B.Tech-3rd(EEE)

Network Theory

Full Marks : 50

Time : $2\frac{1}{2}$ hours

Answer **all** questions

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

Any supplementary materials to be provided

1. Answer *all* questions : 2×5

(*a*) Considering a live conductor, (*i*) State whether the change in flux linkage $(\delta\lambda)$, will be uniform or not if the core of conductor is made by a ferromagnetic material, and (*ii*) Is superposition theorem applicable here or not ?

(*b*) $[Z_{11}]=[\Upsilon_{11}]^{-1}$; The statement is valid or invalid, and why ?

(c) In which condition, a second order circuit settles fast after changing the state of switch ? Justify.

(d) Write the necessary and sufficient conditions for a rational function with real coefficients to be a positive real function ?

(e) Define the term '*Linked Tree*' and '*Oriented Graph*' in graph theory.

2. (a) A first order R-L circuit is connected with a voltage source $v(t) = V\sin(\omega t+\phi)$ through a switch (k). The switch is closed/ established a contact with the network at $\omega t = 90°$ and $\phi = 0$. (*i*) Assuming the circuit is driven by the linear differential equations, draw the circuit and find its response. (*ii*) How shall you be able to control the transient/ steady state conditions of the network ? Justify. 4

(b) At time $t = 0+$, the switch is closed considering a generator's voltage expressed by $v(t) = V \sin\sqrt{t/MC}$ to the circuit shown in Fig. 1; All the symbols have their conventional notations used in the network and expressions. 4

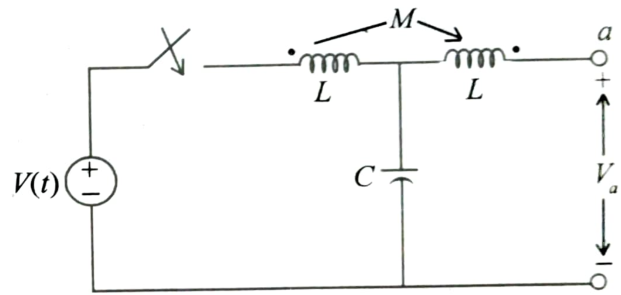


Fig. 1

Show that;

$$Va(0+) = 0; \frac{dVa(0+)}{dt} = \frac{V}{L}\sqrt{\frac{M}{C}},$$

$$\text{and } \frac{d^2Va(0+)}{dt^2} = 0$$

Or

(*a*) At time $t = 0+$, the switch is closed considering the circuit is energized using a voltage source, $v(t) = 5V$ to a R-C circuit; find the response of the circuit $i(t), \dfrac{di(t)}{dt}$ at time $t = 0+$ if values of $R = 1\text{–}\Omega$, $C = 1\text{-F}$. 4

(*b*) Fig. 2 shows a peicewise linear characteristic. Let $x = q_c$ and $y = v_c$ so that the characteristic represents a nonlinear capacitor. If the voltage applied to the capacitor, plot the corresponding $i_c(t)$. 4

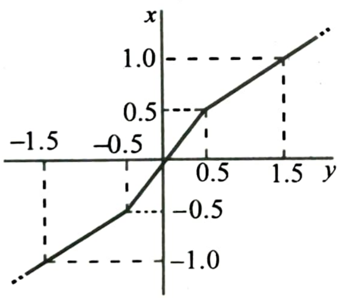
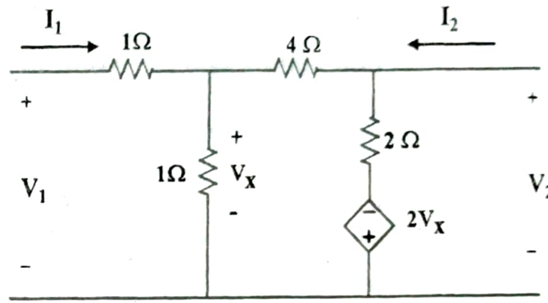


Fig. 2

3. (*a*) Find the Z-parameters of the Fig. 3 shown in below. 4



[Fig. 3]

(*b*) If a small signal (incremental analysis) of a two-port model is represented by Fig. 4, then answer following : 4

$$v_b = h_{ie} i_b + h_{re} v_c$$
$$i_c = h_{fe} i_b + h_{oe} v_c$$

[Fig. 4]

(*i*) Which parameter is used to represent the model ?

