3 Transient Response

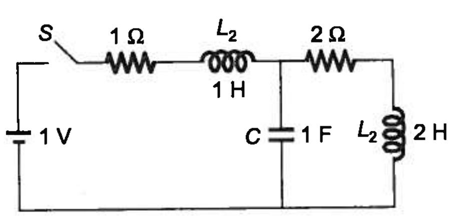
Multiple Choice Questions

Q.1 When a unit impulse voltage is applied to an inductor of 1 H, the energy supplied by the source is

(a) ∞ (b) 1 J
(c) (1/2) J (d) 0

[ESE-1991]

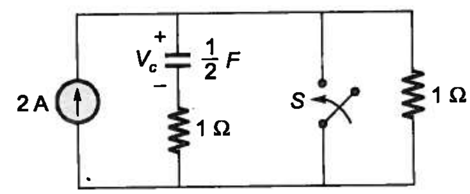
Q.2 In the network shown in the given figure, there is no initial current through L_2 and no initial voltage across the C. The switch 'S' is closed at $t = 0$. The current i_{L_1} in inductor L_1 and the voltage V_c across C at $t = 0^+$ and $t = \infty$ will be



	$I_{L1}(0^+)$	$I_{L1}(\infty)$	$V_c(0^+)$	$V_c(\infty)$
(a)	1/3A	1/3A	2/3V	2/3V
(b)	0	1/3A	0	1V
(c)	1/3A	0	2/3	0
(d)	0	1/3A	0	2/3V

[ESE-1995]

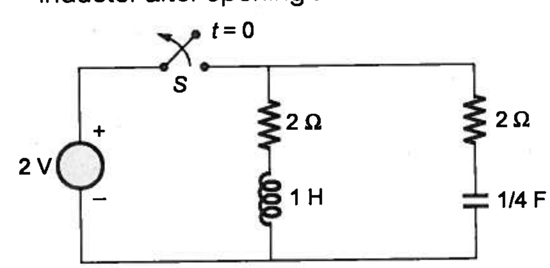
Q.3 The circuit shown in the given figure is in steady-state with switch 'S' open. The switch is closed at $t = 0$. The values of $V_c(0^+)$ and $V_c(\infty)$ will be respectively.



(a) 2 V, 0 V (b) 0 V, 2 V
(c) 2 V, 2V (d) 0 V, 0 V

[ESE-1997]

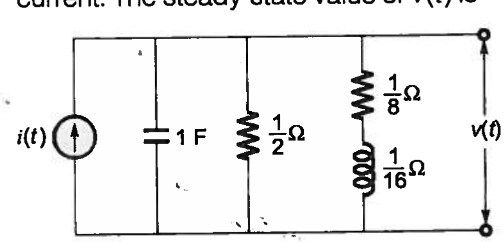
Q.4 On closing switch 'S', the circuit in the given figure is in steady-state. The current in the inductor after opening the switch 'S' will



(a) decay exponentially with a time constant of 2 s
(b) decay exponentially with a time constant of 0.5 s
(c) consist of two decaying exponentials each with a time constant of 0.5 s
(d) be oscillatory

[ESE-1999]

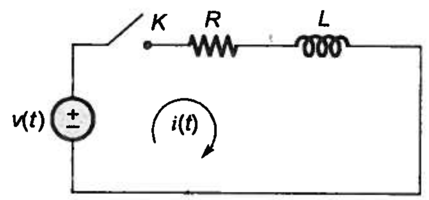
Q.5 In the circuit shown in the figure, $i(t)$ is a unit step current. The steady-state value of $v(t)$ is



(a) 2.5 V (b) 1 V
(c) 0.1 V (d) zero

[ESE-1999]

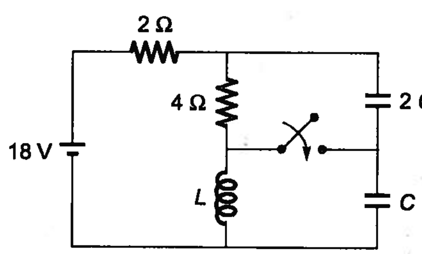
Q.6 In the circuit shown in the figure below, switch K is closed at $t = 0$. The circuit was initially relaxed. Which one of the following sources of $v(t)$ will produce maximum current at $t = 0^+$?



