國 立 清 華 大 學 命 題 紙

九十二學年度 電子工程研判所 系（所） 組碩士班研究生招生考試

科目 電子學 科號 2602 共 3 頁第 1 頁 *請在試卷【答案卷】內作答

1. For the circuit shown in Fig. 1, the transistor parameters are $\beta = 100$, $V_A = \infty$, $V_{BE(on)} = 0.7$ V, and kT/q = 25 mV. Perform the DC analysis, find I_{B1} (2%), I_{C1} (1%), I_{E1} (1%), I_{C2} (1%), I_{E2} (1%), V_{CE1} (2%), and V_{CE2} (2%). Plot the small-signal equivalent circuit of this amplifier (3%). Find out the parameters of g_{m1} (1%), g_{m2} (1%), $r_{\pi 1}$ (1%), and $r_{\pi 2}$ (1%). Calculate the voltage gain v_o/v_s (5%), the input resistance R_{is} (2%), and the output resistance R_o (1%).

Fig. 1

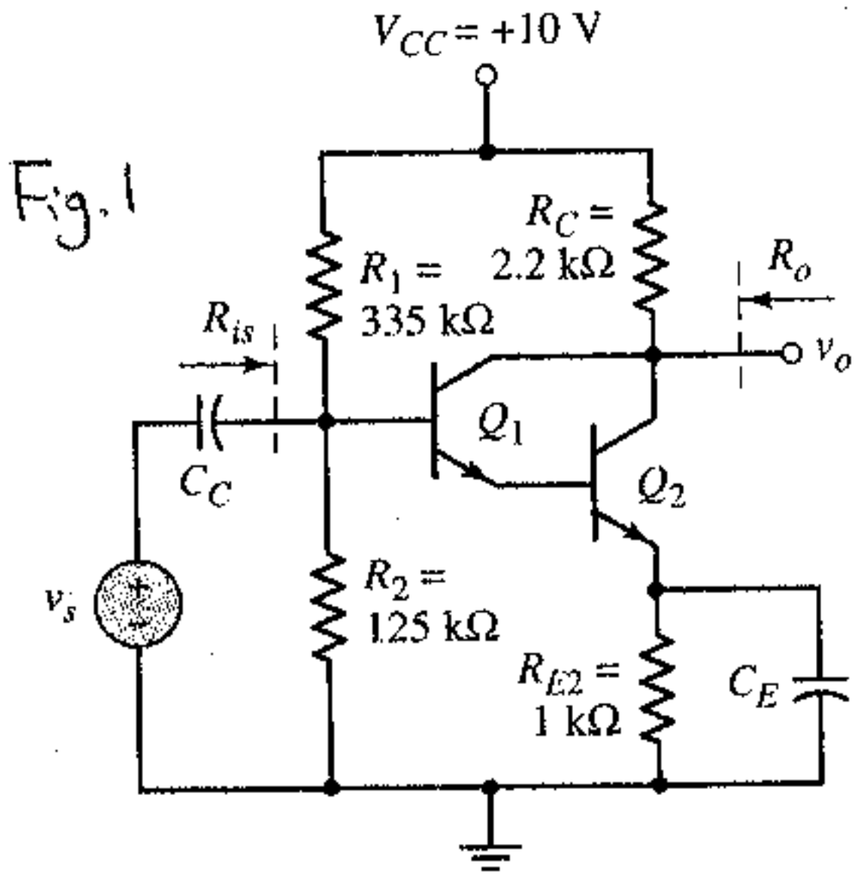
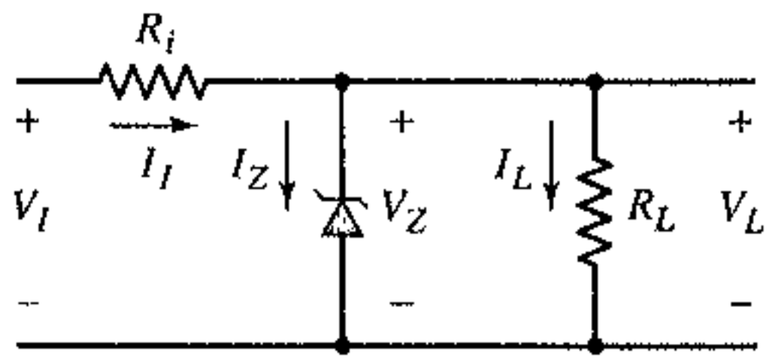


Fig. 2



2. In the voltage regulator shown in Fig. 2, $V_I = 6.3$ V, $R_i = 12\ \Omega$, and $V_Z = 4.8$ V. If I_Z is in the range of 100 mA $\geq I_Z \geq$5 mA, find the range for I_L (3%) and R_L (2%). Also, find the power rating for the Zener diode (2%) and R_L (3%).

Use the following device parameters, NMOS $V_{TN} = 1$ V, $k' = 100\ \mu A/V^2$, $\lambda = 0.01\ V^{-1}$; PMOS $V_{TP} = -1$ V, $k' = 40\ \mu A/V^2$, $\lambda = 0.01\ V^{-1}$ for Problems 3 and 4.

