Electronics I * Exam ~~II~~ I * November 2, 2010 * 50 minutes * closed books and notes

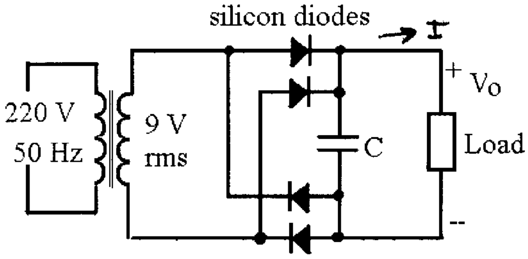
I have neither given nor received unauthorized help with this exam, nor do I believe anyone else has.

ID number: ERKAYA Name: SOLUTIONS Signature:______________

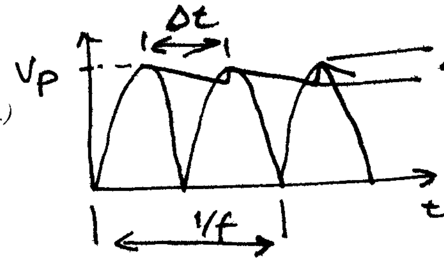
1) For the rectifier circuit below, find the peak-to-peak ripple and the average of the output voltage for a load current of 400 mA. (C=1000μF)

Peak-to-peak ripple voltage = 4V

Average of V_o= 9.33V



Full-wave rectifier with LP filter



(Recommended time period for this question is 10 minutes.)

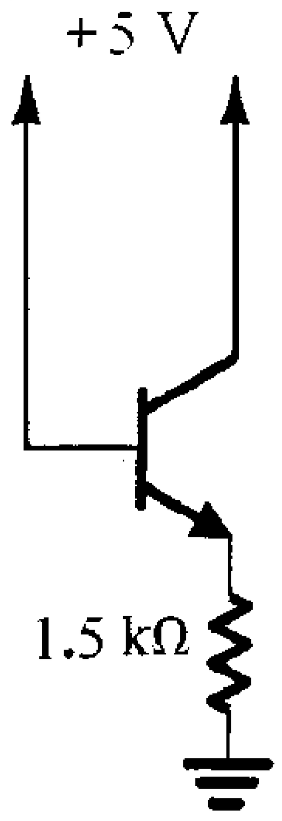
$V_p \cong 9\sqrt{2} - 2 \times 0.7 = 11.33V$

$I = C \frac{\Delta V}{\Delta t} \rightarrow \Delta V = \frac{I \Delta t}{C} = \frac{0.4 \times \frac{1}{100}}{1000 \times 10^{-6}} = 4V$

$\langle V_o \rangle = V_p - \frac{\Delta V}{2} = 11.33 - 2 = 9.33V$

2) Find the operating points of the transistors given below. Assume silicon BJTs with $\beta = 200$.

(Recommended time period for this question is 10 minutes.)

