4 Transient Analysis

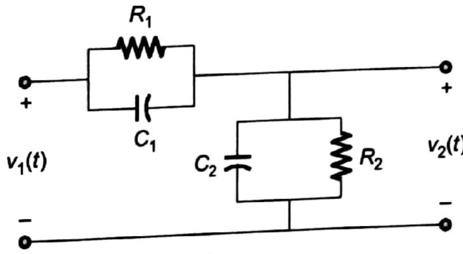
4.1 A 10 Ω resistor, a 1 H inductor and 1 μF capacitor are connected in parallel. The combination is driven by a unit step current. Under the steady state condition, the source current flows through :
(a) the resistor
(b) the inductor
(c) the capacitor only
(d) all the three elements **[1989 : 2 Marks]**

4.2 If the Laplace transform of the voltage across a capacitor of value of $\frac{1}{2}$F is

$$V_C(s) = \frac{s+1}{s^3+s^2+s+1},$$

the value of the current through the capacitor at $t = 0^+$ is
(a) 0 A (b) 2 A
(c) (1/2) A (d) 1 A
[1989 : 2 Marks]

4.3 For the compensated attenuator of figure, the impulse response under the condition $R_1C_1 = R_2C_2$ is



(a) $\frac{R_2}{R_1+R_2}[1-e^{\frac{1}{R_1C_1}}]u(t)$

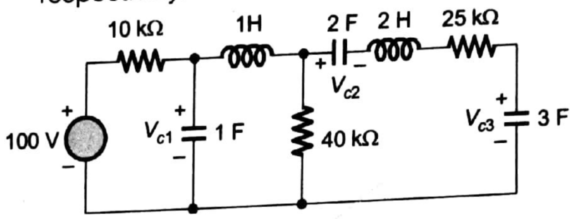
(b) $\frac{R_2}{R_1+R_2}\delta(t)$

(c) $\frac{R_2}{R_1+R_2}u(t)$

(d) $\frac{R_2}{R_1+R_2}e^{\frac{t}{R_1C_1}}u(t)$ **[1992 : 2 Marks]**

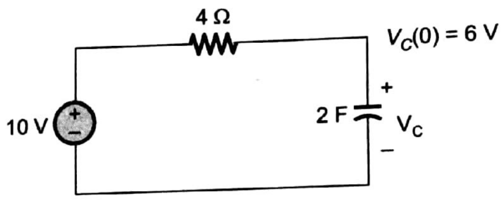
4.4 A ramp voltage, $v(t) = 100\,t$ Volts, is applied to an RC differentiating circuit with R = 5 kΩ and C = 4 μF. The maximum output voltage is
(a) 0.2 volt (b) 2.0 volts
(c) 10.0 volts (d) 50.0 volts
[1994 : 1 Mark]

4.5 The voltage V_{C1}, V_{C2} and V_{C3} across the capacitors in the circuit in Fig., under steady state, are respectively.



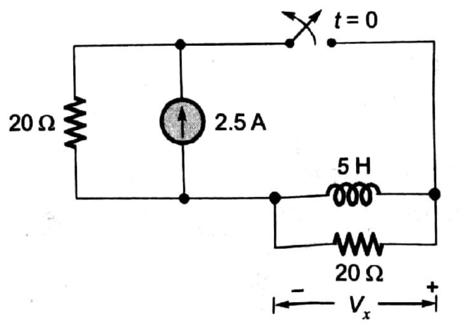
(a) 80 V, 32 V, 48 V (b) 80 V, 48 V, 32 V
(c) 20 V, 8 V, 12 V (d) 20 V, 12 V, 8 V
[1996 : 2 Marks]

4.6 In the circuit of Fig. the energy absorbed by the 4 Ω resistor in the time interval (0, ∞) is



(a) 36 Joules
(b) 16 Joules
(c) 256 Joules
(d) None of the above **[1997 : 2 Marks]**

