German University in Cairo
Information Engineering and Technology
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April 11th, 2011

Bar Code

Electronic circuits for MCTR, ELCT 609
Spring Semester 2011
Midterm Exam

Instructions: **Read Carefully Before Proceeding.**

1- Calculators are permitted for this exam.

2- Write your solutions in the space provided. If you need more space, write on the back of the sheet containing the problem.

3- Attempt as much of the problems as you can within the time limits. Partial credit is achievable, so include all your calculations and clearly indicate what you are trying to do.

4- This exam booklet contains 13 pages, including this one. *Extra sheets of scratch paper are attached* and have to be kept attached, you should inform the supervisor about any missing paper or it will be your own responsibility.

5- Make reasonable approximations and assumptions. State and justify any such assumptions and approximations you do make.

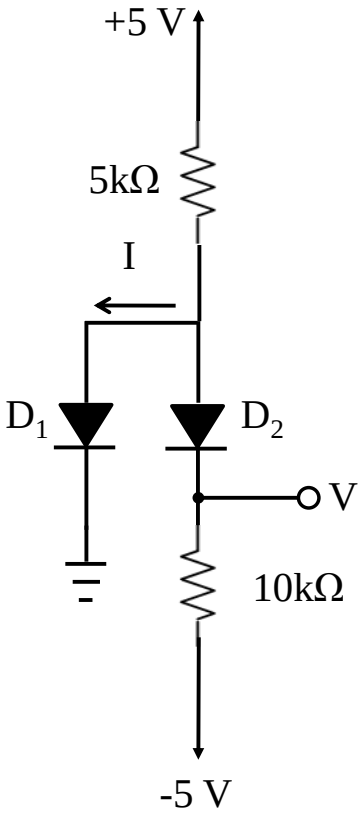
6- Total time allowed for this exam is ***120 min.***

Good Luck!

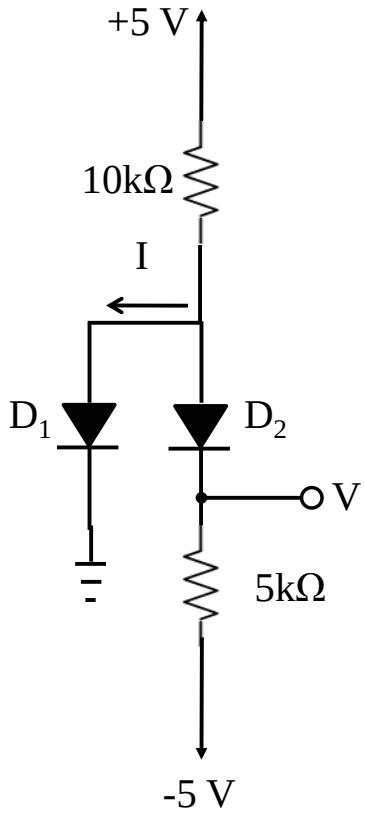
Question Number	1	2	3	4	Total
Maximum Score	25	20	25	30	100
Obtained Score					

Problem 1

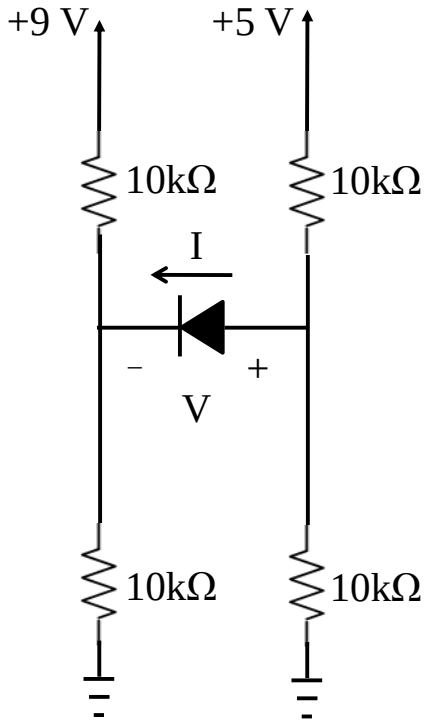
Assuming that the diodes in the circuits below are ideal, find the values of the labeled voltages and currents.



(a)



(b)



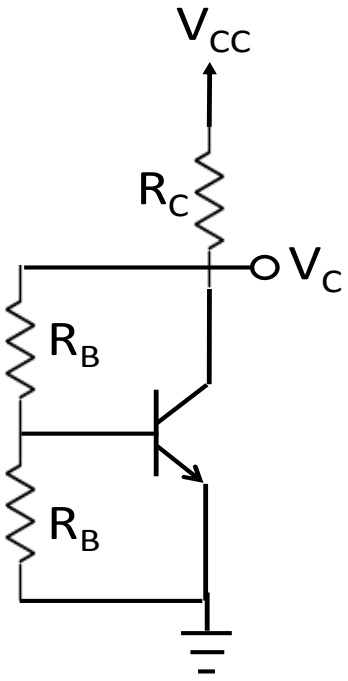
(c)

Problem 2

Using a 5-V power supply, V_{CC}, the feedback bias circuit in the figure shown below provides I_C = 1mA and V_C = 2V for β_F = 90.

(i) Find R_C and R_B.

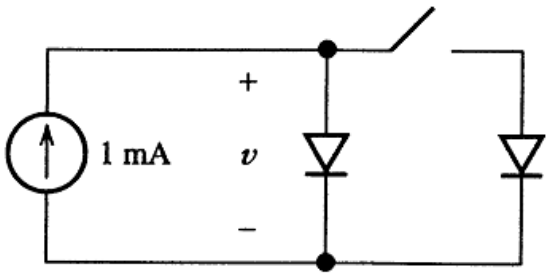
(ii) Find V_C and I_C for very large value of β_F (i.e., $I_C \approx I_E$). In which mode does the transistor operate? What is the ideal value of β_F?