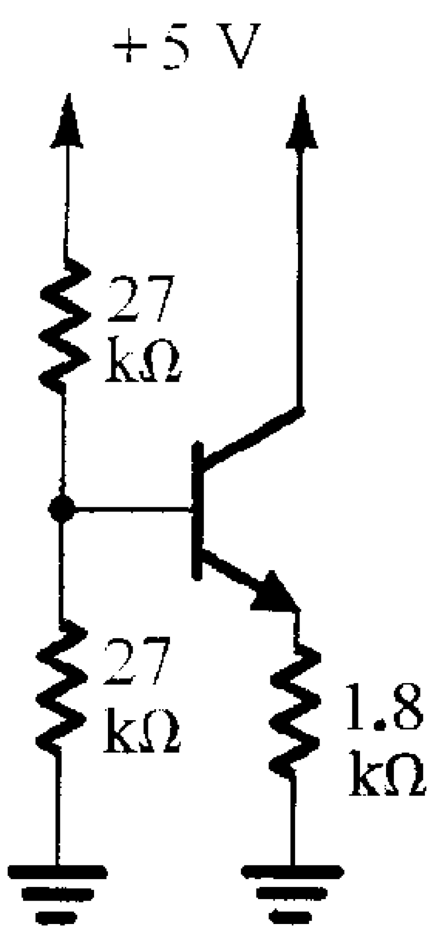


$V_E = 5 - 0.7 = 4.3$ V

$I_C \simeq I_E = \frac{4.3}{1.5} = 2.87$ mA

$V_{CE} = V_{BE} = 0.7$ V

$I_C =$ 2.87mA $V_{CE} =$ 0.7V



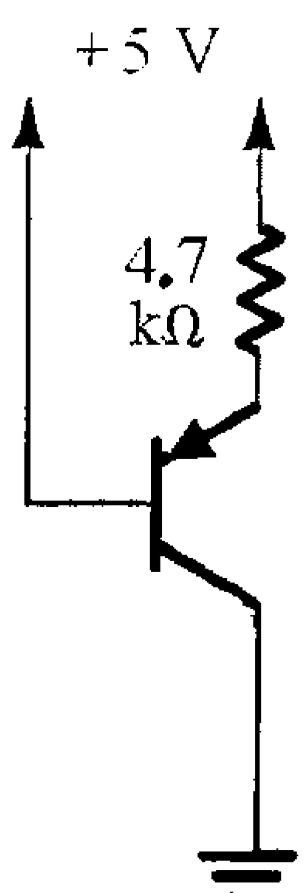
$V_B \simeq 5 \frac{27}{27+27} = 2.5$ V

$V_E = 2.5 - 0.7 = 1.8$ V

$I_C \cong I_E = \frac{1.8}{1.8} = 1$ mA

$V_{CE} = 5 - 1.8 = 3.2$ V

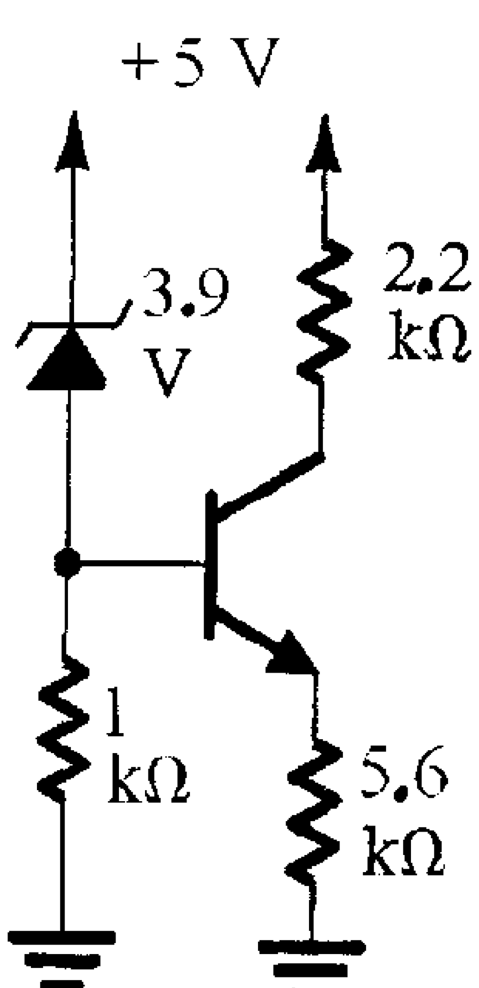
$I_C =$ 1mA $V_{CE} =$ 3.2V



BE junction is not fwd biased

cut-off $I_c \cong 0$ $V_{EC} = 5$V

$I_C =$ 0 $V_{EC} =$ 5V



$V_B = 5 - 3.9 = 1.1$ V

$V_E = 1.1 - 0.7 = 0.4$V

$I_C \cong I_E = \frac{0.4}{5.6} = 0.07$mA

$V_{CE} \cong 5 - (2.2 + 5.6)0.07 = 4.44$V

$I_C =$ 0.07mA $V_{CE} =$ 4.44V

3) Find the value of R in the amplifier circuit below such that the silicon PNP BJT has 1.5 mA collector current. Find its voltage gain, input resistance and output resistance. (β=300)