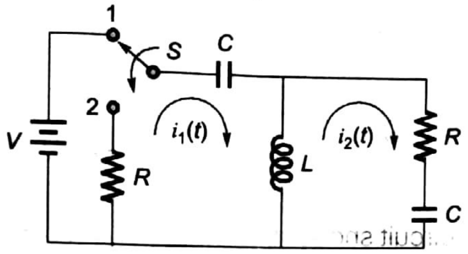
4.7 In the figure, the switch was closed for a long time before opening at t = 0. The voltage V_x at $t = 0^+$ is



(a) 25 V (b) 50 V
(c) –50 V (d) 0 V
[2002 : 1 Mark]

The circuit for 4.8 and 4.9 is given. Assume that the switch S is in position 1 for a long time and thrown to position 2 at $t = 0$.

4.8 At $t = 0^+$, the current i_1 is



(a) $\frac{-V}{2R}$ (b) $\frac{-V}{R}$

(c) $\frac{-V}{4R}$ (d) zero

[2003 : 2 Marks]

4.9 $I_1(s)$ and $I_2(s)$ are the Laplace transforms of $i_1(t)$ and $i_2(t)$ respectively. The equations for the loop currents $I_1(s)$ and $I_2(s)$ for the circuit shown in the figure, after the switch is brought from position 1 to position 2 at $t = 0$, are

(a) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + \frac{1}{Cs} \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \begin{bmatrix} \frac{V}{s} \\ 0 \end{bmatrix}$

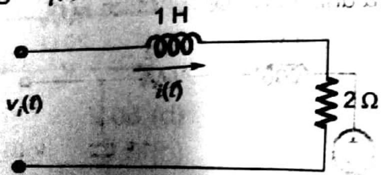
(b) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + \frac{1}{Cs} \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \begin{bmatrix} -\frac{V}{s} \\ 0 \end{bmatrix}$

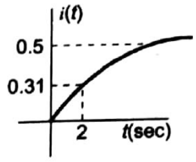
(c) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + Ls + \frac{1}{Cs} \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \begin{bmatrix} -\frac{V}{s} \\ 0 \end{bmatrix}$

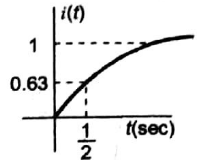
(d) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + Ls + \frac{1}{Cs} \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \begin{bmatrix} \frac{V}{s} \\ 0 \end{bmatrix}$

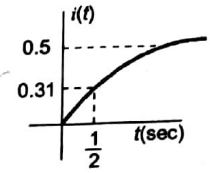
[2003 : 2 Marks]

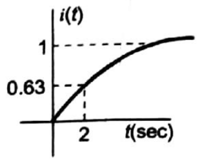
4.10 For the *R-L* circuit shown in the figure, the input voltage $v_i(t) = u(t)$. The current $i(t)$ is



(a)


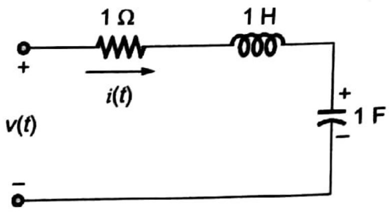
(b)


(c)


(d)


[2004 : 1 Mark]

4.11 The circuit shown in the figure has initial current $i_L(0^-) = 1$ A through the inductor and an initial voltage $v_C(0^-) = -1$ V across the capacitor. For input $v(t) = u(t)$, the Laplace transform of the current $i(t)$ for $t \geq 0$ is

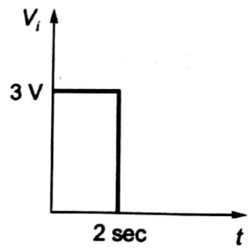


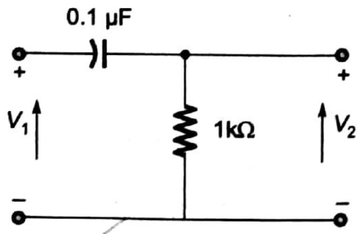
(a) $\frac{s}{s^2 + s + 1}$ (b) $\frac{s+2}{s^2 + s + 1}$

