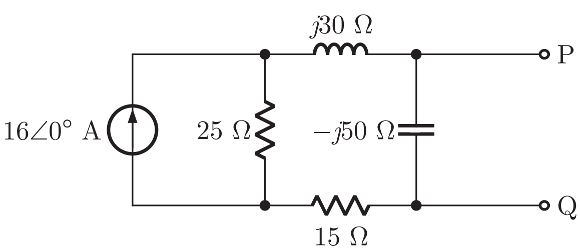
UNIT 2

Networks

GATE 2011 **ONE MARK**

MCQ 2.1

In the circuit shown below, the Norton equivalent current in amperes with respect to the terminals P and Q is

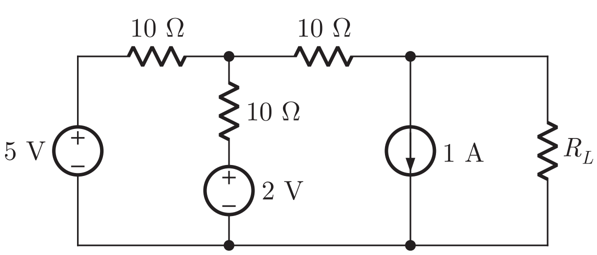


(A) $6.4 - j\,4.8$ (B) $6.56 - j\,7.87$

(C) $10 + j0$ (D) $16 + j0$

MCQ 2.2

In the circuit shown below, the value of R_L such that the power transferred to R_L is maximum is



(A) $5\,\Omega$ (B) $10\,\Omega$

(C) $15\,\Omega$ (D) $20\,\Omega$

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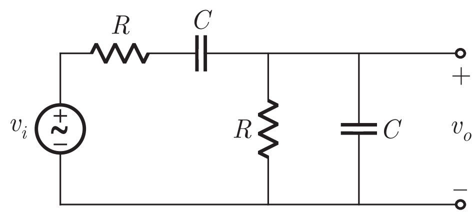
MCQ 2.3

The circuit shown below is driven by a sinusoidal input $v_i = V_p \cos(t/RC)$. The steady state output v_o is



(A) $(V_p/3)\cos(t/RC)$

(B) $(V_p/3)\sin(t/RC)$

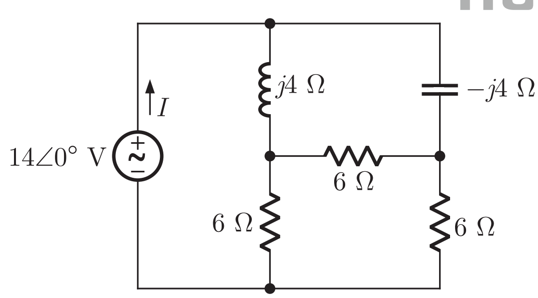
(C) $(V_p/2)\cos(t/RC)$

(D) $(V_p/2)\sin(t/RC)$

2011 **TWO MARKS**

MCQ 2.4

In the circuit shown below, the current I is equal to



(A) $1.4\angle 0°$ A

(B) $2.0\angle 0°$ A

(C) $2.8\angle 0°$ A

(D) $3.2\angle 0°$ A

MCQ 2.5

In the circuit shown below, the network N is described by the following Y matrix:

$$Y = \begin{bmatrix} 0.1\text{ S} & -0.01\text{ S} \\ 0.01\text{ S} & 0.1\text{ S} \end{bmatrix}.$$ the voltage gain $\frac{V_2}{V_1}$ is

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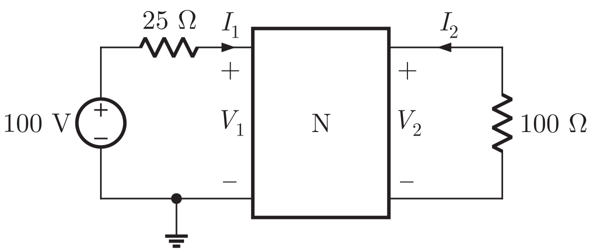


(A) 1/90

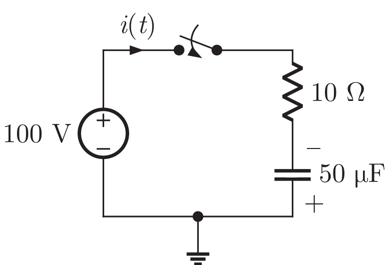
(B) –1/90

(C) –1/99

(D) –1/11

MCQ 2.6

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) $i(t) = 15\exp(-2\times10^3 t)$ A

(B) $i(t) = 5\exp(-2\times10^3 t)$ A

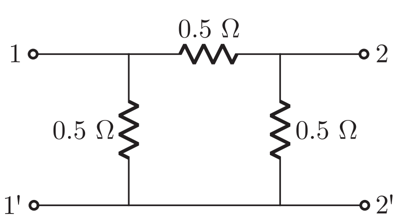
(C) $i(t) = 10\exp(-2\times10^3 t)$ A

(D) $i(t) = -5\exp(-2\times10^3 t)$ A

2010 **ONE MARK**

MCQ 2.7

For the two-port network shown below, the short-circuit admittance parameter matrix is



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(A) $\begin{bmatrix} 4 & -2 \\ -2 & 4 \end{bmatrix}$ S

(B) $\begin{bmatrix} 1 & -0.5 \\ -0.5 & 1 \end{bmatrix}$ S

(C) $\begin{bmatrix} 1 & 0.5 \\ 0.5 & 1 \end{bmatrix}$ S

(D) $\begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$ S

MCQ 2.8

For parallel RLC circuit, which one of the following statements is NOT correct ?

(A) The bandwidth of the circuit decreases if R is increased

(B) The bandwidth of the circuit remains same if L is increased

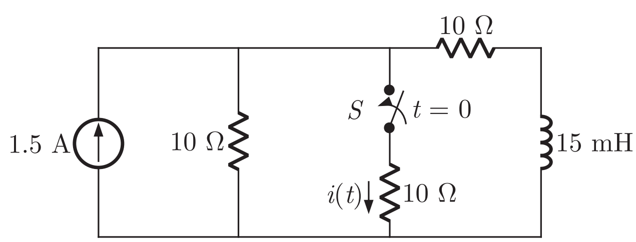
(C) At resonance, input impedance is a real quantity

(D) At resonance, the magnitude of input impedance attains its minimum value.

