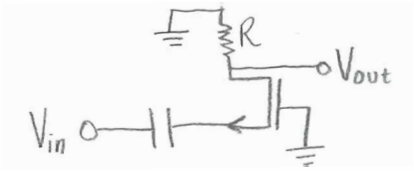
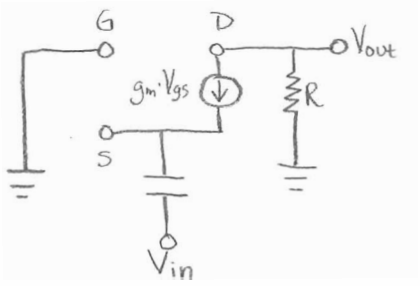
ECE 137A - HW#8
Winter '07

1) $R_{DS} = \infty$



a)



b) $g_m = 200\,mS$, $C = 100\,pF$, $R = 1K\Omega$

Find $\frac{V_{out}(s)}{V_{in}(s)}$ ...?

$V_{out} = -g_m \cdot V_{GS} \cdot R$

& $V_{gs} = 0 - \left(V_{in} + g_m \cdot V_{gs} \cdot \frac{1}{s \cdot C}\right)$

$\Rightarrow V_{gs} = \frac{-V_{in}}{1 + \frac{g_m}{s \cdot C}}$

$\Rightarrow V_{OUT} = (-g_m \cdot R) \cdot \frac{-V_{in}}{1 + \frac{g_m}{s \cdot C}}$

$\Rightarrow$ $\frac{V_{out}}{V_{in}} = \frac{g_m \cdot R}{1 + \frac{g_m}{s \cdot C}}$ or $\frac{s \cdot g_m \cdot R}{s + \frac{g_m}{C}}$ or $\frac{s \cdot C \cdot R}{1 + s \cdot \frac{C}{g_m}}$

c) Find all zero & pole frequencies...?

