American University of Beirut
Department of Electrical and Computer Engineering
EECE 310 – Electronics I
Fall 2004 – 2005
Quiz 2 – December 22, 2004
Closed Book – 90 minutes

P1	**/16**
P2	**/12**
P3	**/20**
P4	**/10**
P5	**/12**
P6	**/10**
P7	**/20**

Grade /100

NAME:______________________________ ID Number: ________________________

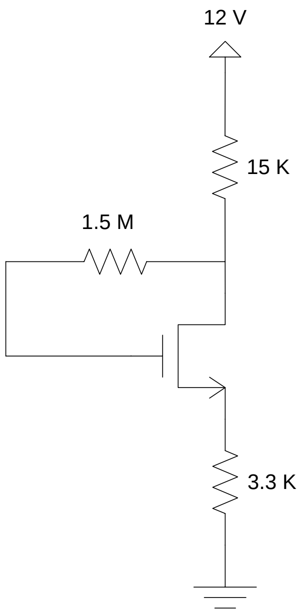
I have neither given nor received aid on this exam

SIGNATURE

Problem 1 [16 points]
The drain current I_D of an enhancement n-channel MOSFET is measured at different values of V_{GS}, V_{DS}, and V_{BS}. The results are shown in the table below. For this transistor, find the values of V_{t0}, $k'(W/L)$, λ, and γ. Assume that $2|\phi_f| = 0.6$ V.

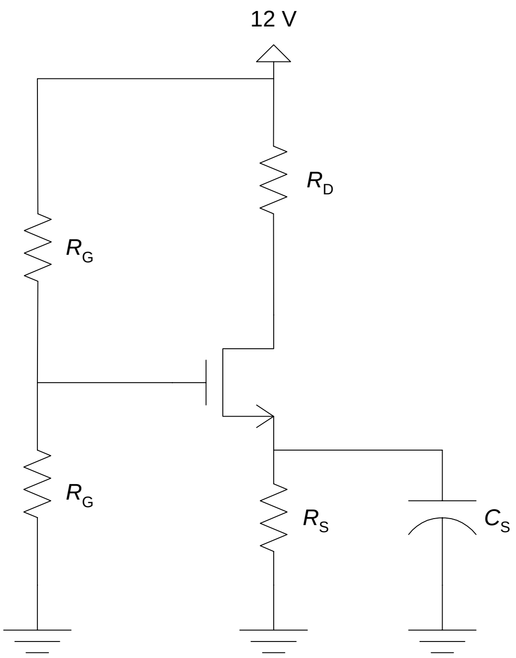
V_{GS} (V)	V_{DS} (V)	V_{BS} (V)	I_D (μA)
2	2	0	101.25
3	3	0	340.20
2	3	0	105.00
2	3	-2	63.69

Problem 2 [12 points]
For the MOSFET shown in the circuit below, find V_{GS}, V_{DS}, and I_D. In what region is the transistor operating? The MOSFET parameters are V_t = 1 V and $k'(W/L)$ = 0.1 mA/V^2.



Problem 3 [20 points]

a) The MOSFET shown in the circuit below is to be biased in the saturation region at V_{DS} = 5 V, I_D = 0.5 mA. Find the required values of R_D and R_S, and calculate the values of the DC voltages V_G, V_S, and V_D. The MOSFET parameters are V_t = 0.8 V, $k'(W/L)$ = 0.06 mA/V^2, and λ = 0.03 V^{-1}.



b) The circuit is used as an amplifier with input at the gate, and output taken at the drain. What is the voltage gain of this amplifier at midband?

c) What is the maximum sinusoidal voltage swing at the drain (with input signal applied at the gate) for the MOSFET to remain in saturation? Express the swing as a DC value, a maximum value, and a minimum value.

Problem 4. [10 points]

a) A MOSFET is biased at V_{DS} = 10 V, V_{GS} = 5 V, and the resulting drain current is I_D = 1 mA. Show the small-signal T-model of this MOSFET at the bias point (with all component values). The MOSFET parameters are V_t = 1 V, and λ = 0.01 V^{-1}.

