ELEC 312: ELECTRONICS – II : ASSIGNMENT-5
Department of Electrical and Computer Engineering
Winter – 2012

Solution: 9.97

All V_{ov} are the same,all V_A are the same
All r_0 are identical and all g_m's are identcal

We know $Ad(s) = g_m R_0 \left[\frac{1+\frac{s\,.\,C_m}{2\,g_{m3}}}{1+\frac{s\,.\,C_m}{g_{m3}}}\right] . \left(\frac{1}{1+s\,C_L\,R_0}\right)$

We also know that the frequencies of the zero f_z and the pole f_{p2} occur at very high frequencies. Thus we can assume that the pole f_{p1}= 1/ (2π C_L R_o) dominates the response of $A_d(s)$ passed the unity gain

Thus:
$Ad(s) = g_m R_0 \left(\frac{1}{1+ j\omega\, C_L\, R_0}\right)$;

At unity gain $|A_d(\omega_1)| = 1$

$\Rightarrow 1 = \frac{g_m R_0}{\sqrt{1+(\omega_1\ C_L R_0)}}$

$\Rightarrow \omega_1^2 = \frac{(g_m R_0)^2 - 1}{(C_L R_0)^2}$

since $g_m R_0 = g_m \frac{r_0}{2} >> 1 \Rightarrow \omega_1 \approx g_m / C_L$

$\Rightarrow f_1 = \frac{g_m}{2\pi\,.\,C_L}$

For V_A = 20 V , V_{ov} = 0.2V ,

I = 0.2 mA , C_L = 100 fF , C_m = 25 fF

All r_o are identical:

$r_0 = \frac{V_A}{I_D} = \frac{20\,V}{(\frac{0.2\,m}{2})} = 200\ k\,\Omega$

All g_m are identical : $g_m = \frac{2\,I_D}{V_{ov}} = \frac{0.2\,m}{0.2} = \frac{1\,mA}{V}$

The low frequency differential gain is :

$A_{dDC} = g_m \frac{r_0}{2} = 100$ V/V

$f_{p1} = \frac{1}{2\pi \,.\, C_L\ R_0} = 15.9$ MHz
$f_{p2} = \frac{g_m}{2\pi \,.\, C_m} = 6.37$ GHz
$f_Z = \frac{2g_m}{2\pi \,.\, C_m} = 2 \times f_{PZ} = 12.74$ GHz

Solution: 9.105

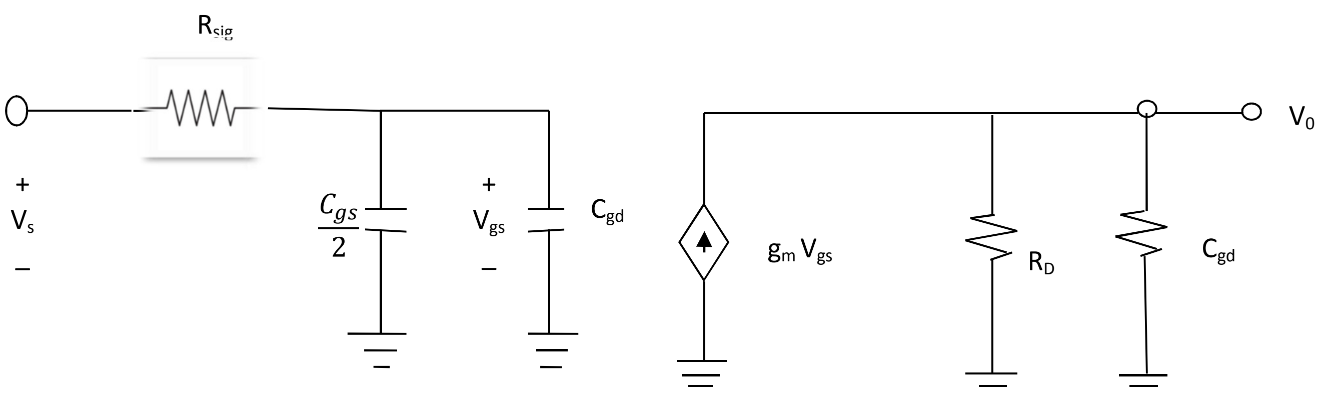
$V_{G1} = \frac{V_S \,.\, \frac{2}{g_m}}{\frac{2}{g_m} + R_{sig}}$ and $I = \frac{V_{G1}}{\frac{2}{g_m}}$

$V_0 = I\,R_D = \frac{V_S \,.\, R_D}{\frac{2}{g_m} + R_{sig}}$

$A_0 = \frac{V_0}{V_S} = \frac{g_m \,.\, R_D}{2 + g_m\ R_{sig}}$

$g_m = \frac{200\ \mu A}{0.2\ V} = 1$ mA so $A_o = 247.5$ V/V

The high frequency equivalent circuit is:



Thus the pole at the input has a frequency $f_{p1} = \frac{1}{2\pi \,.\, R_{sig}\ (\frac{C_{gs}}{2} + C_{gd})} = 350$ KHz

and the pole at the output has a frequency $f_{p2} = \frac{1}{2\pi \,.\, R_D \,.\, C_{gd}} = 3.18$ MHz

Thus $f_H = \frac{1}{\sqrt{(\frac{1}{f_{p1}})^2 + (\frac{1}{f_{p2}})^2}} = 52$

ELEC 312: ELECTRONICS – II : ASSIGNMENT-6

Department of Electrical and Computer Engineering

Winter – 2011-2012

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.

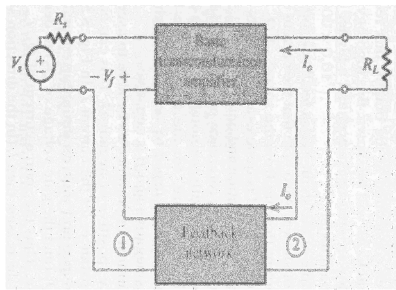


Figure 1:

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?

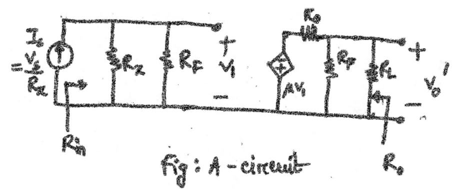
Hints:

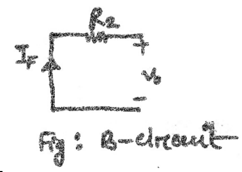
R_o is lowered by amount of feedback i.e. $(1+A\beta) = 80$; $A\beta = 79$, $R_o = R_{of}(1+A\beta)$

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 =1MΩ, 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:





$g_m = 2I_D/V_{OV}$ 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 $\mu = g_m r_o$, $A = V'_o/I'_s = -[R_x \| R_2][R_2 \| r_o]g_m$;
$A_F = V_o/I_s = A/(1+A\beta)$,
Thus $V_o/(I_s R_x) = V_o/V_1 = 1/(\beta R_x) = -R_2/(R_1+R_s)$
$R'_i = (R_s+R_1) \| R_2$; $R_{if} = R'_i/(1+A\beta)$, $R_{in} = R_{if} - R_s$
$R'_o = R_2 \| r_o$, $R_{of} = R'_o/(1+A\beta)$

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:

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

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

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

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

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.
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