JUNE 2005

Code: A-08
Subject: CIRCUIT THEORY & DESIGN
Time: 3 Hours
Max. Marks: 100

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x8)

a.

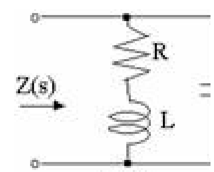

Fig.1

The poles of the impedance Z(s) for the network shown in Fig.1 below will be real and coincident if

(A) $R = 2\sqrt{\frac{L}{C}}$. **(B)** $R = 4\sqrt{\frac{L}{C}}$.

(C) $R = \frac{1}{2}\sqrt{\frac{L}{C}}$. **(D)** $R = 2\sqrt{\frac{C}{L}}$.

b. The network shown in part a has zeros at

(A) s = 0 and s = ∞. **(B)** s = 0 and s = $-R/L$.

(C) s = ∞ and s = $-R/L$. **(D)** s = ∞ and s = $-\frac{1}{CR}$.

c. Of the two methods of loop and node variable analysis

(A) loop analysis is always preferable.
(B) node analysis is always preferable.
(C) there is nothing to choose between them.
(D) loop analysis may be preferable in some situations while node analysis may be preferable in other situations.

d. In a double tuned circuit, consisting of two magnetically coupled, identical high-Q tuned circuits, at the resonance frequency of either circuit, the amplitude response has

(A) a peak, always. **(B)** a dip, always.
(C) either a peak or a dip. **(D)** neither a peak nor a dip.

e. In a series RLC circuit with output taken across C, the poles of the transfer function are located at $-\alpha \pm j\beta$. The frequency of maximum response is given by

(A) $\sqrt{\beta^2 - \alpha^2}$. **(B)** $\sqrt{\alpha^2 - \beta^2}$.
(C) $\sqrt{\beta^2 + \alpha^2}$. **(D)** $\sqrt{\alpha\beta}$.

f. A low-pass filter (LPF) with cutoff at 1 r/s is to be transformed to a band-stop filter having null response at ω_0 and cutoff frequencies at ω_1 and ω_2 $(\omega_2 > \omega_1)$. The complex frequency variable of the LPF is to be replaced by

(A) $\dfrac{s^2 + \omega_0^2}{(\omega_2 - \omega_1)s}$. **(B)** $\dfrac{(\omega_2 - \omega_1)s}{s^2 + \omega_0^2}$.
(C) $\left(\dfrac{s}{\omega_1} + \dfrac{\omega_2}{s}\right)\omega_0$. **(D)** $\left(\dfrac{s}{\omega_2} + \dfrac{\omega_1}{s}\right)\omega_0$.

g. For an ideal transformer,

(A) both z and y parameters exist.
(B) neither z nor y parameters exist.
(C) z-parameters exist, but not the y-parameters.
(D) y-parameters exist, but not the z-parameters.

h. The following is a positive real function

(A) $\dfrac{(s+1)(s+2)}{(s^2+1)^2}$. **(B)** $\dfrac{(s-1)(s+2)}{s^2+1}$.
(C) $\dfrac{s^4+s^2+1}{(s+1)(s+2)(s+3)}$. **(D)** $\dfrac{(s-1)}{(s^2-1)}$.

PART I

Answer any THREE Questions. Each question carries 14 marks.

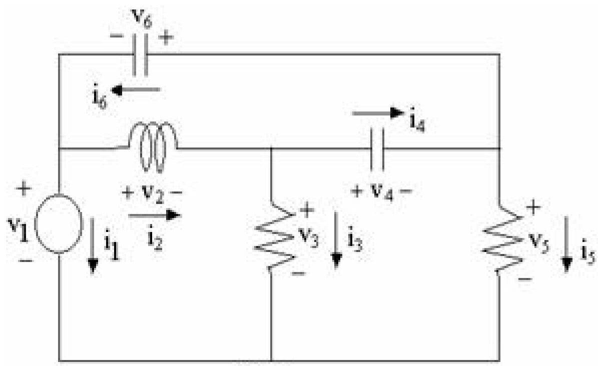

Fig.2

Q.2 a. In the circuit shown in Fig.2 below, it is claimed that $\sum_{k=1}^{6} v_k i_k = 0$. Prove OR disprove. **(7)**

b. A voltage source V_1 whose internal resistance is R_1 delivers power to a load $R_2 + jX_2$ in which X_2 is fixed but R_2 is variable. Find the value of R_2 at which the power delivered to the load is a maximum. **(7)**

Q.3 In the circuit shown in Fig.3 below, $v_3(t) = 2\sin 2t$. Using the corresponding phasor as the reference, draw a phasor diagram showing all voltage and current phasors. Also find $v_1(t)$ and $v_2(t)$. **(14)**

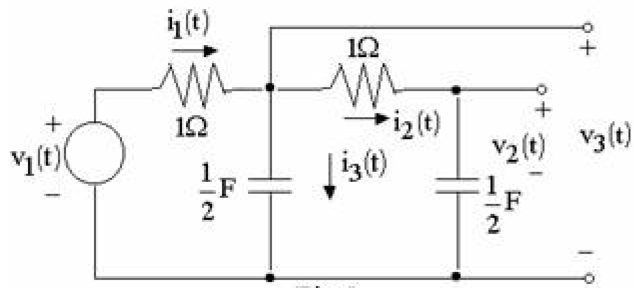

Fig.3

Q.4 a. In the circuit shown in Fig.4 below, $v_1(t) = 2\cos t$, $C = 1F$, $L_1 = L_2 = 1H$ and $M = \frac{1}{4}H$. Find the voltage $v_a(t)$. **(7)**