2010 **TWO MARKS**

MCQ 2.9

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) $i(t) = 0.5 - 0.125e^{-1000t}$ A

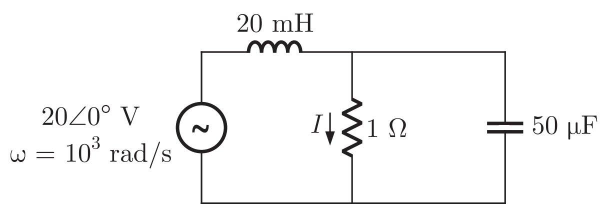
(B) $i(t) = 1.5 - 0.125e^{-1000t}$ A

(C) $i(t) = 0.5 - 0.5e^{-1000t}$ A

(D) $i(t) = 0.375e^{-1000t}$ A

MCQ 2.10

The current I in the circuit shown is



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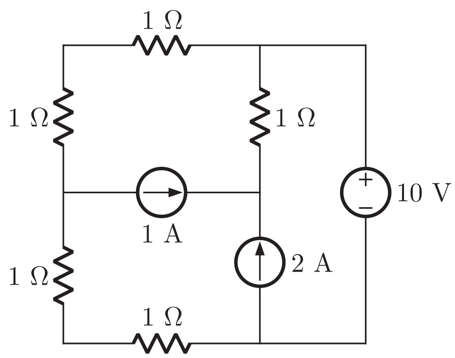
(A) $-j1$ A (B) $j1$ A
(C) 0 A (D) 20 A

MCQ 2.11

In the circuit shown, the power supplied by the voltage source is

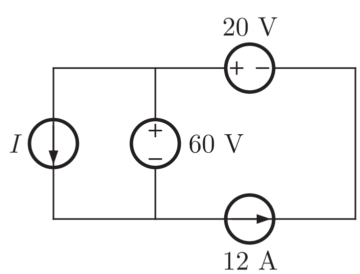


(A) 0 W (B) 5 W
(C) 10 W (D) 100 W

GATE 2009 ONE MARK

MCQ 2.12

In the interconnection of ideal sources shown in the figure, it is known that the 60 V source is absorbing power.



Which of the following can be the value of the current source I?

(A) 10 A (B) 13 A
(C) 15 A (D) 18 A

MCQ 2.13

If the transfer function of the following network is

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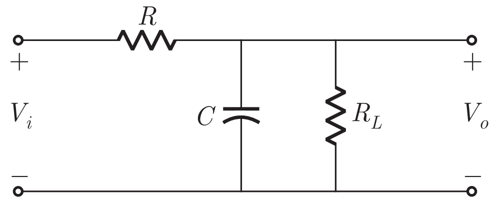
$$\frac{V_o(s)}{V_i(s)} = \frac{1}{2 + sCR}$$



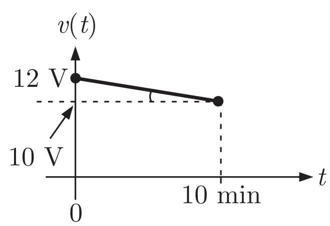
The value of the load resistance R_L is

(A) $\frac{R}{4}$ (B) $\frac{R}{2}$

(C) R (D) $2R$

MCQ 2.14

A fully charged mobile phone with a 12 V battery is good for a 10 minute talk-time. Assume that, during the talk-time the battery delivers a constant current of 2 A and its voltage drops linearly from 12 V to 10 V as shown in the figure. How much energy does the battery deliver during this talk-time?



(A) 220 J (B) 12 kJ

(C) 13.2 kJ (D) 14.4 J

GATE 2009 TWO MARK

MCQ 2.15

An AC source of RMS voltage 20 V with internal impedance $Z_s = (1 + 2j)\,\Omega$ feeds a load of impedance $Z_L = (7 + 4j)\,\Omega$ in the figure below. The reactive power consumed by the load is

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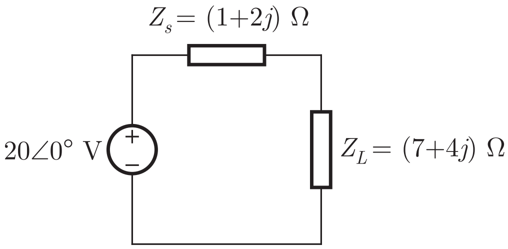
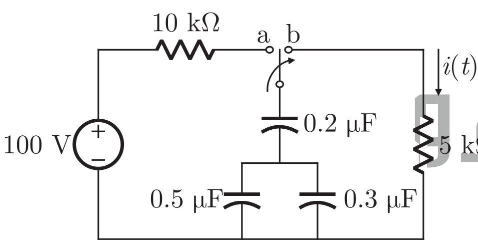


(A) 8 VAR
(B) 16 VAR
(C) 28 VAR
(D) 32 VAR

MCQ 2.16

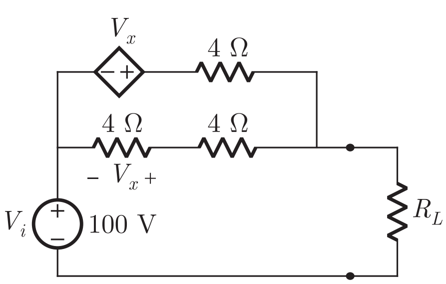
The switch in the circuit shown was on position a for a long time, and is move to position b at time $t = 0$. The current $i(t)$ for $t > 0$ is given by



(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

MCQ 2.17

In the circuit shown, what value of R_L maximizes the power delivered to R_L?