(c) $\frac{s-2}{s^2 + s - 1}$ (d) $\frac{s-2}{s^2 + s + 1}$

[2004 : 2 Marks]

4.12 A square pulse of 3 volts amplitude is applied to C-R circuit shown in the figure. The capacitor is initially uncharged. The output voltage V_2 at time $t = 2$ sec is



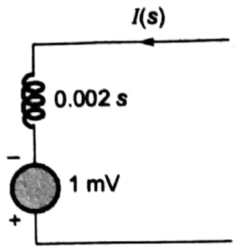


(a) 3 V (b) −3 V

(c) 4 V (d) −4 V

[2005 : 2 Marks]

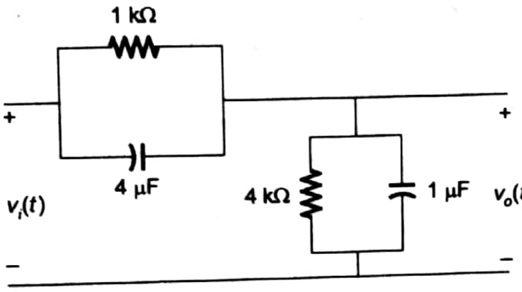
4.13 A 2 mH inductor with some initial current can be represented as shown below, where s is the Laplace Transform variable. The value of initial current is



(a) 0.5 A
(b) 2.0 A
(c) 1.0 A
(d) 0.0 A

[2006 : 1 Mark]

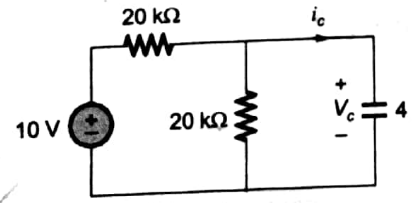
4.14 In the figure shown below, assume that all the capacitors are initially uncharged. If $v_i(t) = 10u(t)$ Volts, $v_0(t)$ is given by



(a) $8e^{-t/0.004}$ Volts
(b) $8(1-e^{-t/0.004})$ Volts
(c) $8u(t)$ Volts
(d) 8 Volts

[2006 : 1 Mark]

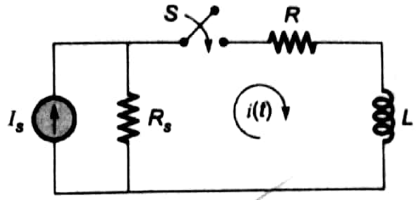
4.15 In the circuit shown, V_C is 0 volts at $t = 0$ sec. For $t > 0$, the capacitor current $i_c(t)$, where t is in seconds, is given by



(a) 0.50 exp(−25t) mA
(b) 0.25 exp(−25 t) mA
(c) 0.50 exp(−12.5t) mA
(d) 0.25 exp(−6.25 t) mA

[2007 : 2 Marks]

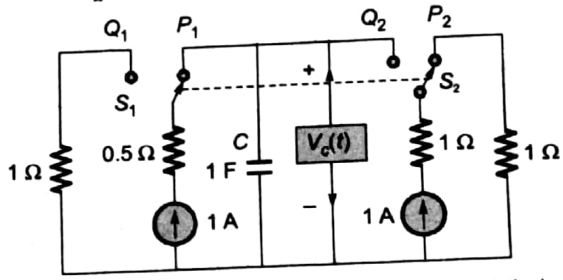
4.16 In the following circuit, the switch S is closed at $t = 0$. The rate of change of current $\frac{di}{dt}(0^+)$ is given by



(a) 0
(b) $\frac{R_s I_s}{L}$
(c) $\frac{(R+R_s)I_s}{L}$
(d) ∞

[2008 : 1 Mark]

