Networks Test 3

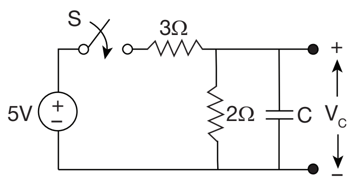
Number of Questions: 25 **Time: 60 min.**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. The response of a network is i(t) = 2t.e^{-5t} A for t ≥ 0, the value of 't' at which the i(t) will become maximum, is

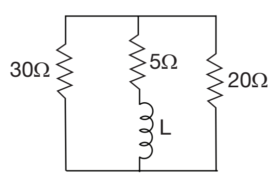
(A) 0.2 sec (B) 0.4 sec
(C) 0.25 sec (D) 0.8 sec

2. In the network shown below, it is given that V_c = 2.5V and $\frac{dV_c}{dt}$ = –8V/s at a time 't', where t is the time constant after the switch 'S' is closed. What is the value of 'C'?



(A) 3.25 mF (B) 1.25 mF
(C) 1 μF (D) 0.052 F

3.



If the time constant of circuit is 1.5 msec. Then the value of L is ______

(A) 18 mH (B) 25.5 mH
(C) 5.3 mH (D) 30 mH

4. In an $A.C$ series RLC circuit, the voltage across R and L is 20V, voltage across L and C is 9V and voltage across RLC is 15V. Then the ratio of $\frac{V_L}{V_C}$ is _____

[Assume $V_L > V_C$].

(A) 0.64 (B) 2.52
(C) 3.43 (D) 2.28

5. A network has a transfer function

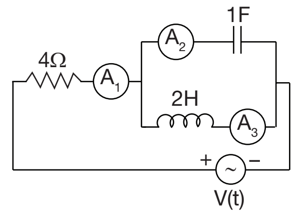
$$Z(S) = \frac{3s+2}{0.5s+3}$$

If the current $i(t)$ is a unity step function, the steady – state value of $V(t)$ is given by

(A) 0 (B) 1.5
(C) 2/3 (D) ∞

6. Consider the circuit shown in figure

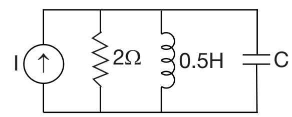
If A_1, A_2 and A_3 are ideal ammeters. It A_1 and A_3 reads 8A and 3A respectively, then A_2 should read _____



(A) 5A (B) 11A
(C) 8.66A (D) None

7. Consider the circuit shown in below

If the roots of the response is complex conjugate then the value of C is ______

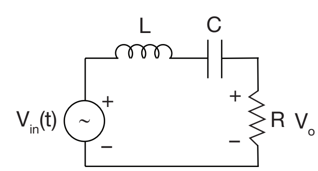


(A) 0.25 F (B) 15 mF
(C) 30 mF (D) 32 mF

8. The coil of a certain relay is operated by 15V battery. If the coil has a resistance of 200 Ω and an inductance of 25 mH and the current needed to pull in is 40 mA, calculate the relay delay time.

(A) 0.11 ms (B) 0.15 ms
(C) 1.25 ms (D) 0.5 ms

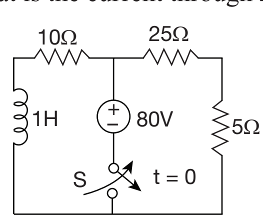
9. Consider the circuit shown in below.



It is a

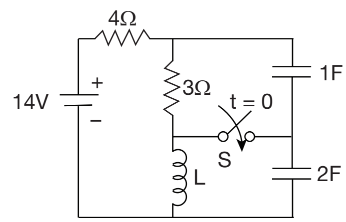
(A) BSF (B) APF
(C) BPF (D) HPF

10. In the circuit shown in the figure given below, the switch is opened at t = 0, after having been closed for a long time. What is the current through 25Ω resistor?