(a) Unit step
(b) Unit impulse
(c) Unit ramp
(d) Unit step plus unit ramp

[ESE-2000]

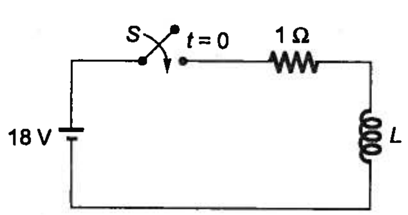
Q.7 In the circuit shown in the figure below, steady-state was reached when the switch S was open. The switch was closed at $t = 0$. The initial value of the current through the capacitor 2 C is



(a) zero (b) 1 A
(c) 2 A (d) 3 A

[ESE-2000]

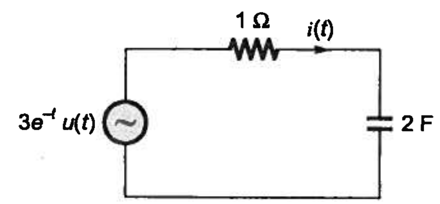
Q.8 In the circuit below, S was initially open. At time $t = 0$, S is closed. When the current through the inductor is 6 A, the rate of change of current through the resistor is 6 A/s. The value of the inductor would be



(a) 1 H (b) 2 H
(c) 3 H (d) 4 H

[ESE-2000]

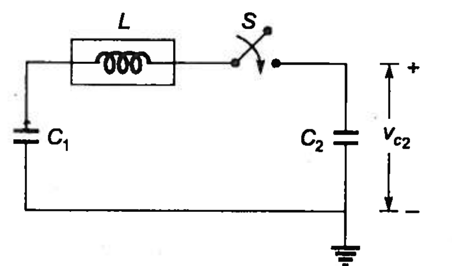
Q.9 In the circuit shown in the given figure, the values of $i(0^+)$ and $I(\infty)$ will be, respectively



(a) zero and 1.5 A (b) 1.5 A and 3 A
(c) 3 A and zero (d) 3 A and 1.5 A

[ESE-2001]

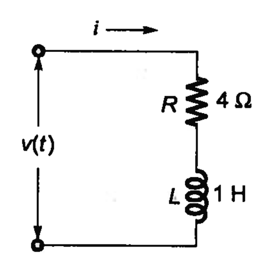
Q.10 In the circuit shown in the given figure, $C_1 = C_2 = 2$ F and the capacitor C_1 has a voltage of 20V when S is open.



It the switch S is closed at $t = 0$ the voltage V_{C_2} will be a
(a) fixed voltage of 20 V
(b) fixed voltage of 10 V
(c) fixed voltage of –10 V
(d) sinusoidal voltage

[ESE-2001]

Q.11 Consider a L-R circuit in which a current $i = 5e^{-2t}$A is flowing. The voltage across the R-L circuit is given by



(a) $20e^{-2t}$ V
(b) $-10e^{-2t}$ V
(c) $10e^{-2t}$ V
(d) $5e^{-2t}$ V

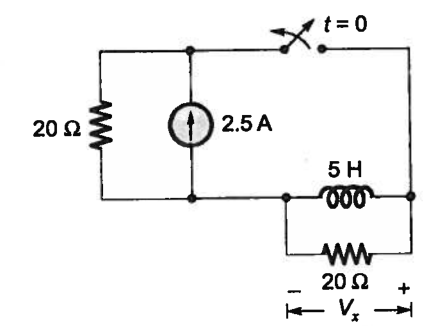
[ESE-2012]

Q.12 A series RL circuit is initially relaxed. A step voltage is applied to the circuit. If τ is the time constant of the circuit, the voltage across R and L will be the same at time t equal to

(a) τ (b) $-\tau \ln\left(\frac{1}{2}\right)$
(c) $1/\tau \ln 2$ (d) $1/\tau \ln\left(\frac{1}{2}\right)$

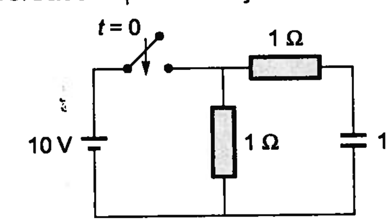
[ESE-2002]

Q.13 In the figure, the switch was closed for a long time before opening at $t = 0$. The voltage V_x at $t = 0^+$ is



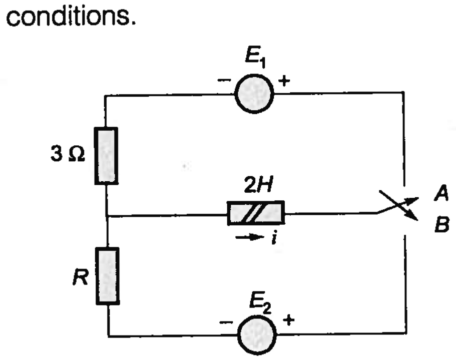
(a) 25 V (b) 50 V
(c) –50 V (d) 0 V [GATE-2002]

Q.14 In the circuit shown below, the switch is closed at $t = 0$. The current through the capacitor will decrease exponentially with a time constant



(a) 0.5 s (b) 1 s
(c) 2 s (d) 10 s [ESE-2003]

Q.15 In the circuit shown below, the switch is moved from position A to B at time $t = 0$. The current i through the inductor satisfies the following conditions.