3. For the circuit in Fig. 3, M_2 and M_3 are identical PMOSFETs, M_1 with $C_{gs} = 100$ fF, $C_{gd} = 10$ fF, W = 10 μm, L = 5 μm. Neglect all other parasitic capacitances. (20%)

(a) Find the small-signal transfer function of this circuit. (5%)

(b) Find the dominant poles of this circuit. (5%)

(c) What is the small-signal voltage gain at low frequency? (5%)

(d) Sketch the gain and phase Bode plots of this circuit. (5%)

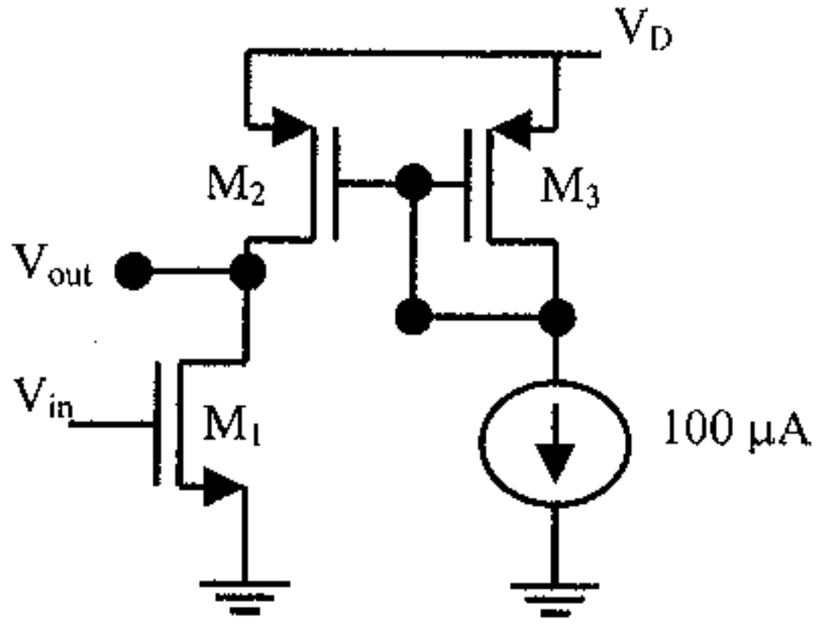


Fig. 3

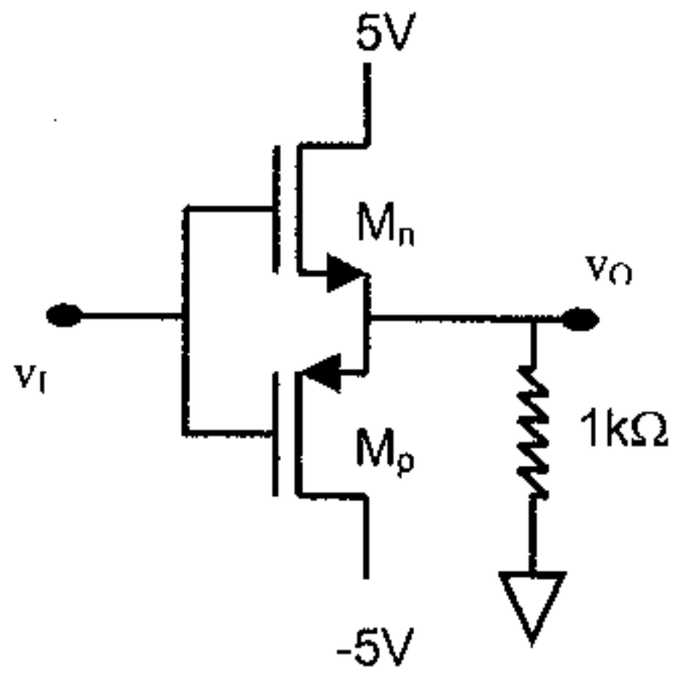


Fig. 4

4. Class-B Output Stage in Fig. 4. (10%)
(a) Plot the transfer characteristics, v_O–v_I for v_I ranges from –5 V to 5 V. Please label the maximum and minimum v_O obtainable. (5%)
(b) Explain what crossover distortion means and propose a method to reduce crossover distortion in the circuit. (5%)

5. The input signal v_{in} applied to the circuit shown in Fig. 5 is a 0-10 V sawtooth having a rise time of 8 μs and a fall time of 2 μs. Accurately sketch the resulting output voltage v_o. (15%)

6. Determine the frequency of oscillation and the value of R_{c1} for which the circuit shown in Fig. 6 just oscillates. Assuming that Q_1 and Q_2 have h_{ie} (or r_π) = 1 kΩ and h_{fe} (or β) = 100. (10%)