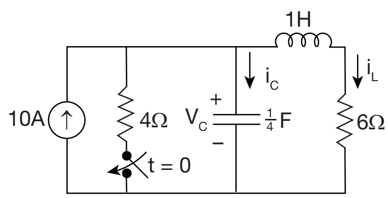
(A) 8.e^{-10t} A (B) 6.e^{-10t} A
(C) 8.e^{-40t} Amp (D) 4.e^{-40t} A

11. The circuit given below is in steady state for a long time with switch S open, The switch is closed at t = 0. The current through switch will be _____



(A) 2/3 A (B) 1/3 A
(C) 0 (D) –1/4 A

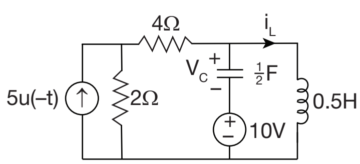
12. Consider the circuit shown in figure



Determine the values of $\frac{di_L(0^+)}{dt}$ and $\frac{dV_c(0^+)}{dt}$

(A) –10 A/sec and 0
(B) 10 A/sec and –60 V/sec
(C) 12.5 A/sec and 45 V/sec
(D) 0 and –60 V/sec

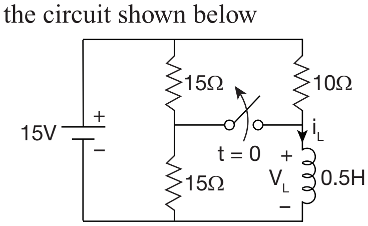
13. Consider the circuit shown in below.



The values of $\frac{di(0^+)}{dt}$ *and* $\frac{dV_C(0^+)}{dt}$ would be ____

(A) 0 and –10/3 V/sec
(B) 3.2 A/sec and 4 V/sec
(C) –2.5 A/sec and –5/3 V/sec
(D) 0 and 2.5 V/sec

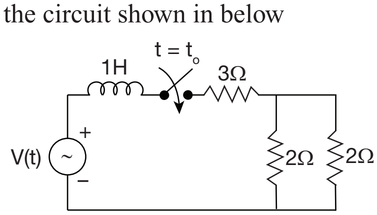
14. Consider the circuit shown below



Find the energy stored in the inductor at $t = O^+$.

(A) 1.25 mJ (B) 4.5 mJ
(C) 3.12 J (D) 1.56 J

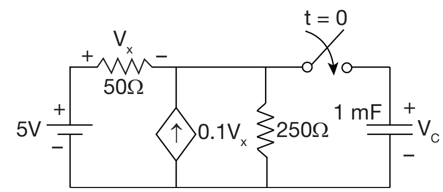
15. Consider the circuit shown in below



If $V(t) = 4 \sin 2t$ volts, the circuit is in transient free condition, then the value of t_o is ________

(A) 13.28 sec (B) 2.25 sec
(C) 0.2318 sec (D) 3.25 msec

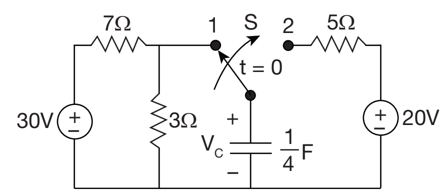
16.



Find the value of V_c at $t = 2$ms.

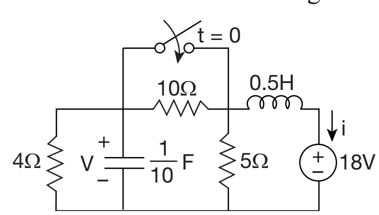
(A) 1.06 V (B) 0.75 V
(C) 3.5 V (D) 1.25 V

17. For the circuit shown in figure below, the switch has been in position 1 for a long time. At $t = 0$, the switch is moved to position 2. Then, the capacitor voltage $V_c(t)$ for $t > 0$ is ______



(A) $(9 + 11.e^{-4t/5})$ volts (B) $(20 - 11.e^{-4t/5})$ volts
(C) $(20 + 9.e^{-1.25t})$ volts (D) $(9 + 11\ e^{-1.25t})$ volts

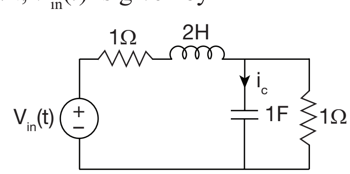
18. Consider the circuit shown in below figure



Find the steady state values of voltage and current.

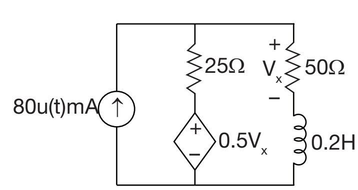
(A) 10V, 8.1A (B) 18V, –8.1A
(C) 8V, 4.5A (D) 6V, 9A

19. If $i_c(t) = -5.e^{-2.5t}$ A, the voltage of the source of the given circuit, $V_{in}(t)$ is given by



(A) $-16.e^{-2.5t}$ V (B) $14.e^{-2.5t}$ V
(C) $8.e^{-2.5t}$ V (D) $-10.e^{-2.5t}$ V

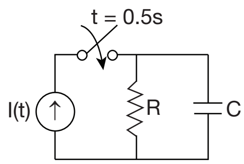
20.



