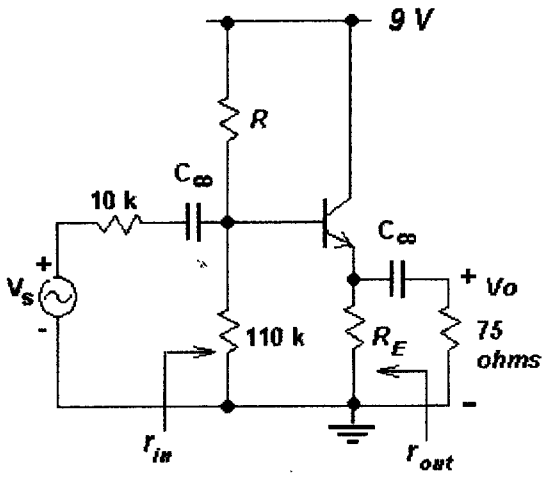
ELECTRONISC I midterm 2 * November 25, 2008 * 75 minutes * closed books and notes

ID no : SOLUTIONS *Name:* ERKAYA *Signature:* _____

1. Find R_E and R in the BJT amplifier such that the BJT has 1.5 mA collector current, 4.5 V collector-emitter voltage. Find its voltage gain, input resistance and output resistance when it is operated with a signal source whose output resistance is 10 kohm and a load of 75 ohms. (Assume silicon NPN BJT, β=300, and any value of resistor is available)

9:17



$V_E = 9 - 4.5 = 4.5V$

$R_E = \frac{V_E}{I_E} \simeq \frac{V_E}{I_C} = \frac{4.5}{1.5} = 3k\Omega$

$V_B = V_E + V_{BE} = 4.5 + 0.7 = 5.2\ V$ ignoring the base current

$\frac{5.2}{110k} = I_2 \simeq I_1 = 0.047\ mA$

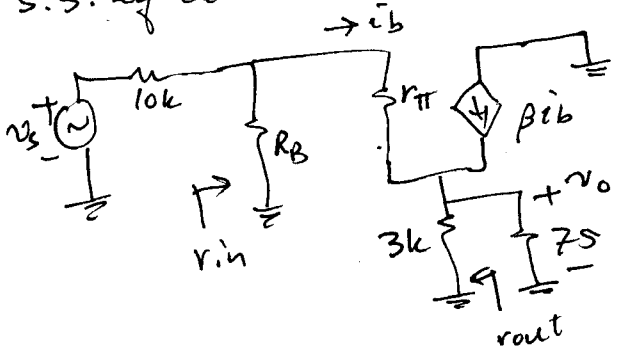
$R = \frac{9 - 5.2}{0.047} \simeq 80\ k\Omega$

$R_B = 80k \| 110k = 46.3k$

$g_m = \frac{I_C}{V_T} = \frac{1.5}{0.025} = 60\ mA/V$

$r_\pi = \frac{\beta}{g_m} = \frac{300}{60} = 5k\Omega$

S.S. eq. ckt



$r_{in} = R_B \| [r_\pi + (\beta+1)(R_E \| R_L)]$

$= 46.3 \| [5 + 301(3k \| 0.075)]$

$= 17.06\ k\Omega$

$r_{out} = 3k \| \frac{r_\pi + (10k \| R_B)}{\beta+1}$

$= 3k \| \frac{5 + 10k \| 46.3}{301} \simeq 0.043k$

$\frac{v_o}{v_s} = \frac{(\beta+1)(R_L \| R_E)}{r_\pi + (\beta+1)(R_L \| R_E)} \frac{r_{in}}{R_s + r_{in}} \simeq \frac{301 \times 73}{5000 + 301 \times 73} \frac{17.06}{10 + 17.06} \simeq 0.51$

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2. Find the operating points of the silicon bipolar transistors given below (β=100).

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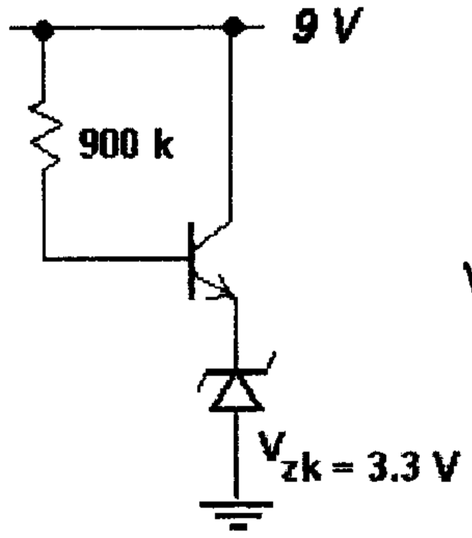

