JJUNE 2007

Code: AE-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 minimum amount of hardware required to make a lowpass filter is
(A) a resistance, a capacitance and an opamp.
(B) a resistance, an inductance and an opamp.
(C) a resistance and a capacitance.
(D) a resistance, a capacitance and an inductance.

b. A system is described by the transfer function . The value of its step response at very large time will be close to
(A) -1 **(B)** 0
(C) 1 **(D)** ∞

c. A network N is to be connected to load of 500 ohms. If the Thevenin's equivalent voltage and Norton's equivalent current of N are 5Volts and 10mA respectively, the current through the load will be
(B) 10mA **(B)** 5mA
(C) 2.5mA **(D)** 1mA

d. A unit impulse voltage is applied to one port network having two linear components. If the current through the network is 0 for t<0 and decays exponentially for *t>0* then the network consists of
(A) R and L in series **(B)** R and L in parallel

(C) R and C in parallel **(D)** R and C in series

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

f. If *F(s)* is a positive-real function, then $Ev\{F(s)\}|_{s=j\omega}$

(A) must have a single zero for some value of ω
.
(B) must have a double zero for some value of ω.
(C) must not have a zero for any value of ω.
(D) may have any number of zeros at any values of ω but $Ev\{F(s)\}|_{s=j\omega} \geq 0$ for all ω.

g. The poles of a Butterworth polynomial lie on

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

h. A reciprocal network is described by $z_{21} = \frac{s^3}{3s^2+2}$ and $z_{22} = \frac{s^3+4s}{3s^2+2}$. Its transmission zeros are located at

(A) $s = 0$ **(B)** $s = \pm j2$
(C) $s = 0$ and at $s = \pm j2$ **(D)** $s = 0$ and at $s = \infty$

i. In order to apply superposition theorem, it is necessary that the network be only

(A) Linear and reciprocal.
(B) Time-invariant and reciprocal.
(C) Linear and time-invariant.
(C) Linear.

j. The Q-factor of a parallel resonance circuit consisting of an inductance of value 1mH, capacitance of value 10^{-5}F and a resistance of 100 ohms is

(A) 1 **(B)** 10
(C) 20π **(D)** 100

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

Q.2 a. Write minimum number of integro-differential mesh equations required to solve for all node voltages and branch currents in the network of Fig.Q2.The term v_g should not be present in your equations. **(6)**

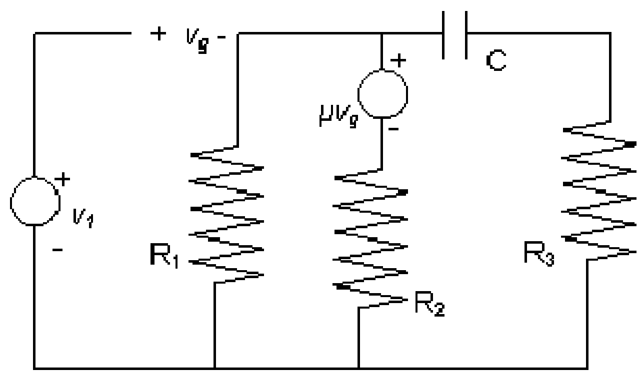

Fig.Q2

b. Derive the condition for maximum power transfer from a source whose internal impedance is resistive to a load which is a series combination of a resistance and a reactance. **(10)**

Q.3 a. In Fig.Q3, $v_1 = 230\sqrt{2}\cos 2\pi 50t$ and the initial voltage on the capacitor is 50V. If the switch is closed at $t=0$, determine the current through the capacitor and the voltage across the inductor at $t=0+$. **(6)**

b. Assume that the switch in Fig.Q3 has been closed for a long time. Using phasor methods, find the current drawn from the source and the circuit impedance, resistance and reactance. **(10)**

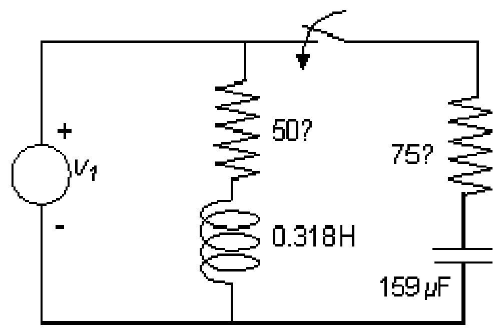

Fig.Q3

Q.4 a. Find the Thevenin's voltage and the Thevenin's equivalent resistance across terminals a-b in Fig.Q4. Assume V_1=10V, R_1=5 Ohms, R_2= 2 Ohms, r= 1 Ohm, I=2A and V=12V. Determine the power drawn from the 12V source when the load is connected. **(8)**