Find $V_x(t)$ for all t?

(A) $1.6[1 - e^{-150t}]u(t)$ mV (B) $80[1 - e^{-150t}].u(t)$ mV
(C) $2.5[1 - e^{-75t}]u(t)$ V (D) $1.6[1 - e^{-75t}]\ u(t)$ mV

21. Consider the circuit shown in figure



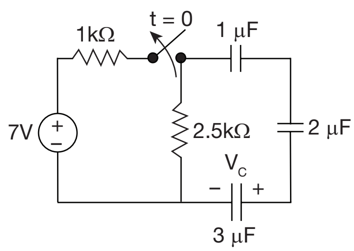
If $i(t) = I_m.\ \cos(2t + \phi)$Amp and time constant of the circuit is ½ sec.

At what value of ϕ, the circuit gives transient free response?

(A) 135° (B) 1.356 rad
(C) 77.70° (D) B and C

Common Data for 22 and 23:

Consider the circuit shown in figure



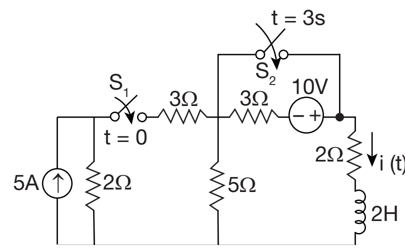
22. Find the $V_c(t)$.

(A) $5.e^{-1000t/1.36}$ V (B) $0.9.e^{-1000t/1.36}$ Volts
(C) $3.2.e^{-1000t/6}$ V (D) $0.9.e^{-500t/3}$ Volts

23. At $t = 1$ ms the power dissipated by the 2.5 $k\Omega$ is _____.

(A) 1.52 mW (B) 1.78 mW
(C) 2.3 mW (D) 4.4 mW

Common Data for 24 and 25:



24. Find the $i(t)$ for $0 < t < 3$.

(A) $2\left(1-e^{\frac{-15t}{4}}\right)$ A (B) $2\left(1+e^{\frac{-15}{4}t}\right)$ A

(C) $2e^{-\frac{15}{4}t}$ A (D) $e^{-15/4t}$ A

25. Calculate $i(t)$ for $t > 3$

(A) $1.11 - 0.88.e^{-4/9(t-3)}$ A
(B) $2 - 0.88.e^{-2.25t}$ A
(C) $1.11 + 0.88.e^{-2.25(t-3)}$ A
(D) $1.11 - 0.88.e^{-4/9\ t}$ A

Answer Keys

1. A	**2.** D	**3.** B	**4.** D	**5.** C	**6.** B	**7.** D	**8.** A	**9.** C	**10.** C
11. A	**12.** D	**13.** A	**14.** D	**15.** C	**16.** A	**17.** B	**18.** B	**19.** B	**20.** A
21. D	**22.** B	**23.** C	**24.** A	**25.** C					

Hints and Explanations

1. For $i(t)$ to be maximum only when

$$\frac{di(t)}{dt} = 0\ and\ \frac{d^2 i(t)}{dt^2} < 0$$

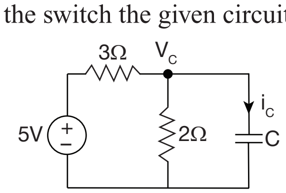
Given $i(t) = 2t.e^{-5t}\ A$

$$\frac{di}{dt} = 2\{e^{-5t} + t.(-5).e^{-5t}\} = 0$$

$1 - 5t = 0$

$t = 1/5$ sec Choice (A)

2. After closing the switch the given circuit becomes



$$\frac{V_C - 5}{3} + \frac{V_C}{2} + C.\frac{dV_c}{dt} = 0$$

$$2V_C - 10 + 3V_C + 6C\frac{dV_C}{dt} = 0$$

Given $V_C = 2.5$ volts

$$\frac{dV_C}{dt} = -8\ \text{V/sec}$$

$5V_C - 10 = 6 \times 8$V

$$C = \frac{2.5}{48}\ \text{F}$$

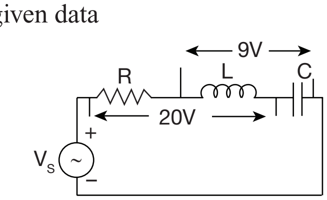
$= 0.052$ Farads Choice (D)