4.17 The circuit shown in the figure is used to charge the capacitor C alternately from two current sources as indicated. The switches S_1 and S_2 are mechanically coupled and connected as follows:
For $2nT \le t < (2n+1)T$, $(n = 0,1,2...)$ S_1 to P_1 and S_2 to P_2.
For $(2n+1)T \le t < (2n+2)T$, $(n = 0,1,2. ...)$ S_1 to Q_1 and S_2 to Q_2



Assume that the capacitor has zero initial charge. Given that $u(t)$ is a unit step function, the voltage $V_c(t)$ across the capacitor is given by

(a) $\sum_{n=0}^{\infty}(-1)^n tu(t-nT)$

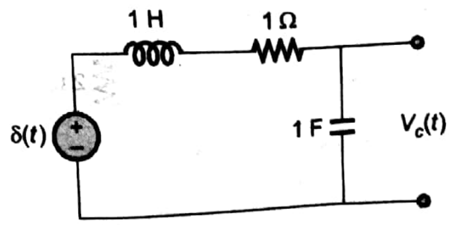
(b) $u(t)+2\sum_{n=1}^{\infty}(-1)^n u(t-nT)$

(c) $tu(t)+2\sum_{n=1}^{\infty}(-1)^n (t-nT)u(t-nT)$

(d) $\sum_{n=0}^{\infty}\left[0.5-e^{-(t-2nT)}+0.5e^{-(t-2nT-T)}\right]$

[2008 : 2 Marks]

Common Data for Questions 4.18 and 4.19:
The following series RLC circuit with zero initial conditions is excited by a unit impulse function $\delta(t)$.



4.18 For $t > 0$, the output voltage $V_c(t)$ is

(a) $\frac{2}{\sqrt{3}}\left(e^{-\frac{1}{2}t} - e^{-\frac{\sqrt{3}}{2}t}\right)$

(b) $\frac{2}{\sqrt{3}}te^{-\frac{1}{2}t}$

(c) $\frac{2}{\sqrt{3}}e^{-\frac{1}{2}t}\cos\left(\frac{\sqrt{3}}{2}t\right)$

(d) $\frac{2}{\sqrt{3}}e^{-\frac{1}{2}t}\sin\left(\frac{\sqrt{3}}{2}t\right)$

[2008 : 2 Marks]

4.19 For $t > 0$, the voltage across the resistor is

(a) $\frac{1}{\sqrt{3}}\left(e^{-\frac{\sqrt{3}}{2}t} - e^{-\frac{1}{2}t}\right)$

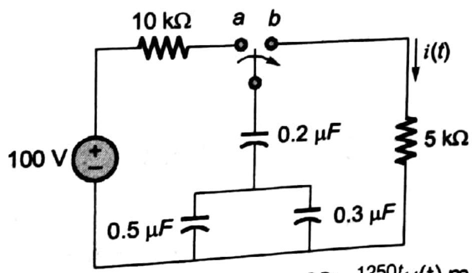
(b) $e^{-\frac{1}{2}t}\left[\cos\left(\frac{\sqrt{3}t}{2}\right) - \frac{1}{\sqrt{3}}sin\left(\frac{\sqrt{3}t}{2}\right)\right]$

(c) $\frac{2}{\sqrt{3}}e^{-\frac{1}{2}t}\sin\left(\frac{\sqrt{3}\,t}{2}\right)$

(d) $\frac{2}{\sqrt{3}}e^{-\frac{1}{2}t}\cos\left(\frac{\sqrt{3}\,t}{2}\right)$

[2008 : 2 Marks]

4.20 The switch in the circuit shown was on position a for a long time, and is moved to position b at time $t = 0$. The current $i(t)$ for $t > 0$ is given by



(a) $0.2e^{-125t}u(t)$ mA
(b) $20e^{-1250t}u(t)$ mA
(c) $0.2e^{-1250t}u(t)$ mA
(d) $20e^{-1000t}u(t)$ mA

