DECEMBER 2008

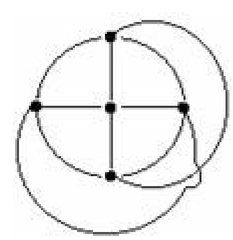
Code: AE08
Subject: CIRCUIT THEORY & DESIGN
Time: 3 Hours
Max. Marks: 100

NOTE: There are 9 Questions in all.

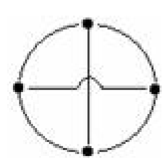
- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given,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

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

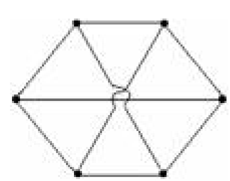
a.



Example of a planar graph is



(A) **(B)**



(C) **(D)** None of these

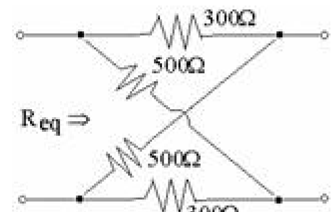


Fig.1

b. The value of $R_{eq}(\Omega)$ for the circuit of Fig.1 is

(A) 200 **(B)** 800
(C) 600 **(D)** 400

c. A 2 port network using Z parameter representation is said to be reciprocal if

(A) $Z_{11} = Z_{22}$ **(B)** $Z_{12} = Z_{21}$
(C) $Z_{12} = -Z_{21}$ **(D)** $Z_{11}Z_{22} - Z_{12}Z_{21} = 1$

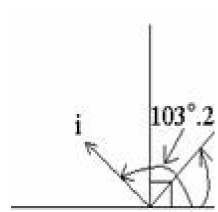


Fig.3

d. The phasor diagram shown in Fig.3 is for a two-element series circuit having

(A) R and C, with tan $\theta = 1.3367$
(B) R and C, with tan $\theta = 4.2635$
(C) R and L, with tan $\theta = 1.1918$
(D) R and L, with tan $\theta = 0.2345$

e. The condition for maximum power transfer to the load for Fig.4 is

(A)

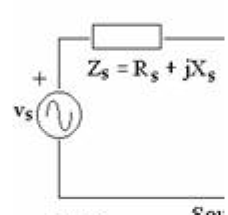


Fig.4

$R_\ell = R_s$

(B) $X_\ell = -X_s$

(C) $Z_\ell = Z_s^*$

(D) $Z_\ell = Z_s$

f. The instantaneous power delivered

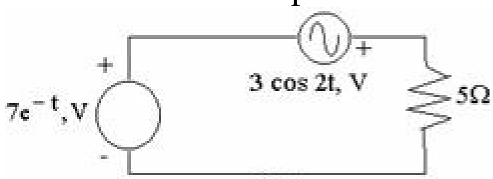


Fig.5

to the 5Ω resistor at t=0 is (Fig.5)

(A) 35W **(B)** 105W

(C) 15W **(D)** 20W

g. Of the following, which one is not a Hurwitz polynomial?

(A) $(s+1)(s^2+2s+3)$ **(B)** $(s+3)(s^2+s-2)$

(C) $(s^3+3s)\left(1+\frac{2}{s}\right)$ **(D)** $(s+1)(s+2)(s+3)$

h. Which of these is not a positive real function?

(A) $F(s) = Ls(L \rightarrow Inductance)$ **(B)** $F(s) = R(R \rightarrow Resistance)$

(C) $F(s) = \frac{K}{s}(K \rightarrow constant)$ **(D)** $F(s) = \frac{s+1}{s^2+2}$

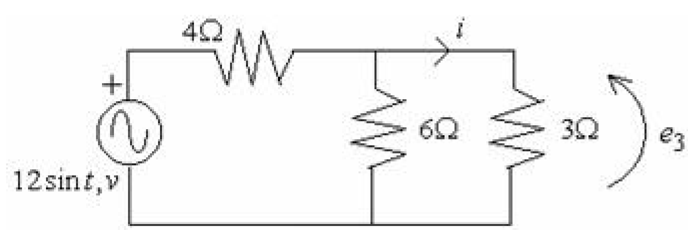


Fig.6

i. The voltage across the 3 Ω resistor e_3 in Fig.6 is :

(A) $6 \sin t, v$
(B) $4 \sin t, v$
(C) $3 \sin t, v$
(D) $12 \sin t, v$

j. A stable system must have

(A) zero or negative real part for poles and zeros.
(B) atleast one pole or zero lying in the right-half s-plane.
(C) positive real part for any pole or zero.
(D) negative real part for all poles and zeros.

