DECEMBER 2005

Code: A-08
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. The free response of RL and RC series networks having a time constant τ is of the form:

(A) $A + Be^{-\frac{t}{\tau}}$ **(B)** $Ae^{-\frac{t}{\tau}}$

(C) $Ae^{-t} + Be^{-\tau}$ **(D)** $(A + Bt)e^{-\frac{t}{\tau}}$

b. A network function can be completely specified by:

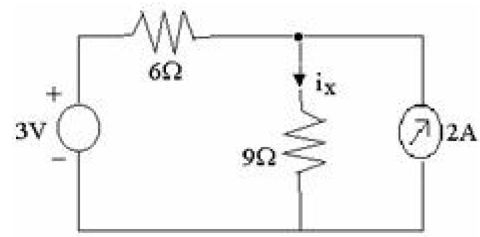
(A) Real parts of zeros **(B)** Poles and zeros
(C) Real parts of poles **(D)** Poles, zeros and a scale factor

c. In the complex frequency $s = \sigma + j\omega$, ω has the units of rad/s and σ has the units of:

(A) Hz **(B)** neper/s
(C) rad/s **(D)** rad

d. The following property relates to LC impedance or admittance functions:

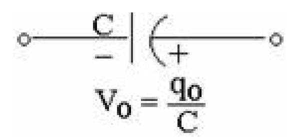
(A) The poles and zeros are simple and lie on the $j\omega$-axis.
(B) There must be either a zero or a pole at origin and infinity.
(C) The highest (or lowest) powers of numerator or denominator differ by unity.



(D) All of the above.

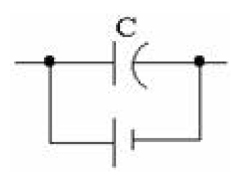
e. The current i_x in the network is:

(A) 1A **(B)** $\frac{1}{2}A$

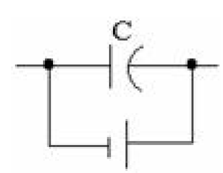


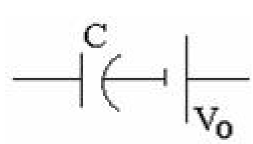
(C) $\frac{1}{3}A$ **(D)** $\frac{4}{5}A$

f. The equivalent circuit of the capacitor shown is

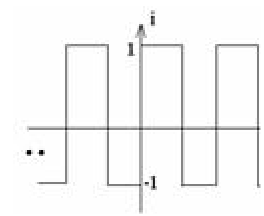


(A) **(B)**





(C) **(D)**

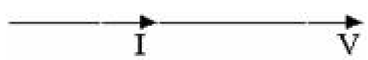


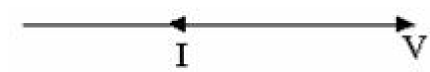
g. The value of $\left(\frac{I_{rms}}{I_{max}}\right)$ for the wave form shown is

(A) $\sqrt{2}$ **(B)** 1.11

(C) 1 **(D)** $1/\sqrt{2}$

h. The phasor diagram for an ideal inductance having current I through it and voltage V across it is :





(A) **(B)**

(C) **(D)**

i. If the impulse response is realisable by delaying it appropriately and is bounded for bounded excitation, then the system is said to be :

(A) causal and stable **(B)** causal but not stable

(C) noncausal but stable **(D)** noncausal, not stable

j. In any lumped network with elements in b branches, $\sum_{k=1}^{b} v_k(t) i_k(t) = 0,$ for all t, holds good according to:

(A) Norton's theorem. **(B)** Thevenin's theorem.

(C) Millman's theorem. **(D)** Tellegen's theorem.

