國立中山大學109學年度
碩士暨碩士專班招生考試試題

科目名稱：電子學【電機系碩士班甲組】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學109學年度碩士暨碩士專班招生考試試題

科目名稱：電子學【電機系碩士班甲組】　　題號：431009

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共1頁第1頁

Please note that all calculation answers must include the unit and calculation process.

1. (40pt) The NMOS transistor in the CS amplifier shown in Fig. 1 has $V_t = 0.7$ V, $V_A = 50$ V, $R_{sig} = 120$ kΩ, $R_{G1} = 300$ kΩ, $R_{G2} = 200$ kΩ, $R_D = 5$ kΩ, $R_S = 2$ kΩ, $R_L = 5$ kΩ, and $V_{DD} = 5$ V. (a) Neglecting the channel length modulation effect, the MOSFET is operating in saturation with $I_D = 0.5$ mA and $V_{OV} = 0.3$ V. What must the MOSFET's $\mu_n C_{ox}(W/L)$ be? What is the dc voltage at the drain? (b) Find the input resistance R_{in} and overall gain v_o/v_{sig} (V_A effect needs to be considered). (c) If v_{sig} is a sinusoid with a peak amplitude v_s, find the maximum allowable value of v_s for which the transistor remains in saturation. What is the corresponding amplitude of the output voltage? (d) What is the value of resistance R_3 that needs to be inserted in series with capacitor C_{C3} as shown in Fig. 2 in order to allow us to double the input signal peak amplitude v_s? What output voltage now results? (10pt*4)
2. (20pt) For the follower circuit in Fig. 3, let transistor Q_1 has $\beta = 50$ and transistor Q_2 has $\beta = 100$, $V_{CC} = 5$ V, $R_{B1} = R_{B2} = 1$ MΩ, $I_1 = 50$ μA, $I_2 = 5$ mA and neglect the Early effect. Use constant voltage drop model of $V_{BE} = 0.7$ V. Thermal voltage $V_T = 25$ mV. (a) Find the dc emitter current and the dc base voltage of Q_1 transistor. (b) If a load resistance $R_L = 1$ kΩ is connected to the output terminal, find the voltage gain from the base to the emitter of Q_2 and the input resistance R_{ib2} looking into the base of Q_2. (10pt*2)
3. (15pt) A current-mirror-loaded MOS differential amplifier of the type shown in Fig. 4 is specified as follows: $(W/L)_n = 100$, $(W/L)_p = 200$, $\mu_n C_{ox} = 2\ \mu_p C_{ox} = 0.2$ mA/V^2, $V_{An} = |V_{Ap}| = 20$ V, and $I = 0.8$ mA. (a) Calculate the differential gain A_d. (b) Let the output resistance of current source is 25 kΩ. Calculate common-mode gain $|A_{cm}|$ and CMRR (in dB). (5pt, 10pt)
4. (25pt) Consider a CC-CE amplifier such as that in Fig. 5 with the following specifications: $I_1 = I_2 = 1$ mA and identical transistors with $\beta = 100$, $f_T = 400$ MHz, and $C_\pi = 2$ pF. Thermal voltage $V_T = 25$ mV. Let the amplifier be fed with a source v_{sig} having a resistance $R_{sig} = 4$ kΩ, and assume a load resistance $R_L = 4$ kΩ. Find the midband voltage gain v_o/v_{sig} and estimate the 3-db frequency f_H by the method of open-circuit time constants (please show the value of each time constant). (5pt, 20pt)

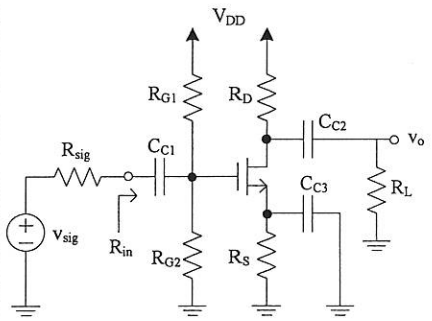

Fig. 1

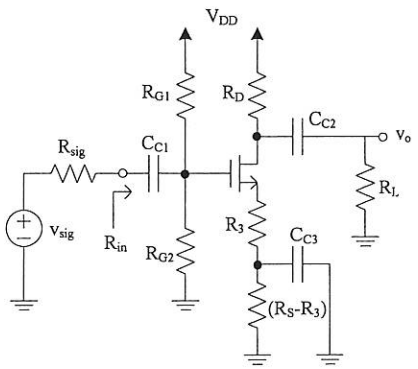

Fig. 2

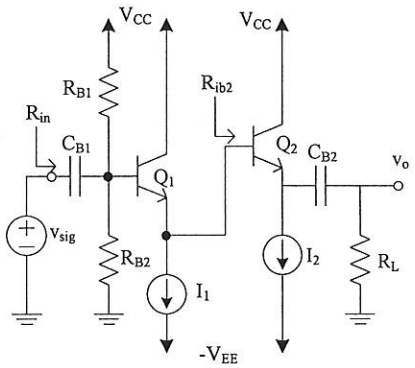

Fig. 3

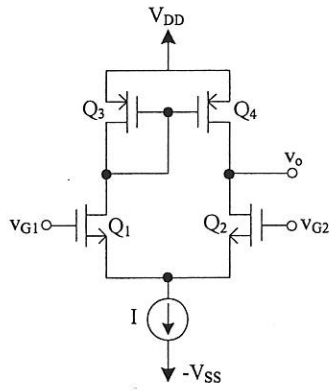

Fig. 4

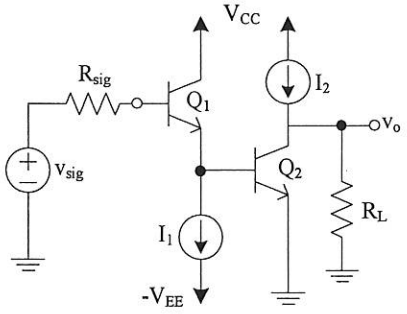

Fig. 5

試題請隨卷繳回，請留意背面是否有題