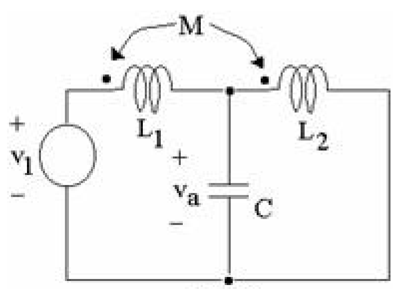

Fig.4

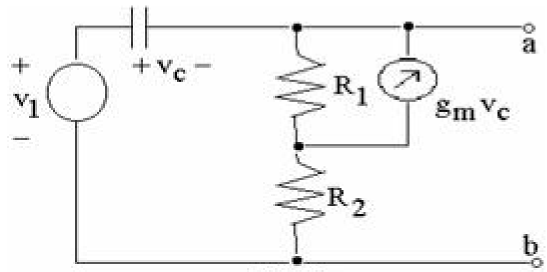

Fig.5

b. Determine the equivalent Norton network at the terminals a and b of the circuit shown in Fig.5 below. **(7)**

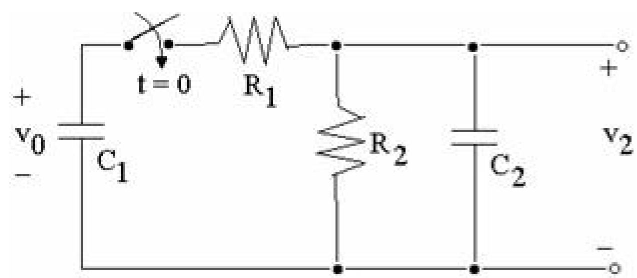

Fig.6

Q.5 In the network shown in Fig.6 below, $C_1 = C_2 = 1F$ and $R_1 = R_2 = 1\Omega$. The capacitor C_1 is charged to $V_0 = 1V$ and connected across the $R_1 - R_2 - C_2$ network at t = 0. C_2 is initially uncharged. Find an expression for $v_2(t)$. **(14)**

Q.6 a. The switch K (Fig.7) is in the steady state in position a for $-\infty < t < 0$. At t = 0, it is connected to position b. Find $i_L(t), t \geq 0$. **(7)**

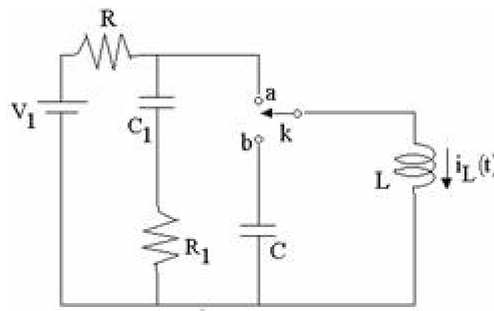

Fig.7

b. A battery of voltage v is connected at t = 0 to a series RC circuit in which the capacitor is relaxed at t = $0-$. Determine the ratio of the energy delivered to the capacitor to the total energy supplied by the source at the instant of time t. **(7)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

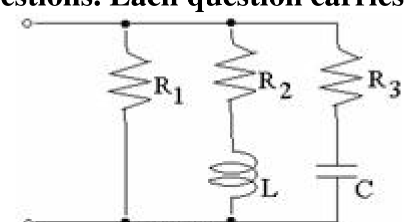

Fig.8

Q.7 Synthesize the admittance function $Y(s) = \dfrac{(s+2)(s+4)}{(s+1)(s+5)}$ in the form shown in Fig. 8 below. **(14)**

Q.8 Synthesize an RC ladder and an RL ladder network to realize the function $F(s)=\frac{s^2+4s+3}{s^2+8s+12}$ as an impedance or an admittance. **(14)**

Q.9 a. Determine the condition for which the function $F(s)=\frac{s^2+a_1s+a_0}{s^2+b_1s+b_0}$ is positive real. It is given that a_0 , b_0 a_1 and b_1 are real and positive. **(10)**

b. Determine the common factor between the even and odd part of the polynomial $2s^6+s^5+13s^4+6s^3+56s^2+25s+25$. **(4)**

Q.10 a. In the network shown in Fig.9 below, find V_2/V_1 if $Z_aZ_b=R$. **(8)**

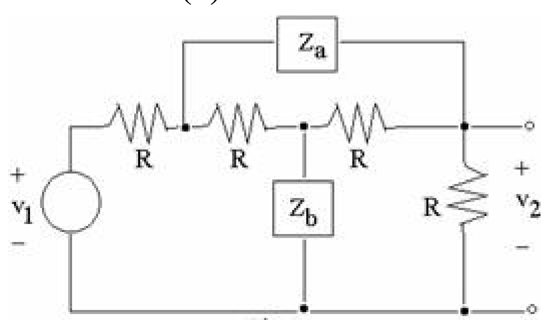

Fig.9

b. Synthesize Z_a and Z_b if $\frac{V_2}{V_1}=\frac{2s^2+1}{s^3+4s^2+5s+2}$ and R =1. **(6)**

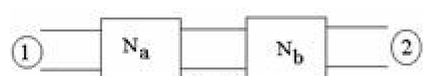

Fig.10

Q.11 a. Two two-port networks N_a and N_b are connected in cascade as shown in Fig.10 below. Let the z – and y parameters of the two networks be distinguished by additional subscripts a and b. Find the z_{12} and y_{12} parameters of the overall network. **(10)**

b. Determine the z-parameters of the network shown in Fig.11 below. **(4)**

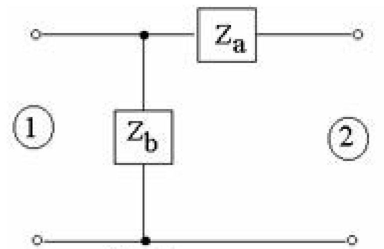

Fig.11