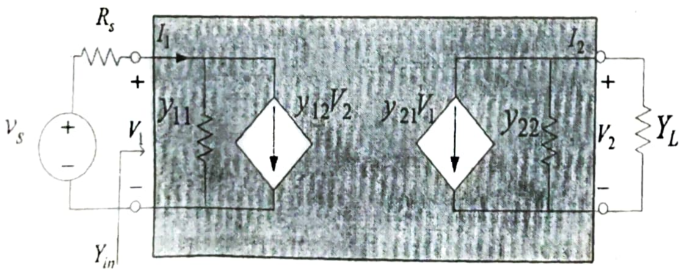
(*ii*) Enlist one application that can be modeled and analyzed using Fig. 4.

Or

(*a*) As shown in Fig. 5 below; 8

(*i*) Prove that $Y_{in} = y_{11} - \dfrac{y_{12}\, y_{21}}{y_{11}\,(y_{22} + Y_L)}$

(*ii*) Find the voltage gain of the circuit $(V_2/\ V_1)$.



[Fig. 5]

4. (*a*) Design an electrical equivalent circuit of the transfer function mentioned below, find the value of 'K' of the admittance function.

$$Y(s) = \frac{K(s+1)}{(s+2)(s+4)}$$

Considering that series-arm impedance and shunt-arm impedance of the network are parallel tuning circuits. Where, the values of series –arm elements are $\mathbf{R_1}$ of 1.5-Ω resistance connected in parallel to a capacitor $\mathbf{C_1}$ 0.67-F while; the values of shunt–arm elements are $\mathbf{R_2}$ of 0.167-Ω resistance connected in parallel to a capacitor $\mathbf{C_2}$ of 2-F. 4

(*b*) Write down the driving-point impedance $Z(s)$ of the network shown in Fig. 6. Locate the poles and zeros of $Z(s)$ on the s-plane. 4

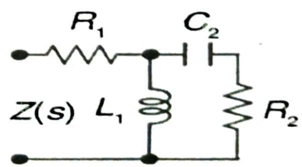


Fig. 6

Or

(*a*) The differential equation of a system is given as;

$$4\frac{d^2e_0}{dt^2}+2\frac{de_0}{dt}+e_0=3\frac{de_i}{dt}$$

Where, e_i is input signal and e_0 is the output signal of the analogy.

(*i*) Find the system function.

(*ii*) Plot the pole-zero configurations.

A potential of the form $5e^{jt}$ is applied to the system. Find the output ? 8

5. (*a*) Identify the type of network, and apply Foster-Form to synthesize a electrical/electronic network.

$$Z(s)=\frac{4(s^2+1)(s^2+9)}{s(s^2+4)}$$

Can it be realizable ? 4

(*b*) Comment over the possibility to realize an *R-L* network based on given admittance function using either Foster-Form I/II. 4

$$Y(s)=\frac{s(s+2)}{(s+1)(s+3)}$$

Or

(*a*) Comment over the possibility to realize an *R-L* network based on given admittance function using either Foster-Form I / Cauer-Form II. 4

$$Y(s)=\frac{(s^4+10s^2+9)}{(s^3+4s)}$$

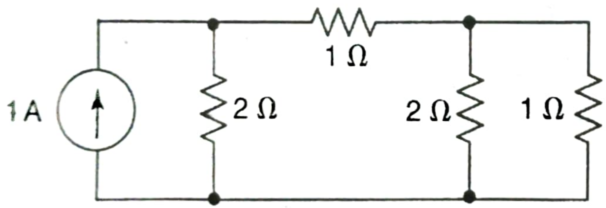
(*b*) Apply the Cauer-Form of the impedance function given below, and comment over the realization of the network. 4

$$Z(s)=\frac{4(s^2+1)(s^2+9)}{s(s^2+4)}$$

6. (*a*) Draw the oriented incidence matrix M given below, and the participating Nodes and Branches are as follows : 4

Nodes ↓	Branches → 1	2	3	4	5	6
A	-1	0	0	1	-1	0
B	1	-1	0	0	0	-1
C	0	1	-1	0	1	0
D	0	0	1	-1	0	1

(*b*) For the network shown in Fig.7, develop a fundamental cut-set matrix, and thus, find the KCL Equations. 4

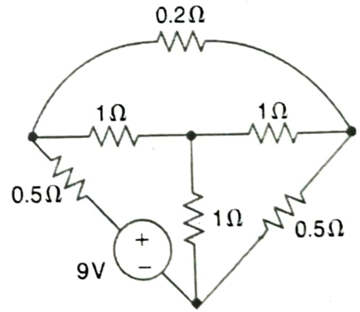


[Fig-7]

Or

(*a*) For the network shown in Fig.7, develop a fundamental tie-set matrix, and oriented graph of it. Also, find the possible numbers of tree that can be constructed of the given graph. 4

(*b*) For the network as sketched in Fig.8, draw the graph and write a Tie-set schedule. Using the Tie-set schedule obtain the loop equations and find the currents in all branches. 4



[Fig-8]