國　立　清　華　大　學　命　題　紙

95 學年度 動力機械工程學 系（所） 乙 組碩士班入學考試

科目 電路學及電子學 科目代碼 1602 共 肆 頁第 壹 頁 *請在【答案卷卡】內作答

Note: Assuming whatever variables and/or parameters if necessary.

1. In the following circuit as shown in Fig. 1, denote the power delivered to the load R_L by P_L. Obtain the expression for P_L as a function of R_L. From this expression, find the value of R_L for maximum power transfer and the associated maximum power. (10%)

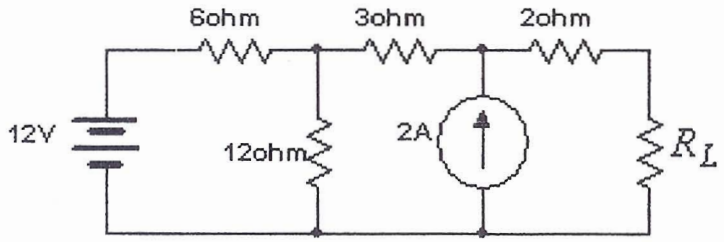

Fig. 1

2. The step response of V_c of the RC circuit as shown in Fig. 2a is measured. From this step response as shown in Fig. 2b, find:
   (i) The time constant of the system (4%)
   (ii) R (2%)
   (iii) V_s (3%)
   (iv) $i(0^+)$ (3%)

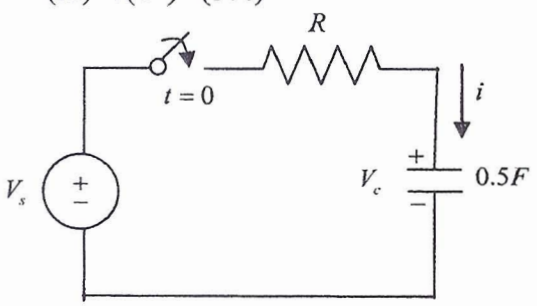

Fig. 2a

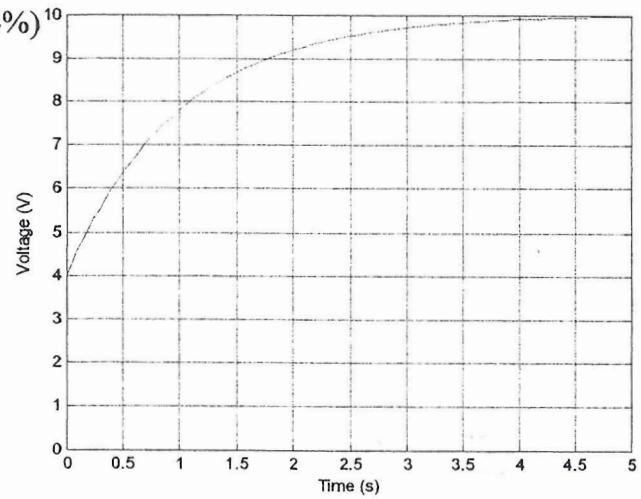

Fig. 2b

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3. A sinusoidal voltage of $4\sin(\omega t)\,V$ is applied across the terminals of a black box and the instantaneous power absorbed by the box is measured below in Fig. 3. Please find:
   (i) The frequency of the sinusoidal voltage (in rad/s) (2%),
   (ii) The average power, the reactive power, and the complex power. (4%)
   (iii) Moreover, determine whether the black box is a series RL or a series RC circuit. Find the R, L (or C) values. (6%) ***(Hint:*** $2\sin A\sin B=\cos(A-B)-\cos(A+B)$***)***

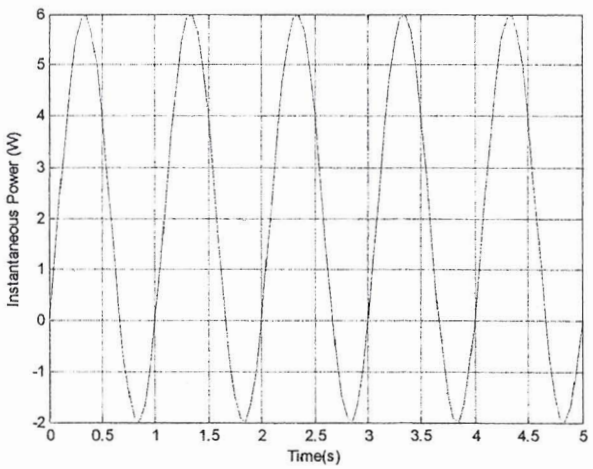

Fig. 3

4. In the following circuit as shown in Fig. 4, $u(t)$ is a unit step function. Find
   (i) $i_1(0), i_2(0)$, and $v_0(0^+)$ (2%)
   (ii) $i_1(\infty)$ and $i_2(\infty)$ (2%)
   (iii) The mesh equations for $i_1(t)$ and $i_2(t)$ (3%)
   (iv) The characteristic equation of the circuit (3%)
   (v) $i_1(t)$ and $v_0(t)$. (6%)