1. $i(0) = -8$ A
2. $di/dt(t = 0) = 3$ A/s
3. $i(\infty) = 4$ A

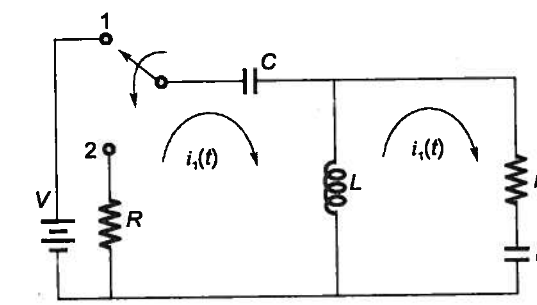
The value of R is
(a) 0.5 ohm (b) 2.0 ohm
(c) 4.0 ohm (d) 12 ohm

[ESE-2003]

Q.16 In a circuit the voltage across an element is $v(t) = 10(t - 0.01)\, e^{-100t}$ V. The circuit is
(a) Undamped
(b) Underdamped
(c) Critically damped
(d) Overdamped

[ESE-2003]

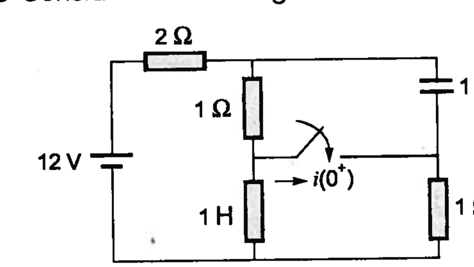
Q.17 At $t = 0^+$, the current i_1 is



(a) $\frac{-V}{2R}$ (b) $\frac{-V}{R}$
(c) $\frac{-V}{4R}$ (d) zero

[GATE-2003]

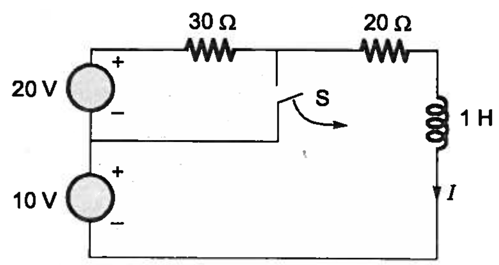
Q.18 Consider the following circuit :



The circuit shown above is in steady state before closing the switch. What is the current $i(0^+)$ through the switch if the circuit is closed at $t = 0$?
(a) – 4 A (b) 0 A
(c) 4 A (d) 12 A

[ESE-2004]

Q.19 Consider the following circuit :

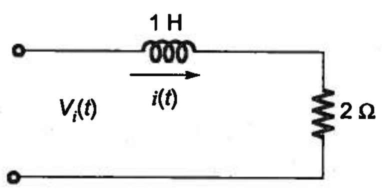


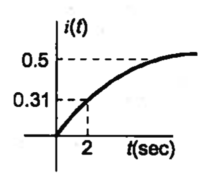
The circuit shown above attains a steady state with the switch S closed. What is the value of i(t) for $t \geq 0$, if the switch S is opened at $t = 0$?

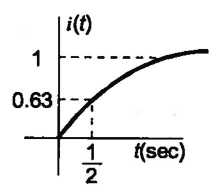
(a) $0.5 + 0.5\,e^{-50t}$ (b) $0.6 - 0.1\,e^{-50t}$
(c) $0.5 - .05\,e^{-50t}$ (d) $0.6 - 0.6\,e^{-20t}$

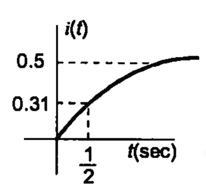
[ESE-2004]

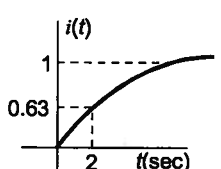
Q.20 For the *R-L* circuit shown in the figure, the input voltage $v_i(t) = u(t)$. The current $i(t)$ is



(a)


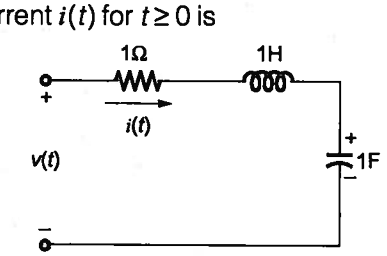
(b)


(c)


