Solutions: Tutorial-5

Q-1.

A	B	C	D	S_1	S_0	I_0	I_1	I_2	I_3	F
0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	0	1	0	0	0	0
0	0	1	1	1	1	1	0	0	0	0
0	1	0	0	0	0	0	1	0	0	0
0	1	0	1	0	1	0	1	0	0	1
0	1	1	0	1	0	0	1	0	0	0
0	1	1	1	1	1	0	1	0	0	0
1	0	0	0	0	0	0	0	1	0	0
1	0	0	1	0	1	0	0	1	0	0
1	0	1	0	1	0	0	0	1	0	1
1	0	1	1	1	1	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	0	1	0	1	0	0	0	1	0
1	1	1	0	1	0	0	0	0	1	0
1	1	1	1	1	1	0	0	0	1	1

a. The Karnaugh map is:

AB \ CD	00	01	11	10
00	1	0	0	0
01	0	1	0	0
11	0	0	1	0
10	0	0	0	1

b. The minimal SOP form:

$$= A'B'C'D' + A'BC'D + ABCD + AB'CD'$$

c. The minimal POS form:

$$= (A' + C)(A + C')(B' + D)(B + D')$$

Q-2.

a.	***b.***	***c.***	***d.***	***e.***
$i(0^+) = 0A$	$\frac{di}{dt}(0^+) = \frac{10}{L} = 10A/s$	$\frac{d^2i}{dt^2}(0^+) = -1000A/s^2$	$V_c(0^+) = 0V$	$V_L(0^+) = 10V$

Q-3.

a. If the switch is closed a long time before t=0, it means that the circuit has reached dc steady state at t=0. At dc steady state, the inductor acts like a short circuit, while the capacitor acts like an open circuit (Fig.3a). Hence, at **t=0⁻**,

$$i(0^-) = \frac{12}{4+2} = 2A, \quad v(0^-) = 2i(0^-) = 4V$$

Since the inductor current cannot change abruptly

$$i(0^+) = i(0^-) = 2A$$

b. From fig.5, and argument given in section **a**, the voltage is given by-

$$v(0^+) = v(0^-) = 4V$$

c. At time **t=0⁺**, the switch is opened. The equivalent circuit is shown in (Fig.3b). The same current flows through both the inductor and capacitor. Hence,

$$i_c(0^+) = i(0^+) = 2A$$

Applying the KVL to the loop in Figure 2 results in

$$-12+4i(0^+) + v_L(0^+) + v(0^+) = 0$$

or

$$v_L(0^+) = 12 - 8 - 4 = 0$$

Hence,

$$\frac{di(0^+)}{dt} = \frac{v_L(0^+)}{L} = 0A/s$$

d. At time **t=0⁺**, since

$$C\frac{dv}{dt} = i_c, \quad \frac{dv}{dt} = \frac{i_c}{C}$$

$$\frac{dv(0^+)}{dt} = \frac{i_c(0^+)}{C} = \frac{2}{0.1} = 20V/s$$

e. $t \to \infty$, the circuit reaches steady state, Fig.3c. The inductor acts like a short circuit and the capacitor like an open circuit, hence, $i\,(\infty) = 0\ A$ and,

f. $V(\infty) = 12\ V$.

