EE225 Network Theory

TUTORIAL PROBLEMS - SET THREE,

Q1. In the network of Fig. 1, the switch K is in position a for a long time. At t = 0, the switch is moved from a to b. Find $v_2(t)$. The 2H inductor is initially unexcited.

Q2. In Fig. 2, $v_1(t) = e^{-t}u(t)$ with the capacitor initially uncharged at $t = 0$. Obtain $v_2(t)$.

Q3. In the network of Fig. 3, the switch K_1 is closed at $t = 0$. Subsequently, the switch K_2 is closed at $t = t_0$ ($t_0 > 0$). Obtain the inductor current $i_L(t)$ assuming the inductor was unexcited at $t = 0$.

Q4. The circuit of Fig. 4 is initially unexcited, when switch S is suddenly closed. Obtain the time derivatives $dv_i(t)/dt$ at $t = 0^+$; i = 1,2,3

Q5. In the network of Fig. 5, steady state is reached and then the switch K is suddenly thrown open from its closed position initially. Obtain the voltages and time derivatives of the voltages for ALL elements in the network including the (open) switch at $t = 0^+$.

Q6. In the network of Fig. 6, the inductor current and capacitor voltage are zero at $t = 0^-$. At $t = 0$, switch K_1 is closed while K_2 and K_3 are left open. At $t = t_0$ ($t_0 > 0$), switch K_2 is also closed, leaving only K_3 open. At $t = t_1$, all three switches are closed. Formulate a method of solution clearly for obtaining the inductor and capacitor voltages as a function of time.

Q7. In the network of Fig. 7, show that there exist values of the inductor current and capacitor voltages at $t = 0^-$, such that the circuit exhibits NO transient response for a given starting phase.

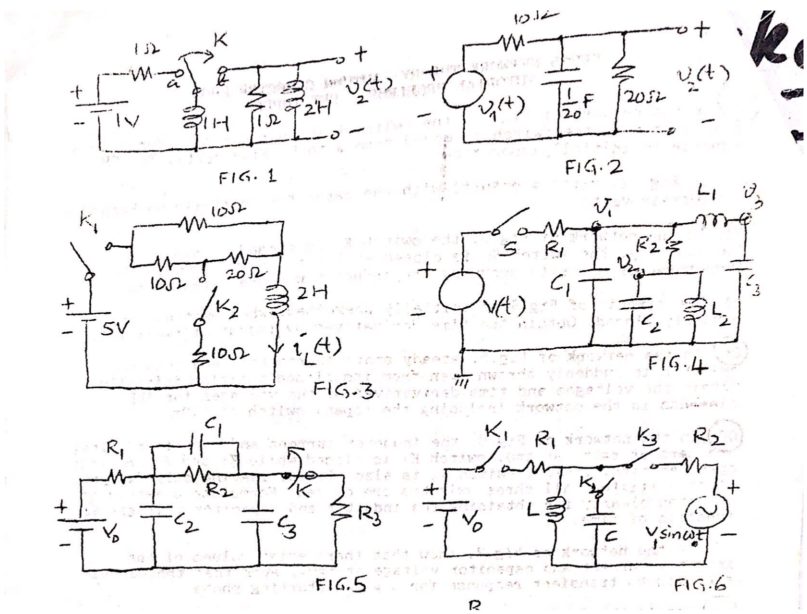
Q8. Obtain the frequency response of all the networks shown in Fig. 8 with designated input and output. All of them are initially unexcited as needed for linearity. Also make a broad categorization of the frequency response as lowpass, highpass, bandpass or bandstop. Sketch the magnitude of the frequency response in each case. In the case of the networks with R, L and C, it may be necessary to consider separate cases depending upon the relative values of R, L and C.