(d)


[GATE-2004]

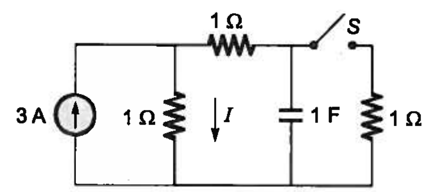
Q.21 The circuit shown in the figure has initial current $i_L(0^-) = 1$ A through the inductor and an initial voltage $v_C(0^-) = -1$ V across the capacitor. For input $v(t) = u(t)$, the Laplace transform of the current $i(t)$ for $t \geq 0$ is



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

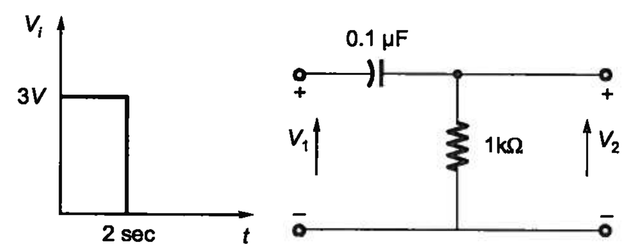
[GATE-2004]

Q.22 In the circuit given below, the steady state is attained with *S* open. *S* is closed at $t = 0$. What is the value of current *I* at $t = 0^+$?



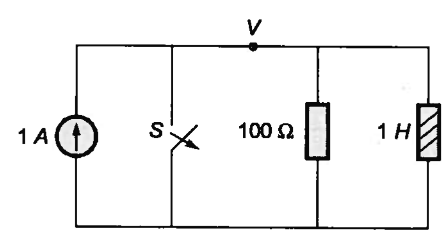
(a) 2 A (b) 2.25 A
(c) 3 A (d) 4 A [ESE-2005]

Q.23 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



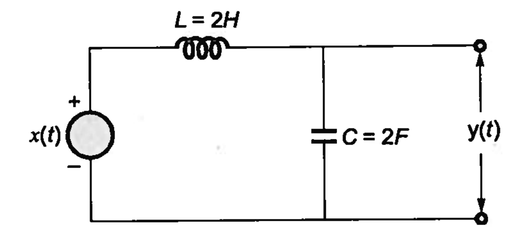
(a) 3 V (b) –3 V
(c) 4 V (d) – 4 V [GATE-2005]

Q.24 If the switch *S* in the circuit shown below is opened at $t = 0$, what are the values of $v(0^+)$ and $\frac{dv}{dt}(0^+)$, respectively?



(a) 100 V, 10,000 V/s
(b) 100 V, –10,000 V/s
(c) –100 V, 10,000 V/s
(d) –100 V, –10,000 V/s [ESE-2006]

Q.25 $x(t)$: Input voltage
$y(t)$: Output voltage
Consider the circuit shown below:

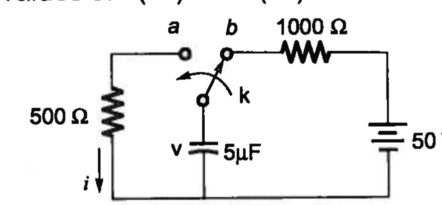


What is the natural response of this system?

(a) A sinusoid with constant amplitude
(b) A growing sinusoid
(c) Zero
(d) A decaying sinusoid

[ESE-2006]

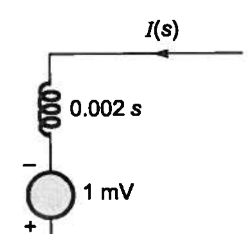
Q.26 At $t = 0$, the switch *K* is thrown from *b* to a of the circuit as shown below. What are the values of $v(0^+)$ and $i(0^+)$?



(a) 50 V, 90 mA (b) 50 V, 100 mA
(c) 50 V, 110 mA (d) 50 V, 120 mA

[ESE-2006]

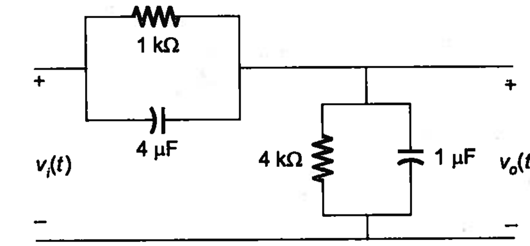
Q.27 A 2 mH inductor with some initial current can be represented as shown below, where s is the Laplace Transform variable. The value of initial current is



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

[GATE-2006]