Problem 3

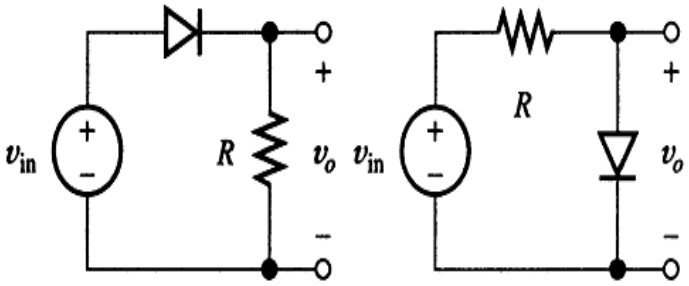
[a]

Consider the circuit displayed in the shown figure. The diodes are identical and $\eta = 1$. The temperature of each diode is 300K. Before the switch is closed, the voltage v is 600mV. Find v after the switch is closed.



[b]

Sketch the transfer functions (v_o versus v_{in}) for the circuits displayed. Also, plot v_o against time for $v_{in}(t) = 10\sin(200\pi t)$. Assume 0.7V voltage drop across the diode.

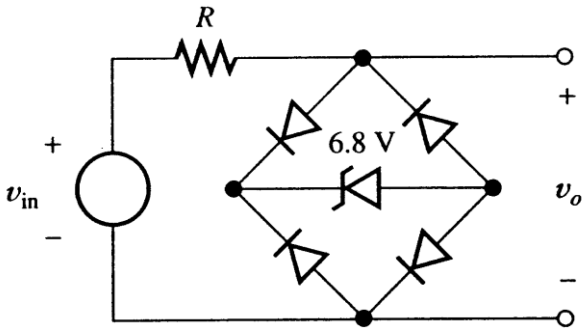


(i) (ii)

Problem 4

[a]

Consider the circuit in the figure shown. Allow 0.6V for the forward drops of the diodes. Sketch the transfer characteristics $\boldsymbol{v_o}$ versus $\boldsymbol{v_{in}}$. Also, plot v_o against time for $v_{in}(t) = 10\sin(200\pi t)$.

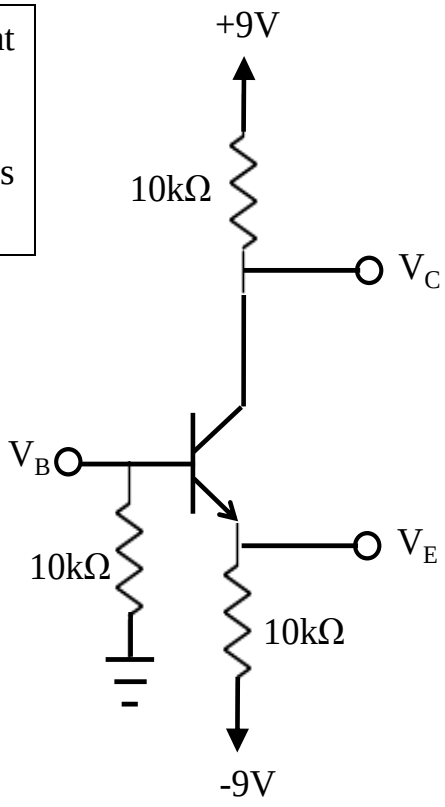


[b]

For the circuit shown, measurement indicates that V_B=-0.1V.

(i) Calculate V_E, V_C, and β.

(ii) If a transistor with β=∞ is used, what values of V_B, V_E, and V_C result?



Formula sheet

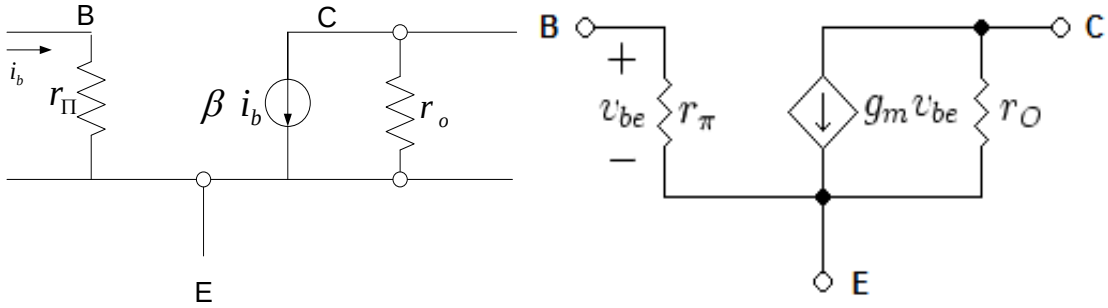
pn junction diode

$$I = I_S\left(e^{\frac{V}{\eta V_T}} - 1\right)$$

$$V_T = \frac{kT}{q}$$

$$k = 1.38\times10^{-23}\ \text{J/K}$$
$$q = 1.6\times10^{-19}\ \text{C}$$

BJT small signal model



$$r_o \equiv \left[\left.\frac{\partial i_C}{\partial v_{CE}}\right|_{v_{BE}=\text{constant}}\right]^{-1} = \frac{V_A}{I_C}$$

$$r_\pi \equiv \frac{v_{be}}{i_b} = \frac{\beta}{g_m}$$

$$g_m = \frac{I_C}{V_T}$$

MOS transistor

$$i_D = K\left[\left(v_{GS} - V_t\right)v_{DS} - \frac{1}{2}v_{DS}^2\right]$$

OR

$$i_D = \frac{K}{2}\left(v_{GS} - V_t\right)^2$$

$$\text{where}\ K = \mu_n C_{ox}\frac{W}{L}$$