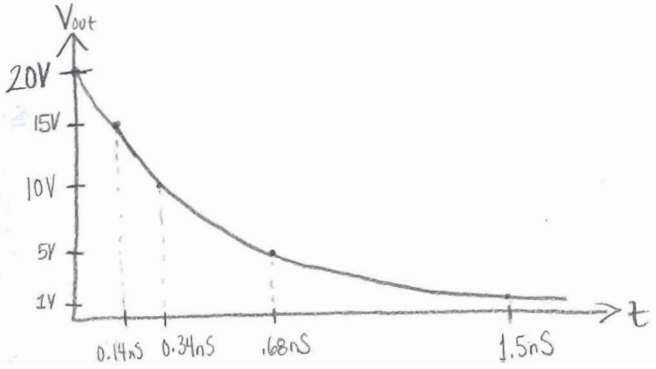
→ 1 zero at $s = 0$ or $f = 0\,Hz$

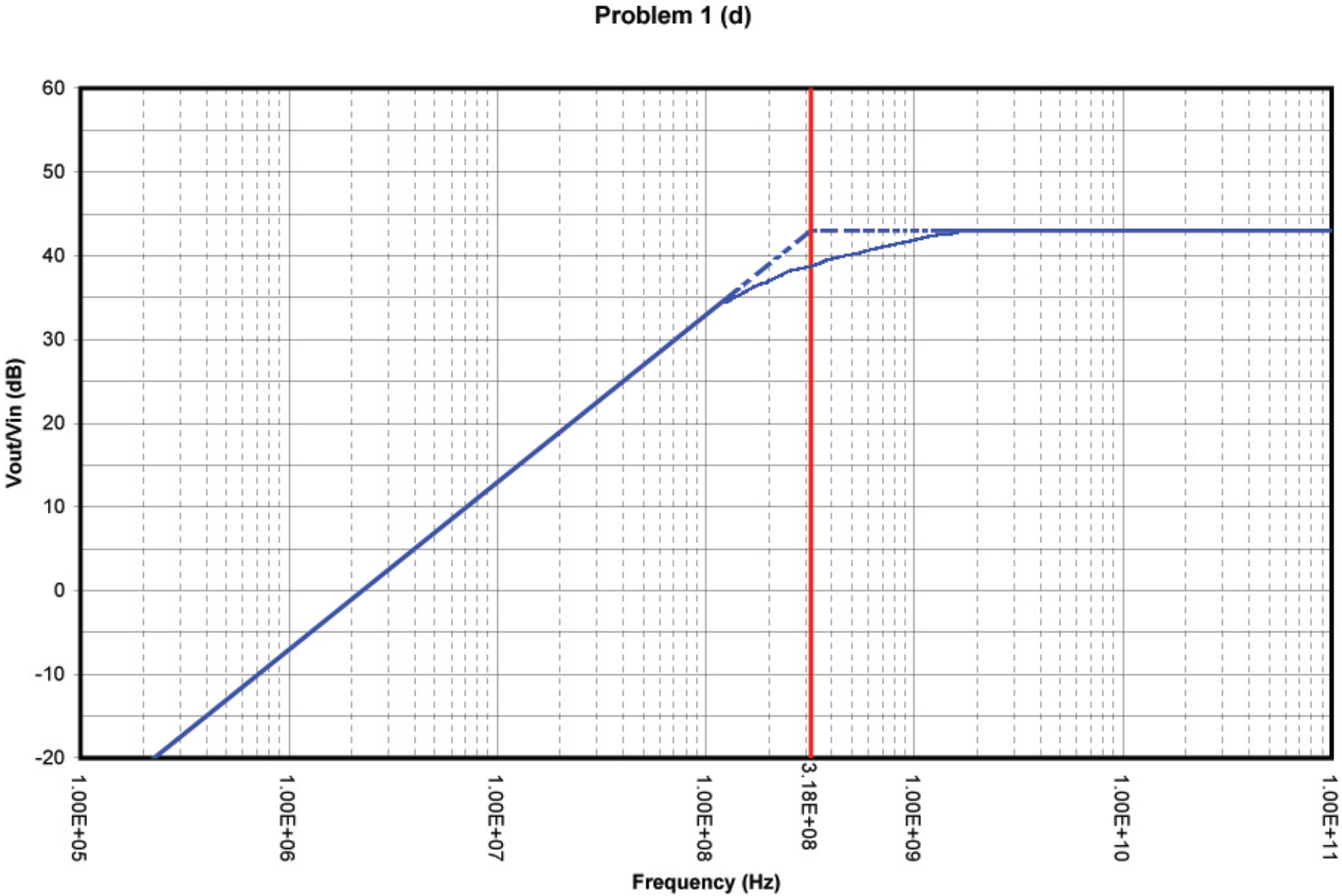
→ 1 pole at $s = \frac{g_m}{C}$ or $f = 318.31\,MHz$

d) see page 2

e) $V_{in} = 100mV \cdot u(t) \Rightarrow V_{out}(s) = \frac{s \cdot g_m \cdot R}{s + \frac{g_m}{C}} \cdot \frac{0.1V}{s} = \frac{20V}{s + 2E9\,Hz}$

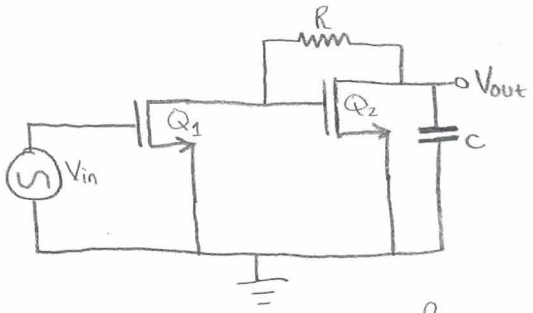
$V_{out}(t) = 20\,V \cdot e^{-2E9Hz \cdot t}$