(A) $2.4\ \Omega$
(B) $\frac{8}{3}\ \Omega$
(C) $4\ \Omega$
(D) $6\ \Omega$

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MCQ 2.18

The time domain behavior of an RL circuit is represented by

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

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

(A) $i(t) \to \frac{V_0}{R}$

(B) $i(t) \to \frac{2V_0}{R}$

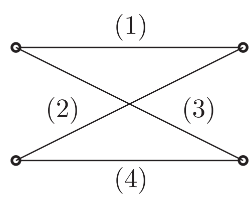
(C) $i(t) \to \frac{V_0}{R}(1 + B)$

(D) $i(t) \to \frac{2V_0}{R}(1 + B)$

GATE 2008 ONE MARK

MCQ 2.19

In the following graph, the number of trees (P) and the number of cut-set (Q) are



(A) $P = 2, Q = 2$

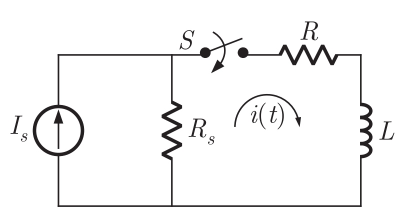
(B) $P = 2, Q = 6$

(C) $P = 4, Q = 6$

(D) $P = 4, Q = 10$

MCQ 2.20

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) ∞

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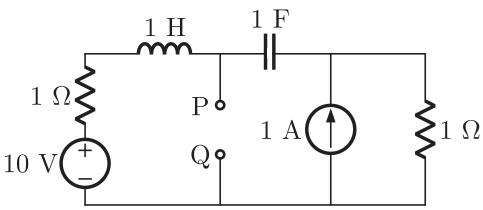
GATE 2008 **TWO MARKS**

MCQ 2.21

The Thevenin equivalent impedance Z_{th} between the nodes P and Q in the following circuit is



(A) 1

(B) $1 + s + \frac{1}{s}$

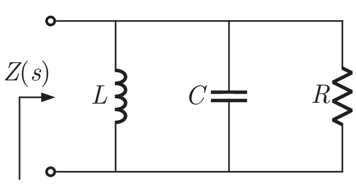
(C) $2 + s + \frac{1}{s}$

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

MCQ 2.22

The driving point impedance of the following network is given by

$$Z(s) = \frac{0.2s}{s^2 + 0.1s + 2}$$



The component values are

(A) $L = 5\,\text{H}, R = 0.5\,\Omega, C = 0.1\,\text{F}$

(B) $L = 0.1\,\text{H}, R = 0.5\,\Omega, C = 5\,\text{F}$

(C) $L = 5\,\text{H}, R = 2\,\Omega, C = 0.1\,\text{F}$

(D) $L = 0.1\,\text{H}, R = 2\,\Omega, C = 5\,\text{F}$

MCQ 2.23

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 $2nT \le t \le (2n+1)T$, $(n = 0, 1, 2, ..)$ S_1 to P_1 and S_2 to P_2

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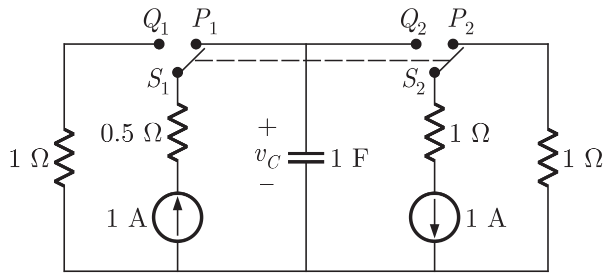
For $(2n+1)T \le t \le (2n+2)T$, $(n = 0,1,2,...)$ S_1 to Q_1 and S_2 to Q_2



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

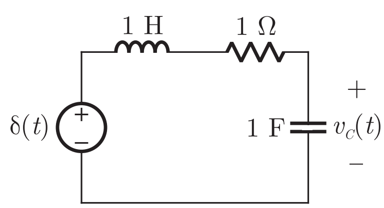
(B) $u(t) + 2\sum_{n=1}^{\infty}(-1)^n u(t-nT)$

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

(D) $\sum_{n=1}^{\infty}[0.5 - e^{-(t-2nT)} + 0.5e^{-(t-2nT)} - T]$

Common data question 2.23 & 2.24 :

The following series RLC circuit with zero conditions is excited by a unit impulse functions $\delta(t)$.



MCQ 2.24

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

(A) $\frac{2}{\sqrt{3}}(e^{\frac{-1}{2}t} - e^{\frac{\sqrt{3}}{2}t})$

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

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MCQ 2.25

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

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

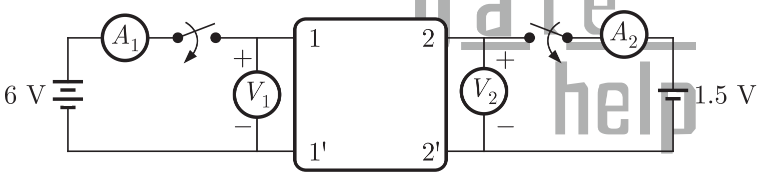
(B) $e^{\frac{-1}{2}t}\left[\cos\left(\frac{\sqrt{3}}{2}t\right) - \frac{1}{\sqrt{3}}\sin\left(\frac{\sqrt{3}\,t}{2}\right)\right]$

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

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

Statement for linked Answers Questions 2.25 & 2.26:

A two-port network shown below is excited by external DC source. The voltage and the current are measured with voltmeters V_1, V_2 and ammeters. A_1, A_2 (all assumed to be ideal), as indicated



Under following conditions, the readings obtained are:

(1) S_1 -open, S_2 - closed $A_1 = 0, V_1 = 4.5\text{ V}, V_2 = 1.5\text{ V}, A_2 = 1\text{ A}$

(2) S_1 -open, S_2 - closed $A_1 = 4\text{ A}, V_1 = 6\text{ V}, V_2 = 6\text{ V}, A_2 = 0$

MCQ 2.26

The z-parameter matrix for this network is

(A) $\begin{bmatrix} 1.5 & 1.5 \\ 4.5 & 1.5 \end{bmatrix}$ (B) $\begin{bmatrix} 1.5 & 4.5 \\ 1.5 & 4.5 \end{bmatrix}$

(C) $\begin{bmatrix} 1.5 & 4.5 \\ 1.5 & 1.5 \end{bmatrix}$ (D) $\begin{bmatrix} 4.5 & 1.5 \\ 1.5 & 4.5 \end{bmatrix}$

MCQ 2.27

The h-parameter matrix for this network is

(A) $\begin{bmatrix} -3 & 3 \\ -1 & 0.67 \end{bmatrix}$ (B) $\begin{bmatrix} -3 & -1 \\ 3 & 0.67 \end{bmatrix}$

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(C) $\begin{bmatrix} 3 & 3 \\ 1 & 0.67 \end{bmatrix}$ (D) $\begin{bmatrix} 3 & 1 \\ -3 & -0.67 \end{bmatrix}$