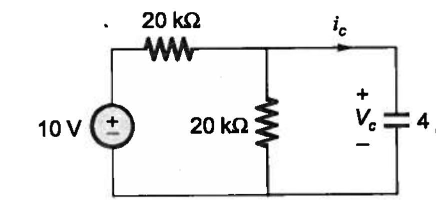
Q.28 In the figure shown below, assume that all the capacitors are initially uncharged. If $v_i(t) = 10u(t)$ Volts, $v_o(t)$ is given by



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

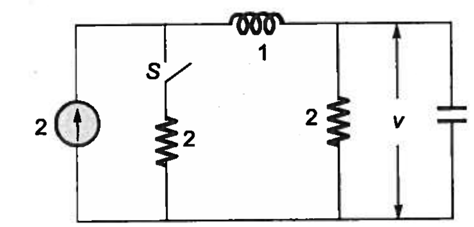
[GATE-2006]

Q.29 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



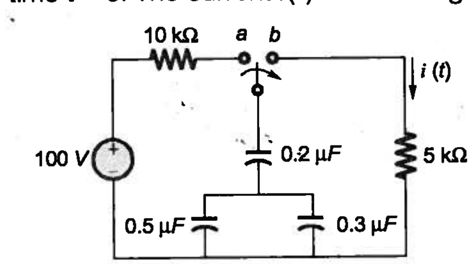
(a) 0.50 exp(–25*t*) mA
(b) 0.25 exp(–25 *t*) mA
(c) 0.50 exp(–12.5 *t*) mA
(d) 0.25 exp(–6.25 *t*) mA [GATE-2007]

Q.30 The circuit as shown below is in the steady state. The switch *S* is closed at $t = 0$. What are the values of v and $\frac{dv}{dt}$ at $t = 0^+$?



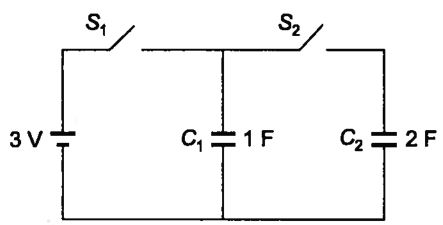
(a) 0 and 4 (b) 4 and 0
(c) 2 and 0 (d) 0 and 2 [ESE-2009]

Q.31 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



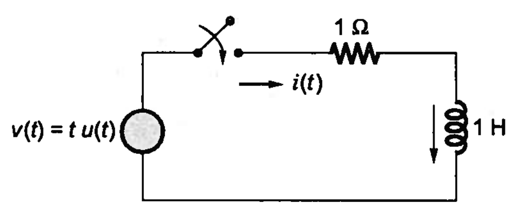
(a) $0.2e^{-125t}u(t)$ mA
(b) $20e^{-1250t}u(t)$ mA
(c) $0.2e^{-1250t}u(t)$ mA
(d) $20e^{-1000t}u(t)$ mA [GATE-2009]

Q.32 In the figure shown, all elements used are ideal. For time $t < 0$, S_1 remained closed and S_2 open. At $t = 0$, S_1 is opened and S_2 is closed. If the voltage V_{c2} across the capacitor C_2 at $t = 0$ is zero, the voltage across the capacitor combination at $t = 0^+$ will be



(a) 1 V (b) 2 V
(c) 1.5 V (d) 3 V
[GATE-2009]

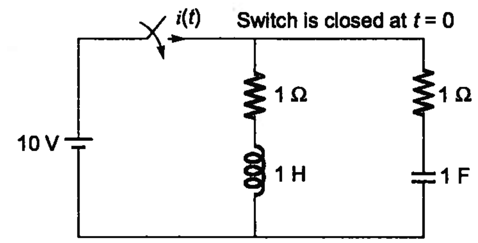
Q.33 The current in the below network is



(a) $\left|t-1+e^{-t}\right|u(t)$
(b) $\left|t^2-t+e^{-t}\right|u(t)$
(c) $\left|t+1+e^{-t}\right|u(t)$
(d) $\left|t-1-e^{-t}\right|u(t)$
[ESE-2010]

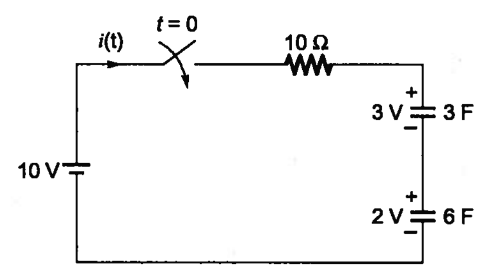
Q.34 A first order circuit is excited with a dc source. The current $i(t)$ through any element of the circuit can be written as (i_f and i_i are the final and initial values, respectively, of the current)
(a) $i_i-(i_i-i_f)\,e^{-t/T}$ (b) $i_f-(i_f-i_i)\,e^{-t/T}$
(c) $i_i-(i_f-i_i)\,e^{-t/T}$ (d) $i_f-(i_i-i_f)\,e^{-t/T}$
[ESE-2010]