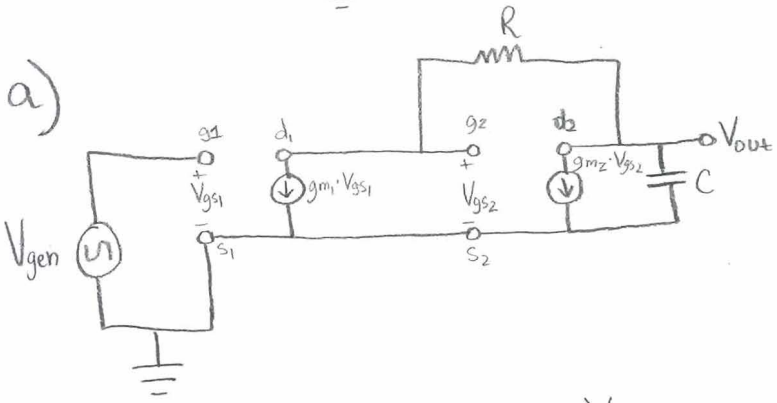

Problem 1 (d)
60
50
40
30
20
10
0
-10
-20
Vout/Vin (dB)
1.00E+05
1.00E+06
1.00E+07
1.00E+08
3.18E+08
1.00E+09
1.00E+10
1.00E+11
Frequency (Hz)

(2) For Q_1 & Q_2 ... $C_{gs} = C_{gd} = 0F$ & $R_{ds} = \infty$

$g_{m_1} = 20mS$, $g_{m_2} = 50mS$, $R = 1K\Omega$, $C = 10\,pF$



a)



b) $V_{gs_1} = V_{gen}$

$$\rightarrow \frac{V_{out} - V_{gs_2}}{R} = g_{m_1} \cdot V_{gen}$$

$$\Rightarrow V_{out} = g_{m_1} \cdot R \cdot V_{gen} + V_{gs_2}$$

$$\rightarrow V_{gs_2} \cdot g_{m_2} + g_{m_1} \cdot V_{gen} + V_{out} \cdot s \cdot C = 0$$

$$\Rightarrow V_{gs_2} = \frac{-g_{m_1} \cdot V_{gen}}{g_{m_2}} - \frac{s \cdot C \cdot V_{out}}{g_{m_2}} \Rightarrow V_{out} \cdot \left(1 + \frac{s \cdot C}{g_{m_2}}\right) = V_{gen} \cdot \left(g_{m_1} \cdot R - \frac{g_{m_1}}{g_{m_2}}\right)$$

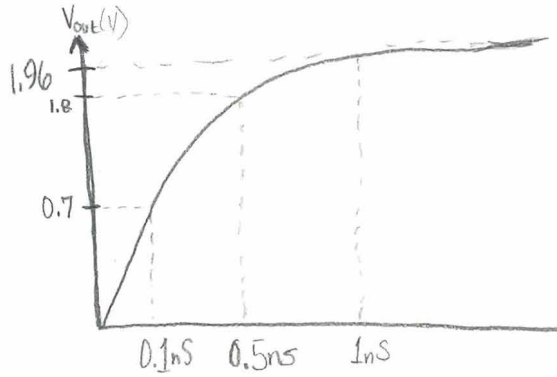
$$\Rightarrow \boxed{\frac{V_{out}(s)}{V_{gen}(s)} = \frac{\frac{g_{m_1}}{C} \cdot (g_{m_2} \cdot R - 1)}{s + \frac{g_{m_2}}{C}} \quad \text{or} \quad \frac{g_{m_1} \cdot R - \frac{g_{m_1}}{g_{m_2}}}{1 + \frac{s \cdot C}{g_{m_2}}}}$$

