國立中正大學
114學年度碩士班招生考試
試 題

[第 4 節]

科目名稱	電子學
系所組別	電機工程學系－電磁晶片組 計算機工程組 晶片系統組

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

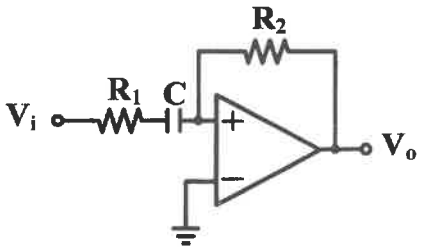
國立中正大學 114 學年度碩士班招生考試試題

科目名稱:電子學　　本科目共 2 頁第 1 頁

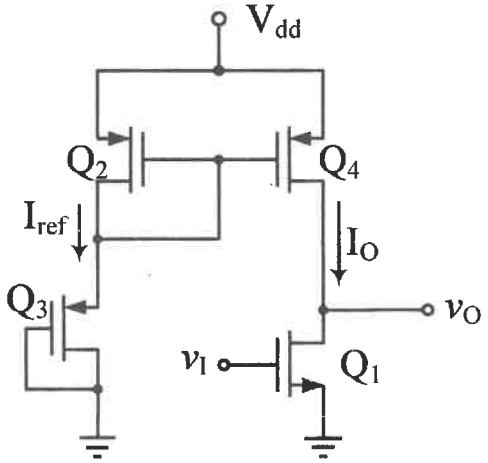
系所組別:電機工程學系-電磁晶片組、計算機工程組、晶片系統組

1. (20%) For an operation in triode region, the NMOS transistor is biased with v_{DS}=0.3V, it conducts 48μA for v_{GS}=2V and 96μA for v_{GS}=3V, respectively.
   (a) (5%) What is the possible threshold voltage V_{TN} ?
   (b) (5%) This transistor is manufactured by 0.18μm process technology and the related k_n' ($=\mu_n C_{ox}$) is 20μA/V^2, what is the aspect ratio (W/L) for it?
   (c) (5%) How much current can be expected to flow through it with v_{GS}=2.85V and v_{DS}=0.25V?
   (d) (5%) If the device operates at v_{DS}=2V, for what value of v_{GS} will the drain-end of the MOSFET channel just become pinch-off .

2 (20%) As shown in the right-hand-side OP-amp circuit,
   (a) (5%) Does it behave like low-pass or high-pass? Please show it by deriving the transfer function.
   (b) (5%) What's the high frequency gain ?
   (c) (5%) What's the 3-dB frequency?
   (d) (5%) At what frequency does the magnitude of high frequency gain reduce to unity?



3 (20%) A MOSFET amplifier with active load is biased with V_{dd} =3 V. The transistor parameters are V_{TN} = 0.5V, V_{TP} = −0.5 V, k'_n= 100μA/V^2, k'_p= 50μA/V^2, and λ_n =λ_p =0.02V^{-1}. The quiescent values are V_O = 1.5 V and V_I = 1.2 V. Q_2 and Q_4 are identical.
   (a) (5%) Taking the channel length modulation effect into considerations to design the required W/L ratio of Q_1, Q_2, Q_4 and Q_3 such that $I_O = I_{ref}$ = 100μA.
   (b) (5%) Please calculate the output resistances (r_{o1} and r_{o4}) of Q_1 and Q_4.
   (c) (5%) Please calculate the transconductance g_{m1} of Q_1.
   (d) (5%) Determine the small-signal voltage gain (v_O/v_I).



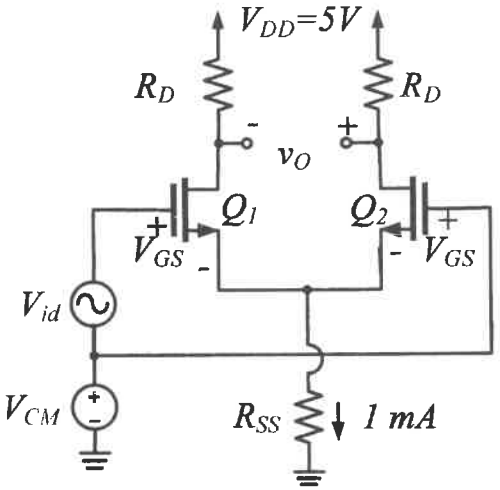
4 (20%) A differential amplifier using a 1kΩ resistor R_{ss} to establish a 1mA dc biased current. The transistors Q_1 and Q_2 are with the properties of k'_n (W/L) = 4mA/V^2, V_{TN}=0.8V. Skip the channel length modulation effect.

(a) (5%) Define the required value of V_{CM}.

(b) (5%) Define the value of R_D so as to get a differential gain A_d of 10 V/V.

(c) (5%) What's the drain voltage over Q_1.

(d) (5%) Determine the common-mode gain $\Delta V_{D1}/\Delta V_{CM}$.



5 (20%) A feedback transresistance amplifier utilizes two identical MOSFETs biased by an ideal current sources I = 0.4 mA. The MOSFETs are sized to operate at V_{OV} = 0.2 V and have V_{TN} = 0.5 V and V_A = 16 V. The feedback resistance R_F = 10 kΩ.

(a) (5%) What's the dc voltage at the input of Q_1?

(b) (5%) What are g_m and r_o of Q_1 and Q_2?

(c) (5%) Derive the open-loop gain in terms of g_{m1}, r_{o1}, g_{m2}, r_{o2} and R_F

(d) (5%) Please express the gain-with-feedback (A_f)