Q.35 The value of the current $i(t)$ in amperes in the below circuit is



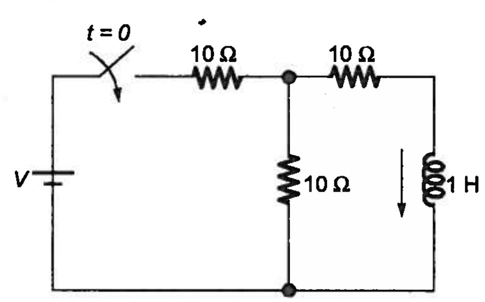
(a) 0 (b) 10
(c) $10\,e^{-t}$ (d) $10\,(1-e^{-t})$
[ESE-2010]

Q.36 In the circuit shown below, switch S is closed at $t = 0$. The time constant of the circuit and initial value of current $i(t)$ are



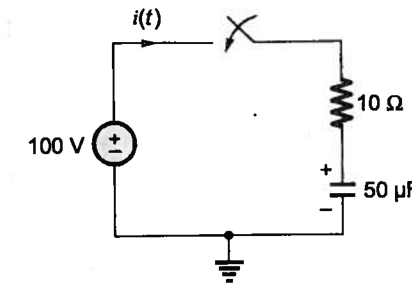
(a) 30 sec, 0.5 A (b) 60 sec, 1.0 A
(c) 90 sec, 1.0 A (d) 20 sec, 0.5 A
[ESE-2010]

Q.37 The value of V that would result in a steady-state current of 1 A through the inductor in the below circuit is



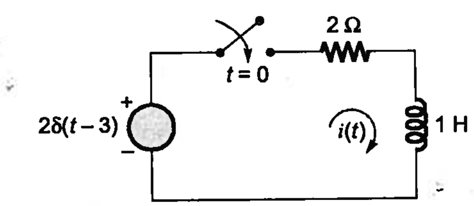
(a) 30 V (b) 15 V
(c) 20 V (d) 25 V [ESE-2010]

Q.38 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) $i(t) = 15\exp(-2\times10^3t)$ A
(b) $i(t) = 5\exp(-2\times10^3t)$ A
(c) $i(t) = 10\exp(-2\times10^3t)$ A
(d) $i(t) = -5\exp(-2\times10^3t)$ A
[GATE-2011]

Q.39 For the network shown below, the current $i(t)$ is

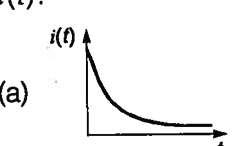


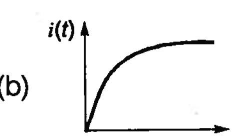
(a) $2e^{-2(t-3)}u(t-3)$ (b) $0.5\,e^{-2(t-3)}u(t)$
(c) $2e^{-(t-3)}u(t-3)$ (d) $2e^{-(t-3)}u(t)$
[ESE-2013]

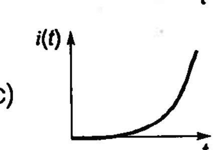
Q.40 A series RC circuit is connected to a DC voltage source at time $t = 0$. The relation between the source voltage V_S, the resistance R, the capacitance C, and the current i(t) is given below:

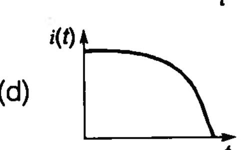
$$V_s = R\,i(t) + \frac{1}{C}\int_0^t i(t)\,dt$$

Which one of the following represents the current $i(t)$?

(a) 

(b) 

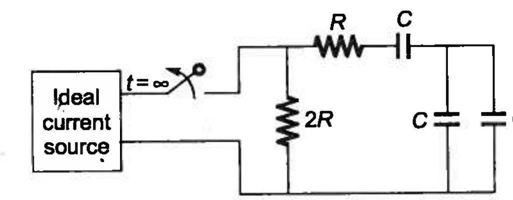
(c) 

(d) 

[GATE-2014]

Q.41 The initial and final values of
$f(t) = 15 - 10t - 10\,e^{-200t}$
are respectively
(a) 5 and ∞ (b) 5 and −∞
(c) 15 and ∞ (d) 15 and 10
[ESE-2014]

Q.42 An ideal current source is connected to the disconnected circuit shown in the figure $t = 0$. The time constant of the circuit is

