KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

FIRST SEMESTER 2014-2015 (S141)

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

Exam Type:	**Major Exam I**
Date:	**Sunday Oct. 19th, 2014**
Time:	**5:30PM-7:00PM**

Student Name: Key

Student ID: ______________________

Section # 5

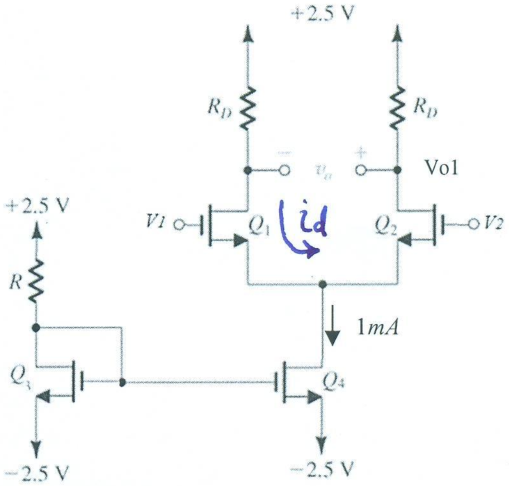
GRADING		
Question 1	**45**	
Question 2	**30**	
Question 3	**25**	
Total:	**100**	

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

Question No.1 [45 points]

A. For the MOS pair shown below, assume $k'(W/L) = 4\ mA/V^2$, and $R_D = 3\ k\Omega$, , assume the current source output resistance (r_{o4}) of $50k\Omega$, and neglect channel-length modulation of Q1 &Q2.

i. Find the single ended differential mode gain $A_{d1}=(V_{o1}/V_{id})$ where $V_{id} = V_{i1}-V_{i2}$. (10 marks)
ii. Find the single ended common mode gain $A_{cm1}=(V_{o1}/V_{cm})$. (10 marks)
iii. Find the single ended common mode rejection ratio CMRR. (5 marks)



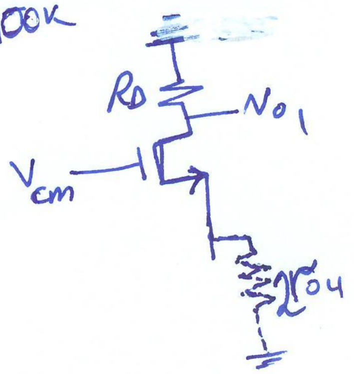
i) $i_d = \dfrac{v_1 - v_2}{\frac{2}{g_m}} = \frac{1}{2} g_m v_{id}$ 4

$v_{o1} = i_d R_D \Rightarrow A_{d1} = \dfrac{v_{o1}}{v_{id}} = \frac{1}{2} g_m R_D$ 4

$A_{d1} = \frac{1}{2}\sqrt{2 \times 4m \times 0.5m} \times 3K = 3\ V/V$ 2

ii) $A_{cm1} = \dfrac{v_{o1}}{v_{cm}} = -\dfrac{R_D}{\frac{1}{g_m} + 2r_{o4}} = -\dfrac{3K}{0.5K + 100K}$ 6

$= -0.03\ V/V$ 4



Half circuit

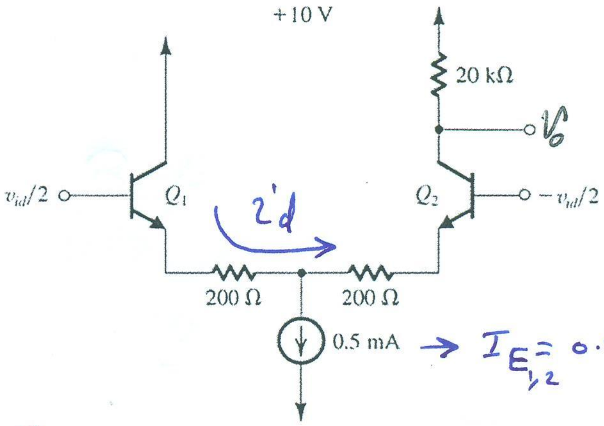
iii) $CMRR = \left|\dfrac{A_{d1}}{A_{cm1}}\right| = \dfrac{3}{0.03}$

$= 100$

5

B. For the BJT pair shown below, β=100 & $\alpha \approx 1$, ignore r_o,

i. Find the differential mode gain $A_d=(v_o/v_{id})$. [10 points]
ii. Find the differential input resistance R_{id}. [10 points]



→ $I_{E_{1,2}} = 0.25mA$

i

$$i_d = \frac{v_{id}}{2r_e + 200 + 200}$$ 4

$$r_e = \frac{V_T}{I_E} = \frac{25m}{0.25m} = 100\Omega$$ 2

$$v_o = i_d \times 20K = \frac{v_{id}}{600} \times 20K$$ 2

$$A_d = \frac{v_o}{v_{id}} = 33.3 \; V/V$$ 2

ii

$$R_{id} = 2 \times r_\pi + (\beta+1)(200+200)$$ 8

$$= 2 \times (101)(100) + (101)(400) = 60600\Omega$$ 2

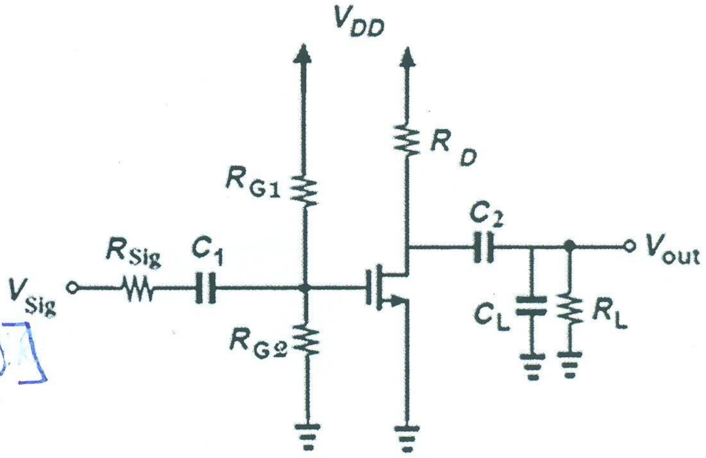
Question No. 2 [30 points]