GATE 2007 **ONE MARK**

MCQ 2.28

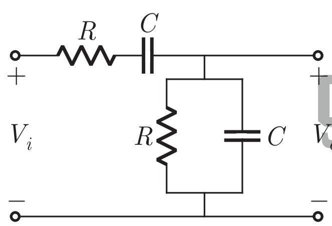
An independent voltage source in series with an impedance $Z_s = R_s + jX_s$ delivers a maximum average power to a load impedance Z_L when

(A) $Z_L = R_s + jX_s$ (B) $Z_L = R_s$

(C) $Z_L = jX_s$ (D) $Z_L = R_s - jX_s$

MCQ 2.29

The RC circuit shown in the figure is



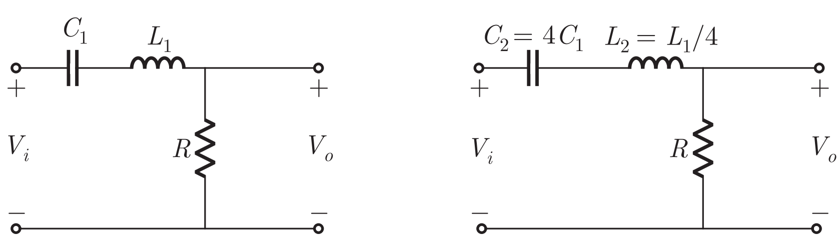
(A) a low-pass filter (B) a high-pass filter

(C) a band-pass filter (D) a band-reject filter

GATE 2007 **TWO MARKS**

MCQ 2.30

Two series resonant filters are as shown in the figure. Let the 3-dB bandwidth of Filter 1 be B_1 and that of Filter 2 be B_2. the value $\frac{B_1}{B_2}$ is



(A) 4 (B) 1

(C) 1/2 (D) 1/4

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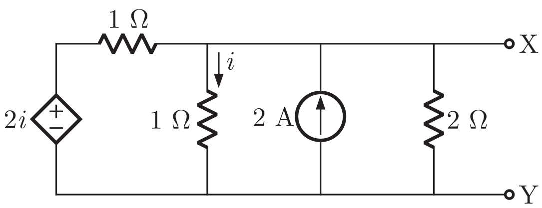
MCQ 2.31

For the circuit shown in the figure, the Thevenin voltage and resistance looking into $X-Y$ are

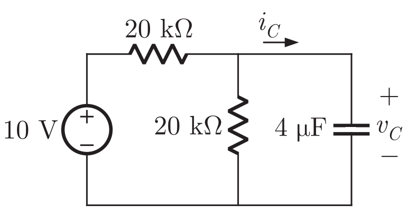


(A) $\frac{4}{3}$ V, 2 Ω (B) 4 V, $\frac{2}{3}$ Ω

(C) $\frac{4}{3}$ V, $\frac{2}{3}$ Ω (D) 4 V, 2 Ω

MCQ 2.32

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

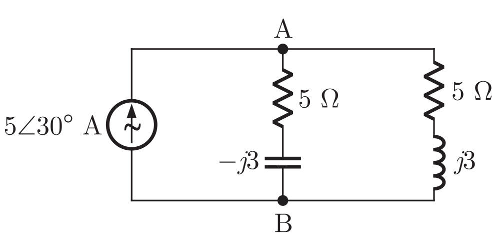


(A) $0.50\exp(-25t)$ mA (B) $0.25\exp(-25t)$ mA

(C) $0.50\exp(-12.5t)$ mA (D) $0.25\exp(-6.25t)$ mA

MCQ 2.33

In the ac network shown in the figure, the phasor voltage V_{AB} (in Volts) is



(A) 0 (B) $5\angle 30°$

(C) $12.5\angle 30°$ (D) $17\angle 30°$

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GATE 2006 **TWO MARKS**

MCQ 2.34

A two-port network is represented by $ABCD$ parameters given by

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

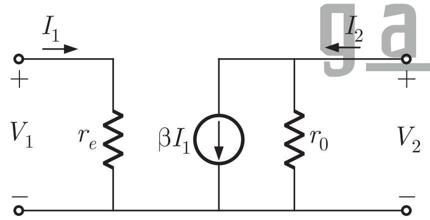
If port-2 is terminated by R_L, the input impedance seen at port-1 is given by

(A) $\frac{A + BR_L}{C + DR_L}$ (B) $\frac{AR_L + C}{BR_L + D}$

(C) $\frac{DR_L + A}{BR_L + C}$ (D) $\frac{B + AR_L}{D + CR_L}$

MCQ 2.35

In the two port network shown in the figure below, Z_{12} and Z_{21} and respectively



(A) r_e and βr_0 (B) 0 and $-\beta r_0$

(C) 0 and βr_o (D) r_e and $-\beta r_0$

MCQ 2.36

The first and the last critical frequencies (singularities) of a driving point impedance function of a passive network having two kinds of elements, are a pole and a zero respectively. The above property will be satisfied by

(A) RL network only (B) RC network only

(C) LC network only (D) RC as well as RL networks

MCQ 2.37

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

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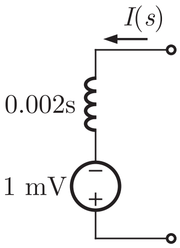
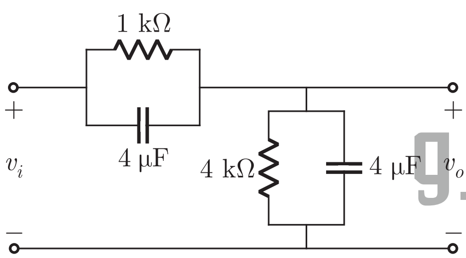


(A) 0.5 A
(B) 2.0 A
(C) 1.0 A
(D) 0.0 A

MCQ 2.38

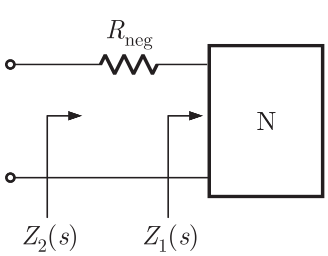
In the figure shown below, assume that all the capacitors are initially uncharged. If $v_i(t) = 10u(t)$ Volts, $v_o(t)$ is given by