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

Q.2 a. Find the power dissipated in the 4Ω resistor in the circuit shown in Fig.7, using loop analysis. **(8)**

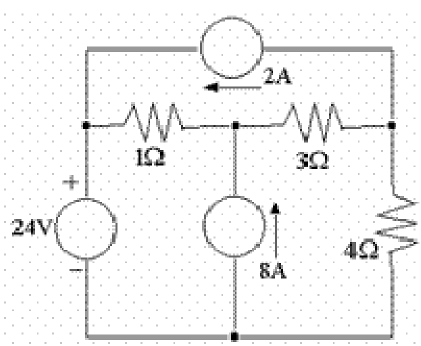


Fig.7

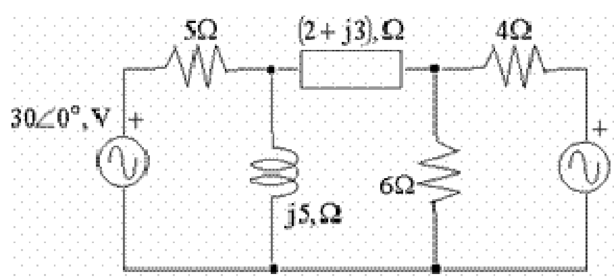


Fig.8

b. Find v_x in the network of Fig.8, if the current through $(2+j3)$ element is zero. **(8)**

Q.3 a. Derive the expression for transient current i(t) for a series R-L-C circuit with d-c excitation of V, volts, assuming zero initial conditions. What will i(t) if $R = 200\Omega$, L=0.1H, $\omega_0 = 100\sqrt{10}$ rad/s and $\frac{di(0^+)}{dt} = 2000 A/s$? **(4+4)**

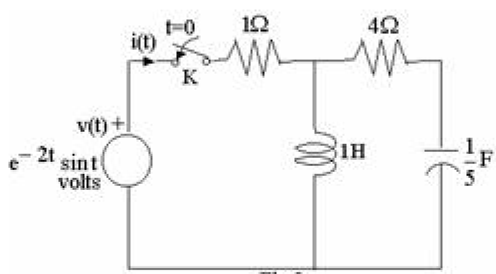


Fig.9

b. Find the transform current I(s) drawn by the source shown in Fig.9 when switch K is closed at time t = 0. Assume zero initial conditions. **(8)**

Q.4 a. State Thevenin theorem. Obtain the Thevenin equivalent of the network across the terminal AB as shown in Fig.10 (all element values are in Ω). **(4+4)**

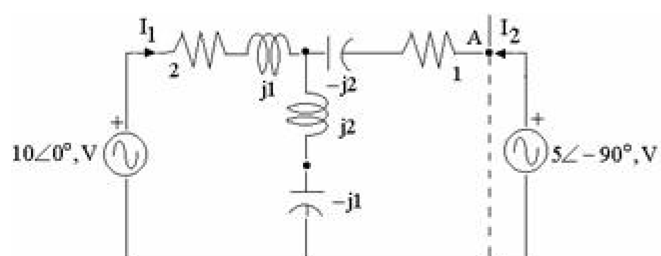


Fig.10

b. For the transform current function $I(s) = \frac{4s(s+2)}{(s+1)(s+3)}$, draw its pole-zero plot. Compute the inverse laplace transform. **(8)**

Q.5 a. Derive the condition for maximum power transfer to the load $(R_\ell + jX_\ell)$ from a voltage source v_s having source impedance $(R_s + jX_s)$. Calculate this power if a $50\angle 0^\circ$ voltage source having source impedance of 15+j20, Ω drives the impedance-matched load. **(5+3)**

