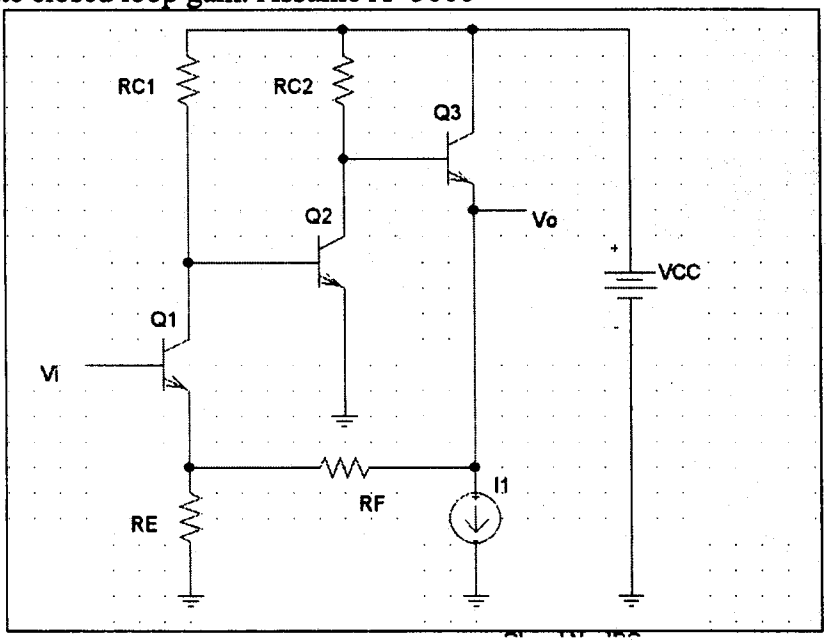
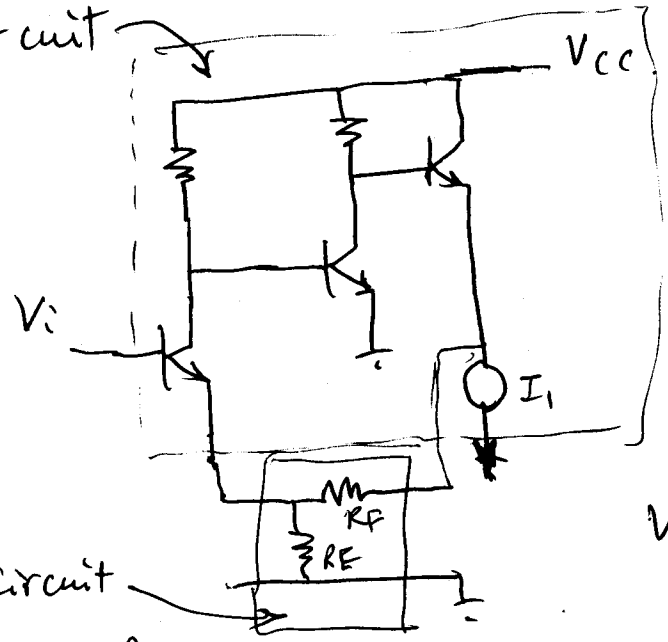
ECE414 Fall 2003	Name	
Quiz 4 (open book)	Mark	/ 25

1. For the common emitter amplifier below, RE=100 ohms, RF=1.5k ohm. (10 points)
(a) Draw the A circuit and the β circuit separately. Find the expression for β.
(b) Find approximate closed loop gain. Assume A=5000



(a) A Circuit



β Circuit

$V_f = \beta V_o = \frac{R_E}{R_F + R_E} V_o$

$\beta = \frac{R_E}{R_F + R_E} = 0.0625$

(b) $A_f = \frac{A}{1 + A\beta} = \frac{5000}{1 + 5000 \cdot \beta}$

$= 15.9$

or $A_f \doteq \frac{1}{\beta} \doteq 16.$

2. An amplifier has midband gain of 10^7, and three poles at the same location 10^6 rad/s, find the value of **βmin** so that closed loop control is ~~stable~~ unstable, assume β is frequency independent. Find the corresponding closed loop midband gain for **β=0.1βmin**. What is the frequency of the closed loop pole corresponding to the open loop dominate pole **at βmin** (15 points).

(a) $A(s) = \dfrac{10^7}{\left(1+\frac{s}{10^6}\right)^3}$.

(9)

$$\varphi = -3\tan^{-1}\frac{\omega}{10^6}.$$

when $\varphi = -180°$, $|A\beta| \geq 1$ unstable

$$-3\tan^{-1}\frac{\omega}{10^6} = -180°, \quad \omega = \sqrt{3}\times 10^6 \text{ rad/s}.$$

$$|\beta A| = \frac{10^7}{\left(1+\frac{\sqrt{3}\times 10^6}{10^6}\right)^{3/2}}\beta \geq 1, \quad \frac{10^7}{8}\beta \geq 1$$

$\beta_{min} = 8\times 10^{-7}$ for system unstable

or $\beta < 8\times 10^{-7}$ to make feedback stable

(4) (b). $\beta = 0.1\beta_{min} = 0.8\times 10^{-7}$.

$$A_{f_M} = \frac{A}{1+A\beta} = \frac{10^7}{1+0.8\times 10^{-7}\times 10^7} = 0.58\times 10^7$$

(2) (c) $A_f(s) = \dfrac{A(s)}{1+A(s)\beta_{min}}$, new pole, $1+A(s)\beta_{min}=0$.

$$1+8\times 10^{-7}\frac{10^7}{\left(1+\frac{s}{10^6}\right)^3}=0. \quad \left(1+\frac{s}{10^6}\right)^3 = -8, \quad 1+\frac{s}{10^6} = -2$$

$s = -3\times 10^6$ rad/s. 3- new pole at 3×10^6 d/s