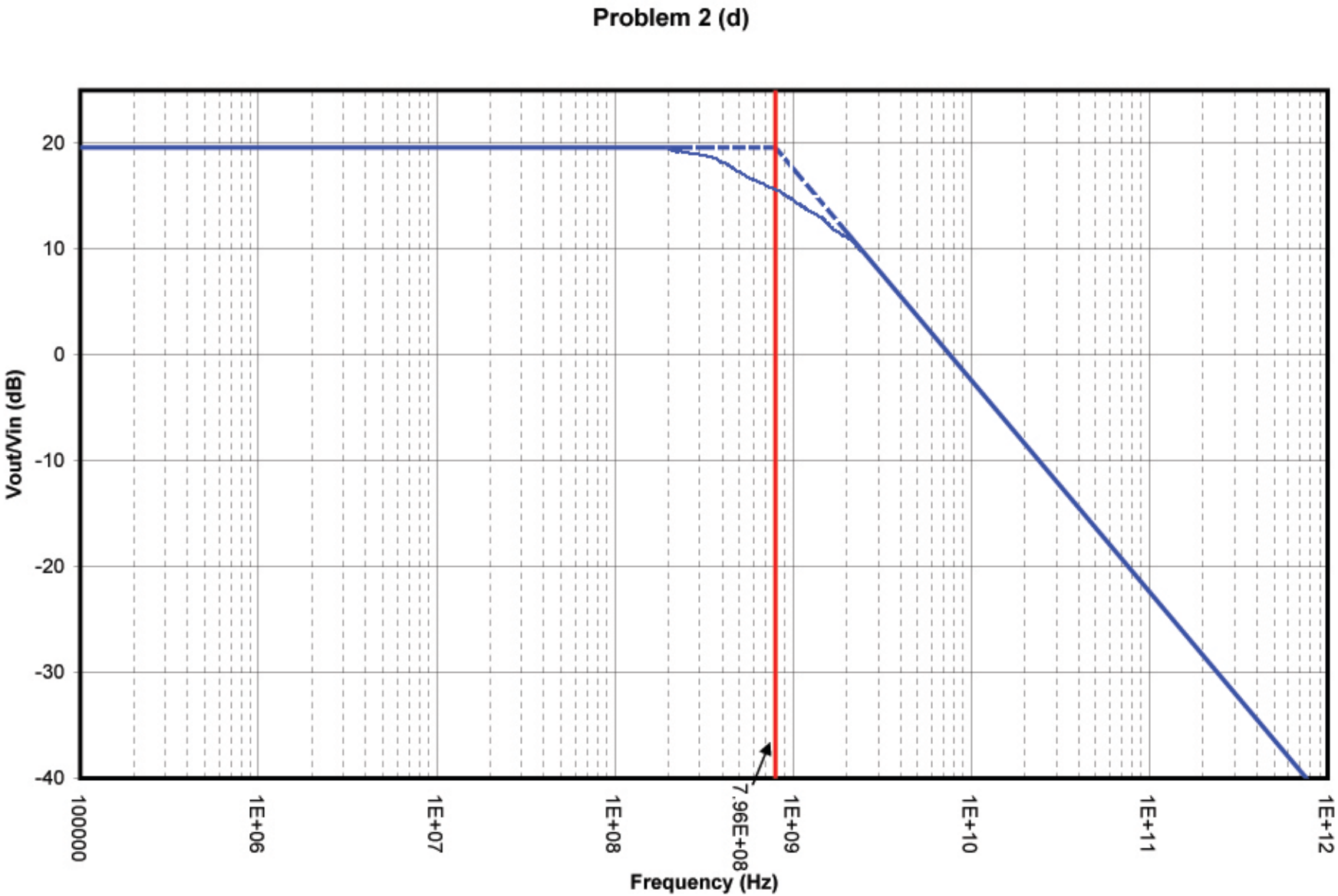
c) 1 pole @ $s = \frac{g_{m_2}}{C} \Rightarrow \boxed{f_p = 795.775\,MHz}$

d) See page 4...

e) $$V_{out}(s) = \frac{g_{m_1} \cdot R - \frac{g_{m_1}}{g_{m_2}}}{1 + \frac{s \cdot C}{g_{m_2}}} \cdot \frac{0.1V}{s} = \frac{19.6}{1 + s \cdot 0.2ns} \cdot \frac{0.1V}{s} = \frac{9.8E9}{s \cdot (s + 5E9)} = \frac{-1.96}{s + 5E9} + \frac{1.96}{s}$$

$$\Rightarrow V_{out}(t) = 1.96 \cdot u(t) \cdot \left[1 - e^{-5GHz \cdot t}\right]$$




Problem 2 (d)
Vout/Vin (dB)
20
10
0
-10
-20
-30
-40
100000
1E+06
1E+07
1E+08
7.96E+08
1E+09
1E+10
1E+11
1E+12
Frequency (Hz)