

國立中山大學 114 學年度 碩士班考試入學招生考試試題

科目名稱：電子學【電機系碩士班乙組選考、戊組選考、通訊所碩士班乙組選考、電波聯合碩士班選考】

—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，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，後果由考生自負。
- 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，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 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。

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※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 2 頁第 1 頁

1. (15%) A third-order low-pass filter has transmission zeros at $\omega = 5$ rad/s and at $\omega = \infty$. Its natural modes are at $s = -2$ and $s = -0.3 \pm j0.6$. The dc gain is unity. Find the transfer function $T(s)$.
2. (30%) In the circuit of Fig. 1, the NMOS transistor has $|V_t| = 0.9$ V, and $V_A = 100$ V, and operates with $V_D = V_{GS} = 2$ V. (a) What is the voltage gain v_o/v_i ? (10%) (b) What does V_D become when I increase to 1 mA? (10%) And (c) what is the new gain? (10%)

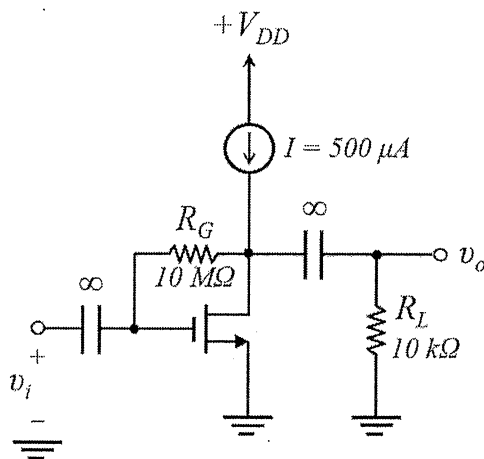


Fig. 1

3. (30%) The current-steering circuit of Fig. 2 is fabricated in a CMOS technology for which $k'_n = 90 \mu\text{A}/\text{V}^2$, $k'_p = 30 \mu\text{A}/\text{V}^2$, $V_{tn} = 0.8 \text{ V}$, and $V_{tp} = -0.9 \text{ V}$. If all devices have $L = 2 \mu\text{m}$, design the circuit so that $I_{REF} = 20 \mu\text{A}$, $I_2 = 100 \mu\text{A}$, and $I_5 = 40 \mu\text{A}$. Use the minimum width of $2 \mu\text{m}$ for as many of the devices as possible. (a) Give the required width for each transistor and the value of R required. (10%) (b) What is the highest voltage possible at the drain of Q_2 ? (5%) (c) What is the lowest voltage possible at the drain of Q_5 ? (5%) (d) If $V_{An} = 6 L$ and $|V_{Ap}| = 10 L$, where L is in μm and V_{An} and V_{Ap} are in volts, (d) find the output resistance of the current source Q_2 , (5%) and (e) the output resistance of the current sink Q_5 . (5%)

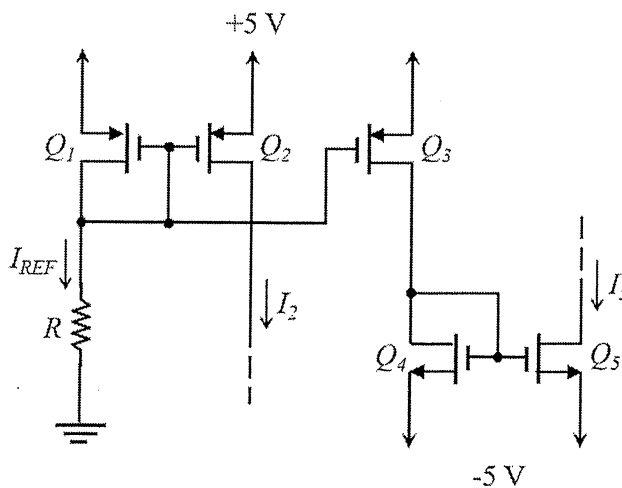


Fig. 2

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4. (25%) In the emitter follower in Fig. 3, the signal source is directly coupled to the transistor base. If the dc component of v_s is zero, (a) find the dc emitter current. Assume $\beta = 120$. (5%) Neglecting r_o , (b) find R_i , (5%) (c) the voltage gain v_o/v_s , (5%) (d) the current gain i_o/i_i , (5%) and (e) the output resistance R_o . (5%)

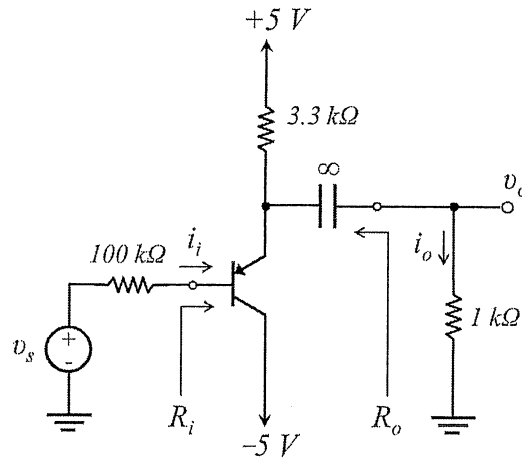


Fig. 3