[2009 : 2 Marks]

4.21 The time domain behaviour of an RL circuit is represented by

$$L\frac{di}{dt} + Ri = V_0\left(1 + Be^{-Rt/L}\sin t\right)u(t)$$

For an initial current of $i(0) = \frac{V_0}{R}$, the steady state value of the current is given by

(a) $i(t) \rightarrow \frac{V_0}{R}$

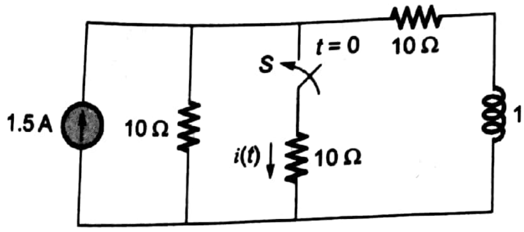
(b) $i(t) \rightarrow \frac{2V_0}{R}$

(c) $i(t) \rightarrow \frac{V_0}{R}(1+B)$

(d) $i(t) \rightarrow \frac{2V_0}{R}(1+B)$

[2009 : 2 Marks]

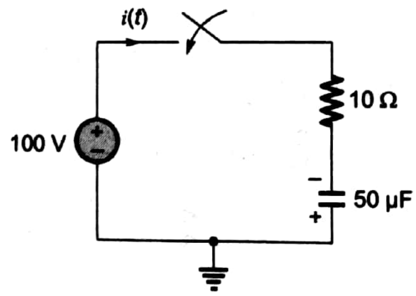
4.22 In the circuit shown, the switch S is open for a long time and is closed at $t = 0$. The current $i(t)$ for $t \geq 0^+$ is



(a) $i(t) = 0.5 - 0.125\,e^{-1000t}$ A
(b) $i(t) = 1.5 - 0.125\,e^{-1000t}$ A
(c) $i(t) = 0.5 - 0.5\,e^{-1000t}$ A
(d) $i(t) = 0.375\,e^{-1000t}$ A

[2010 : 2 Marks]

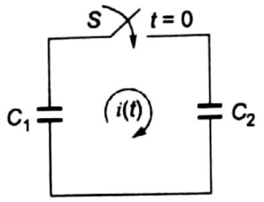
4.23 In the circuit shown below, the initial charge on the capacitor is 2.5 mC, with the voltage polarity as indicated. The switch is closed at time $t = 0$. The current $i(t)$ at a time t after the switch is closed is



(a) $i(t) = 15\exp(-2 \times 10^3 t)$ A
(b) $i(t) = 5\exp(-2 \times 10^3 t)$ A
(c) $i(t) = 10\exp(-2 \times 10^3 t)$ A
(d) $i(t) = -5\exp(-2 \times 10^3 t)$ A

[2011 : 2 Marks]

4.24 In the following figure, C_1 and C_2 are ideal capacitors. C_1 had been charged to 12 V before the ideal switch S is closed at $t = 0$. The current $i(t)$ for all t is



(a) zero
(b) a step function
(c) an exponentially decaying function
(d) an impulse function

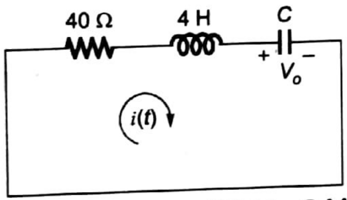
[2012 : 1 Mark]

4.25 For maximum power transfer between two cascaded sections of an electrical network, the relationship between the output impedance Z_1 of the first section to the input impedance Z_2 of the second section is

(a) $Z_2 = Z_1$ (b) $Z_2 = -Z_1$
(c) $Z_2 = Z_1^*$ (d) $Z_2 = -Z_1^*$

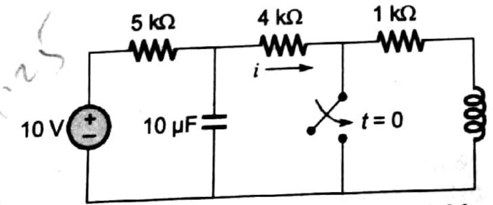
[2014 : 1 Mark, Set-1]

4.26 In the circuit shown in the figure, the value of capacitor C (in mF) needed to have critically damped response $i(t)$ is ______.