3. $R_{eq} = 5 + 20||30 = 17\ \Omega$

$$\tau = \frac{L}{R} \Rightarrow L = 1.5 \times 17\ \text{mH}$$

$L = 25.5$ mH Choice (B)

4. From the given data



$V_L - V_C = 9V$
$V_S = 15$ V
$(15)^2 = V_R^2 + (9)^2$

$V_R = 12V$ and $V_x = \sqrt{V_R^2 + V_L^2}$

$(20)^2 = (12)^2 + V_L^2$

$V_L = 16V$
$V_L - V_C = 9V$
$V_C = 16 - 9 = 7$ volts

$\therefore \frac{V_L}{V_C} = 2.28$ Choice (D)

5. $Z(S) = \frac{V(S)}{I(S)} = \frac{3S+2}{0.5S+3}$

$I(S) = \frac{1}{S}$

$V(S) = Z(S).I(S)$

$V(S) = \frac{(3S+2)}{S(0.5S+3)}$

$\therefore$ steady state value nothing but final value

$\therefore \quad V = \underset{S\to 0}{lt}\, S.V(S) = \frac{2}{3}V$ Choice (C)

6. From the given circuit
$I_1 = I_s = 8A$
$I_3 = I_L = 3A$

$\therefore$ we know $I_S = \sqrt{I_R^2 + (I_L - I_C)^2}$

But $I_R = 0$
$I_S = (I_L - I_C)$ or $I_C - I_L$
$\therefore \quad I_C = I_L + I_S = 11$ Amp Choice (B)

7. From the given data
Roots are complex conjugate, so it is a under damped system

$\therefore \quad \xi < 1$

$\xi = \frac{1}{2Q}$

$Q = R\sqrt{\frac{C}{L}}$ for parallel RLC circuits

$\therefore \quad \frac{1}{2R}\sqrt{\frac{L}{C}} < 1$

$\frac{1}{4}\sqrt{\frac{1}{2C}} < 1$

$\frac{1}{2C} < 16$

$C > \frac{1}{32}$

$C > 31.25$ mF

$\therefore$ Let $C = 32$ mF Choice (D)

8. The current through the coil is given by
$i(t) = i(\infty) + \{i(0) - i(\infty)\}.e^{-t/\tau}$

$i(0) = 0,\ i(\infty) = \frac{15}{200} = 75$ mA

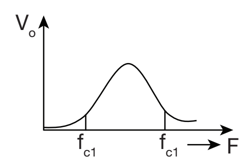
$\tau = \frac{L}{R} = \frac{30\times 10^{-3}}{200} = 0.15\,\text{ms}$

$i(t) = 75[1 - e^{-t/\tau}]$ mA
If $i(td) = 40$ mA, then $t_d = ?$
$40 = 75[1 - e^{-t/\tau}]$
$e^{-t/\tau} = 0.466$

$-\frac{t_d}{\tau} = \ln(0.466)$

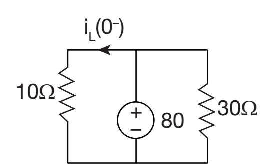
$t_d = 0.7621\tau = 0.11$ msec Choice (A)

9. At low frequencies $f \to 0$ Hz
$L \to$ short circuit
$C \to$ open circuit
$I_R = 0$ Amp
$\therefore \quad V_o = 0$ volts at high frequencies
$f \to \infty$
$L \to$ open circuit
$C \to$ short circuit
$I_R = 0$
$\therefore \quad V_o = 0$



BPF Choice (C)

10. Initially at $t = 0^-$ switch was closed
In steady state the inductor behaves like short circuit



$i_L(0^-) = \frac{80}{10} = 8$ Amp

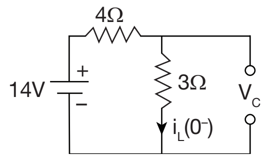
For t ≥ 0:–
Switch is opened at $t > 0$
$\therefore$ for $t > 0$ it becomes source free circuit
$i_L(t) = I_o.e^{-t/\tau}$ A

$\tau = \frac{L_{eq}}{R_{eq}}$

$L = 1H$
$R_{eq} = (10 + 30)\ \Omega = 40\ \Omega$
$\tau = 1/40$
$i_L(t) = 8.e^{-40}t$ Amp Choice (C)

