JUNE 2008

Code: AE08
Subject: CIRCUIT THEORY & DESIGN
Time: 3 Hours
Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a.

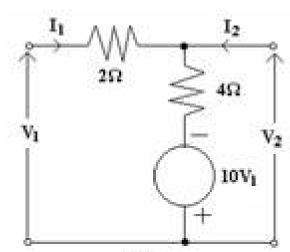


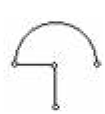
Fig.1

The value of z_{22} (Ω) for the circuit of Fig.1 is:

(A) $\frac{4}{11}$ **(B)** $\frac{11}{4}$

(C) $\frac{4}{9}$ **(D)** $\frac{9}{4}$

b.



A possible tree of the topological equivalent of the network of Fig.2 is

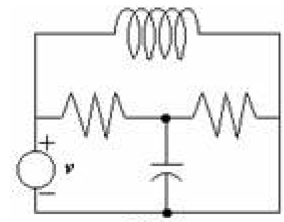
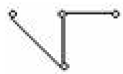


Fig.2

(A)



(B)

(C) Neither **(A)** nor **(B)**
(D) Both **(A)** and **(B)**

c. Given $F(s)=\frac{5s+3}{s(s+1)}$ then $f(\infty)$ is

(A) 1 **(B)** 2
(C) 0 **(D)** 3

d. The two-port matrix of an *n:1* ideal transformer is $\begin{bmatrix} n & 0 \\ 0 & 1/n \end{bmatrix}$. It describes the transformer in terms of its

(A) *z*-parameters. **(B)** *y*-parameters.

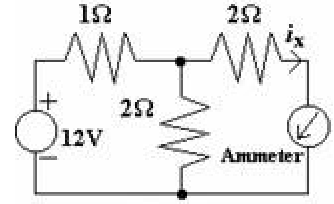


Fig. 3

(C) *Chain*-parameters. **(D)** *h*-parameters.

e. The value of i_x(A) (in the circuit of Fig.3) is

(A) 1 **(B)** 2
(C) 3 **(D)** 4

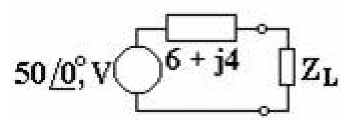


Fig.4

f. To effect maximum power transfer to the load, $Z_L(\Omega)$ in Fig.4 should be

(A) 6
(B) 4
(C) $7.211\angle 33.69^\circ$
(D) $7.211\angle -33.69^\circ$

g. The poles of a stable Butter worth polynomial lie on

(A) parabola **(B)** left semicircle
(C) right semicircle **(D)** an ellipse

h. If $F_1(s)$ and $F_2(s)$ are p.r., then which of the following are p.r. (Positive Real)?

(A) $\frac{1}{F_1(s)}$ and $\frac{1}{F_2(s)}$ **(B)** $F_1(s)+F_2(s)$
(C) $\frac{F_1(s)\cdot F_2(s)}{F_1(s)+F_2(s)}$ **(D)** All of these

i. For the pole-zero of Fig.5, the network function is

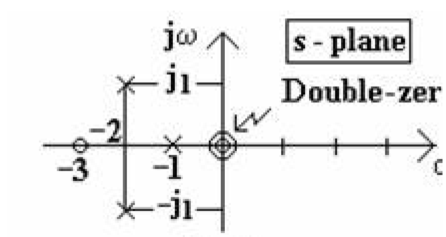


Fig.5

(A) $\dfrac{s^2(s+1)}{(s+3)(s+2+j)(s+2-j)}$

(B) $\dfrac{s^2(s+2+j)(s+2-j)}{(s+1)(s+3)}$

(C) $\dfrac{(s+1)(s^2+4s+5)}{s^2(s+3)}$

(D) $\dfrac{s^2(s+3)}{(s+1)(s^2+4s+5)}$

j. For a series R-C circuit excited by a d-c voltage of 10V, and with time-constant τ, s, the voltage across C at time $t = \tau$ is given by

(A) $10(1-e^{-1})$, V
(B) $10(1-e)$, V
(C) $10-e^{-1}$, V
(D) $1-e^{-1}$, V

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Determine the loop currents, I_1, I_2, I_3 and I_4 using mesh (loop) analysis for the network shown in Fig.6.

(8)

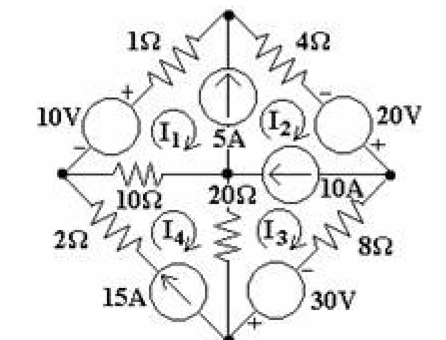


Fig.6

b. Find the power delivered by the 5A current source (in Fig.7) using nodal analysis. **(8)**

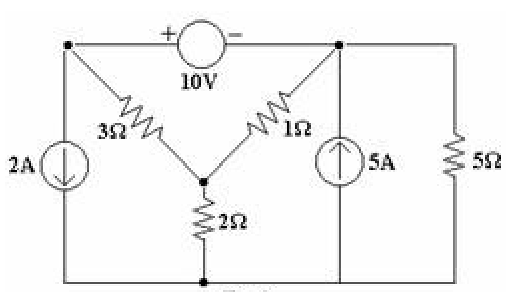


Fig.7

Q.3 a. The capacitor in the circuit of Fig.8 is initially charged to 200V. Find the transient current after the switch is closed at t=0. **(8)**