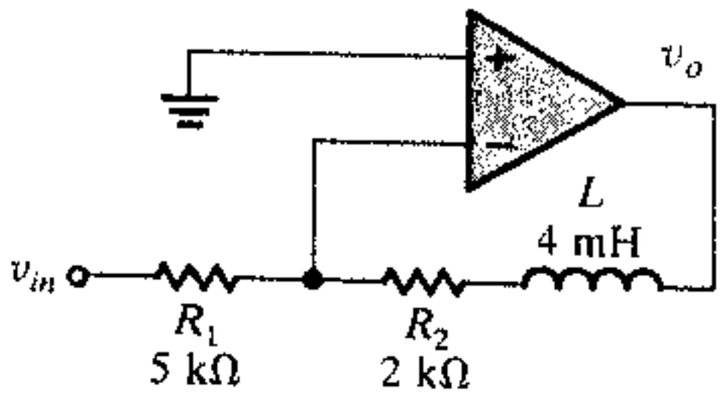


Fig. 5

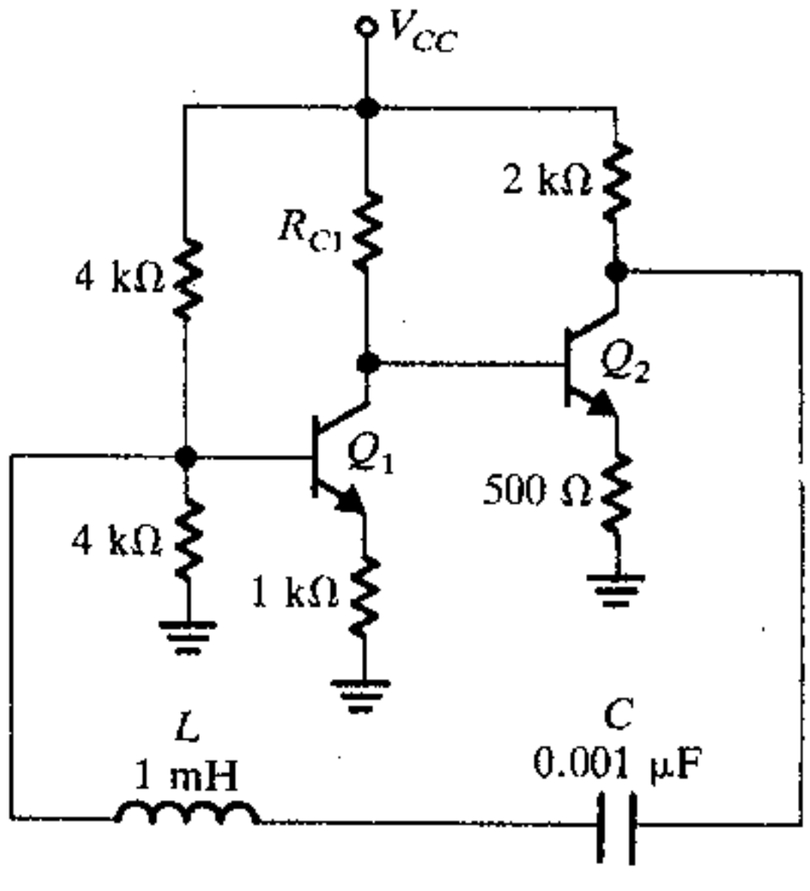


Fig. 6

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7. A noninverting amplifier shown in Fig. 7 is constructed with $R_2 = 100$ Ω and R_f adjustable. The op amp open-loop gain is $A_{OL}(s) = 10\alpha^3/[(s + \alpha)(s + 2\alpha)^2]$.

(a) Find the value of R_f that will just place one of the closed-loop amplifier poles at $s = -3\alpha$. (5%)

(b) For the value of R_f chosen in part (a), what are the locations of the other two amplifier poles? (5%)

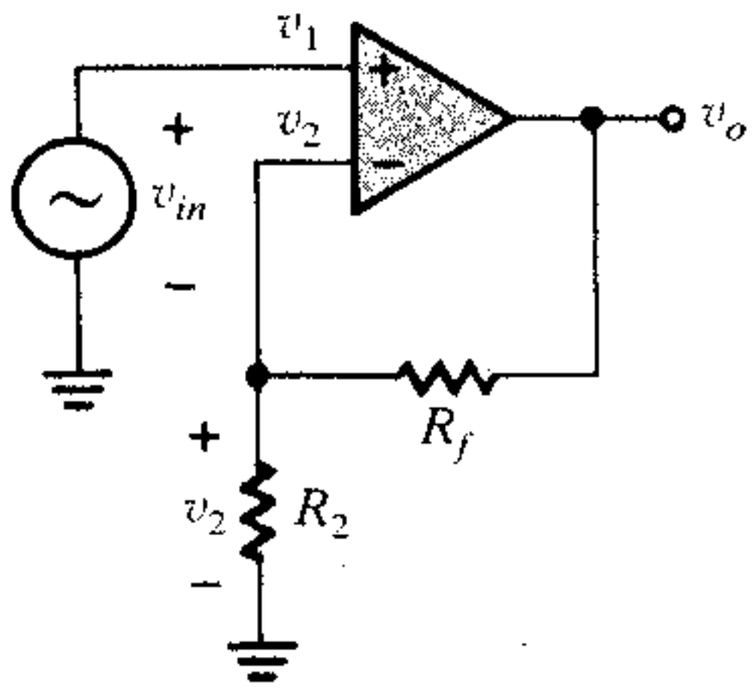

Fig. 7