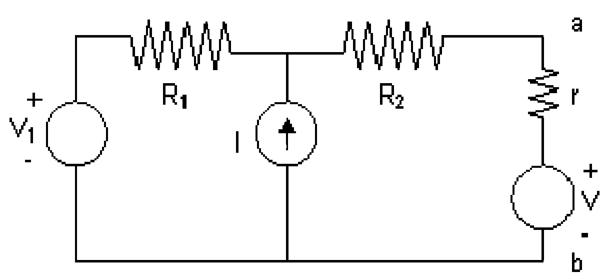

Fig.Q4

b. Consider a series resonance circuit consisting of a 10 Ohms resistance, a 2mH inductance and a 200nF capacitance. Determine the maximum energy stored , the energy dissipated per cycle and the bandwidth of the circuit. Write the normalized form of the admittance for this circuit. **(8)**

Q.5 For the given network function $F(s)=\dfrac{26}{s^2+s+26}$, draw its pole-zero plot and determine (i) ω_{max} , the frequency at which $F(j\omega)$ attains its maximum value, (ii) $|F(j\omega_{max})|$, (iii) the half power points, and (iv) the magnitude of the function at half power points. Using this information, draw a neat sketch of the magnitude and the phase responses. **(16)**

Q.6 Determine the h-parameters of the network shown in Fig.Q6. **(16)**

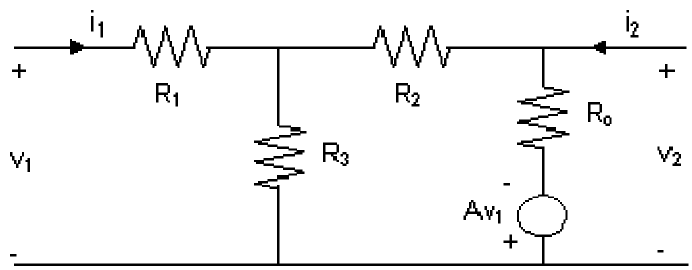

Fig.Q6

Q.7 a. Determine if the function $F(s)=\dfrac{s^3+5s^2+9s+3}{s^3+4s^2+7s+9}$ is positive real. **(10)**

b. Given that $\operatorname{Re} G(j\omega)=\dfrac{\omega^4+21\omega^2}{\omega^4+17\omega^2+16}$, determine a realizable *G(s)*. **(6)**

Q.8 a. Synthesise the voltage transfer function $T(s)=\dfrac{2Ks}{s^3+2s^2+2s+1}$ by any method and obtain the realized value of *K*. **(9)**

b. Determine the voltage transfer function of the network shown in Fig.Q8. All resistances are 1 ohm, inductors 1H and capacitors 1F. **(7)**

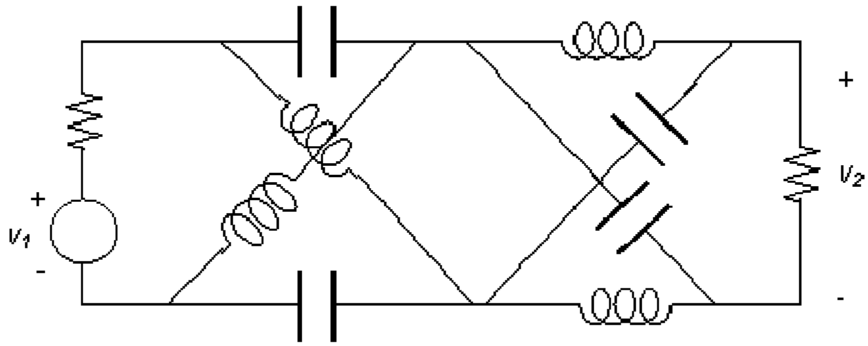

Fig.Q8

Q.9 a. Realize the impedance $Z(s)=\frac{2(s^2+1)(s^2+9)}{(s^2+4)s}$ in three different ways. **(12)**

b. Show that the filter described by the transfer function

$$H(s)=\frac{1}{(s^2+0.76536s+1)(s^2+1.84776s+1)}$$

is a lowpass filter. **(4)**