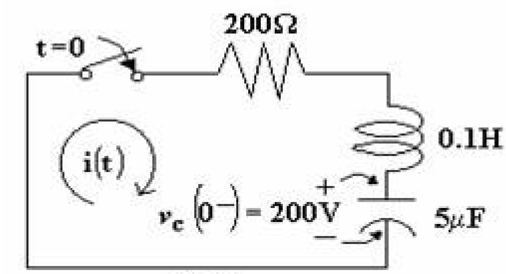


Fig.8

b. Determine the r.m.s. value of current, voltage drops across R and L, and power loss when 100 V (r.m.s.), 50 Hz is applied across the series combination of R=6 Ω and $L = \frac{8}{314}$, H. Represent the current and voltages on a phasor diagram. **(8)**

Q.4 a. Using Kirchhoff's laws to the network shown in Fig.9, determine the values of v_6 and i_5 . Verify that the network satisfies Tellegen's theorem. **(8)**

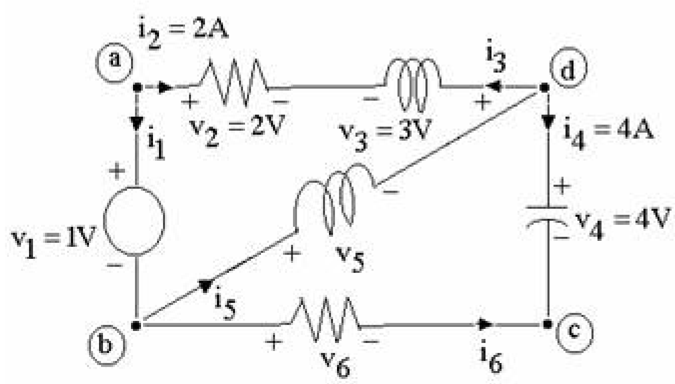


Fig.9

b. State Reciprocity Theorem for a linear, bilateral, passive network. Verify reciprocity for the network shown in Fig.10. **(8)**

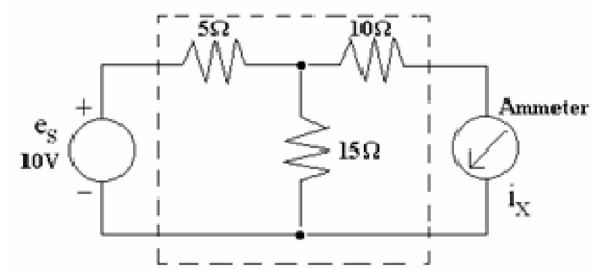


Fig.10

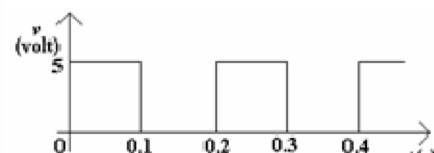


Fig.11

Q.5 a. Find

(i) the r.m.s. value of the square-wave shown in Fig.11.

(ii) the average power for the circuit having $z_{in} = 1.05 - j0.67, \Omega$ when the driving current is $40 - j3, A$.

(8)

b. The voltage across an impedance is 80+j60 Volt, and the current though it is 3+j4 Amp. Determine the impedance and identify its element values, assuming frequency to be 50Hz. From the phasor diagram, identify the lag or lead of current w.r.t. voltage. **(8)**

Q.6 a. Consider the function $F(s)=\dfrac{s^2+1.03}{s^2+1.23}$. Plot its poles and zeroes. Sketch the amplitude and phase for F(s) for $1\le\omega\le 10$. **(8)**

b. Determine whether the function $F(s)=\dfrac{s^3+2s^2+3s+1}{s^3+s^2+2s+1}$ is positive real or not. **(8)**

Q.7 a. Given the Z parameters of a two-port network, determine its Y parameters. **(8)**

b. Find the y-parameters for the two-port network of Fig.12. **(8)**

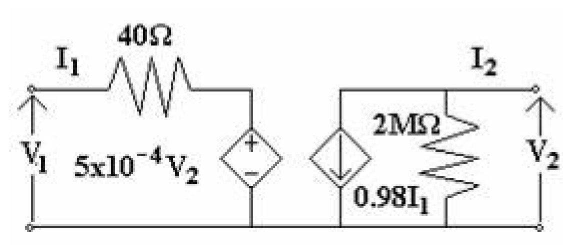


Fig.12

Q.8 a. Synthesise a one-port L-C network whose driving-point impedance is $Z(s)=\dfrac{6s^3+2s}{12s^4+8s^2+1}$ **(8)**

b. Determine the condition for a lattice terminated in R as shown in Fig.13 to be a constant-resistance network. **(8)**

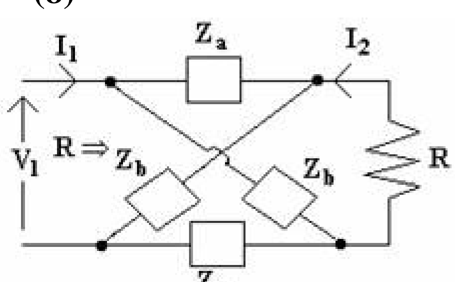


Fig.13

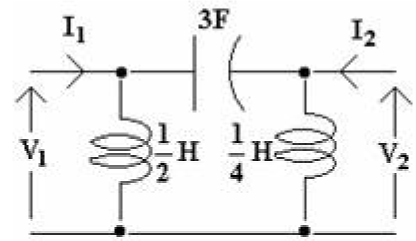


Fig.14

Q.9 a. Find the y-parameters of the circuit of Fig.14 in terms of s. Identify the poles of $y_{ij}(s)$. Verify whether the residues of poles satisfy the general property of L-C two-port networks. **(8)**

b. A third-order Butterworth polynomial approximation is desired for designing a low-pass filter. Determine H(s) and plot its poles. Assume unity d-c gain constant. **(8)**