The University of Jordan
Electrical Engineering Department

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Electronics I EE0903261
Answer all questions in ink.

Second Exam
Exam Duration: 120 min.

Reg. #: 0094557
Date: May 13 , 2014
Mark out of 30:

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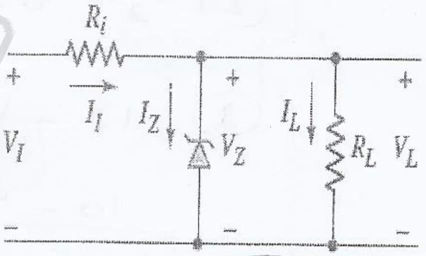
(1) نموذج

Q.1 a) Consider the zener diode circuit shown. Let V_I = 57 V, V_Z = 12 V, the power rating of the diode is 3W , R_i = 150 Ω , r_z = 0 Ω , and the minimum diode current is 25 mA.

i) Calculate the maximum diode current.

ii) What is the power dissipated in R_i . What maximum value of R_L ensures safe operation of the diode. What minimum value of R_L results in minimum diode current.



(1) $I_{Z_{min}} = 0.1\, I_{Z_{max}} \Rightarrow I_{Z_{max}} = 250\,mA$

(2) $P_{R_i} = \dfrac{(V_I - V_Z)^2}{R_i} = \dfrac{2025}{150} =$

$\therefore P_{R_i} = 13.5\,W$

$I_{L_{min}} = \dfrac{3}{12} = 0.25\,A$

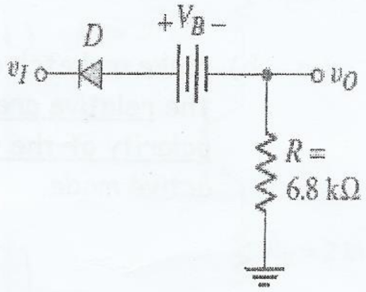
$I_{L_{max}}$: $150 = \dfrac{57-12}{0.025 + I_{L_{max}}}$, $I_{L_{max}} = 0.275\,A$

max. value of R_L is at $I_{L_{min}}$:

$V_L = 12 = I_{L_{min}} R_{L_{max}} \Rightarrow R_{L_{max}} = \dfrac{12}{0.25} = 48\,\Omega$

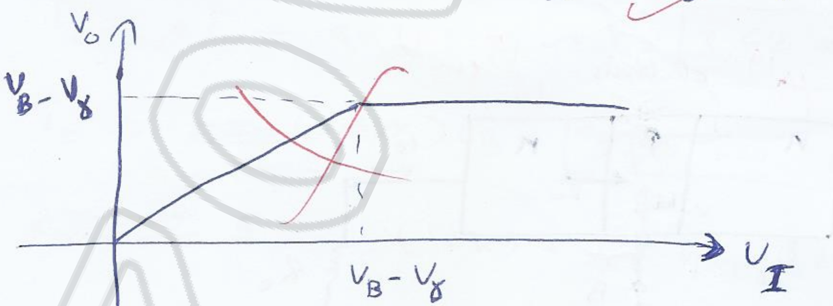
$R_{L_{min}} = \dfrac{12}{I_{L_{max}}} = \dfrac{12}{0.275} = 43.64\,\Omega$

b) Consider the circuit shown.
Obtain the condition on V_I, V_B, and V_γ for the diode to be ON, Hence write the value of v_o in this case. Make a sketch of v_O against v_I.



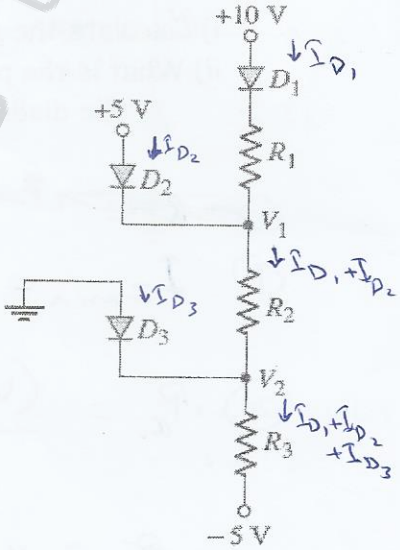
$+V_I = V_\gamma + V_B$

the condition is to be $V_I < V_B - V_\gamma$



$V_O = -V_B + V_\gamma + V_I$

Q2) a) Consider the circuit shown. Determine V_1 , V_2 , and Calculate the values of the three resistors assuming the diodes are all ON with $I_{D1} = 0.2$ mA , $I_{D2} = 0.3$ mA , and $I_{D3} = 0.5$ mA. Let $V_\gamma = 0.7$ V.



