ELEC 312: ELECTRONICS – II : ASSIGNMENT-3

Department of Electrical and Computer Engineering

Winter – 2012-2013

1. A series-series feedback circuit represented by Fig.1, and using an ideal transconductance amplifier operates with $V_s = 100$ mV, $V_f = 95$ mV, and $I_o = 10$ mA. What are the corresponding values of A and β? Include the correct units for each.

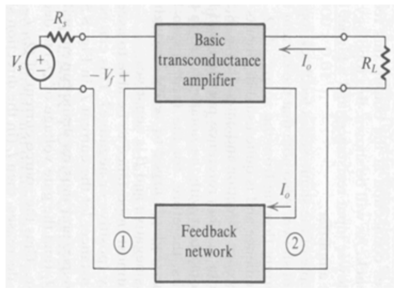

Figure 1:

Hints:

$V_1 = V_s - V_f$; $V_f = \beta I_o$ hence, $\beta = V_f / I_o$; $A = I_o / V_1$; $A_F = I_o / V_s = A/(1+A\beta)$.

2. For an amplifier connected in a negative feedback loop in which the output voltage is sampled (i.e., a shunt connection), measurement of the output resistance before and after the loop is connected shows a change by a factor of 80. Is the resistance with feedback higher or lower? What is the value of the loop gain Aβ? If R_{of} is 100 Ω, what is R_o without feedback?

Hints:

R_o is lowered by amount of feedback i.e. $(1+A\beta) = 80$; $A\beta = 79$, $R_o = R_{of}(1+A\beta)$

3. The shunt-shunt feedback amplifier in the Figure 3 has I = 1 mA and $V_{GS} = 0.8$ V. The MOSFET has $V_t = 0.6$ V and $V_A = 30$ V. For $R_S = 10$ kΩ, $R_1 = 1$MΩ, and $R_2 = 4.7$ MΩ, find the voltage gain v_o/v_s, the input resistance R_{in} and the output resistance R_{out}. You need to figure out the *ac* parameters for the MOS device.

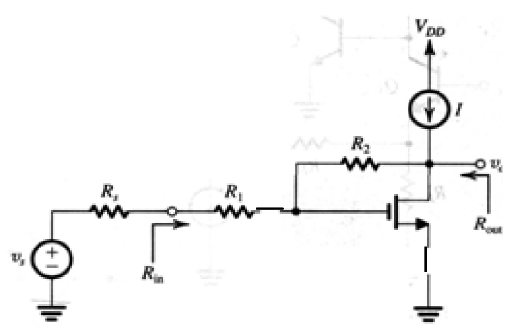

Figure 3:

Hints:

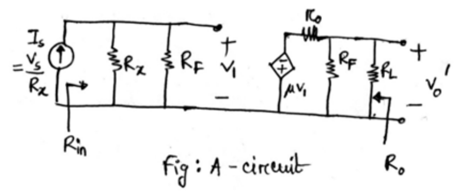

Fig: A-circuit

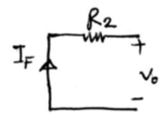

Fig: B-circuit

$g_m = 2I_D/V_{OV}$ and $r_o = V_A/I$,

Shunt-shunt feedback. We use Y-parameter model for the feedback circuit.

Find y_{11} , y_{22}, y_{12} for R_1, R_2 . Remember $\beta=y_{12}$.
Draw loaded ac equivalent circuit. Use $R_{11}(=1/y_{11})$ in shunt at input, R_{22} $(=1/y_{22})$ in shunt at output..
$\beta = I_F/V_o = -1/R_2$, Let $R_x = R_s + R_1$ and $\mu = g_m r_o$, $A = V'_o/I'_s = -[R_x||R_2][R_2||r_o]g_m = -2.478E8$; $A_F = V_o/I_s = A/(1+A\beta) = -4.612E6$
Thus $V_o/(I_s R_x) = V_o/V_1 = 1/(\beta R_x) = -R_2/(R_1+R_s)$
$R'_i = (R_s+R_1)||R_2$; $R_{if} = R'_i/(1+A\beta) = 15473.2$, $R_{in} = R_{if} - R_s = 5473.2$
$R'_o = R_2||r_o$, $R_{of} = R'_o/(1+A\beta) = 554.8 = R_O$; $v_o/v_s = -4.57$

4. An op amp having a low-frequency gain of 10^3 and a single-pole transfer function with -3dB frequency of 10^4 rad/s is connected in a negative feedback loop via a feedback network having a transmission $\beta(s)$ given by $\beta(s) = \frac{\beta_o}{(1+s/10^4)^2}$. Find the value of β_o above which the closed-loop amplifier becomes unstable.

Hints:

$$A(s) = \frac{10^3}{1+s/10^4}, \quad \beta(s) = \frac{\beta_o}{(1+s/10^4)^2}$$

$Ang(A\beta) = -\tan^{-1}(\omega/10^4) - 2\tan^{-1}(\omega/10^4) = 3\tan^{-1}(\omega/10^4)$
For 180^0, $\omega_{180} = \sqrt{3}\text{x}10^4$; for $|A\beta(\omega_{180})|<1$, Determine condition for β_0 (=0.008)

5. A DC amplifier has an open-loop gain of 1000 and two poles, a dominant one at 1 kHz and a high-frequency one whose location can be controlled. It is required to connect this amplifier in a negative feedback loop that provides a dc closed-loop gain of 100 and a maximally flat response. The transfer function of the amplifier can be modeled as:

$$A(s) = \frac{1000}{(1+s/\omega_1)(1+s/\omega_2)}$$

In the above ω_1 is the dominant pole frequency. It is required that under feedback, the amplifier will have a maximally flat response according to the model

$$A_f(s) = \frac{1000\omega_1\omega_2}{s^2+(\omega_p/Q_p)s+\omega_p^2}$$, with Q_p= 0.707.

Calculate the required ω_2.

Hints:

$$A(s) = \frac{1000}{(1+s/\omega_1)(1+s/\omega_2)};$$

$A_f(0) = 10^3/(1+10^3\beta) = 100$, calculate β (=0.009).

Formulate the $A_f(s)$ under feedback, and concentrate on the denominator polynomial *D(s)* in the form

$s^2+(\omega_p/Q_p)s+(\omega_p)^2$

Compare it with

$s^2 + s(\omega_1+\omega_2) + (1+A_o\beta)\omega_1\omega_2 = 0$

$Q_P = \sqrt{[(1+A_o\beta)\omega_1\omega_2]}/(\omega_1+\omega_2)$, calculate ω_2 Where, $Q_P = 0.707$ and $\omega_1 = 2\pi x1000$ rad/s. Solve the quadratic eq. in ω_2. Accept the value which is > 2*pi*f_1 (since f_1 =1000 Hz is the dominant pole)

ω_2 =1.1278E5 rad/s; f_2 =17950.33 Hz.