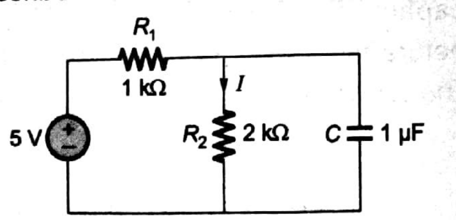
[2014 : 2 Marks, Set-1]

4.27 In the figure shown, the ideal switch has been open for a long time. If it is closed at $t = 0$, then the magnitude of the current (in mA) through the 4 kΩ resistor at $t = 0^+$ is ______.



[2014 : 1 Mark, Set-2]

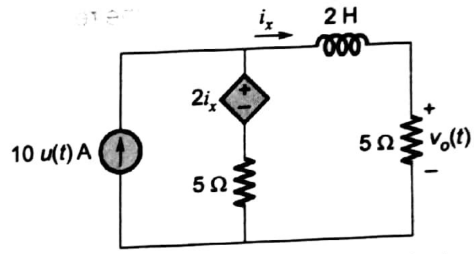
4.28 In the figure shown, the capacitor is initially uncharged. Which one of the following expressions describes the current $I(t)$ (in mA) for $t > 0$?



(a) $I(t) = \frac{5}{3}(1 - e^{-t/\tau}),\ \tau = \frac{2}{3}$ msec
(b) $I(t) = \frac{5}{2}(1 - e^{-t/\tau}),\ \tau = \frac{2}{3}$ msec
(c) $I(t) = \frac{5}{3}(1 - e^{-t/\tau}),\ \tau = 3$ msec
(d) $I(t) = \frac{5}{2}(1 - e^{-t/\tau}),\ \tau = 3$ msec

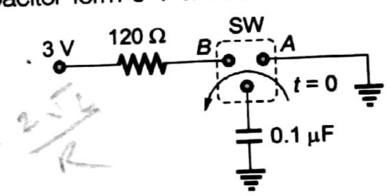
[2014 : 2 Marks, Set-2]

4.29 In the circuit shown in the figure, the value of $v_o(t)$ (in volts) for $t \to \infty$ is ______.



[2014 : 2 Marks, Set-4]

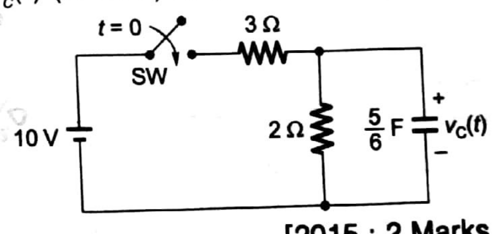
4.30 In the circuit shown, the switch SW is thrown from position A to position B at time $t = 0$. The energy (in μJ) taken from the 3 V source to charge the 0.1 μF capacitor form 0 V to 3 V is



(a) 0.3 (b) 0.45
(c) 0.9 (d) 3

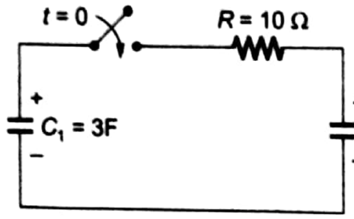
[2015 : 1 Mark, Set-1]

4.31 In the circuit shown, switch SW is closed at $t = 0$. Assuming zero initial conditions, the value of $v_c(t)$ (in Volts) at $t = 1$ sec is ______.