11. **For t < 0:–**
At $t = 0^-$; switch opened, the circuit is in steady state

$\therefore$ $L \to$ short circuit
$C \to$ open circuit



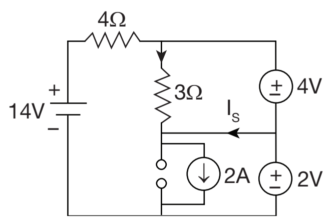
$i_L(0^-) = \frac{14}{7} = 2A$

$V_C(0^-) = 6V$

$\therefore$ $V_{1F}(0^-) = \frac{6 \times 2}{3} = 4V$

$V_{2F}(0^-) = \frac{6 \times 1}{3} = 2V$

$\therefore$ for $t > 0$, the circuit becomes shown below

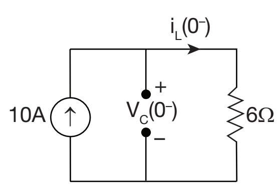


$\therefore$ $i_L = i_{3\Omega} + I_s$

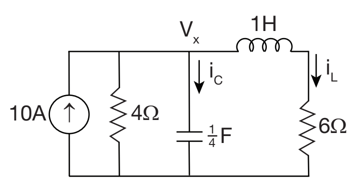
$2 = \frac{4}{3} + I_s$

$I_S = 2 - \frac{4}{3} = 2/3$ Amp Choice (A)

12. For t < 0:–
In steady state the equivalent circuit becomes



$i_L(0^-) = 10$ A $= i_L(0^+)$
$V_C(0^-) = 60$ V $= V_C(0^+)$
For t > 0:–



$$-10 + \frac{V_x}{4} + i_c + i_L = 0$$

$$i_c = \frac{CdV_c}{dt}$$

$$V_L = L.\frac{di_L}{dt}$$

But $V_x = V_C$

$$-10 + \frac{V_C}{4} + C.\frac{dV_c}{dt} + i_L = 0$$

at $t = 0^+$

$$C\frac{dV_c(0^+)}{dt} = 10 - \frac{V_c(0^+)}{4} - i_L(0^+)$$

$= 10 - 15 - 10$

$$\frac{dV_C(0^+)}{dt} = \frac{-15}{\frac{1}{4}}$$

$$\frac{dV_c(0^+)}{dt} = -60 \text{ V/sec}$$

$V_x = V_L + 6i_L$
$V_x = V_C$

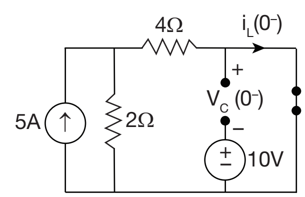
$$V_C(0^+) = L\frac{di_L(0^+)}{dt} + 6i_L(0^+)$$

$$60 - 6 \times 10 = \frac{L\,di_L}{dt}$$

$$\frac{di_L}{dt} = 0 \text{ A/sec}$$

Choice (D)

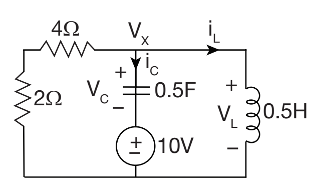
13. For t < 0:–
At $t = 0^-$; the circuit is in steady state



$V_C(0^-) = -10V = V_C(0^+)$

$i_L(0^-) = \frac{2}{6} \times 5 = \frac{5}{3} A = i_L(0^+)$

for t > 0:–
$5u(-t) = 0 \Rightarrow$ open circuit
The equivalent circuit becomes



$V_L = V_C + 10$

$$\frac{L.di_L(0^+)}{dt} = V_C(0^+) + 10$$

$$\frac{di_L(0^+)}{dt} = 0$$

at $t = 0^+$
$V_x(0^+) = V_C(0^+) + 10V$

$V_x(0^+) = 0V$

$\therefore \quad i_C = -i_L$

$$i_c = \frac{C.dV_c}{dt} = -i_L$$

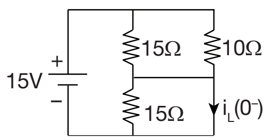
$$\frac{dV_c(0^+)}{dt} = \frac{-i_L(0^+)}{C} = -5/3 \times 2$$

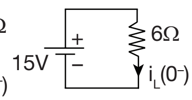
$$= \frac{-10}{3} \text{ V/sec}$$

Choice (A)

