The University of Jordan
Electrical Eng. Dept.
First Exam

Electronics II EE361 **Wed. 16/7/2014**

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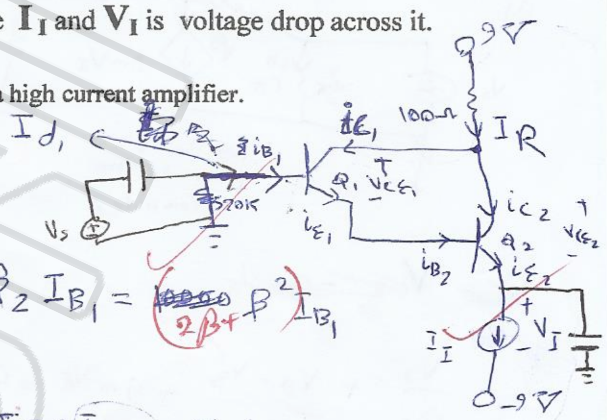
Answers should be written in ink. **Exam Duration: 50 min** **Mark out of 20:** 20

Question 1

Consider the circuit shown in Fig. 1, with a current source of value I_I and V_I is voltage drop across it.

a) Indicate the directions of I_I and the other transistors currents.

b) Add additional **components** and **signal**(s) to the circuit for it to act as a high current amplifier.



c) Perform the following **dc analysis.**

i) Express I_R in terms of β and I_{B1}.

$I_R = \beta_1 \beta_2 I_{B_1} = (2\beta + \beta^2) I_{B_1}$

ii) Write **two** equations involving V_I.

$0.7 + V_I - 9 + I_{BQ_1} 520 + 0.7 = 0 \rightarrow V_I + 520 I_{BQ_1} = 7.6$

$V_I - V_{CEQ2} - I_R(0.1) + 9 + 9 = 0 \rightarrow V_I - V_{CEQ2} - 0.1 I_R = -18$

iii) Solve for I_{B1} given that V_{CE2}=8V.

$V_I + 520 I_{BQ_1} = 7.6$

$V_I - 8 - 0.1 I_R = -18$

$I_{BQ_1} = \frac{I_{EQ_1}}{1+\beta_1} = \frac{I_{BQ_2}}{1+\beta_1} = \frac{I_I}{(1+\beta_1)(1+\beta_2)}$

$I_R = I_{CQ_1} + I_{CQ_2} = \beta I_{BQ_1} + \beta I_{BQ_2}$

$= \beta I_{BQ_1} + \beta I_{BQ_1}(1+\beta)$

$I_R = (\beta + \beta(1+\beta)) I_{BQ_1}$

$V_I + 520 I_{B_1} = 7.6$

$V_I - 0.1(\beta + \beta + \beta^2) I_{BQ_1} = -10$

$V_I - 1020 I_{B_1} = -10$

$\rightarrow 520 I_{B_1} + 1020 I_{B_1} = 17.6$

$I_{B_1} = 0.01429$ mA

$\Rightarrow V_I = 1.65758$ V

iv) Calculate V_{CE1}.

$V_{CE1} = -0.1 I_R + 9 + 9 - 0.7 - V_I = -0.1(11.615758) + 17.3 - 1.65758 = 3.98484$ V

d) Calculate r_π and g_m for the Q_2 transistor.

$r_{\pi_2} = \frac{V_T}{I_{BQ_2}} = \frac{0.026}{\ldots} = 0.02252$ V

$g_m = \frac{I_{CQ_2}}{V_T} = 4439.726$ kΩ

$I_{B_2} = I_{E_2} = I_{B_1}(1+\beta) = 1.154329$

$\therefore I_{CQ_2} = \beta I_{B_2} = 115.43$

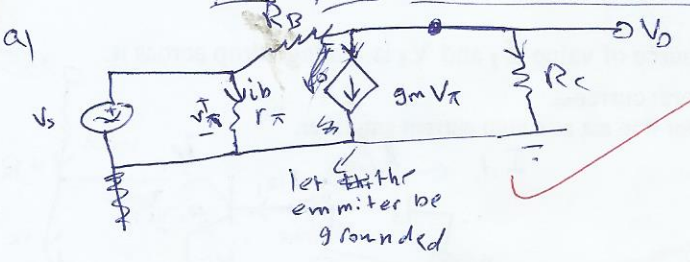
Question 2

Consider the circuit shown in Fig. 2

a) Draw the small signal low frequency equivalent circuit when $r_o = \infty\ \Omega$.

b) Use the equivalent circuit together with **KCL** (or otherwise) to determine the voltage gain $\mathbf{A_v}$ in terms of $\mathbf{R_C}$, $\mathbf{R_B}$ and g_m. What is $\mathbf{A_v}$ when $\mathbf{R_B}$ approaches $\infty\ \Omega$.

a)



$$\frac{V_o}{R_C} + \frac{V_o - V_s}{R_B} + g_m V_\pi = 0 \quad \text{but } V_\pi = V_s$$

$$V_o\left(\frac{1}{R_C} + \frac{1}{R_B}\right) = \left(-g_m + \frac{1}{R_B}\right) V_\pi$$

$$V_o = \left(-g_m + \frac{1}{R_B}\right)(R_C \| R_B)\, V_s$$

$$A_v = \frac{V_o}{V_s} = \left(-g_m + \frac{1}{R_B}\right)(R_C \| R_B)$$

$$A_v \Big|_{R_B \to \infty} = -g_m R_C$$

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c) Suppose r_o **is now finite**, can you easily write $\mathbf{A_v}$ in this case based on $\mathbf{A_v}$ already obtained in part b?. If NO, why not?. If YES, what is $\mathbf{A_v}$ now, (**Warning**: Don not calculate from first principles) .

Yes,

$$A_v = \left(-g_m + \frac{1}{R_B}\right)\left((R_C \| r_o) \| R_B\right)$$

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Question 3

Consider the circuit shown in Fig. 3

a) Write down the **most simple** expression for $\mathbf{A_v}$. $= -\frac{R_{C_2}}{R_E}$

b) Write down the input resistance $\mathbf{R_i}$. $= R_B \| (r_\pi + (1+\beta)R_E)$

c) Write down the **configuration** of the amplifier, and the output resistance $\mathbf{R_o}$. Common emitter, $R_o = R_{C_2}$

d) Add a passive component to increase $\mathbf{A_v}$ without affecting the dc biasing.

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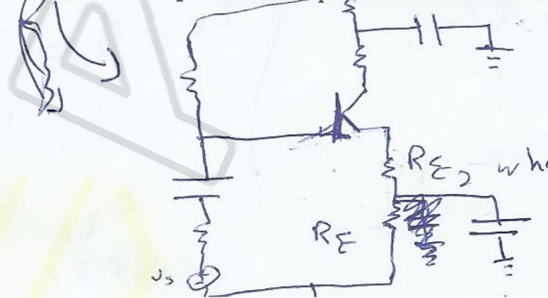

R_{E_2} where $R_{E_2} < R_E$ so in dc R_E will dominate so theres no much affect due to R_{E_2}