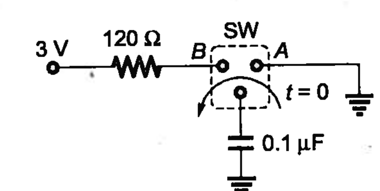


(a) $\frac{RC}{2}$ (b) RC
(c) $2RC$ (d) $\frac{9RC}{2}$
[ESE-2015]

Q.43 Transients are caused because
1. the load is suddenly connected to or disconnected from the supply
2. of the sudden change in applied voltage from one finite value to the other
3. of the change in stored energy in inductors and capacitors

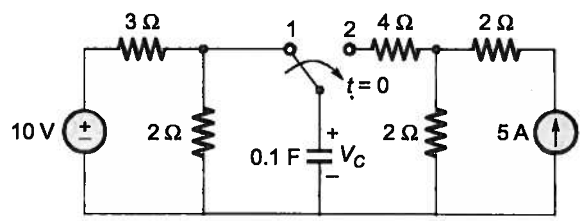
Which of the above statements are correct?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3
[ESE-2015]

Q.44 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
[GATE-2015]

Q.45 The switch has been in position 1 for a long time and abruptly changes to position 2 at $t = 0$.



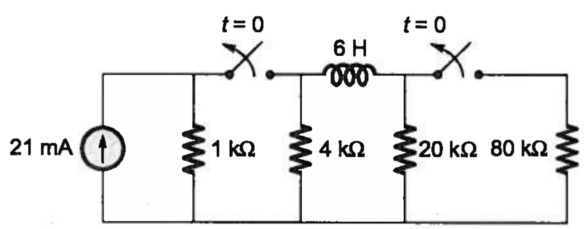
If time t is in seconds, the capacitor voltage V_C (in volts) for $t > 0$ is given by

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

[GATE-2016]

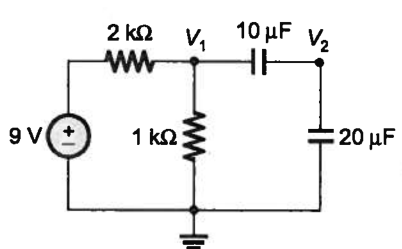
Numerical Data Type Questions

Q.46 In the circuit below, both the switches are open at $t = 0$ after having been closed for a long time.

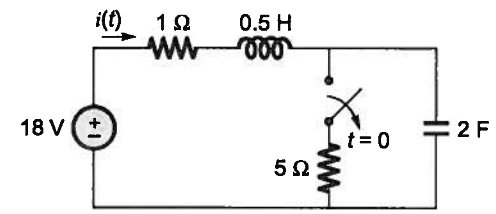


After what time the energy dissipated in the 4 kΩ resistor will be 10% of the initial energy stored in the inductor (in μ sec)?

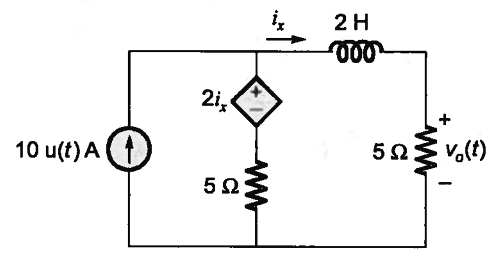
Q.47 In the given circuit, the node voltage V_2 at steady state is ________ Volts.



Q.48 If the switch in the figure opens at $t = 0$ after being closed for a long time, then what will be the current $i(t)$ at $t = 1$ sec (in Amp)?

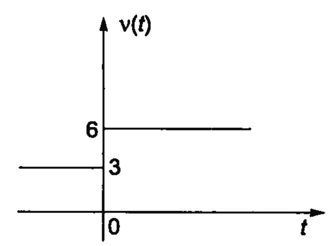


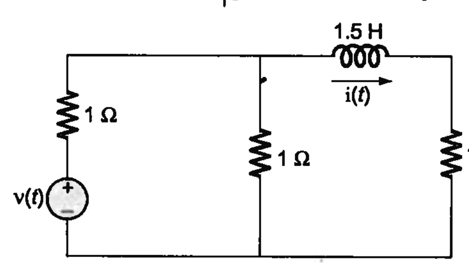
Q.49 In the circuit shown in the figure, the value of $v_o(t)$ (in volts) for $t \to \infty$ is ___.



[GATE-2014]

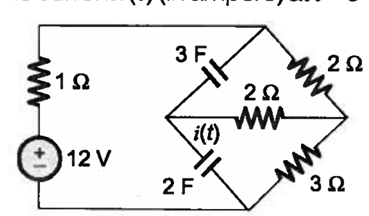
Q.50 The voltage $v(t)$ shown below is applied to the given circuit. $v(t) = 3$ V for $t < 0$ and $v(t) = 6$ V for $t > 0$. The value of current $i(t)$ at $t = 1$ s, in ampere is_______.