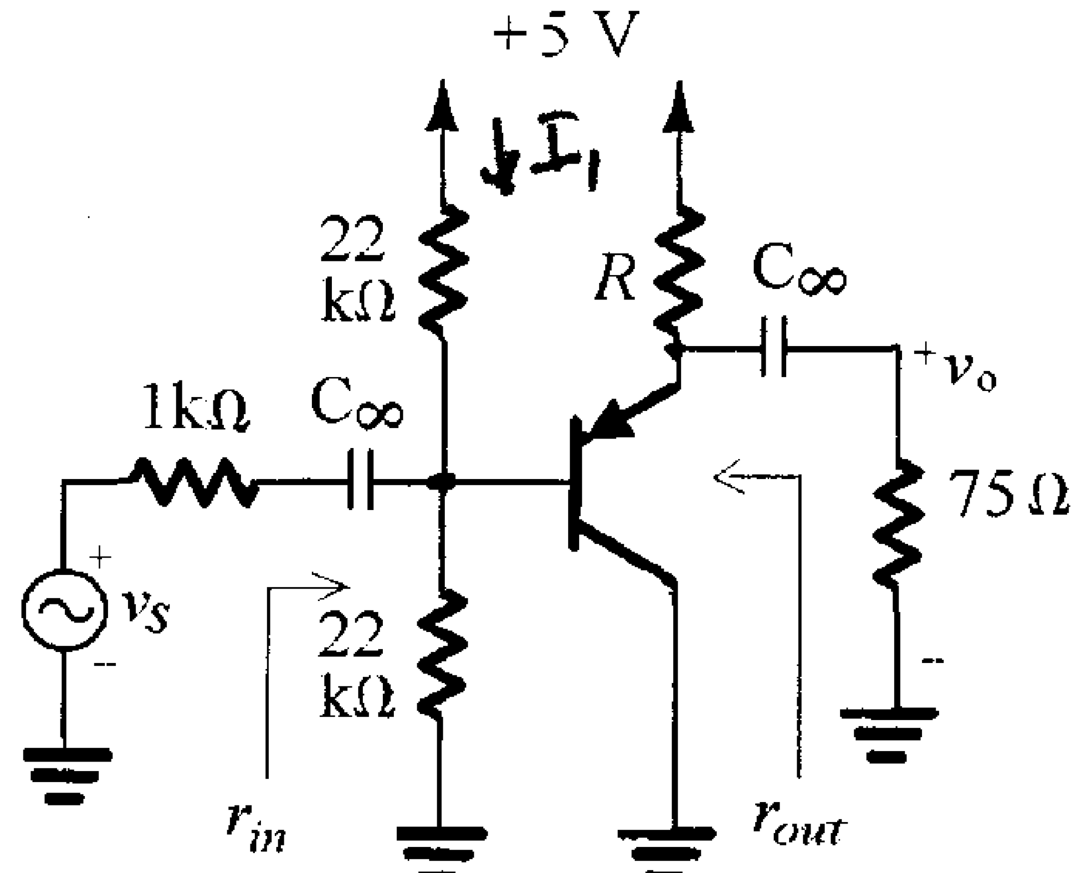
(Recommended time period for this question is 30 minutes.)