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

Q.2 a. Simplify the network, shown in Fig.1, using source transformations: **(8)**

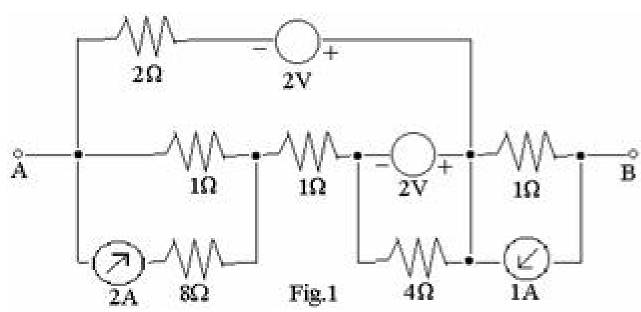


Fig.1

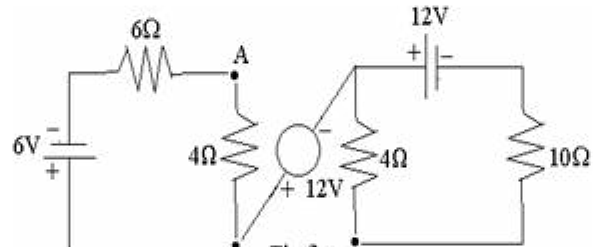


Fig. 2

b. Using any method, obtain the voltage V_{AB} across terminals A and B in the network, shown in Fig.2: **(8)**

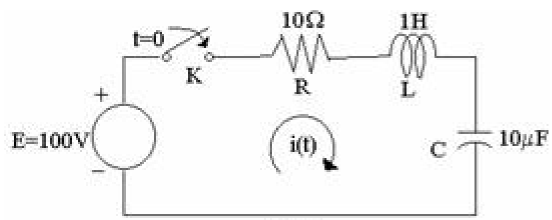


Fig.3

Q.3 a. For the network shown in Fig.3, the switch is closed at t = 0. If the current in L and voltage across C are 0 for t < 0, find $i(0^+), \left.\frac{di(t)}{dt}\right|_{t=0+}, \left.\frac{d^2i(t)}{dt^2}\right|_{t=0+}$. **(8)**

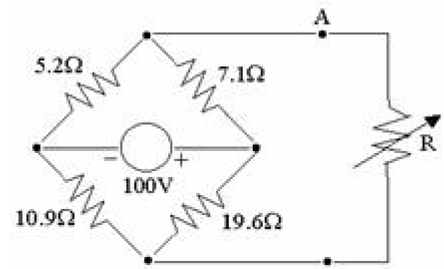


Fig.4

b. Use the Thevenin equivalent of the network shown in Fig.4 to find the value of R which will receive maximum power. Find also this power. **(8)**

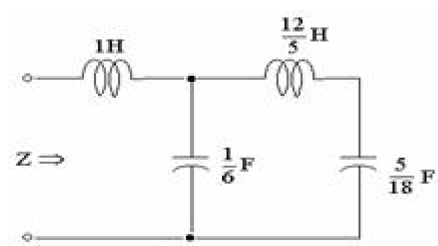


Fig.5

Q.4 a. Express the impedance Z (s) for the network shown in Fig.5 in the form: $Z(s) = K\frac{N(s)}{D(s)}$. Plot its poles and zeros. From the pole-zero plot, what can you infer about the stability of the system? **(8)**

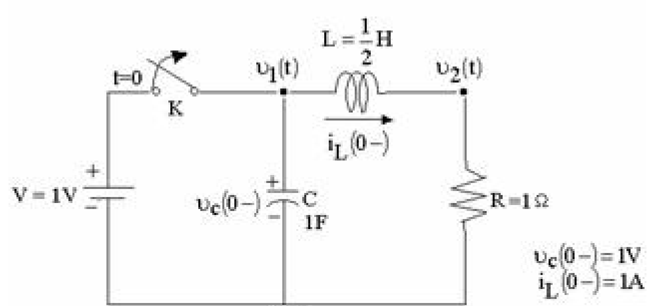


Fig.6

b. Switch K in the circuit shown in Fig.6 is opened at t = 0. Draw the Laplace transformed network for t > 0+ and find the voltages $\upsilon_1(t)$ and $\upsilon_2(t)$, t > 0+. **(8)**