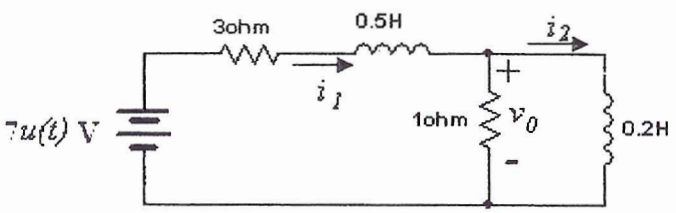

Fig. 4

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5. Determine the β value for the following transistor circuit with R_C=1.2 k ohm, R_F=33 k ohm as shown in Fig. 5 where a minimal voltage gain of v_o/v_i =250 is needed. (15 %)

Note: $\gamma_\pi = \dfrac{25mV}{I_B}$, $g_m = \dfrac{\beta}{\gamma_\pi}$ and $V_{BE,\ active}$= 0.7 V.

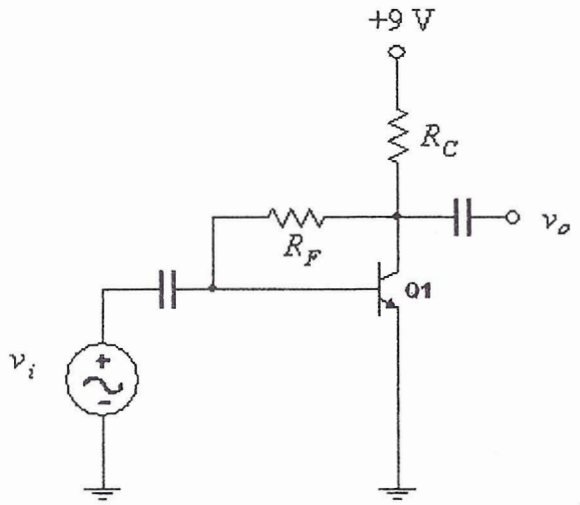

Fig. 5

6. Assuming the OP AMP in Fig. 6 is ideal and β=∞, $V_{CE,\ sat}$ = 0. 2V for transistor Q1. With the following parameters given as: V_i =12 V, V_z=5V, R_1=R_2=10 k ohm, R_3= 100 ohm R_L=20 ohm. (15 %)

(i) Determine V_L and I_i .

(ii) Determine the minimum operating voltage of V_i .

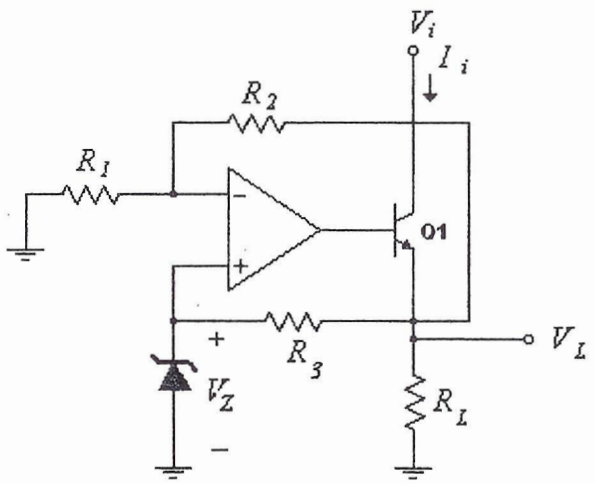

Fig. 6

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7. Consider the following OPAMP circuit as shown in Fig. 7 which is a phase-lead compensator for the purpose of feedback control.
   (i) Derive the transfer function of $v_o(s)/v_i(s)$ in terms of R_1, R_2, C_1 and C_2 (10 %)
   (ii) If we let $T=R_2C_2$, and $\alpha=R_2/R_1=C_2/C_1$. Obtain the maximum phase lead, θ_m, and the frequency ω_m in terms of α and T. (10 %)

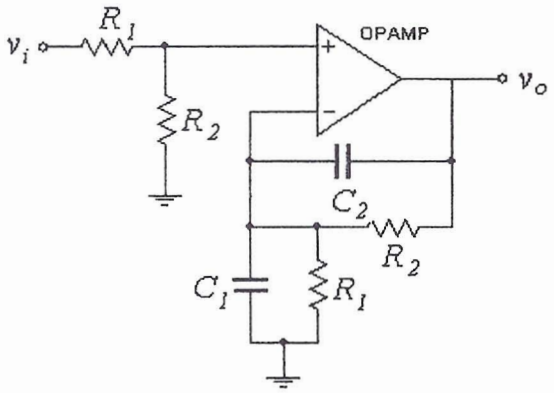

Fig. 7

The End of the test