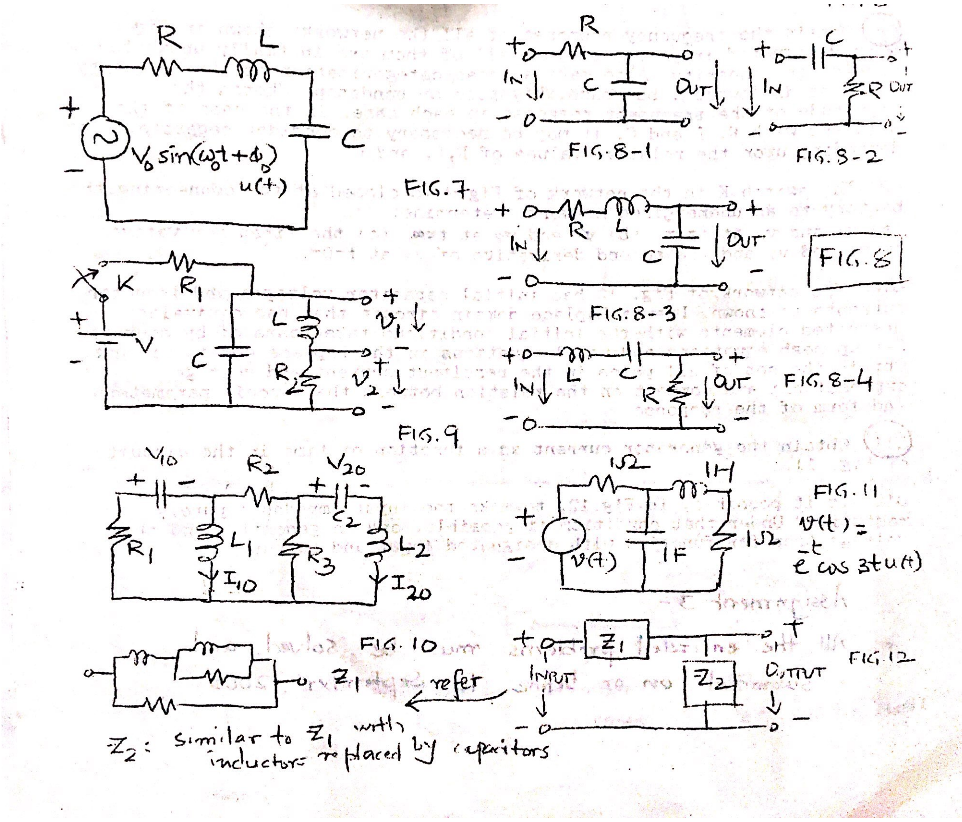
Q9. The switch K in the network of Fig. 9 is closed at $t = 0$ connecting the battery to the unenergized network. Determine :
(a) v_1 and v_2 at $t = 0^+$ (b) v_1 and v_2 at $t = \infty$ (c) the first derivatives of v_1 and v_2 and second derivative of v_2 at $t = 0^+$

Q10. The network of Fig. 10 has initial capacitor voltages and inductor current as shown. Draw a Laplace domain circuit that has equivalent unexcited elements with the initial conditions taken care of by sources. Set up mesh equations and nodal equations in the Laplace domain circuit. Obtain the set of all poles in the resultant current and voltage expressions ; and comment on the relation between the circuit parameters and form of the response.

Q11. Obtain the generator current as a function of time in the current of Fig. 11.

Q12. Is it possible, in Fig. 12, to make the input impedance purely resistive ? Under that condition if possible, and in general, find the voltage transfer function with the designated input and output.




R
L
C
$V_0 \sin(\omega_0 t + \phi_0)$
u(t)
FIG. 7
IN
OUT
FIG. 8-1
FIG. 8-2
FIG. 8-3
FIG. 8-4
FIG. 8
K
R_1
V
v_1
v_2
R_2
FIG. 9
V_{10}
V_{20}
C_2
R_1
L_1
R_3
L_2
I_{10}
I_{20}
FIG. 10
1Ω
1H
1F
v(t)
FIG. 11
$v(t) = e^{-t} \cos 3t\, u(t)$
Z_1
Z_2
refer
INPUT
OUTPUT
FIG. 12
Z_2: similar to Z_1 with inductors replaced by capacitors