = \frac{(1k)(2k)}{1k+2k} + 3k = 3{,}666\Omega$$



$$0 - I_B(3{,}666) - I_E(500) + 1.7 - 0.7 + 3 = 0$$

$$I_E\left(\frac{-3666}{101} - 500\right) = -4$$

$$I_E = 7.46mA$$

$$I_B = \frac{7.46mA}{101} = 73.8\mu A$$

$$I_C = 100(73.8\mu A) = 7.39mA$$

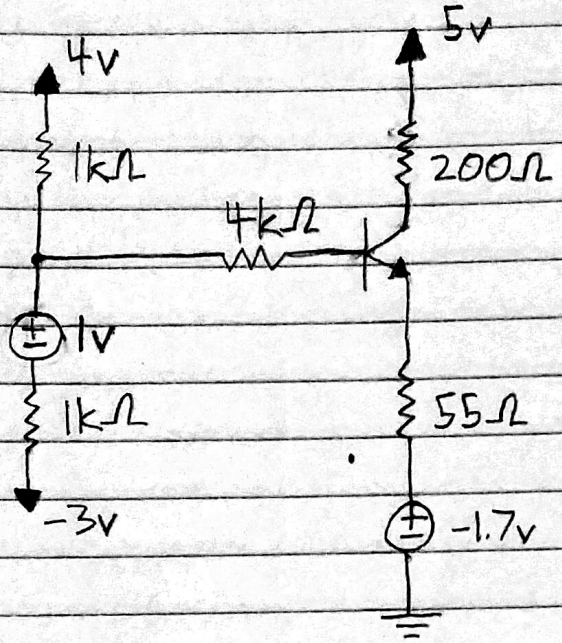
$$V_B = 1 - 73.8\mu A(3666) = -0.3V$$

$$V_E = -0.3 - 0.7 = -1V$$

$$V_C = 3 - 0.7 = 2.3 = 2.3V$$

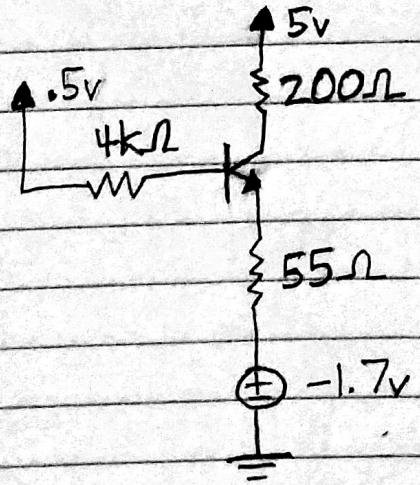
10.

$\beta = 99$



$$V_{Th} = \frac{((4v - 1v)\,1k\Omega) + (-3v + 1v))\,1k\Omega}{1k\Omega + 1k\Omega} = .5v$$

$$R_{Th} = \frac{(1k\Omega)(1k\Omega)}{1k\Omega + 1k\Omega} = 500\Omega$$



$$.5 - I_B(4k\Omega) - 0.7 - I_E(55\Omega) - 1.7 = 0$$

$$I_E\left(\frac{4k\Omega}{100} - 55\Omega\right) = -1.9$$

$$I_E = 20mA$$

$$I_B = \frac{20mA}{100} = .2mA$$

$V_B = (4k)(.2mA) - 0.7 = 0.1v$ $I_C = (99)(.2mA) = 19.8mA$

$V_E = 0.1 - 0.7 = -0.6v$

$V_C = (19.8mA)(200) - 1.7 - .5 - 0.7 = 1.04v$