The University of Jordan
Electrical Eng. Dept.
First Exam

Electronics II EE361
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Answers should be written in ink.
Exam Duration: 50 min

Wed. 16/7/2014
Registration #: 0110494
Mark out of 20: 15

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. $A_i \simeq \beta_1 \beta_2$

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

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

$I_{RC} = I_{C2} + I_{C1}$

$I_{C2} = \beta_2 I_{B2} = \beta_2 I_{E1} = \beta_2 (1+\beta_1) I_{B1}$

$I_{C1} = \beta_1 I_{B1}$

$\therefore I_R = (1+\beta_1)\beta_2 I_{B_1} + \beta_1 I_{B_1}$ $= (\beta^2 + 2\beta) I_{B1}$ → 1

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

eq 1: $0 + 520 I_{B_1} + 0.7 + 0.7 + V_I - 9 = 0$ ✓

eq 2: $-9 + 100 I_R + V_{CE_2} + V_I - 9 = 0$ ✓

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

$V_{CE2} = 8 Volt$, $I_R = (1+\beta_1)\beta_2 I_{B_1} + \beta_1 I_{B_1}$ ---(*)

From the 2 eq's in (ii): $V_I = 9 - 1.4 - 520 I_{B_1} = 7.6 - 520 I_{B_1}$

sub ① in ②: $-9 + 100 I_R + 8 + (7.6 - 520 I_{B_1}) - 9 = 0$

& I_R eq: $-9 + 100(101 * 100 I_{B_1} + 100 I_{B_1}) + 8 + 7.6 - 520 I_{B_1} - 9 = 0$

$\therefore$ ~~1006580~~ 9680k $I_{B_1} - 2.4 = 0$

$I_{B_1} = \frac{2.4}{~~1006580~~\ 9680 \times 10^3} = 2.47 * 10^{-7}$ Ampere

iv) Calculate V_{CE1}.

$V_{C2} = 9 - 100 I_R = 8.975$

$-8.975 + V_{CE_1} +$

d) Calculate r_π and g_m for the Q_2 transistor.

$I_{B_2} = I_{E_1} = I_B (1+\beta_1)$

$r_{\pi_1} = \frac{V_T}{I_{B_2}} =$ ~~$\frac{26 mV}{2.37 * 10^{-6}} = 10.97 * 10^3$~~ $\frac{26 mV}{(101) * 2.47 * 10^{-7}} = 1042.2\ \Omega$

$g_{m_2} = \frac{I_{C_2}}{V_T} = \frac{2.49 * 10^{-3}}{26 mV} = 9.595 * 10^{-2}$ Volt

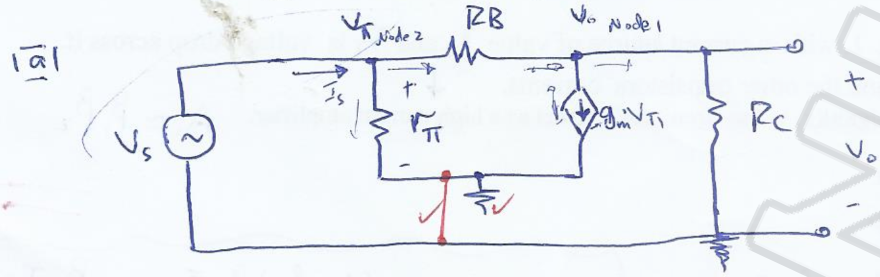
Question 2

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)



(b)

Node 1 : $\dfrac{V_o - V_\pi}{R_B} + \dfrac{V_o}{R_C} + g_m V_\pi = 0$

Node 2 : $\dfrac{V_\pi - V_o}{R_B} + \dfrac{V_\pi}{r_\pi} = 0$

$\boxed{V_s = V_\pi}$ (*)

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$\therefore \dfrac{V_o - V_s}{R_B} + \dfrac{V_o}{R_C} + g_m V_s = 0$

$V_s\left(-\dfrac{1}{R_B} + g_m\right) + \dfrac{V_o}{R_B} + \dfrac{V_o}{R_C} = 0$

$\therefore \dfrac{V_o}{V_i} = \dfrac{-\left(\dfrac{R_C + R_B}{R_C R_B}\right)}{\left(g_m - \dfrac{1}{R_B}\right)} = A_v$

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, because we put it Parallel with Rc

$A_v = \dfrac{-\left(\dfrac{(R_C // r_o) + R_B}{(R_C // r_o) * R_B}\right)}{\left(g_m - \dfrac{1}{R_B}\right)}$

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Question 3

Consider the circuit shown in Fig. 3

a) Write down the **most simple** expression for $\mathbf{A_v}$ ...... $= \dfrac{-\beta R_a}{r_\pi + (1+\beta)R_E} * \dfrac{R_B // R_{ib}}{R_B // R_{ib} + R_s} = \dfrac{-\beta R_a}{R_{ib}} * \dfrac{R_i}{R_i + R_s}$

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

* c) Write down the **configuration** of the amplifier, and the output resistance $\mathbf{R_o}$ ... $= R_a$: RCM CEX

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

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