國 立 清 華 大 學 命 題 紙

96 學年度 動力機機工程學 系 乙（電機控制）組 碩士班入學考試

科目 電路學及電子學 科目代碼 1102 共 4 頁 第 1 頁 *請在【答案卷內】內作答

1. Consider a circuit shown below. Assume that the switch K_1 has contacted point A for a long time and switch K_2 is open. R, L and C represent the resistance, the inductance and the capacitance respectively.

   (a) Find V_C. (5%)

   (b) If K_1 is switched to point B at t = 0 and K_2 is still open, find $v(t)$ for $t \geq 0$. (5%)

   (c) If K_1 is switched to point B at t = 0 and K_2 is closed at the same time, draw roughly the possible waveforms of $v(t)$ for $t \geq 0$. (5%)

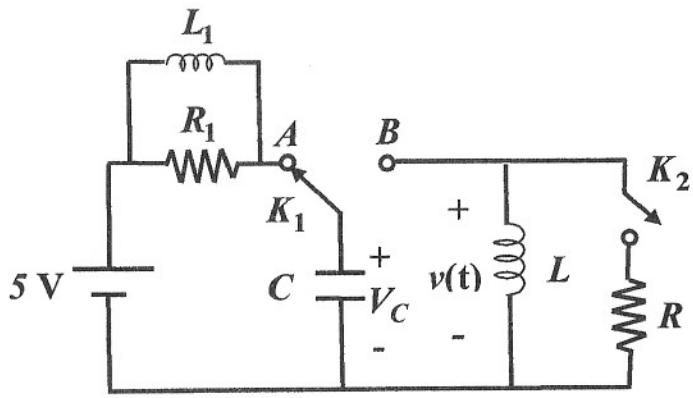

Figure 1

2. Assume that the following two circuits as shown in Fig. 2 are equivalent.

   (a) Find V_{TH} and R_{TH}. (10%)

   (b) Prove that the circuit has delivered maximum power to R when $R = R_{TH}$. (5%)

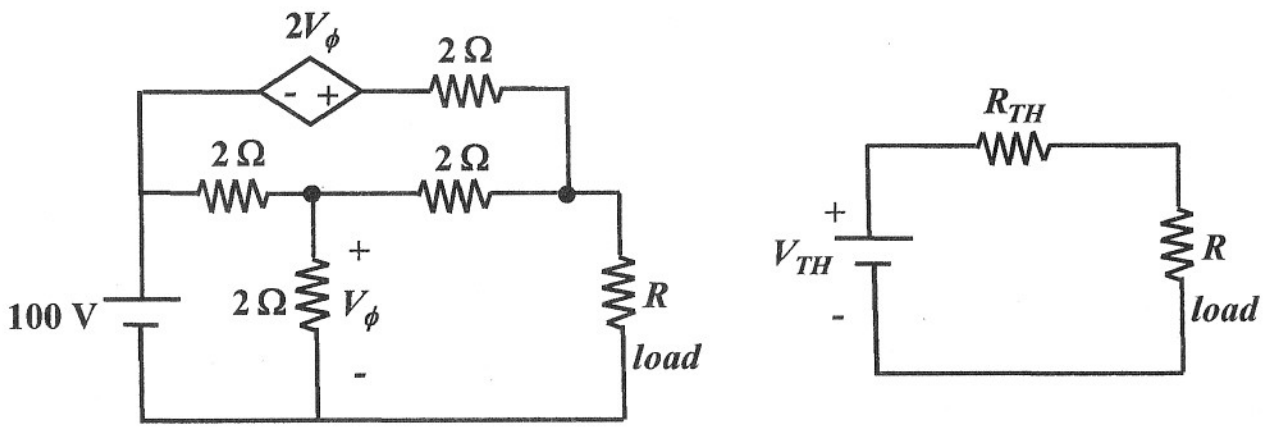

Figure 2

3. Consider a circuit shown in Fig. 3A. Fig. 3B is the phasor-domain equivalence circuit of Fig. 3A.

(a) Find I_S, Z_{R1}, Z_{R2}, Z_L and Z_C in Fig. 3B. (5%)

