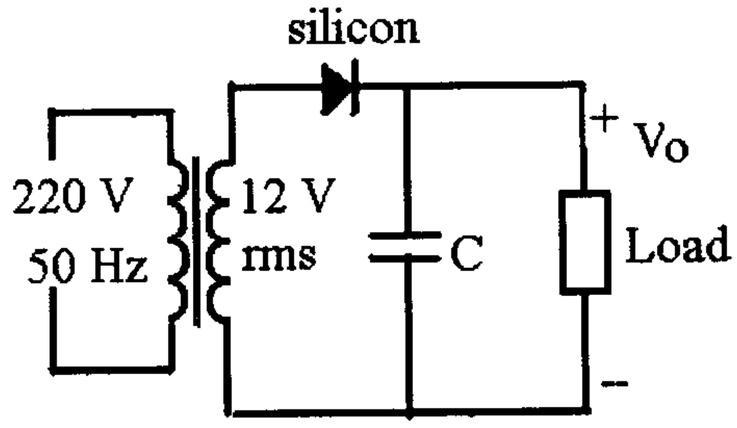
Electronics I * Exam II * August 12, 2010 * 90 minutes * closed books and notes

I have neither given nor received unauthorized help with this exam, nor do I believe anyone else has.

ID number: ERKAYA Name: SOLUTIONS Signature:_____

3) For the rectifier circuit below, the peak-to-peak ripple is required to be less than 4 % of the peak voltage. Find the minimum value of C for a load current of 400 mA. min C = _____



peak output voltage $= 12\sqrt{2} - 0.7 = 16.27\,V$

$4\% \rightarrow 0.65\,V$

$I = C\frac{\Delta V}{\Delta T} \rightarrow C = \frac{I}{\frac{\Delta V}{\Delta T}} = \frac{0.4}{\frac{0.65}{\frac{1}{50}}} = 0.0123\,F = 12292\,\mu F$

$\Delta T = \frac{1}{50}\,s$

$\Delta V = 0.65\,V$

$I = 0.4\,A$

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2) Find the operating points of the transistors given below: $(\beta = 100)$

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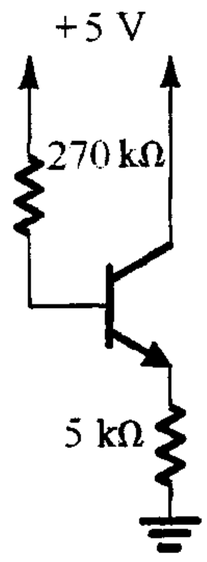
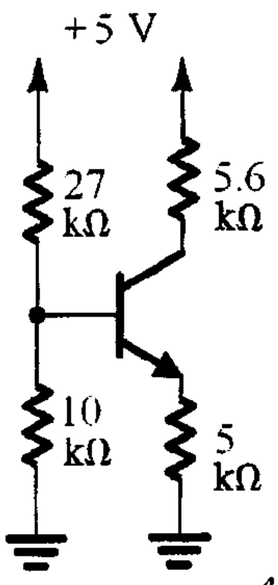


$$I_c = \frac{100\,(5-0.7)}{101\times 5+270} = 0.554\ mA$$

$$V_{CE} = 5 - 5\times 0.554 = 2.22\ V$$

$I_C =$ 0.554 mA $V_{CE} =$ 2.22 V

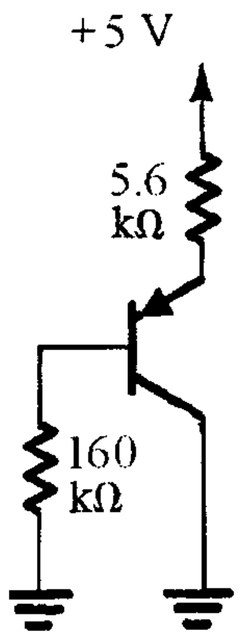


$$V_{th} = 5\times \frac{10}{27+10} = 1.35\ V \qquad I_c = \frac{\beta(V_{th}-V_{BE})}{(\beta+1)R_E + R_{th}}$$

$$R_{th} = 27 \| 10 = 7.29\ k\Omega \qquad I_c = \frac{100(1.35-0.7)}{101\times 5+7.29} = 0.127\ mA$$

$$V_{CE} \cong 5 - 0.127\times 5.6 - 0.127\times 5 = 3.65\ V$$

$I_C =$ 0.127 mA $V_{CE} =$ 3.65 V

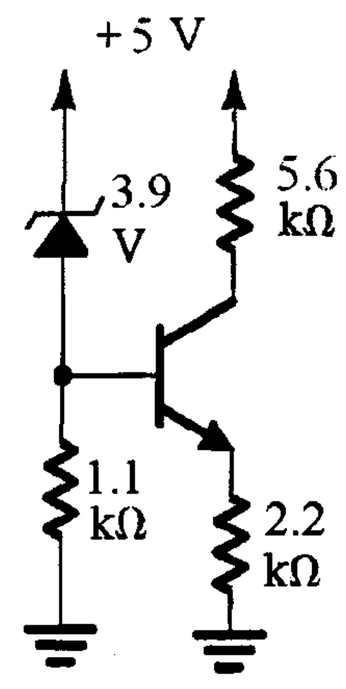


$$160 I_B + V_{EB} + 5.6\times 101\times I_B = 5V$$

$$I_C = \beta I_B = \beta\,\frac{5-0.7}{101\times 5.6+160} = 0.592\ mA$$

$$V_{EC} = 5 - 5.6\times 0.592 = 1.68\ V$$

$I_C =$ 0.59 mA $V_{EC} =$ 1.68 V



$$V_B = 5 - 3.9 = 1.1\ V$$

$$V_E = 1.1 - 0.7 = 0.4\ V$$

$$I_E = \frac{0.4}{2.2} = 0.182\ mA$$

$$I_C \cong I_E = 0.182\ mA$$

$$V_{CE} \cong 5 - 0.182(5.6+2.2) = 3.58\ V$$

$I_C =$ 0.18 mA $V_{CE} =$ 3.58 V

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3) Design a common collector BJT amplifier such that the BJT has 1.5 mA collector current. Find its voltage gain, input resistance and output resistance when it is operated with a signal source whose output resistance is 1 kohm and a load of 75 ohms. (β=300, V_{CC}= 9 V)