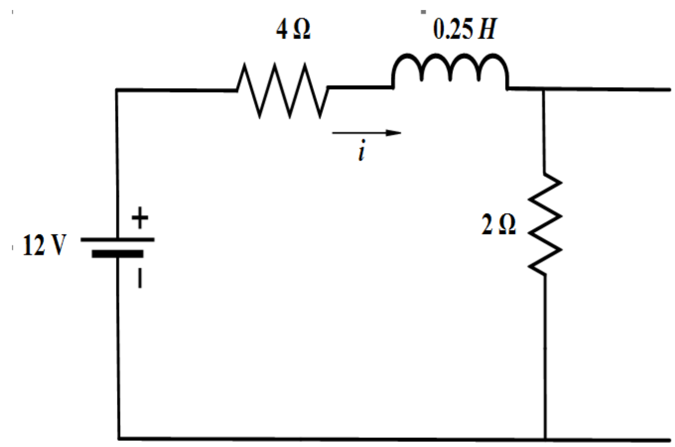

Fig.3a

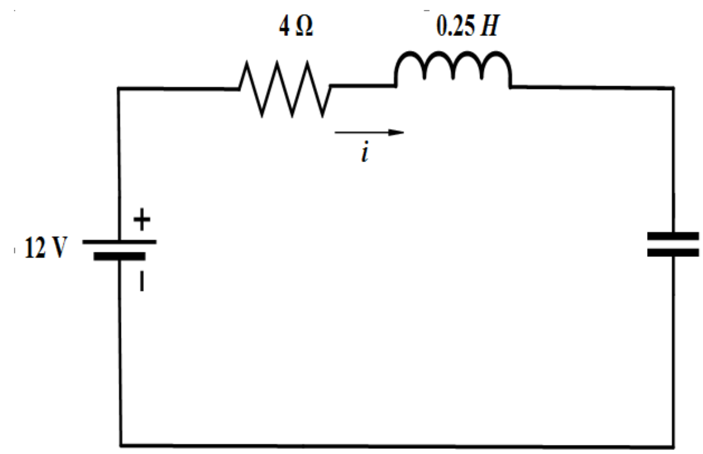

Fig.3b

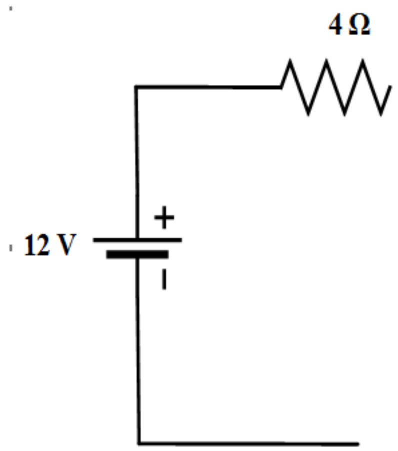

Fig.3c

Q-4. The operation impedances of the different branches are-

$$Z_R = 1$$
$$Z_L = 2p$$
$$Z_c = \frac{1}{pC} = \frac{3}{p}$$

The operation impedance of the as seen from the terminals **a-b** is-

$$Z_{ab} = Z_R + \frac{Z_L Z_C}{Z_L + Z_C} = 1 + \frac{2p \times \frac{3}{p}}{2p + \frac{3}{p}} = \frac{2p^2 + 6p + 3}{2p^2 + 3}$$

The current in the network is-

$$i = \frac{e}{Z_{ab}} = \frac{2p^2+3}{2p^2+6p+3}e$$

the current through the inductor is

$$i_L = \frac{Z_C}{Z_L+Z_C} i = \frac{\frac{3}{p}}{2p+\frac{3}{p}} \times \frac{2p^2+3}{2p^2+6p+3}e$$

$$= \frac{3}{2p^2+6p+3}e$$

Hence, the governing differential equation is

$$(2p^2+6p+3)i_L = 3e$$

$$\Rightarrow 2\frac{d^2 i_L}{dt^2} + 6\frac{di_L}{dt} + 3i_L = 3e$$

Q-5. The period of the waveform is T=4. Over a period, the current waveform can be written as-

$$i(t) = \begin{cases} 5t, \ 0<t<2 \\ -10, \ 2<t<4 \end{cases}$$

The rms value is

$$\mathrm{I}_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2 dt} = \sqrt{\frac{1}{4}\left[\int_0^2 (5t)^2 dt + \int_2^4 (-10)^2 dt\right]}$$

$$= \sqrt{\frac{1}{4}\left[25\frac{t^3}{3}\right]_0^2 + \left[100t\right]_2^4} = 8.165A$$

The power absorbed by 2 Ohm resistor is

$$\mathrm{P}=\mathrm{I}_{rms}^2 R = (8.165)^2(2) = 133.3W$$

Q-6.

W	X	Y	Z	S	C	I_0	I_1	I_2	I_3	S_1	S_0	H
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	1	0	0	0	1	1
0	0	1	0	1	0	0	1	0	0	1	0	0
0	0	1	1	0	1	1	0	0	0	1	1	0
0	1	0	0	0	0	0	0	0	0	0	0	0
0	1	0	1	1	0	0	1	0	0	0	1	1
0	1	1	0	1	0	0	1	0	0	1	0	0
0	1	1	1	0	1	1	0	0	0	1	1	0
1	0	0	0	0	0	0	0	0	1	0	0	0
1	0	0	1	1	0	0	1	0	1	0	1	1
1	0	1	0	1	0	0	1	0	1	1	0	0
1	0	1	1	0	1	1	0	0	1	1	1	1
1	1	0	0	0	0	0	0	1	1	0	0	0
1	1	0	1	1	0	0	1	1	1	0	1	1
1	1	1	0	1	0	0	1	1	1	1	0	1
1	1	1	1	0	1	1	0	1	1	1	1	1

YZ \ WX	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	1	1
10	0	0	1	0

$SOP: H = Y'Z + WZ + WXY$ *and,*

$POS: H = (Y + Z)(\overline{Y} + W)(X + Z)$

Q-7.

X	Y	S_1	S_0	I_0	I_1	I_2	I_3	F
0	0	0	1	1	0	0	0	0
0	1	1	0	0	1	0	0	0
1	0	1	0	0	0	1	0	1
1	1	1	1	0	0	0	1	1

Y \ X	0	1
0	0	1
1	0	1

$$F = X$$