(b) Use the values of (a) to find the matrix A and the vector C in the following node-voltage equation

$$A \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = C$$

where V_1 and V_2 in Fig. 3B are phasors of node voltage. (10%)

(c) Find i(t) when the circuit is in sinusoidal steady state. (5%)

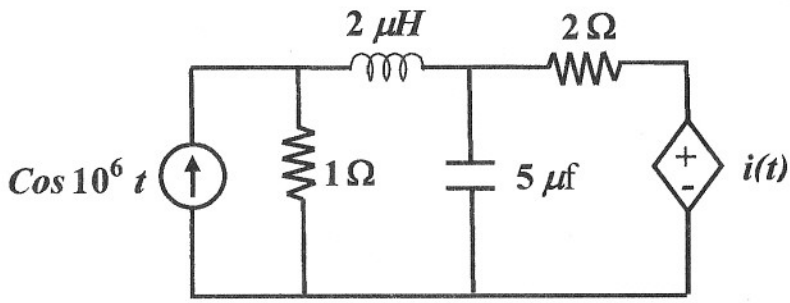

Figure 3A

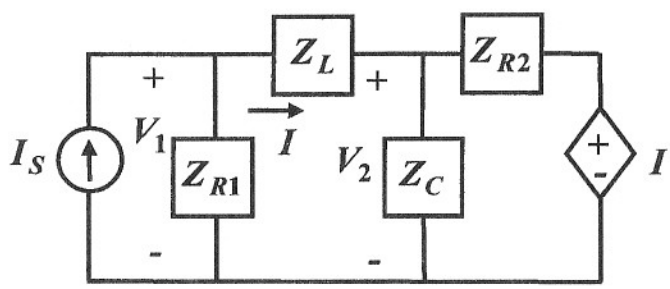

Figure 3B

4. The circuit shown in Fig. 4 is a general two-pole active filter formed by an ideal operational amplifier and four admittances Y_1, Y_2, Y_3, and Y_4 of passive elements. Find the transfer function of V_o / V_i in terms of Y_1, Y_2, Y_3, and Y_4. (10%).

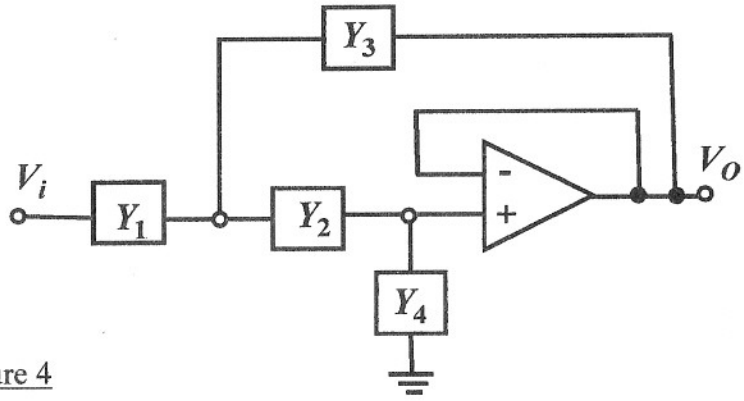

Figure 4

5. For the circuit shown in Fig. 5, the collector current of Q_2 is I_{C2}= 1.6 mA and the voltage across Q_2 is V_{CE2} = 6 V. Assume that β = 100 and $|V_{BE}|$ = 0.7 V for the transistors.

