

19-3-2021

BILKENT UNIVERSITY

Department of Electrical and Electronics Engineering

EEE313 Electronic Circuit Design

MidTerm Exam #1

Name and Surname: -----

Student ID no: -----

Section:-----

Signature:-----

Exam Duration: 120 minutes. Solve all 5 questions.

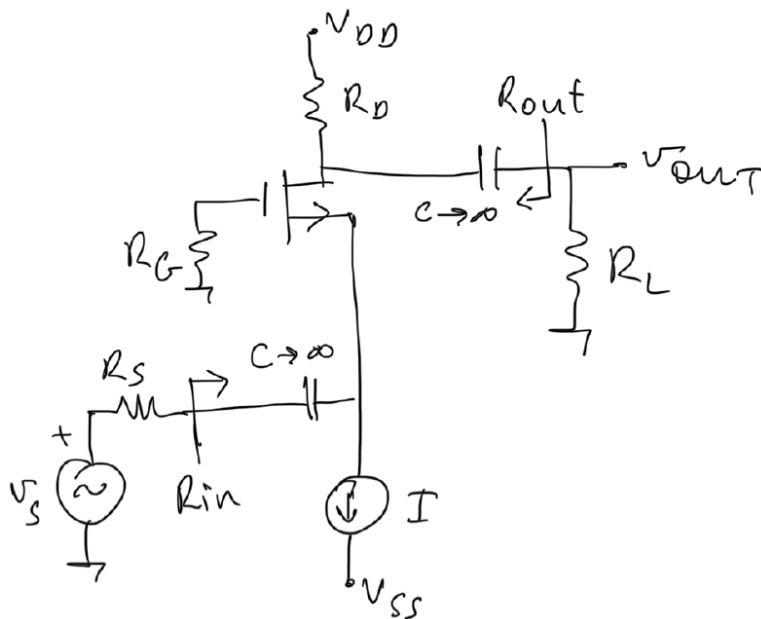
## **PART-2, 2 questions, 75 minutes**

Question#	Your score	Out of
Q1		15
Q2		15
Q3		10
Q4		30
Q5		30
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

**Q4. (30 points)**

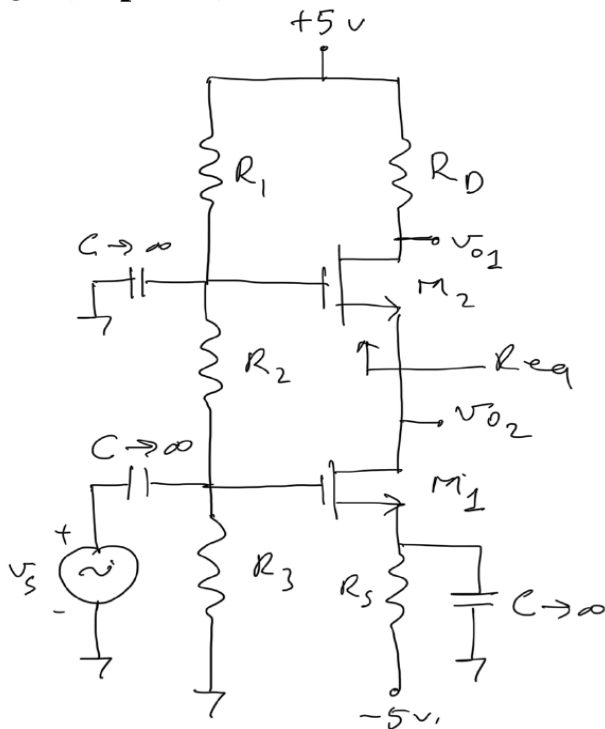


For the circuit shown on the left,  
 $V_{DD} = 10\text{V}$ ,  $V_{SS} = -10\text{V}$ ,  $V_{TN} = 1.5\text{V}$ ,  
 $K_n = 0.5\text{mA/V}^2$ ,  $R_D = 15\text{k}\Omega$ ,  $R_L = 15\text{k}\Omega$ ,  $R_G = 4.7\text{M}\Omega$ ,  $R_S = 50\Omega$ , and  $I = 0.5\text{mA}$ .

**a)** Assuming  $\lambda = 0$ , derive and find small signal ac  $A_v = v_{out}/v_s$ ,  $R_{in}$ ,  $R_{out}$ .  
 Note: Verify your assumptions.

**b)** Assuming  $\lambda = 1/75\text{V}^{-1}$  and that the Q-point values are the same as above, find small signal ac  $R_{in}$  and  $A_v = v_{out}/v_s$ .

**Q5. (30 points)**



For the cascode circuit shown on the left, the transistor parameters are  $V_{TN1} = V_{TN2} = 1\text{ V}$ ,  $K_{n1} = K_{n2} = 2\text{ mA/V}^2$ , and  $\lambda_1 = \lambda_2 = 0$ .

**a)** Let  $R_s = 1.2\text{ k}\Omega$  and  $R_1 + R_2 + R_3 = 500\text{ k}\Omega$ . Design the circuit such that  $I_{DQ} = 3\text{ mA}$  and  $V_{DSQ1} = V_{DSQ2} = 2.5\text{ V}$ .

**b)** Draw the small signal ac circuit. Derive and determine the small signal ac voltage gain  $A_{v1} = v_{o1}/v_s$ .

**c)** Also derive and determine the small signal ac  $R_{eq}$  (shown on the figure), and voltage gain  $A_{v2} = v_{o2}/v_s$ .