KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

FIRST SEMESTER 2012-2013 (S121)

Course Title:	**Electronics II**
Course Number:	**EE 303**

Exam Type:	**Major Exam I**
Date:	**Saturday Oct. 6th, 2012**
Time:	**6:00PM-7:30PM**

Student Name: Key

Student ID: ______________________

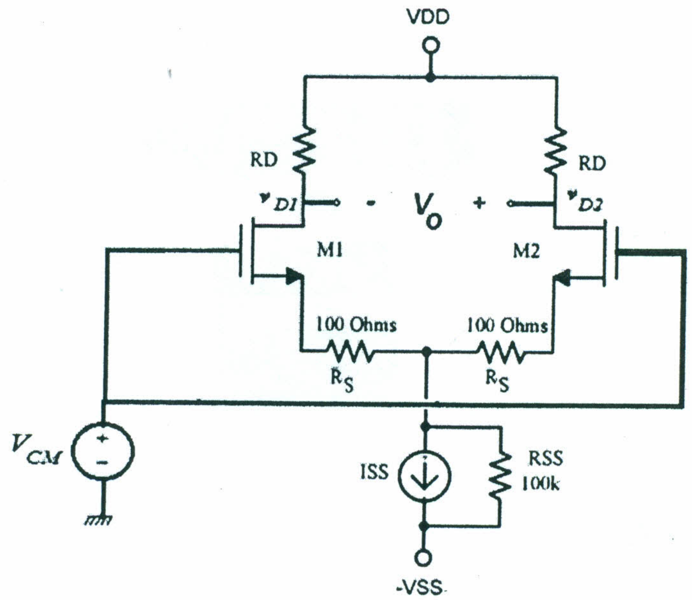
Section # ______________________

GRADING		
Question 1	**25**	
Question 2	**15**	
Question 3	**20**	
Total:	**60**	

Show all your work and results. Do not give more than one answer otherwise the wrong one will be considered.

Question No.1 [25 points]

For the MOS pair with a common-mode voltage V_{CM} applied as shown below. Assume $V_{DD} = 5$ V, $V_{SS} = 5$ V, $k'(W/L) = 5$ mA/V^2, $V_t = 0.5$ V, $I_{SS} = 1.5$ mA, and $R_D = 2$ kΩ, and neglect channel-length modulation.



a- Find the highest permitted value of V_{CM}. [4 points]

b- Develop the **differential** and **common** mode half circuits for the given Differential amplifier. [10 points]

c- Calculate Common-Mode Rejection Ratio (CMRR). [6 points]

d- What is the function of R_S (i.e. the main difference compared with the case of $R_S = 0$). [5 points]

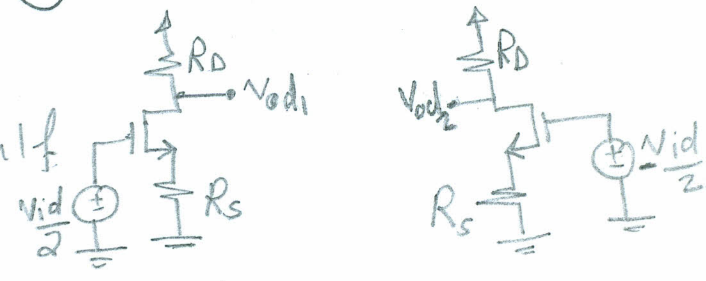
a) $V_{GD} < V_t \Rightarrow V_G < V_t + V_D \Rightarrow V_{CM_{max}} < V_t + V_{DD} - I_{D_1} R_D$

$I_{D_1} = \frac{1}{2} I_{SS} = 0.75\ mA \Rightarrow V_{CMmax} < 0.5 + 5 - 0.75 \times 2$

(4)

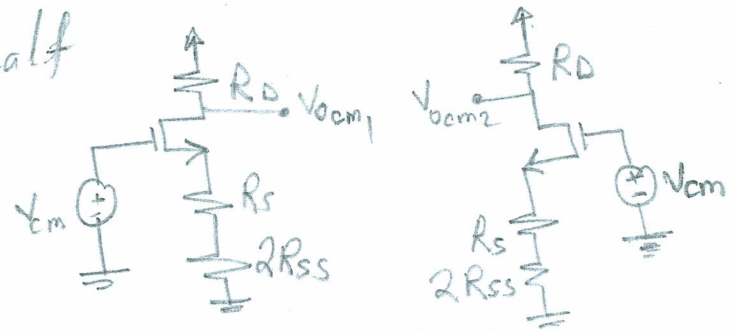
$V_{CMmax} = 4\ V$

b) Differential half



(5)

Common mode half



(5)

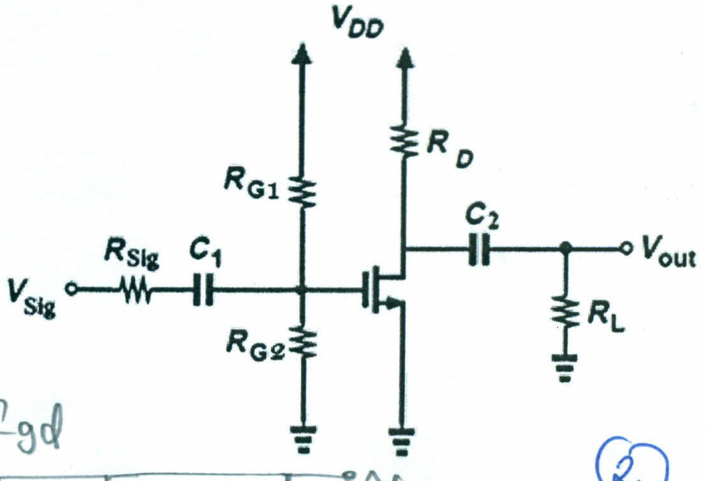
c) $CMRR = \left|\frac{A_d}{A_{cm}}\right|$; $A_d = \frac{V_o}{V_{id}} = \frac{2R_D}{\frac{2}{a} + 2R_c} = \frac{R_D}{\frac{1}{a} + R_c}$, $A_{cm} = 0$ [6]