(a) Find R_{E2}. (5%)

(b) Use the results of part (a) to find V_{EC1}. (5%)

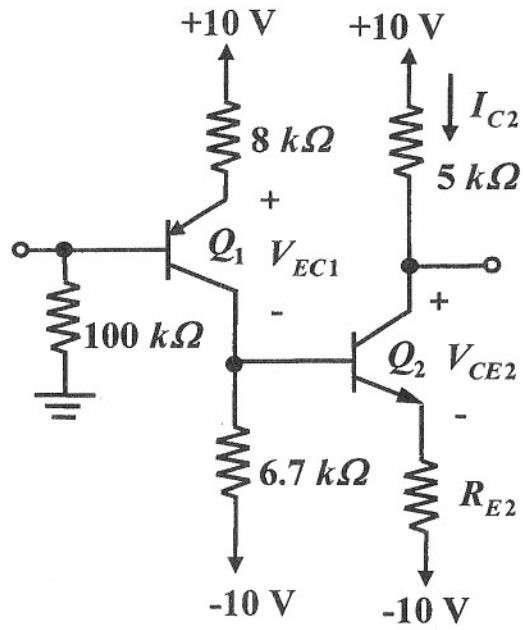

Figure 5

6. The circuit shown in Fig. 6 is a MOSFET current mirror with active load.

(a) Draw the small-signal equivalent circuit. (5%)

(b) Derive the expression for the output resistance R_O. (5%)

(c) Derive the expression for the voltage gain v_O/v_I. (5%)

(Notice that please include the output resistance r_o of all transistors in your answers.)

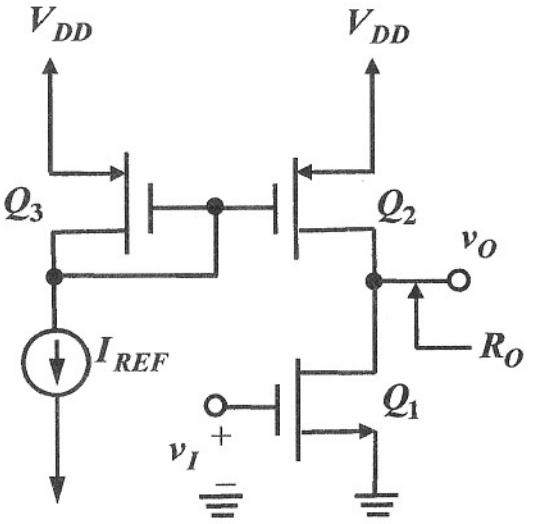

Figure 6

7. The circuit shown in Fig. 7 is a common-gate amplifier with loads R_L and C_L. Using the open-circuit time constant method to estimate the 3-dB frequency f_H for the circuit. The body effect of the transistor can be neglected. In the transistor, only the internal capacitances between gate and drain C_{gd}, and between gate and source C_{gs} are considered in this circuit. (15%)

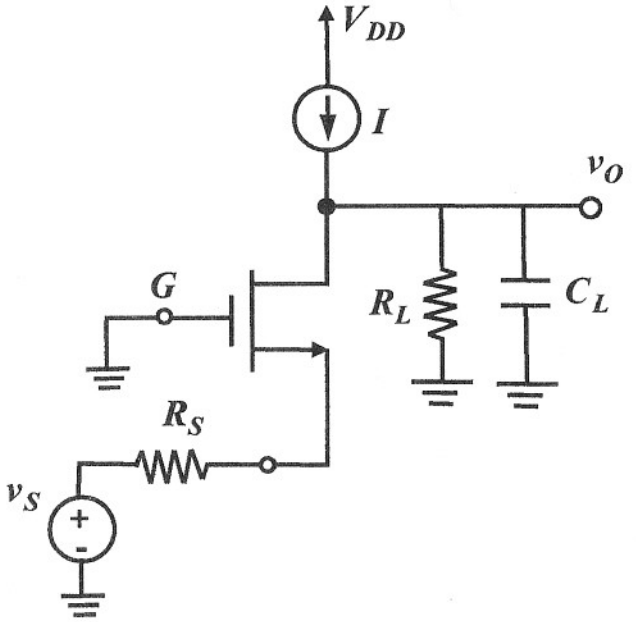

Figure 7