(1) $V_1 = 5 - V_\gamma = 5 - 0.7 = \boxed{4.3\,V}$

(2) $V_2 = 0 - 0.7 = \boxed{-0.7\,V}$

(3) $10 - V_1 = V_\gamma + I_{D_1} R_1$

$10 - 4.3 = 0.7 + 0.2\times10^{-3}(R_1)$

$\therefore R_1 = \boxed{25\,k\Omega}$

(4) $V_1 - V_2 = (I_{D_1} + I_{D_2}) R_2$

$R_2 = \dfrac{4.3 + 0.7}{0.5\times10^{-3}} = \boxed{10\,k\Omega}$

(5) $V_2 - (-5) = (I_{D_1} + I_{D_2} + I_{D_3}) R_3$

$R_3 = \dfrac{-0.7 + 5}{1\times10^{-3}} = \boxed{4.3\,k\Omega}$

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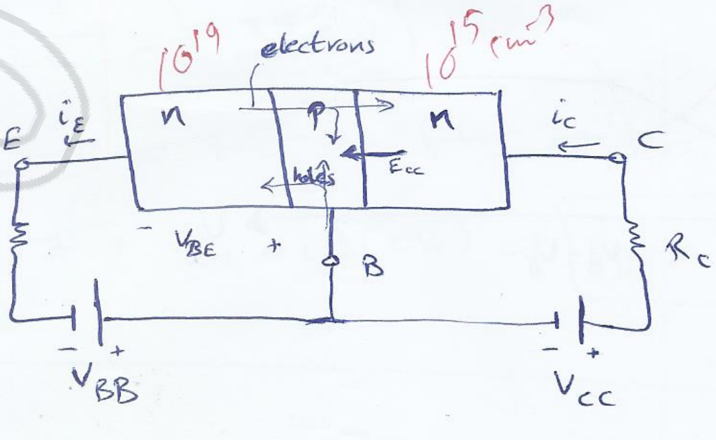
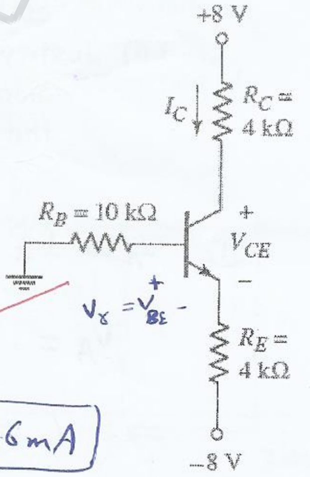
b) Make a sketch of a npn transistor implemented on a slice of silicon. Cleary showing the relative areas of each region , the carrier concentration in each region and the polarity of the voltage sources connected to drive the transistor in the forward active mode.



Q3 a) Consider the transistor circuit shown . Assuming V_γ=0.7 V, and β= 99, calculate V_{CE} and verify if the transistor is indeed in the forward active mode.