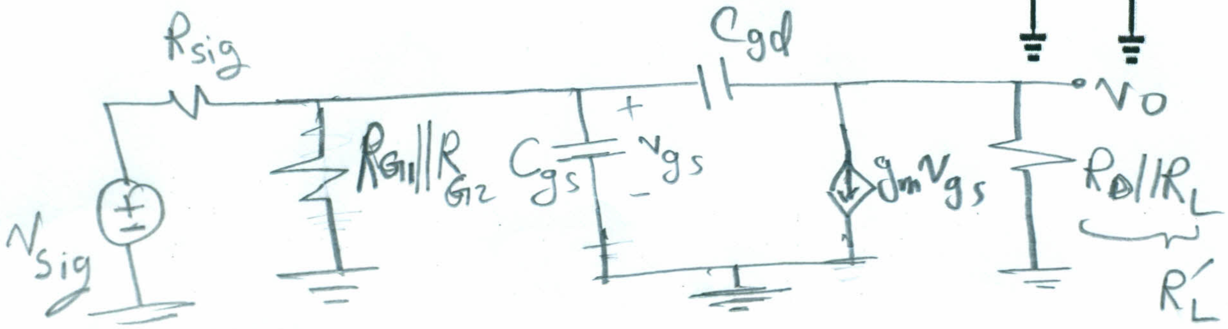
d) R_s will increase input Differential Range. [5]

Question No. 2 [15 points]

In the circuit shown, g_m = 1 ms, C_{gs} = 10 pF, C_{gd} = 1 pF, C_1 = C_2 = 10 μF, R_{sig} = 1 kΩ, R_{G1} = 8.6 MΩ, R_{G2} = 8.6 MΩ, R_D = 12 kΩ, and R_L = 24 KΩ.

Determine and then calculate all of the high frequency poles. [15 points]





(2)

Miller theorem $K = -g_m R_L' = -8$ V/v

$C_1 = C_{gd}(1 + g_m R_L') = 9 C_{gd} = 9$ pF

$C_2 = C_{gd}\left(1 + \frac{1}{g_m R_L'}\right) = 1.125$ pF

(5)

$C_{eq} = C_{gs} + C_1 = 19$ pF

Pole due C_{eq}: $\omega_{H1} = \dfrac{1}{C_{eq}[R_{sig} \| R_{G1} \| R_{G2}]} = 52.6$ M rad/s

(4)

Pole due C_2: $\omega_{H2} = \dfrac{1}{C_2 (R_L \| R_D)} = 111.1$ Mrad/s

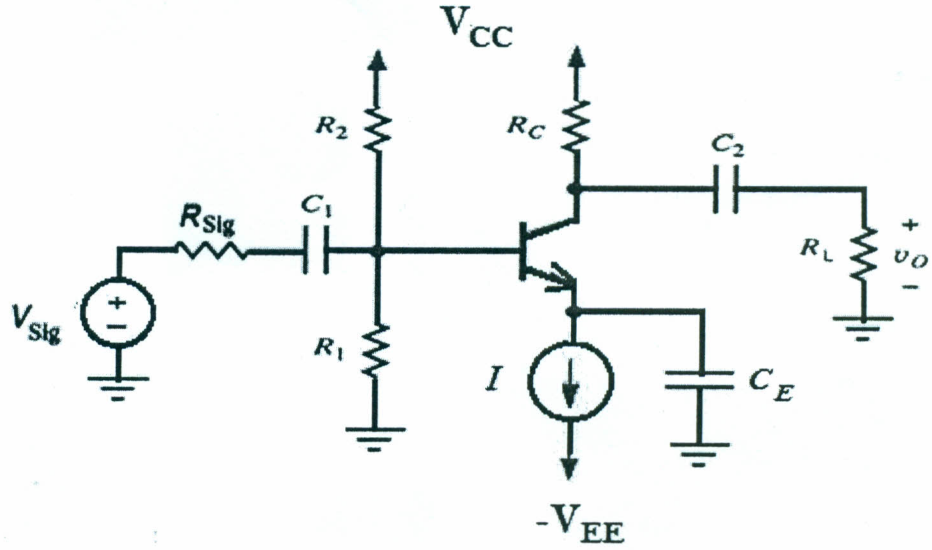
(4)

Question No. 3 [20 points]

For the common emitter amplifier shown; assumes r_x and r_o are neglected:

a- Drive the expressions for all low frequency poles. [15 points]

b- Find an expression for the low corner frequency f_L (*do not neglect any pole*). [5 points]



a):

$$\omega_{L1} = \frac{1}{C_1\left[R_{sig} + (R_1 \| R_2 \| r_\pi)\right]}$$ 5

$$\omega_{L2} = \frac{1}{C_E\left[r_e + \frac{R_1 \| R_2 \| R_{sig}}{\beta+1}\right]}$$ 5

$$\omega_{L3} = \frac{1}{C_2\left[R_C + R_L\right]}$$ 5

b) $\omega_L = \omega_{L1} + \omega_{L2} + \omega_{L3}$ (3)

$$f_L = \frac{\omega_L}{2\pi}$$ (2)