(A) $8e^{-t/0.004}$ Volts
(B) $8(1 - e^{-t/0.004})$ Volts
(C) $8u(t)$ Volts
(D) 8 Volts

MCQ 2.39

A negative resistance R_{neg} is connected to a passive network N having driving point impedance as shown below. For $Z_2(s)$ to be positive real,



(A) $|R_{neg}| \le \text{Re}\, Z_1(j\omega), \forall\omega$
(B) $|R_{neg}| \le |Z_1(j\omega)|, \forall\omega$
(C) $|R_{neg}| \le \text{Im}\, Z_1(j\omega), \forall\omega$
(D) $|R_{neg}| \le \angle Z_1(j\omega), \forall\omega$

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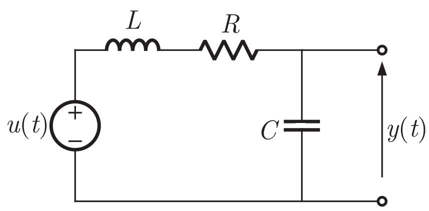
GATE 2005 **ONE MARK**

MCQ 2.40

The condition on R, L and C such that the step response $y(t)$ in the figure has no oscillations, is



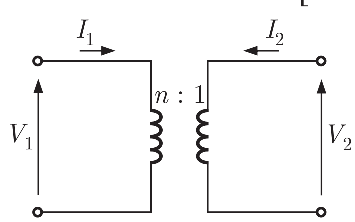
(A) $R \geq \frac{1}{2}\sqrt{\frac{L}{C}}$ (B) $R \geq \sqrt{\frac{L}{C}}$

(C) $R \geq 2\sqrt{\frac{L}{C}}$ (D) $R = \frac{1}{\sqrt{LC}}$

MCQ 2.41

The $ABCD$ parameters of an ideal $n:1$ transformer shown in the figure are

$$\begin{bmatrix} n & 0 \\ 0 & x \end{bmatrix}$$



The value of x will be

(A) n (B) $\frac{1}{n}$

(C) n^2 (D) $\frac{1}{n^2}$

MCQ 2.42

In a series RLC circuit, $R = 2\,\text{k}\Omega$, $L = 1$ H, and $C = \frac{1}{400}\,\mu\text{F}$ The resonant frequency is

(A) 2×10^4 Hz (B) $\frac{1}{\pi} \times 10^4$ Hz

(C) 10^4 Hz (D) $2\pi \times 10^4$ Hz

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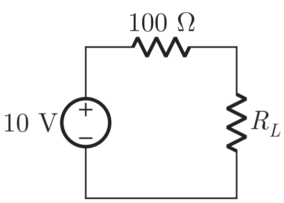
MCQ 2.43

The maximum power that can be transferred to the load resistor R_L from the voltage source in the figure is



(A) 1 W (B) 10 W

(C) 0.25 W (D) 0.5 W

MCQ 2.44

The first and the last critical frequency of an RC-driving point impedance function must respectively be

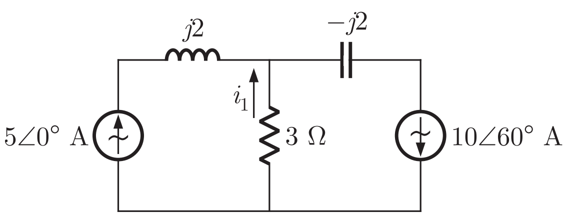
(A) a zero and a pole (B) a zero and a zero

(C) a pole and a pole (D) a pole and a zero

GATE 2005 **TWO MARKS**

MCQ 2.45

For the circuit shown in the figure, the instantaneous current $i_1(t)$ is



(A) $\frac{10\sqrt{3}}{2}\angle 90°$ A (B) $\frac{10\sqrt{3}}{2}\angle -90°$ A

(C) $5\angle 60°$ A (D) $5\angle -60°$ A

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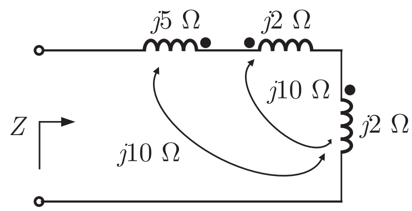
MCQ 2.46

Impedance Z as shown in the given figure is

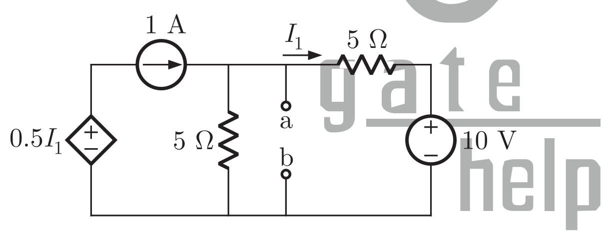


(A) $j29\,\Omega$ (B) $j9\,\Omega$

(C) $j19\,\Omega$ (D) $j39\,\Omega$

MCQ 2.47

For the circuit shown in the figure, Thevenin's voltage and Thevenin's equivalent resistance at terminals a – b is

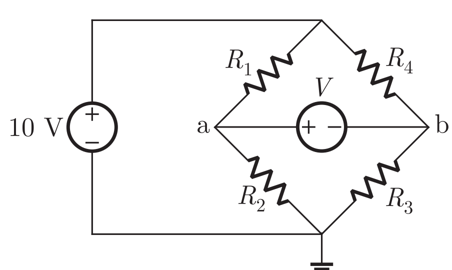


(A) 5 V and $2\,\Omega$ (B) 7.5 V and $2.5\,\Omega$

(C) 4 V and $2\,\Omega$ (D) 3 V and $2.5\,\Omega$

MCQ 2.48

If $R_1 = R_2 = R_4 = R$ and $R_3 = 1.1R$ in the bridge circuit shown in the figure, then the reading in the ideal voltmeter connected between a and b is



(A) 0.238 V (B) 0.138 V

(C) -0.238 V (D) 1 V

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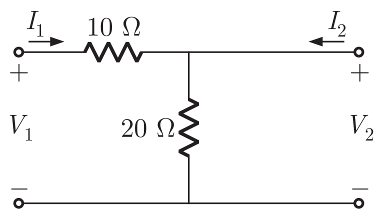
MCQ 2.49