~~i_B — 0 — V_γ~~

$0 = i_B(10k) + V_\gamma + i_E(4k) - 8$

$0 = i_B(10k) + 0.7 + (1+\beta)\, i_B(4k) - 8$

$7.3 = i_B(10k + 400k) \Rightarrow \boxed{i_B = 17.8\,\mu A}$

$i_c = \beta\, i_B = 99(17.8\mu) \Rightarrow \boxed{i_c = 1.76 mA}$

$i_E = (1+\beta)\, i_B = 100(17.8\mu) \Rightarrow \boxed{i_E = 1.78 mA}$

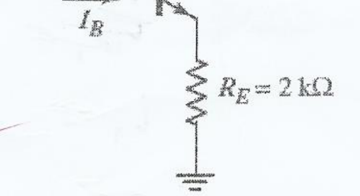
$8 = i_c(4k) + V_{CE} + i_E(4k) - 8 \Rightarrow \boxed{V_{CE} = 1.84 V}$ ~~6.16 V~~

$V_{CE} = V_{CB} + V_{BE}$ ~~$\Rightarrow V_{CB} = +1.86 V \Rightarrow V_{BC} = 6.86 V$~~

$1.84 = V_{CB} + 0.7 \Rightarrow V_{CB} = 1.14 V \Rightarrow V_{BC} = -1.14 V \Rightarrow$ R.B

$\therefore$ B-C : R.B & B-E : F.B $\Rightarrow \therefore$ in FAM

b) Consider the transistor circuit shown . Assuming V_γ=0.7 V, and β= 99, calculate V_c and V_{CE} .



$5 = i_c(10k) + i_B(20k) + V_\gamma + i_E(2k)$

$5 = \beta\, i_B(10k) + i_B(20k) + V_\gamma + (1+\beta)\, i_B(2k)$

$i_B = \dfrac{5 - 0.7}{10^3 * 1210} = \boxed{3.55\,\mu A}$

$i_c = \beta\, i_B = 99(3.55\mu) = \boxed{3.52 * 10^{-4} A}$

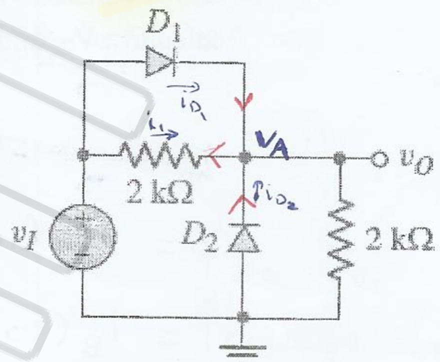
$i_E = (1+\beta)\, i_B = \boxed{3.55 * 10^{-4} A}$

$5 = i_c(10k) + V_{CE} + i_E(2k) \Rightarrow \boxed{V_{CE} = 0.77 V}$

$V_c = V_{CE} + i_E R_E \Rightarrow V_c = 0.77 + 3.55 * 10^{-4}(2 * 10^3)$

$\therefore \boxed{V_c = 1.48 V}$

Q4 Consider the circuit shown with $V_I = 5$ V, and $V_\gamma = 0.7$ V.



i) By considering KCL at the v_o node or otherwise establish why the two diodes cannot be both ON.

ii) Justify the possibility of diode D_1 being ON, and diode D_2 being OFF. If this case is valid, calculate the values of the currents involved.

① If Both D_1 & D_2 are ON:

$V_A = -0.7$ V

$\Rightarrow \therefore V_o = -0.7 - (-0.7) = 0$ V ?

$i_{D_1} + \frac{-0.7 - 5}{2k} + i_{D_2} = 0$?

$i_{D_1} + i_{D_2} = 2.85$ mA

but $i_1 = \frac{+0.7 + 5}{2k} = 2.85$ mA

$\therefore$ D_1 & D_2 can't be both ON.

$5 + 0.7 = 2k(i)$

$i = ()$

$i_{D_1} + \frac{V_A - 5}{2k} = i_{D_2}$

$i_{D_1} + i_{D_2} = \frac{5 - 0.7}{2k}$

2.15 mA

$5 + 0.7 = i(2)$

$i =$

② for D_1 ON & D_2 off;

$i_{D_2} = 0$

~~$i_1 = \frac{0.7}{2k} = 0.35$ mA~~

~~$i_{D_1} =$~~ 2.15 mA

$i_1 = \frac{0.7}{2k} = 0.35$ mA

~~$i_{D_1} = 5 - 0.7 - 2k(i_{D_1} + 0.35m)$~~

$5 = 0.7 + (i_{D_1} + i_1)(2k) \rightarrow i_{D_1} = 1.8$ mA

3.5