$I_B = \frac{9 - 3.3 - 0.7}{900k} = \frac{5}{900}$ mA

$I_C = \beta I_B = \frac{100 \times 5}{900} = \frac{5}{9} = 0.555mA$

$V_{CE} = 9 - 3.3 = 5.7V$

$I_C =$ 0.555mA

$V_{CE} =$ 5.7V

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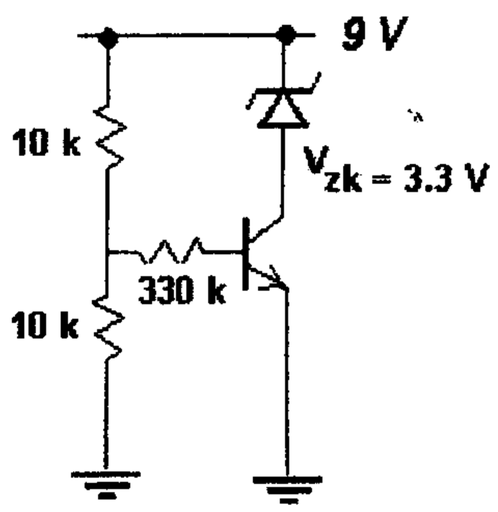
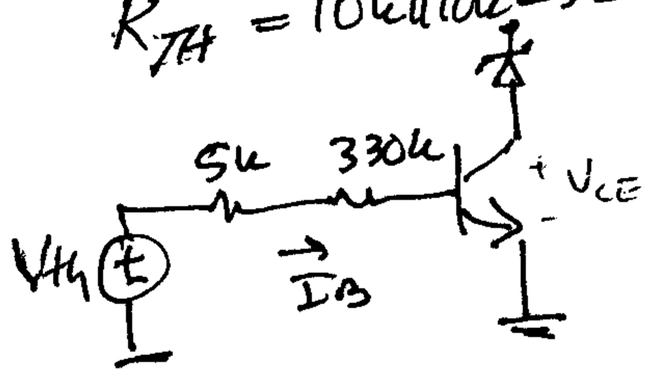


$V_B = 4.5V = V_{TH}$

$R_{TH} = 10k \| 10k = 5k$



$I_B = \frac{4.5 - 0.7}{335k} = 0.0113$ mA

$I_C = 100 I_B = 1.13$ mA

$V_{CE} = 9 - 3.3 = 5.7$

$I_C =$ 1.13mA

$V_{CE} =$ 5.7 V

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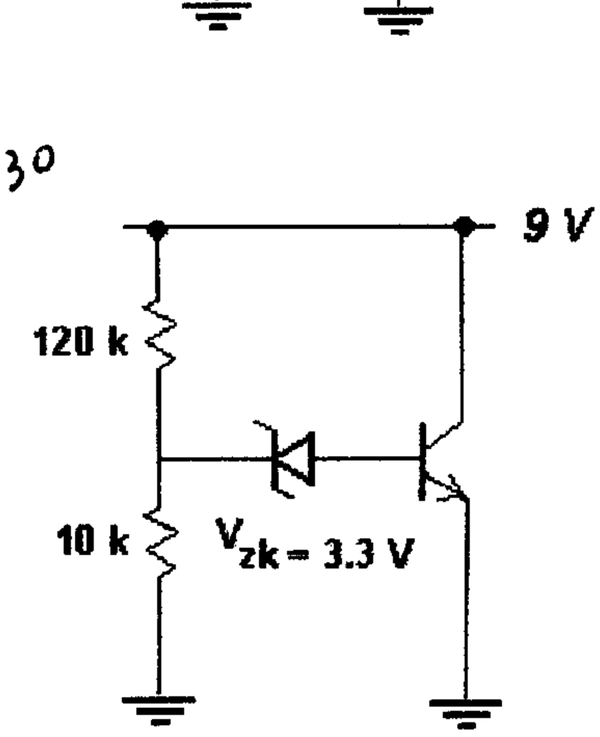
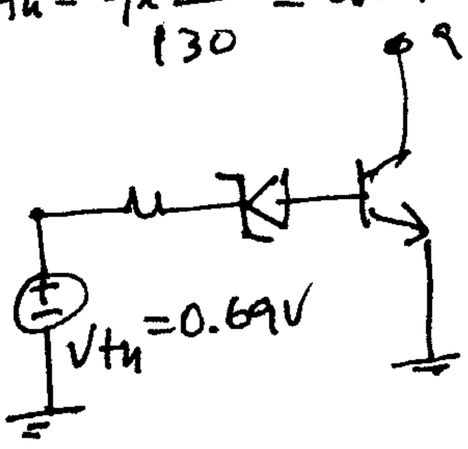