The h parameters of the circuit shown in the figure are

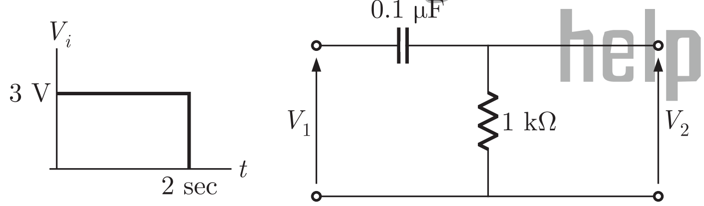


(A) $\begin{bmatrix} 0.1 & 0.1 \\ -0.1 & 0.3 \end{bmatrix}$
(B) $\begin{bmatrix} 10 & -1 \\ 1 & 0.05 \end{bmatrix}$

(C) $\begin{bmatrix} 30 & 20 \\ 20 & 20 \end{bmatrix}$
(D) $\begin{bmatrix} 10 & 1 \\ -1 & 0.05 \end{bmatrix}$

MCQ 2.50

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

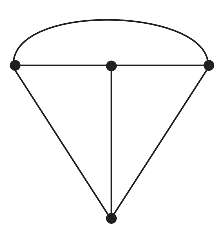


(A) 3 V
(B) -3 V
(C) 4 V
(D) -4 V

GATE 2004 ONE MARK

MCQ 2.51

Consider the network graph shown in the figure. Which one of the following is NOT a 'tree' of this graph ?



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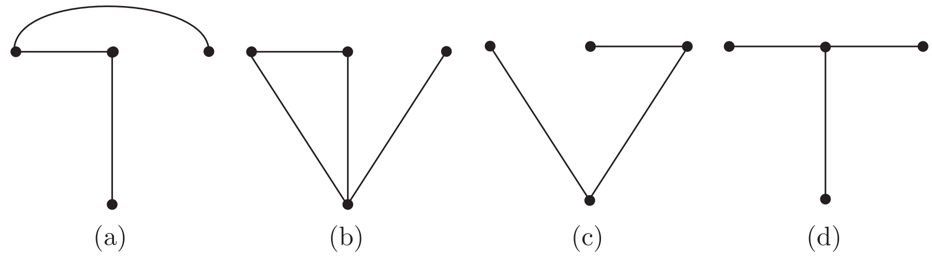
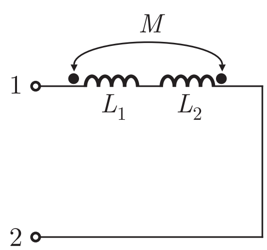


(A) a (B) b

(C) c (D) d

MCQ 2.52

The equivalent inductance measured between the terminals 1 and 2 for the circuit shown in the figure is

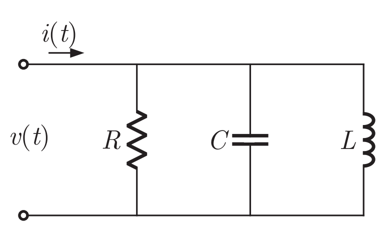


(A) $L_1 + L_2 + M$ (B) $L_1 + L_2 - M$

(C) $L_1 + L_2 + 2M$ (D) $L_1 + L_2 - 2M$

MCQ 2.53

The circuit shown in the figure, with $R = \frac{1}{3}\,\Omega$, $L = \frac{1}{4}$ H and $C = 3$ F has input voltage $v(t) = \sin 2t$. The resulting current $i(t)$ is



(A) $5\sin(2t + 53.1^\circ)$ (B) $5\sin(2t - 53.1^\circ)$

(C) $25\sin(2t + 53.1^\circ)$ (D) $25\sin(2t - 53.1^\circ)$

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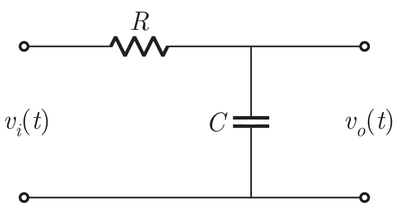
MCQ 2.54

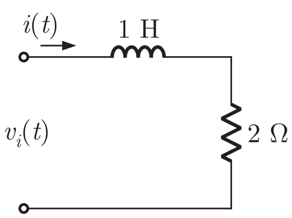
For the circuit shown in the figure, the time constant $RC = 1$ ms. The input voltage is $v_i(t) = \sqrt{2}\sin 10^3 t$. The output voltage $v_o(t)$ is equal to

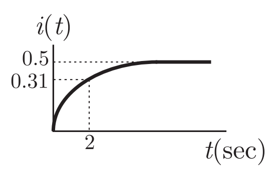


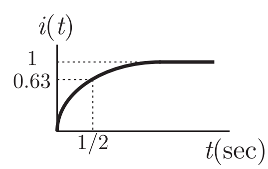
(A) $\sin(10^3 t - 45°)$ (B) $\sin(10^3 t + 45°)$
(C) $\sin(10^3 t - 53°)$ (D) $\sin(10^3 t + 53°)$

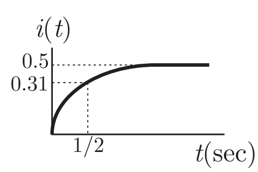
MCQ 2.55

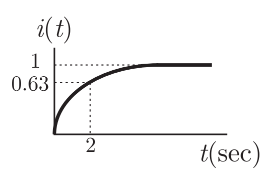
For the $R - L$ circuit shown in the figure, the input voltage $v_i(t) = u(t)$. The current $i(t)$ is



(A)


(B)


(C)


(D)


GATE 2004 **TWO MARKS**

MCQ 2.56

For the lattice shown in the figure, $Z_a = j2\,\Omega$ and $Z_b = 2\,\Omega$. The values

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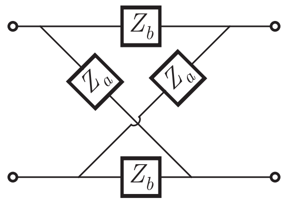
of the open circuit impedance parameters $[z] = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix}$ are