[GATE-2016]

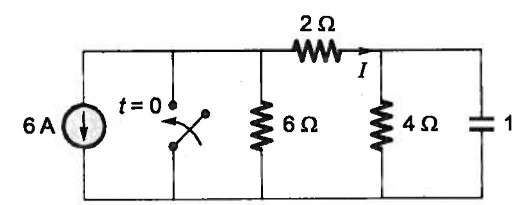
Q.51 Assume that the circuit in the figure has reached the steady state before time $t = 0$ when the 3 Ω resistor suddenly burns out, resulting in an open circuit. The current $i(t)$ (in ampere) at $t = 0^+$ is_____.



[GATE-2016]

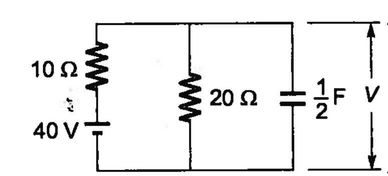
Try Yourself

T1. In the circuit shown, the switch 'S' is open for a long time and closed at $t = 0$. Find the value of I at $t = 0^+$



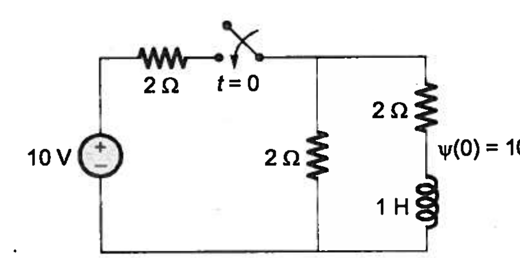
(a) −6
(b) $\frac{3}{2}$
(c) 6
(d) $\frac{9}{2}$

T2. In the network shown, if the voltage 'V' at the time considered is 20 V, then $\frac{dv}{dt}$ at that time will be

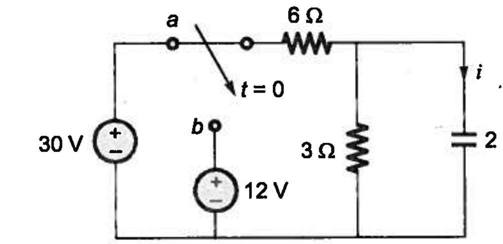


(a) 1
(b) 3
(c) 2
(d) 0

T3. Find $i(t)$ for $t > 0$

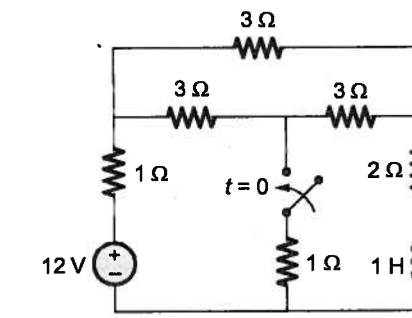


T4. The switch has been in position 'a' for a long time at $t = 0$, it moves to position 'b' calculate $i(t)$ for $t > 0$



(a) $3e^{\frac{-t}{4}}$
(b) $-3e^{\frac{-t}{2}}$
(c) $-3e^{\frac{-t}{4}}$
(d) $\frac{3}{2}e^{\frac{-t}{4}}$

T5. Find $i(t)$ for $t > 0$

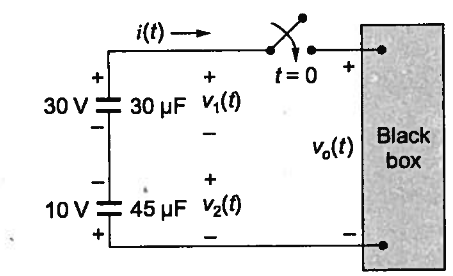


(a) $2 - e^{-3t}$
(b) $2 + e^{-3t}$
(c) $3 - e^{-3t}$
(d) $3 + e^{-3t}$

T6. Find initial value and final value

$$F(s) = \frac{4e^{-2s}(s+2)}{s}$$

T7. Two series connected capacitors of 30 μF and 45 μF having initial voltage 30 V and 10 V respectively, are connected to the terminals of a black box at $t = 0$. The current in the circuit is given as $i(t) = 900\, e^{-2.5t}$ μA, for $t \geq 0$.



The voltage $v_0(t)$, for $t \geq 0$ is given by

(a) $(40 - 20e^{-2.5t})$ V
(b) $(10 + 20e^{-2.5t})$ V
(c) $(40 - 20e^{-2.5t})$ V
(d) $20e^{-2.5t}$ V

■■■■