14. For T < 0:– Switch was closed,

$\therefore$ The circuit becomes shown in below





$$i_L(0^-) = \frac{15}{6} = 2.5 \text{ Amp}$$

$i_L(0^+) = 2.5$ Amp

$$W = \frac{1}{2} L I_o^2 = \frac{1}{2} \times 0.5 \times (2.5)^2$$

$= 1.5625$ Joules

Choice (D)

15. for $t < t_o$:–

Switch opened

For $t > t_o$:–

For RL series circuits, transient free condition is

$\omega t_o + \phi = \text{Tan}^{-1}\ \omega\tau$

where $\phi = 0$

$\omega = 2$ rad/sec

$$\tau = \frac{L}{R} = \frac{1}{4}$$

$$2t_o = \text{Tan}^{-1}\left[\frac{1}{2}\right] = 0.4636$$

$t_o = 0.2318$ sec

Choice (C)

16. For $t < 0$:–

Switch opened;

$\therefore \quad V_c(0^-) = 0 = V_C(0^+)$

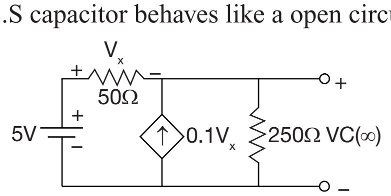
For $t > 0$:–

At $t = 0^+$ switch closed

$V_C(0^+) = OV$

$\therefore$ As $t \to \infty$; circuit is in steady state

In S.S capacitor behaves like a open circuit.



$$\frac{V_C(\infty) - 5}{50} + \frac{V_C(\infty)}{250} = 0.1V_x$$

but $5 - V_x - V_x(\infty) = 0$

$V_x = 5 - V_c(\infty)$

$6V_c(\infty) - 25 = 25[5 - V_c(\infty)]$

$31V_c(\infty) = 150$

$V_c(\infty) = 4.83$ volts

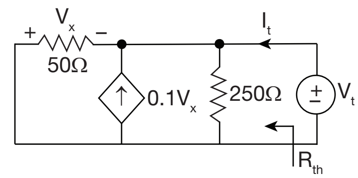
$\therefore \quad V_c(t) = V_c(\infty) + \{V_c(0^+) - V_c(\infty)\}.e^{-t/\tau}$

$\therefore \quad V_c(t) = 4.83[1 - e^{-t/\tau}\}.u(t)$

τ:–

$\tau = RC$

$R = \text{Rth}$:–



$$-I_t + \frac{V_t}{250} + \frac{V_t}{50} - 0.1V_x = 0$$

$V_t + V_x = 0$

$V_x = -V_t$

$$\frac{6V_t}{250} = I_t - 0.1V_t$$

$6V_t = 250\ I_t - 25\ V_t$

$31V_t = 250\ I_t$

$$R_{th} = \frac{V_t}{I_t} = \frac{250}{31} = 8.064\ \Omega$$

$\tau = 8.064 \times 1$ m sec

$\tau = 8.064$ m sec

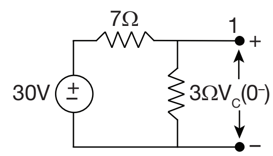
$V_c(t) = 4.83[1 - e^{-124t}]u(t)$ at $t = 2$ m sec

$V_c(2\text{m}) = 1.06$ volts

Choice (A)

17. For t < 0:– The switch connected to position 1.

at $t = 0^-$

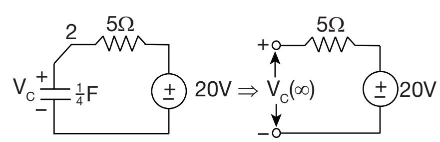


ckt is in S.S

$$\therefore \quad V_C(0^-) = \frac{3}{10} \times 30 = 9V = V_C(0^+)$$

For t > 0:– Switch $\to$ position 2.

The circuit becomes of $t \to \infty$ (in steady state)



$\therefore \quad V_C(\infty) = 20V$

$\therefore \quad V_c(t) = V_c(\infty) + \{V_c(0^+) - V_c(\infty)\}.e^{-t/\tau}$

$$\tau = RC = 5 \times \frac{1}{4} = 1.25 \text{ sec}$$

$V_C(t) = 20 + \{9 - 20\}.e^{-t/1.25}$ volts

$V_C(t) = 20 - 11.e^{-4t/5}$ volts

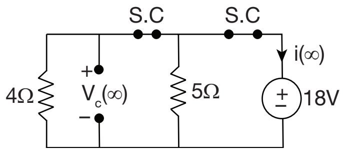
Choice (B)