R = 1.2k

v_o/v_s = 0.715

r_{in} = 7.73kΩ

r_{out} = 19 Ω



$I_B = \frac{1.5}{300} = \frac{0.5}{100} = \frac{5}{1000}$

Current in 22k resistors

$I_1 \simeq \frac{5}{22+22} = \frac{5}{44}$

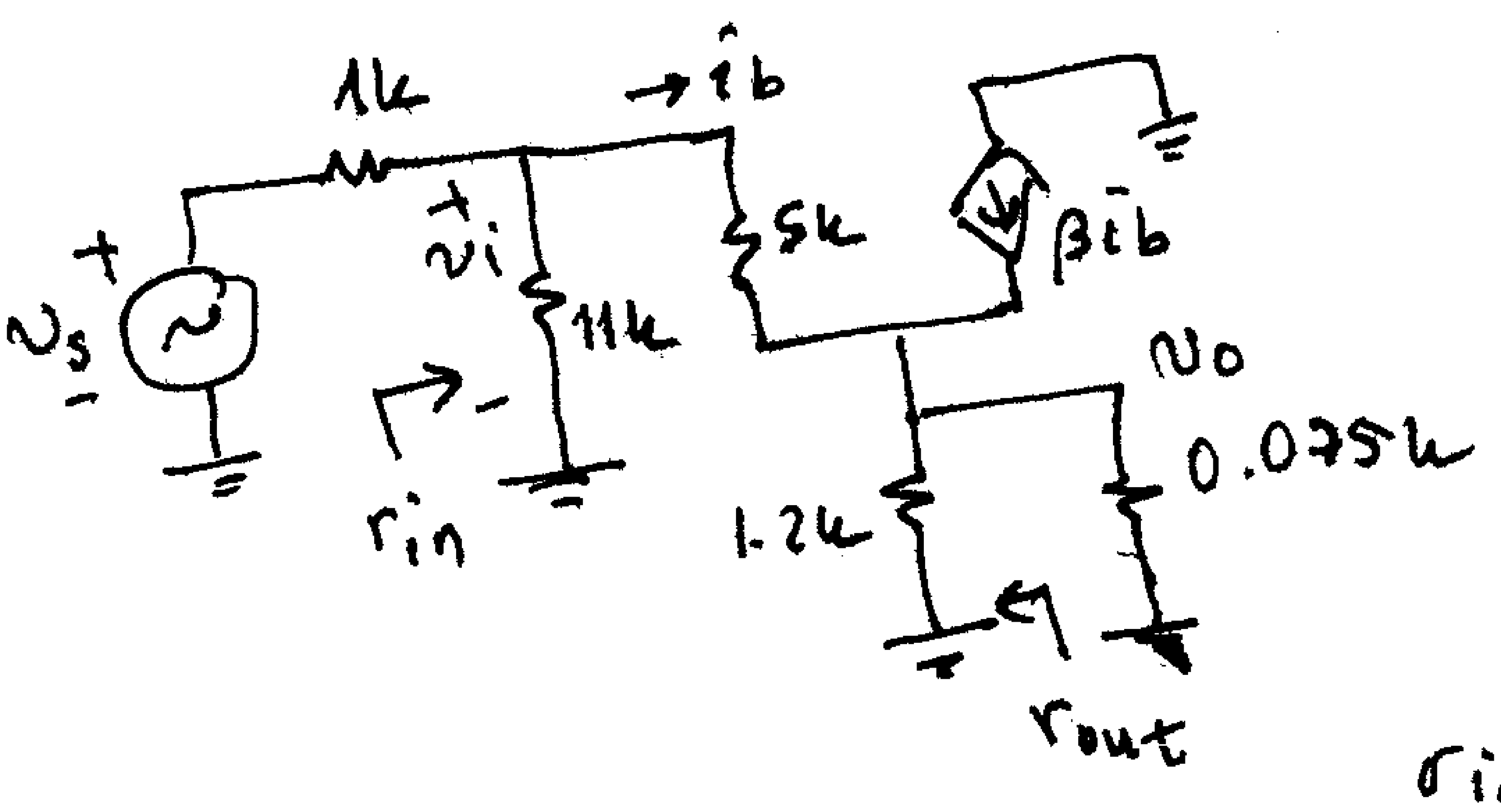
$I_1 \gg I_B \rightarrow$ ignore I_B while calculating V_B.

$V_B \cong 5 \times \frac{22}{22+22} = 2.5V$, $V_E = 2.5 + 0.7 = 3.2V$

$I_E \simeq I_C = 1.5mA$, $I_E = \frac{5-3.2}{R_E} \rightarrow R_E = \frac{5-3.2}{1.5} = \frac{1.8}{1.5} = 1.2\,k\Omega$

$g_m = \frac{1.5}{0.025} = 60\,mA/V$, $r_\pi = \frac{\beta}{g_m} = \frac{300}{60} = 5k\Omega$

Common collector amplifier - Small signal equivalent ckt:



$\frac{v_o}{v_i} = \frac{(\beta+1)(1.2 \| 0.075)}{r_\pi + (\beta+1)(1.2 \| 0.075)} = \frac{301 \times 0.07}{5 + 301 \times 0.07}$

$= 0.808$

$r_{in} = 11k \| [5 + 301 \times 0.07] = 7.73\,k\Omega$

$\frac{v_i}{v_s} = \frac{r_{in}}{1k + r_{in}} = \frac{7.73}{8.73} = 0.885$

$\frac{v_o}{v_s} = 0.808 \times 0.885 = 0.715$

$r_{out} = 1.2k \,\Big\|\, \frac{5k + (1k \| 11k)}{301} \cong 0.019\,k\Omega$