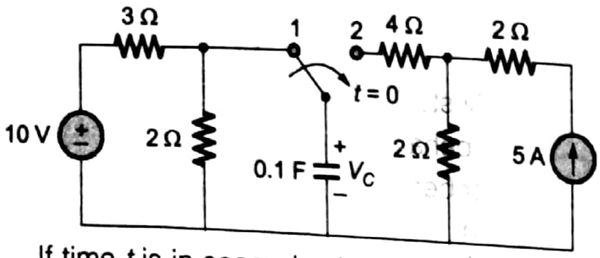
[2015 : 2 Marks, Set-1]

4.32 In the circuit shown, the initial voltages across the capacitors C_1 and C_2 and 1 V and 3 V, respectively. The switch is closed at time $t = 0$. The total energy dissipated (in Joules) in the resistor R until steady state is reached, is ______.



[2015 : 2 Marks, Set-2]

4.33 The switch has been in position 1 for a long time and abruptly changes to position 2 at $t = 0$.

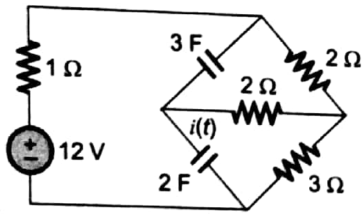


If time t is in seconds, the capacitor voltage V_C (in volts) for $t > 0$ is given by

(a) $4(1 - \exp(-t/0.5))$ (b) $10 - 6\exp(-t/0.5)$
(c) $4(1 - \exp(-t/0.6))$ (d) $10 - 6\exp(-t/0.6)$

[2016 : 1 Mark, Set-2]

4.34 Assume that the circuit in the figure has reached the steady state before time $t = 0$ when the 3 Ω resistor suddenly burns out, resulting in an open circuit. The current $i(t)$ (in ampere) at $t = 0^+$ is ________.

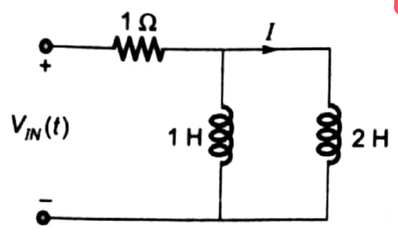


[2016 : 2 Mark, Set-3]

4.35 In the circuit shown, the voltage $V_{IN}(t)$ is described by:

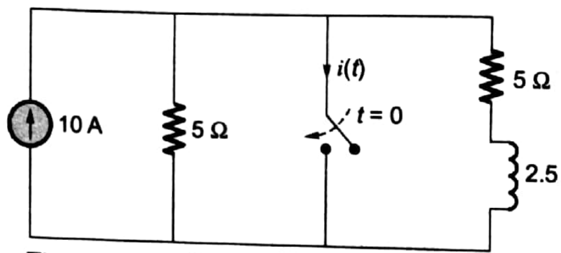
$$V_{IN}(t) = \begin{cases} 0, & \text{for } t < 0 \\ 15 \text{ Volts}, & \text{for } t \geq 0 \end{cases}$$

where t is in seconds. The time (in seconds) at which the current I in the circuit will reach the value 2 Amperes is ________.



[2017 : 2 Marks, Set-1]

4.36 The switch in the circuit, shown in the figure, was open for a long time and is closed at $t = 0$.



The current $i(t)$ (in ampere) at $t = 0.5$ seconds is ______.

[2017 : 2 Marks, Set-2]

Answers Transient Analysis

4.1 (b)	4.2 (c)	4.3 (b)	4.4 (b)	4.5 (b)	4.6 (b)	4.7 (c)	4.8 (a)	4.9 (c)
4.10 (c)	4.11 (b)	4.12 (b)	4.13 (a)	4.14 (c)	4.15 (a)	4.16 (b)	4.17 (c)	4.18 (d)
4.19 (b)	4.20 (b)	4.21 (a)	4.22 (a)	4.23 (a)	4.24 (d)	4.25 (c)	4.28 (a)	4.30 (c)
4.33 (d)								