v_o/v_s = _____

r_{in} = _____

r_{out} = _____

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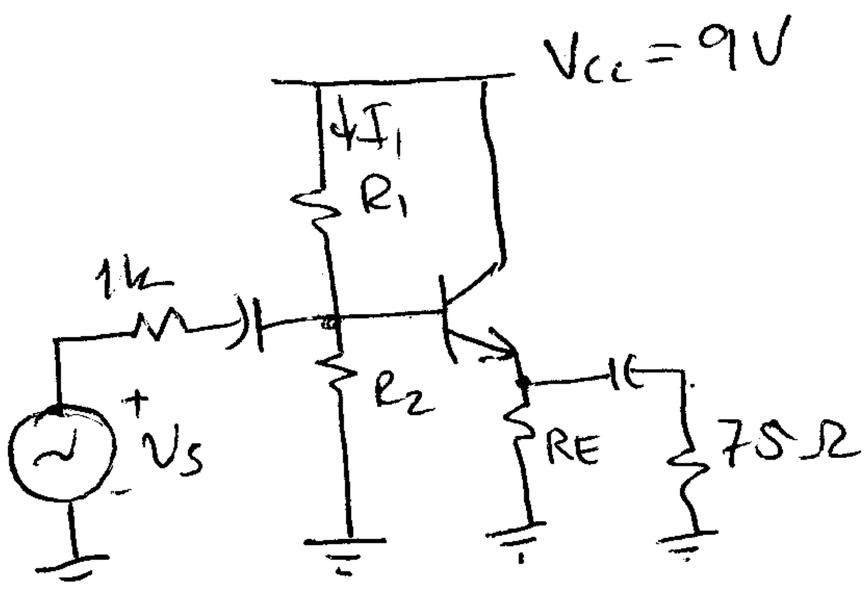


Let $V_{CE} \simeq$ half of V_{CC}

$\rightarrow I_E R_E = 4.5V$

$R_E = \frac{4.5}{1.5} = 3k\Omega$

$I_B = \frac{1.5}{100} = 0.015\,mA$

Let $I_1 \simeq 20\, I_B = 0.03\,mA$.

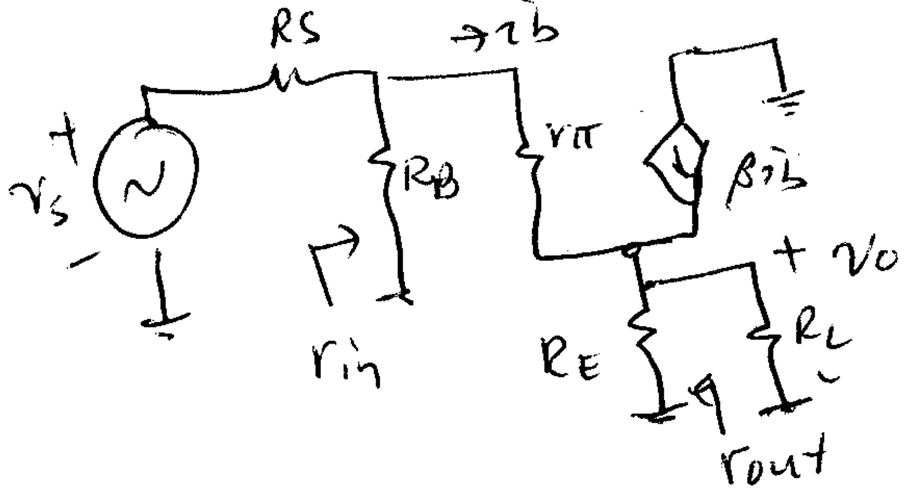
$V_B = V_E + V_{BE} = 4.5 + 0.7 = 5.2\,V$

$I_1 R_1 \simeq 9 - 5.2 = 3.8V$

$R_1 = \frac{3.8}{0.03} \simeq 127\ k\Omega$

$R_2 = \frac{5.2}{0.03} = 173\,k\Omega$

Small signal Eq. cht



$R_B = R_1 \| R_2 = 73.23k$

$r_{in} = R_B \| [r_\pi + (\beta+1)(R_E \| R_4)]$

$= 73.23 \| [5 + 301 \times 3 \| 0.075]$

$= 19.73k\Omega$

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

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

$r_{out} = R_E \| \frac{r_\pi + (R_B \| R_S)}{\beta+1}$

$= 3 \| \frac{5 + (73.23 \| 1)}{301} = 0.0198\,k\Omega$

$\frac{v_o}{v_i} = \frac{(\beta+1)(R_E \| R_L)}{r_\pi + (\beta+1)(R_E \| R_L)} \frac{r_{in}}{R_S + r_{in}} \simeq \frac{301 \times (0.075 \| 3)}{5 + 301 \times (0.075 \| 3)} \frac{19.73}{1 + 19.73}$

$= 0.779$

9=50