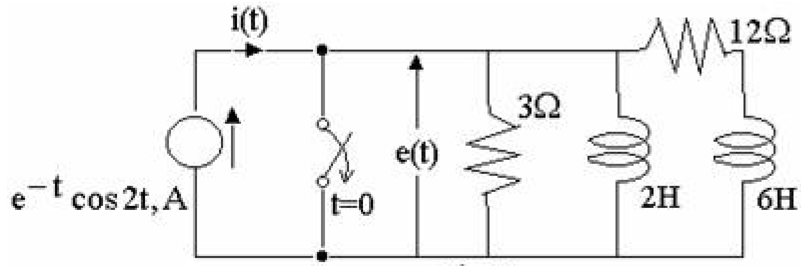


Fig.11

b. For the circuit of Fig.11, determine e(t). Assume zero initial conditions. **(8)**

Q.6 a. Consider the transfer function of pure delay $H(s) = e^{-sT}$, where T = delay w.r.t. the excitation. Sketch the amplitude and phase responses and the delay characteristics. **(8)**

b. The peaking circle for a single-tuned circuit is shown in Fig.12. State the conditions on α and β for ω_{max} to exist. Determine ω_{max}, circuit Q and half-power points for $\alpha = 3, \beta = 5, A:(2,0)$. What is the condition for a high-Q circuit? **(2+5+1=8)**

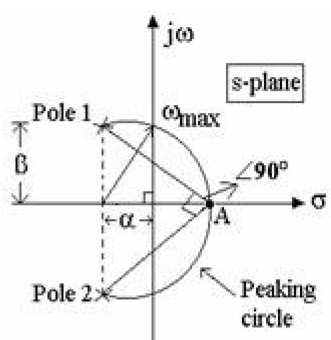


Fig.12

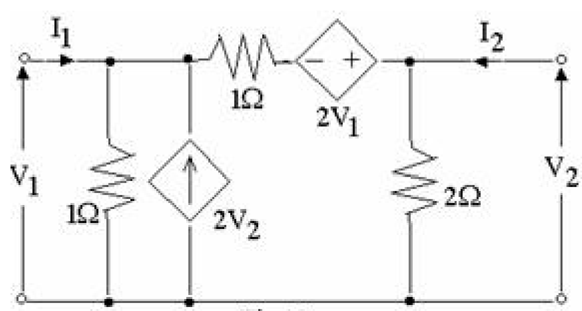


Fig.13

Q.7 a. Determine the y-parameters of the network of Fig.13. **(8)**

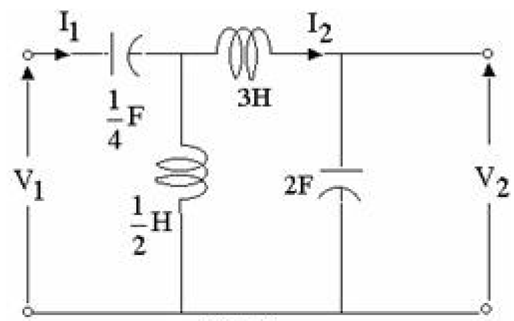


Fig.14

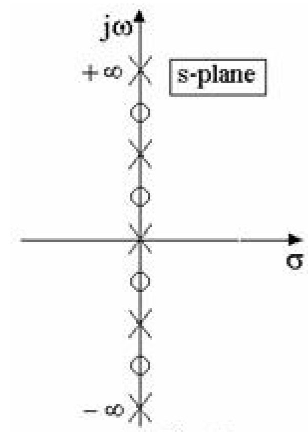


Fig.15

b. Find the voltage transfer function, current transfer function, input and transfer impedances for the network of Fig.14. **(8)**

Q.8 a. From the given pole-zero configuration of Fig.15, determine the four possible L-C network configurations. **(8)**

b. Synthesise an L-C network with 1-Ω termination given the transfer impedance function: $Z_{21}(s) = \dfrac{2}{s^3 + 3s^2 + 4s + 2}$. **(8)**

Q.9 a. Determine the range of constant 'K' for the polynomial to be Hurwitz.

$P(s) = S^3 + 3s^2 + 2s + K$

(8)

b. Define Chebyshev cosine polynomial $C_n(\omega)$. Using recursive formula for $C_n(\omega)$, or otherwise, obtain their values when n = 0 to 4. Plot C_3 and C_4 for $|\omega| \le 1$. **(2+2+4 = 8)**