18. In steady state

$C \rightarrow$ open circuit

$L \rightarrow$ short circuit

The equivalent circuit is



$V_C(\infty) = 18V$

$$\frac{18}{4} + \frac{18}{5} + i(\infty) = 0$$

$18 \times 9 = -20\, i(\infty)$

$i(\infty) = -8.1$ Amp — Choice (B)

19. We know

$$i_c = C.\frac{dv_c}{dt}$$

$$V_c = \frac{1}{c}\int i_c(t).dt$$

$$= \frac{1}{1}\int -5.e^{-2.5}.dt$$

$$V_c = \frac{-5}{-2.5}.e^{-2.5t} = 2.e^{-2.5t} \text{ volts}$$

$$I_R = \frac{V_C}{R} = 2.e^{-2.5t}\text{Amp}$$

$I_{in} = I_C + I_R$

$= -3.e^{-2.5t}$

$$V_{in} - I_{in} \times 1 - L.\frac{dI_{in}}{dt} - V_C = 0$$

$V_{in} = I_{in} + V_C + VL$

$$V_L = 2.\frac{d}{dt}\{-3.e^{-2.5t}\}$$

$V_L = 6 \times 2.5.e^{-2.5t}$ volts

$V_{in} = -3.e^{-2.5t} + 2.e^{-2.5t} + 15.e^{-2.5t}$

$V_{in} = 14.e^{-2.5t}$ volts — Choice (B)

20. For t < 0:–

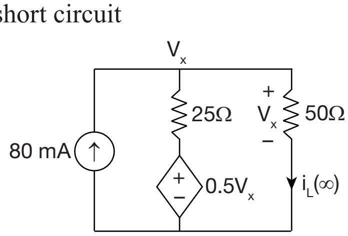
The independent current source deactivates (open circuit)

$\therefore$ $i_L(0^-) = 0$ Amp $= i_L(0^+)$

For t > 0:–

If $t \rightarrow \infty$, the circuit is in steady state

$L \rightarrow$ short circuit



$$-80\text{mA} + \frac{0.5V_x}{25} + i_L(\infty) = 0$$

$$V_x = \frac{i_L(\infty)}{50}$$

$$80 \times 10^{-3} = \frac{i_L(\infty)}{50} \times \frac{1}{50} + i_L(\infty)$$

$$i_L(\infty)\left[1 + \frac{1}{25 \times 10^2}\right] = 80 \times 10^{-3}$$

$i_L(\infty) = 79.96$ mA

$\therefore$ $i_L(t) = i(\infty) + [i(0^-) - i(\infty)].e^{-t/\tau}$

$i^L(t) = i(\infty)[1 - e^{-t/\tau}]\, u(t)$

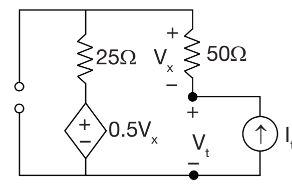
$$\tau = \frac{L_{eq}}{R_{eq}}$$

Res:–

(i) Deactivate all the independent sources.

(ii) Connect one test source

(iii) Find the equivalent resistance



$$\therefore \quad R_{th} = \frac{V_t}{I_t}$$

$V_t + V_x - 25\, I_t - 0.5V_x = 0$

$V_t = 25\, I_t + 50\, I_t$

$$\frac{V_t}{I_t} = R_{th} = 75\ \Omega$$

$$\tau = \frac{0.5}{75} = \frac{1}{150}\text{sec}$$

$\therefore$ $i_L(t) = 79.96[1 - e^{-150t}].u(t)$ mA

$$\therefore \quad V_x = \frac{i_L(t)}{50}$$

$V_x(t) \approx 1.6[1 - e^{-150t}].u(t)$ mV — Choice (A)

21. We know, the transient free conditions

$\omega t_o + \phi = \text{Tan}^{-1}(\omega\tau + \pi/2)$ [for cosinusoidal input]

$$2\, t_o + \phi = \left\{\tan^{-1}\left[2 \times \frac{1}{2}\right] + \frac{\pi}{2}\right\}$$

$t_o = 1$ sec

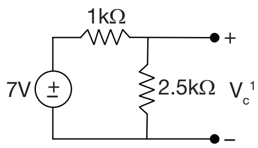
$$\phi = \frac{\pi}{4} + \frac{\pi}{2} -$$

$$\phi = \frac{3\pi}{4} - 2$$

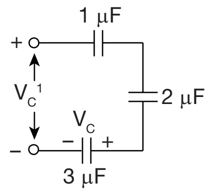
$= 1.356$ rad or $77.70°$. — Choice (D)

