EE 140/240A Linear Integrated Circuits
Fall 2019 Homework 3

1. Model Mania

(a) For a quadratic model MOSFET, sketch the following curves. No units needed, but try to get the shape right with any significant points labeled, and label with something like "goes as sqrt(X)" or "linear in X". Assume $\lambda = 0$.

i. g_m vs. V_{GS} with constant W/L
ii. g_m vs. V_{GS} with constant I_D
iii. g_m vs. I_D with constant W/L
iv. g_m vs. I_D with constant V_{GS}
v. g_m vs. W/L with constant I_D
vi. g_m vs. W/L with constant V_{GS}

(b) **(EE240A)** Repeat questions (a)i., (a)ii., (a)iv., and (a)vi. for subthreshold. You do not need to sketch the plot. You may assume I_S is a constant in all but $\frac{W}{L}$. Do not assume n is necessarily a constant.

(c) **(EE240A)** Repeat part (a), but for the linear region of operation. You do not need to plot for this subpart.

2. Resistive Load CS Amp Biasing

A common source FET amplifier has a resistive load and $\lambda = \frac{1}{50\text{V}}$. The output is biased at 5V, the transistor is in saturation, and the resistive load has the same impedance as the output resistance of the transistor. What is the supply voltage?

3. Single-Pole Amplifier

A single-pole amplifier has a low frequency gain of 1000, and a gain of 2 at 500MHz. What are the pole frequency and unity gain frequency in Hz? What is the gain at 10MHz?

4. Settling Time

Write down a table of settling error vs. time for $\frac{t}{\tau} = \{1,3,5,7\}$. Use a calculator for this one. Memorize the table to one significant digit.

5. RC Low-Pass Filter Transient

An RC low pass filter with a time constant of 1µs is driven with a $0-1$V square wave. Sketch the first full cycle of the input and output when the square wave is first turned on, and the frequency of the square wave is

(a) 1kHz
(b) 1MHz
(c) 1GHz

6. Relationships for Your Cheat Sheet

Fill in the following table for a single-transistor common-source amplifier:

A_{v0} (V/V)	ω_p (rad/s)	ω_u (rad/s)	g_m ($1/\Omega$)	r_o (Ω)	C_L (F)
1000	1M				1p
	1M	0.1G		100k	
		10G		1M	20f
	10	10M			10p