In the circuit shown, $g_m = 1$ ms, $C_{gs} = 10$ pF, $C_{gd} = 1$ pF, $R_{sig} = 10$ kΩ, $R_{G1} = 2$ MΩ, $R_{G2} = 2$ MΩ, $R_D = 18$kΩ, $C_L = 50$ pF, and $R_L = 18$ KΩ.

a- Drive the expressions for all high frequency poles. [12 points]

b- Find the high corner frequency W_H. [8 points]

c- Find the Midband voltage gain $A_M = V_{out}/V_{sig}$. [10 points]



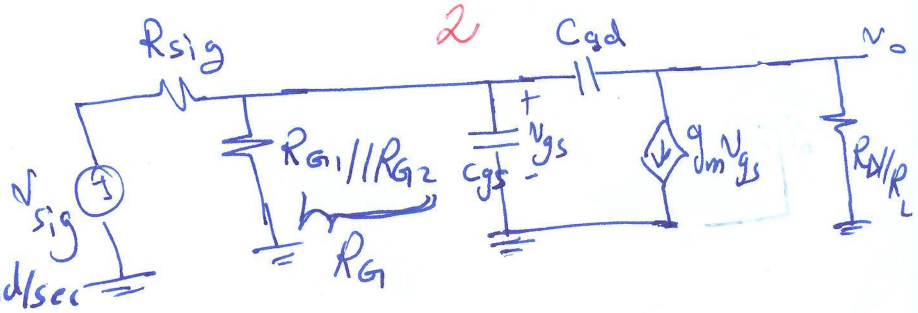
a)

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

$C_1 = C_{gd}(1-K) = C_{gd}[1 + g_m(R_L \| R_D)]$

$= 1p[1 + 1m \times 9K] = 10pF$

$C_{eq} = 10pF + 10pF = 20pF$



$\omega_{H_1} = \dfrac{1}{C_{eq}[R_{sig} \| R_G]}$

$\omega_{H_1} = \dfrac{1}{20P[10K \| 1M]} \simeq 5M$ rad/sec

4

$\omega_{H2} = \dfrac{1}{(C_L + C_2)(R_D \| R_L)}$; $C_2 = C_{gd}(1 - \frac{1}{K}) = C_{gd}(1 + \frac{1}{9}) = 1.1 pF$

$= \dfrac{1}{51.1P \times 9K} = 2.174 M$ rad/sec 4

b)

$\omega_H \simeq \dfrac{1}{\frac{1}{\omega_{H1}} + \frac{1}{\omega_{H2}}} = 1.52 M$ rad/sec

8

c)

$A_M = \dfrac{V_{out}}{V_{sig}} = \dfrac{R_G}{R_{sig} + R_G}(-g_m R_D \| R_L) \simeq 0.99 \times (-1m \times 9K)$

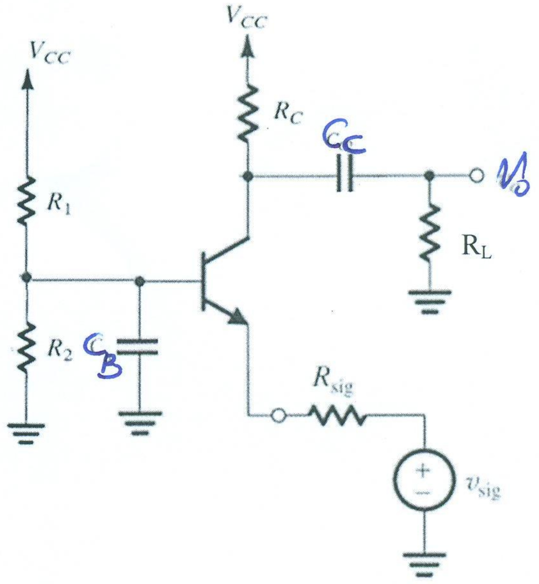
10

$\simeq -8.91$ V/V

Question No. 3 [25 points]

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

- a- Drive the expressions for all low frequency poles. [10 points]
- b- Find an expression for the low corner frequency f_L (*do not neglect any pole*). [5 points]
- c- Drive the expressions for the Midband voltage gain $A_M = V_o/V_{sig}$. [10 points]



a) Low Freq. Poles:

$$\omega_{L1} = \frac{1}{C_B R_{CB}}$$

$$R_{CB} = R_1 // R_2 // [r_\pi + (\beta+1) R_{sig}]$$

$$\omega_{L2} = \frac{1}{C_C (R_C + R_L)}$$

10

b) $\omega_L \simeq \omega_{L1} + \omega_{L2}$

5

c) $A_M = \dfrac{R_C // R_L}{r_e + R_{sig}}$

10