22. For t < 0:– Switch closed at $t = 0^-$; circuit is in steady state

$C \rightarrow$ open circuit



$$V_C^1 = \frac{2.5}{3.5} \times 7 = 5\text{V}$$



$$V_C = \frac{\frac{2}{3} \times V_C^1}{\frac{2}{3} + 3}$$

$$V_C = \frac{2 \times 5}{11} = 0.9\text{V}$$

For $t > 0$:–

$S \rightarrow$ opened;

∴ Source free *RC* circuit

$V_C(t) = V_o . e^{-t/\tau}$

$\tau = R, C$

$C_{eq} = [1\ \mu f \| 2\ \mu f \| 3\ \mu f]$

$= \left(\frac{2}{3}\mu f \parallel 3\mu f\right) = \frac{6}{11}\ \mu F$

$R = 2.5\ k\Omega$

$\tau = 1.36$ m sec

∴ $V_C(t) = 0.9 . e^{-t/1.36\times10^{-3}}$ volts Choice (B)

23. $P = V.I = \dfrac{V_C^2}{R}$

$V_C^1(t) = 5.e^{-t/1.36\times10^{-3}}$ volts

$V_C^1(1ms) = 5.e^{-1/1.36} = 2.4$ volts

$P = \dfrac{5.767}{2.5}\text{mW} = 2.3$ mW Choice (C)

24. Consider three time intervals $t \le 0$, $0 \le t < 3$ and $t \ge 3$ separately.

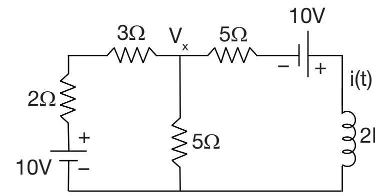
For $t < 0$, switches S_1 and S_2 are open so that $i = 0$

∴ $i(0^-) = i(0^+) = 0$

For $0 \le t < 3$: $S_1 \rightarrow$ closed

S_2 is still open

The equivalent circuit becomes



∴ S_1 is closed forever, $i(\infty) = \dfrac{V_x + 10}{5}$

$$\frac{V_x - 10}{5} + \frac{V_x}{5} + \frac{V_x + 10}{5} = 0$$

$3V_x = 0$

$V_x = 0$

∴ $i(\infty) = 2$ Amp

$i(t) = i(\infty) + \{i(0^-) - i(\infty)\}.e^{-t/\tau}$

$\tau = \dfrac{L_{eq}}{R_{eq}}$

$R_{eq} = 5 + (5 \| 5) = 7.5\ \Omega$

$\tau = \dfrac{2}{7.5} = \dfrac{4}{15}$ sec

∴ for $0 \le t < 3$:–

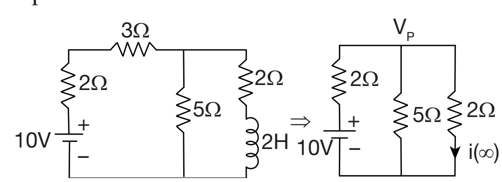
$i(t) = 2\left\{1 - e^{\frac{-15}{4}t}\right\}$; $0 \le t < 3$ Choice (A)

25. For $t \ge 3$, S_1 and S_2 both are closed, thus the initial current in case 2 is

$i(3) = i(3^-) = 2\{1 - e^{-45/4}\}\ A$

$= 1.999 \approx 2A$

The equivalent circuit for $t \ge 3$:–



$$\frac{V_P - 10}{5} + \frac{V_P}{5} + \frac{V_P}{2} = 0$$

$2\ V_P - 10 + 2.5\ V_P = 0$

$4.5\ V_P = 10 \Rightarrow V_P = 2.22$ V

$i(\infty) = 1.11$ Amp

$i(t) = i(\infty) + \{i(t_o) - i(\infty)\}\ e^{-(t - t_o)/\tau}$

$\tau = 2 + (5 \| 5) = 4.5$

$\tau = \dfrac{2}{4.5} = \dfrac{4}{9}$ sec

∴ $i(t) = 1.11 + \{2 - 1.11\}.e^{-9/4(t-3)}$ A

$i(t) = 1.11 + 0.88\ e^{-2.25(t-3)}$ A for $t \ge 3$ Choice (C)