Q.5 a. Given the ABCD parameters of a two-port, determine its z-parameters. **(8)**

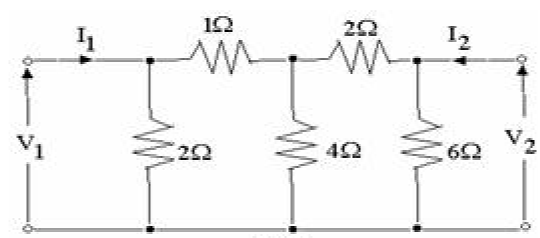


Fig.7

b. Find the y-parameters for the network shown in Fig.7. **(8)**

Q.6 a. Distinguish between Chebyshev approximation and maximally flat approximation as applicable to low pass filters. What is the purpose of magnitude and frequency scaling in low pass filter design? **(8)**

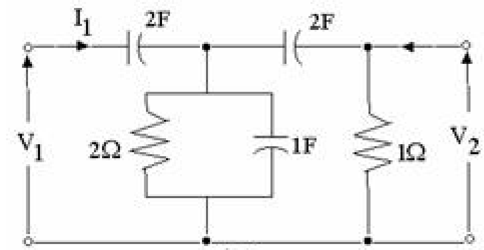


Fig.8

b. Show that the voltage-ratio transfer-function of the ladder network shown in Fig.8 is given by:

$$\frac{V_2(s)}{V_1(s)} = \frac{8s^2}{12s^2 + 12s + 1}$$

. **(8)**

Q.7 a. Explain the following:
(i) Phasor. (ii) Resonance. (iii) Q (iv) Damping coefficient. **(8)**

b. Determine the Thevenin equivalent circuit of the network shown in Fig.9. **(8)**

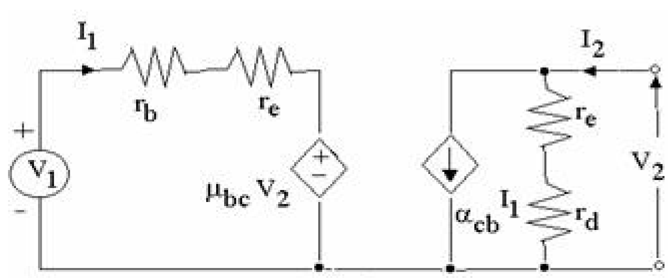


Fig.9

Q.8 a. Test whether:

(i) the polynomial $F_1(s) = s^4 + s^3 + 2s^2 + 3s + 2$ is Hurwitz; and

(ii) the function $F_2(s) = \frac{Ks}{s^2 + \alpha}$ is positive real, where α and K are positive constants.

(8)

b. A system admittance function Y(s) has two zeros at $s=-2,-3$ and two poles at $s=-1,-4,$ with system constant = 1. Synthesise the admittance in the form of three parallel branches: R_1, R_2-L_2 in series, and R_3-C_3 in series. **(8)**

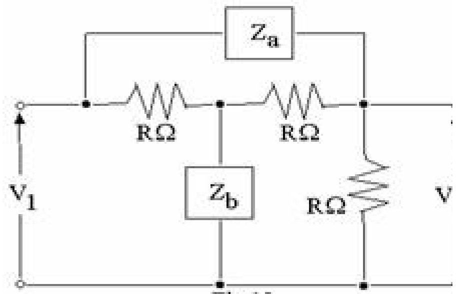


Fig.10

Q.9 a. Explain the meaning of "zeros of transmission". Determine the circuit elements of the constant-resistance bridged- T circuit, shown in Fig.10, that provides the voltage-ratio:

$$\frac{V_2(s)}{V_1(s)}=\frac{s^2+1}{s^2+2s+1}$$

. .Assume R=1 Ω **(8)**

b. Synthesise a ladder network whose driving-point impedance function is given by $Z(s)=\frac{2s^5+12s^3+16s}{s^4+4s^2+3}$. **(8)**