$V_{th} = 9k \frac{10}{130} = 0.69$

≡



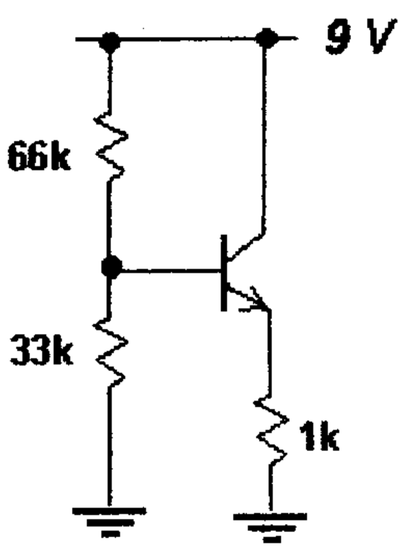
Q: cut-off

$I_C = 0$

V_{CE} 9V

$I_C =$ 0

$V_{CE} =$ 9V



$V_B \cong 9 \frac{33}{33+66} = 3V$

$V_E = 3 - 0.7 = 2.3V$

$I_E = \frac{2.3}{1k} = 2.3mA \cong I_C$

$V_{CE} = 9 - 2.3 = 6.7V$

$I_C =$ 2.3mA

$V_{CE} =$ 6.7V

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3. Find the currents as indicated in the circuit below. Assume the opamp to be ideal, and β=50 for the BJT.

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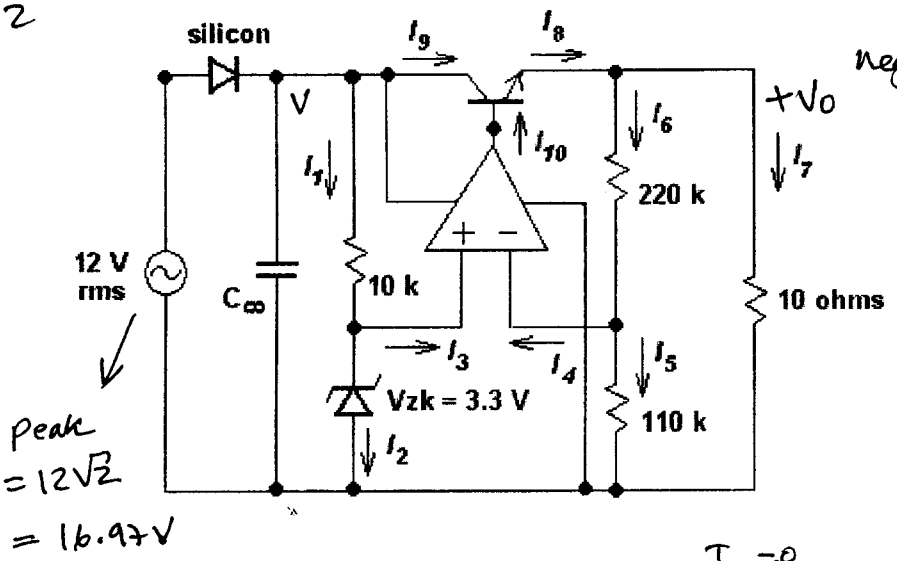

negative fb

$V_+ = V_-$

$V_+ = 3.3V$

Peak $= 12\sqrt{2} = 16.97V$

$V = 16.97 - 0.7 = 16.27\ V$

$I_3 = 0$

$I_4 \simeq 0$

$$I_1 = \frac{V - V_{zk}}{10k} = \frac{16.27 - 3.3}{10k} = 1.29mA$$

$I_2 = I_1$ because $I_3 = 0$

$$I_5 = \frac{3.3}{110k} = 0.03mA$$

$I_6 = I_5 = 0.03\ mA$

$V_o = 110 \times I_5 + 220 \times I_6 = 9.9V.$

$$I_7 = \frac{9.9V}{10} = 0.99\ A$$

$I_8 = I_6 + I_7 = 0.99A + 0.03mA \simeq 0.99\ A$

$$I_9 \simeq \frac{\beta}{\beta+1} I_8 = \frac{50}{51} \times 0.99 = 0.97\ A$$

$$I_{10} = \frac{I_8}{51} = \frac{0.99}{51} = 0.0194\ A = 19.4\ mA$$

I_1= 1.29mA

I_2= 1.29mA

I_3= 0

I_4= 0

I_5= 0.03mA

I_6= 0.03mA

I_7= 0.99 A

I_8= 0.99 A

I_9= 0.97 A

I_{10}= 19.4mA

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