(A) $\begin{bmatrix} 1-j & 1+j \\ 1+j & 1+j \end{bmatrix}$

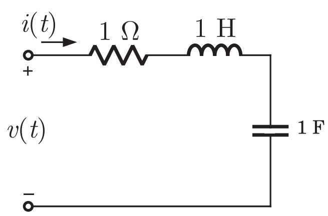
(B) $\begin{bmatrix} 1-j & 1+j \\ -1+j & 1-j \end{bmatrix}$

(C) $\begin{bmatrix} 1+j & 1+j \\ 1-j & 1-j \end{bmatrix}$

(D) $\begin{bmatrix} 1+j & -1+j \\ -1+j & 1+j \end{bmatrix}$

MCQ 2.57

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) $\frac{1}{s^2 + s + 1}$

MCQ 2.58

The transfer function $H(s) = \frac{V_o(s)}{V_i(s)}$ of an RLC circuit is given by

$$H(s) = \frac{10^6}{s^2 + 20s + 10^6}$$

The Quality factor (Q-factor) of this circuit is

(A) 25

(B) 50

(C) 100

(D) 5000

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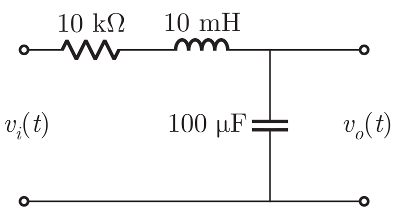
MCQ 2.59

For the circuit shown in the figure, the initial conditions are zero. Its transfer function $H(s) = \frac{V_c(s)}{V_i(s)}$ is



(A) $\frac{1}{s^2 + 10^6 s + 10^6}$

(B) $\frac{10^6}{s^2 + 10^3 s + 10^6}$

(C) $\frac{10^3}{s^2 + 10^3 s + 10^6}$

(D) $\frac{10^6}{s^2 + 10^6 s + 10^6}$

MCQ 2.60

Consider the following statements S1 and S2

S1 : At the resonant frequency the impedance of a series RLC circuit is zero.

S2 : In a parallel GLC circuit, increasing the conductance G results in increase in its Q factor.

Which one of the following is correct?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) S1 is TRUE and S2 is FALSE

(D) Both S1 and S2 are FALSE

GATE 2003 **ONE MARK**

MCQ 2.61

The minimum number of equations required to analyze the circuit shown in the figure is

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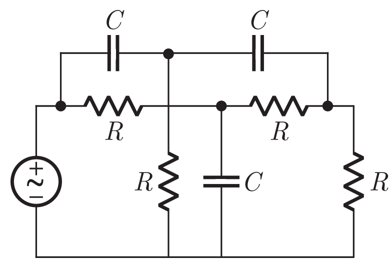


(A) 3
(B) 4
(C) 6
(D) 7

MCQ 2.62

A source of angular frequency 1 rad/sec has a source impedance consisting of 1 Ω resistance in series with 1 H inductance. The load that will obtain the maximum power transfer is

(A) 1 Ω resistance
(B) 1 Ω resistance in parallel with 1 H inductance
(C) 1 Ω resistance in series with 1 F capacitor
(D) 1 Ω resistance in parallel with 1 F capacitor

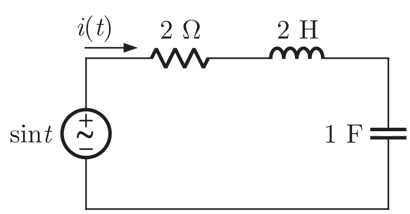
MCQ 2.63

A series RLC circuit has a resonance frequency of 1 kHz and a quality factor $Q = 100$. If each of R, L and C is doubled from its original value, the new Q of the circuit is

(A) 25
(B) 50
(C) 100
(D) 200

MCQ 2.64

The differential equation for the current $i(t)$ in the circuit of the figure is



(A) $2\frac{d^2i}{dt^2} + 2\frac{di}{dt} + i(t) = \sin t$
(B) $\frac{d^2i}{dt^2} + 2\frac{di}{dt} + 2i(t) = \cos t$

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(C) $2\frac{d^2 i}{dt^2} + 2\frac{di}{dt} + i(t) = \cos t$ (D) $\frac{d^2 i}{dt^2} + 2\frac{di}{dt} + 2i(t) = \sin t$

GATE 2003 TWO MARKS

MCQ 2.65

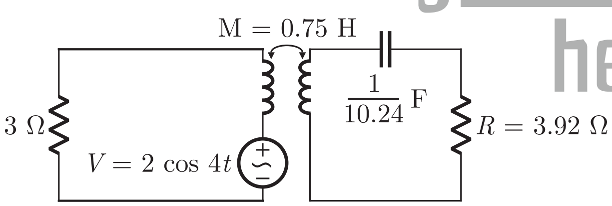
Twelve 1 Ω resistance are used as edges to form a cube. The resistance between two diagonally opposite corners of the cube is

(A) $\frac{5}{6}\,\Omega$ (B) $1\,\Omega$

(C) $\frac{6}{5}\,\Omega$ (D) $\frac{3}{2}\,\Omega$

MCQ 2.66

The current flowing through the resistance R in the circuit in the figure has the form $P\cos 4t$ where P is

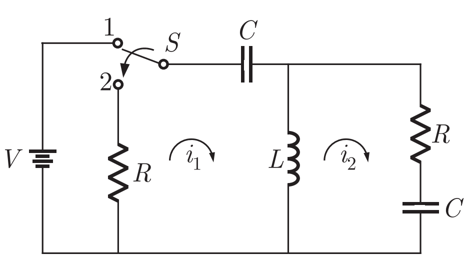


(A) $(0.18 + j0.72)$ (B) $(0.46 + j1.90)$

(C) $-(0.18 + j1.90)$ (D) $-(0.192 + j0.144)$

The circuit for Q. 2.66 & 2.67 is given below.