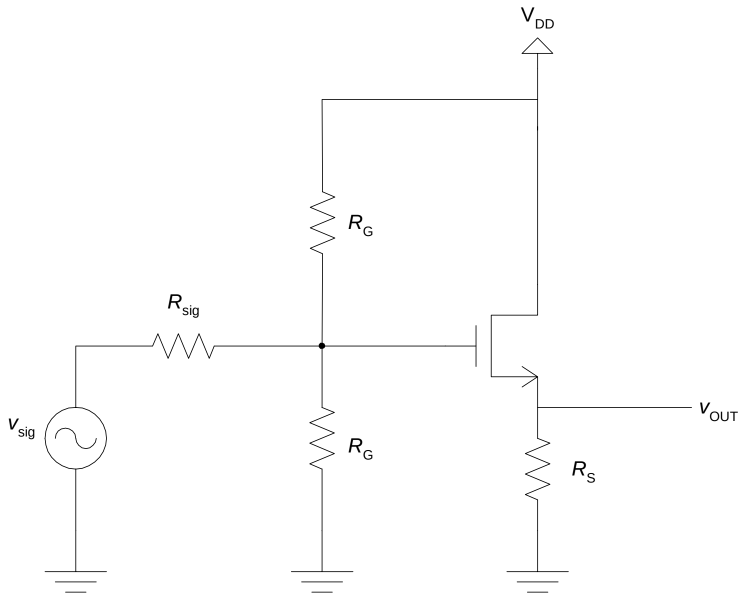
b) How would you modify the T-model if body-effect is present with a signal voltage v_{bs} appearing between body and source? Show the resulting circuit.

Problem 5. [12 points]

a) Three identical amplifier stages are cascaded. For each of the amplifier stages, the input resistance is 100 KΩ, the output resistance is 20 KΩ, and the open-circuit voltage gain is 30. Show the model of the resulting (single) voltage amplifier, with values of R_i, R_o, and A_{vo}.

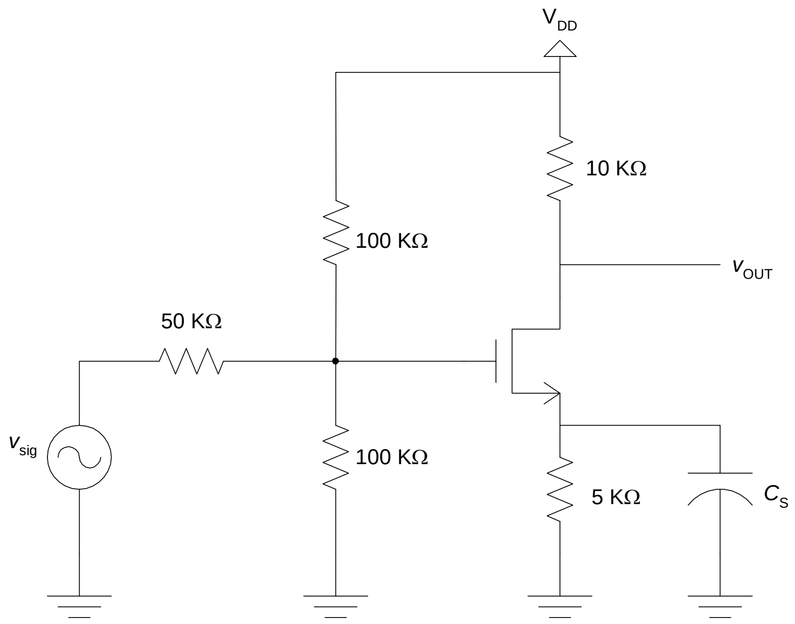
b) Show the equivalent model, with component values, for a (single) transconductance amplifier.

Problem 6. [10 points]
Find the input resistance, voltage gain (v_{out}/v_{sig}), and output resistance of the MOSFET amplifier shown. The MOSFET small-signal parameters are g_m and r_o.



Problem 7. [20 points]

a) Find the midband gain v_{out}/v_{sig} of the amplifier shown in the circuit below. The MOSFET is biased such that its small-signal transconductance is g_m = 1 mA/V. Express the gain in dB.



b) ~~What is the upper 3 dB frequency (in Hz) of this amplifier if C_{gs} = C_{gd} = 1 pF? *Use the Miller approximation*. What is the bandwidth of this amplifier if its lower 3 dB~~ frequency is 100 Hz?

c) Show the magnitude Bode plot for the amplifier transfer function V_{out}/V_{sig}. Use a range of frequencies from 1 Hz to 1 MHz.

d) Find the value of the bypass capacitor C_S to get a lower 3 dB frequency of 100 Hz. Hint: Use the T-model to find $V_{out}(s)/V_{sig}(s)$ at low frequency, then use the definition of the lower 3 dB frequency to solve $\left|\frac{V_{out}(j\omega_L)}{V_{sig}(j\omega_L)}\right| = \frac{|midband\ gain|}{\sqrt{2}}$.