7-11-2021 16:30

Fall 2021-2022

EEE 313: Electronic Circuit Design

Midterm #1

Name and Surname:

Student ID:

Signature:

Exam Duration: 120 minutes

Question#	Your score	Out of
1		20
2		15
3		30
4		35
Total:		**100**

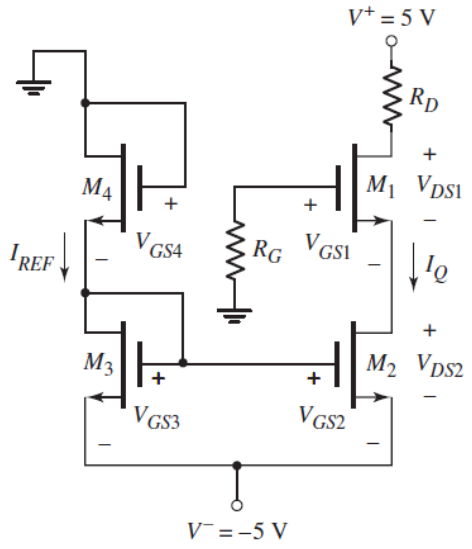
Instructions:

1. Calculators without extensive memory are allowed
2. Clearly explain all your answers in order to receive credit
3. Put a box around your final answer
4. Cheat sheets are not allowed
5. Indicate the units for your final answers
6. Write your student ID on the bottom of every page

Q1. (20 points) In the following circuit it is required that I_{REF} = 200 µA and I_Q = 100 µA. It is given that M_1 and M_2 are matched, K_{n3}/K_{n4} = 4, all transistors have V_{TN} = 1 V, λ = 0, and R_D = 20 KΩ.

a) (15 points) Find K_{n4}, K_{n3}, K_{n2}, and K_{n1}. Verify the states of the transistors.

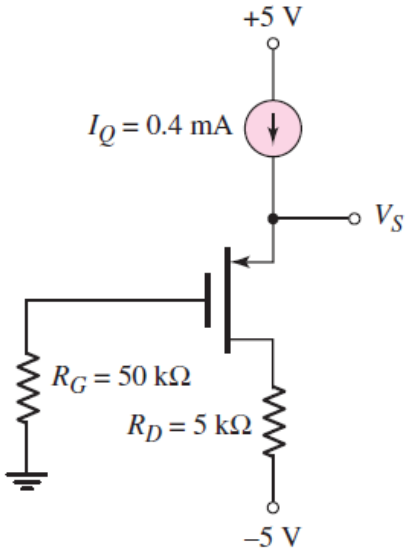
b) (5 points) Find the range of R_D such that all transistors are SAT.



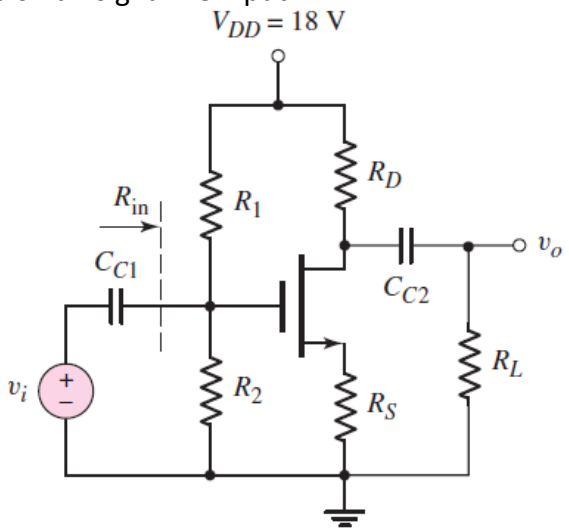
Q2. (15 points) For the circuit below V_{TP} = -0.8 V, K_p = 200 μA/V^2.

a) (5 points) Find V_S and V_{SD} for λ= 0. Verify the state of the transistor.

b) (10 points) Find V_S and V_{SD} for λ= 0.02 V^{-1}. Verify the state of the transistor.



Q3. (30 points) Design the common source amplifier shown below using an n-channel MOSFET (enhancement or depletion type) with λ= 0. The quiscent values are to be I_{DQ} = 6 mA, V_{GSQ} = 2.8 V, and V_{DSQ} = 10 V. The transconductance is g_m = 2.2 mA/V. Let R_L = 1 kΩ, small signal AC voltage gain A_v = -1, and small signal AC input impedance R_{in} = 100 kΩ. Find R_1, R_2, R_S, R_D, K_n, and V_{TN}. Verify the state of the transistor. C_{C1} and C_{C2} are very large, and v_i is a small-signal AC input.



Q4. (35 points) For the circuit below V_{TN} = 0.8 V, k_n' = 100 μA/V^2, W/L = 20, λ= 0.02 V^{-1}, and I_Q = 5 mA. C_{C1} and C_{C2} are very large, and v_i is a small-signal AC input.

a) Find the quiescent values of V_{GS}, V_{DS}, and I_D. You may take λ= 0 in this part. Verify the state of the transistor.
b) Find g_m and r_o using results of part "a", and derive and determine the small-signal AC voltage gain $A_v = v_o/v_i$.
c) Derive and determine the small-signal AC output impedance R_o.
d) What is the small-signal AC voltage gain if v_i has a source impedance of 10 kΩ?
e) What is the unloaded small-signal AC voltage gain of the amplifier?