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



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MCQ 2.67

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

(A) $\frac{-V}{2R}$ (B) $\frac{-V}{R}$

(C) $\frac{-V}{4R}$ (D) zero

MCQ 2.68

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

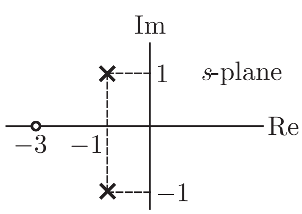
(B) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + \frac{1}{Cs} \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \begin{bmatrix} -\frac{V}{s} \\ 0 \end{bmatrix}$

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

MCQ 2.69

The driving point impedance $Z(s)$ of a network has the pole-zero locations as shown in the figure. If $Z(0) = 3$, then $Z(s)$ is



(A) $\frac{3(s+3)}{s^2+2s+3}$ (B) $\frac{2(s+3)}{s^2+2s+2}$

(C) $\frac{3(s+3)}{s^2+2s+2}$ (D) $\frac{2(s-3)}{s^2-2s-3}$

MCQ 2.70

An input voltage $v(t) = 10\sqrt{2}\cos(t + 10^\circ) + 10\sqrt{5}\cos(2t + 10^\circ)$

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V is applied to a series combination of resistance $R = 1\,\Omega$ and an inductance $L = 1$ H. The resulting steady-state current $i(t)$ in ampere is

(A) $10\cos(t + 55^\circ) + 10\cos(2t + 10^\circ + \tan^{-1}2)$

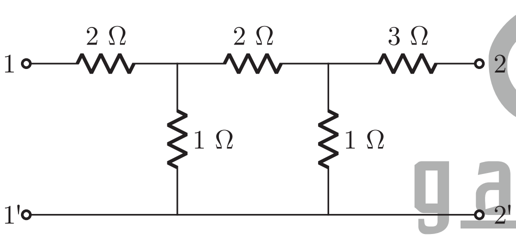
(B) $10\cos(t + 55^\circ) + 10\sqrt{\frac{3}{2}}\cos(2t + 55^\circ)$

(C) $10\cos(t - 35^\circ) + 10\cos(2t + 10^\circ - \tan^{-1}2)$

(D) $10\cos(t - 35^\circ) + \sqrt{\frac{3}{2}}\cos(2t - 35^\circ)$

MCQ 2.71

The impedance parameters z_{11} and z_{12} of the two-port network in the figure are



(A) $z_{11} = 2.75\,\Omega$ and $z_{12} = 0.25\,\Omega$

(B) $z_{11} = 3\,\Omega$ and $z_{12} = 0.5\,\Omega$

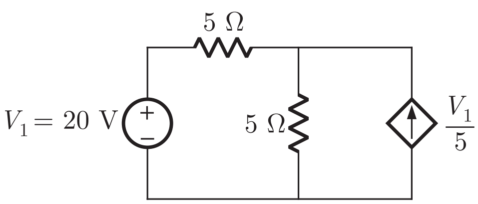
(C) $z_{11} = 3\,\Omega$ and $z_{12} = 0.25\,\Omega$

(D) $z_{11} = 2.25\,\Omega$ and $z_{12} = 0.5\,\Omega$

GATE 2002 **ONE MARK**

MCQ 2.72

The dependent current source shown in the figure



(A) delivers 80 W
(B) absorbs 80 W
(C) delivers 40 W
(D) absorbs 40 W

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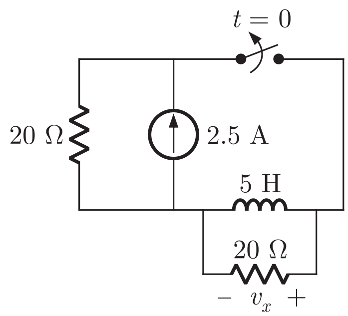
MCQ 2.73

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

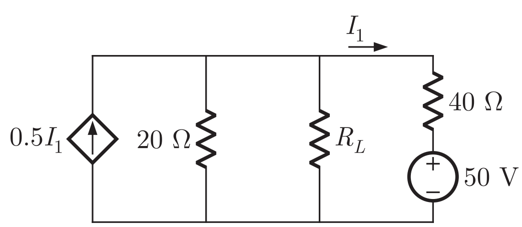


(A) 25 V
(B) 50 V
(C) −50 V
(D) 0 V

GATE 2002 TWO MARKS

MCQ 2.74

In the network of the fig, the maximum power is delivered to R_L if its value is



(A) 16 Ω
(B) $\frac{40}{3}$ Ω
(C) 60 Ω
(D) 20 Ω

MCQ 2.75

If the 3-phase balanced source in the figure delivers 1500 W at a leading power factor 0.844 then the value of Z_L (in ohm) is approximately

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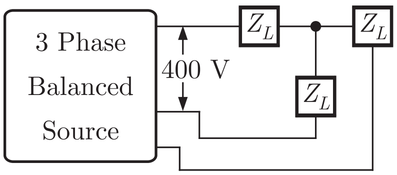


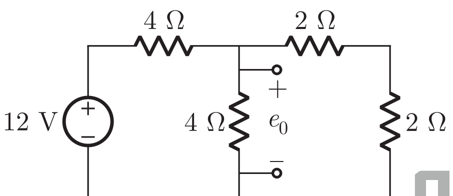
(A) $90\angle 32.44°$ (B) $80\angle 32.44°$

(C) $80\angle -32.44°$ (D) $90\angle -32.44°$

GATE 2001 ONE MARK

MCQ 2.76

The Voltage e_0 in the figure is



(A) 2 V (B) 4/3 V

(C) 4 V (D) 8 V

MCQ 2.77

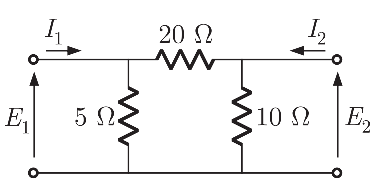
If each branch of Delta circuit has impedance $\sqrt{3}Z$, then each branch of the equivalent Wye circuit has impedance

(A) $\frac{Z}{\sqrt{3}}$ (B) $3Z$

(C) $3\sqrt{3}Z$ (D) $\frac{Z}{3}$

MCQ 2.78

The admittance parameter Y_{12} in the 2-port network in Figure is



(A) -0.02 mho (B) 0.1 mho

(C) -0.05 mho (D) 0.05 mho

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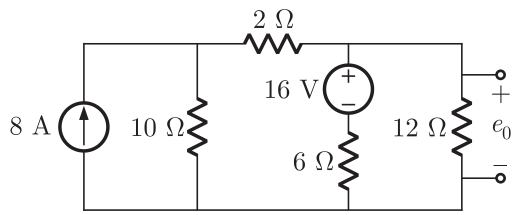
GATE 2001 **TWO MARKS**

MCQ 2.79

The voltage e_0 in the figure is

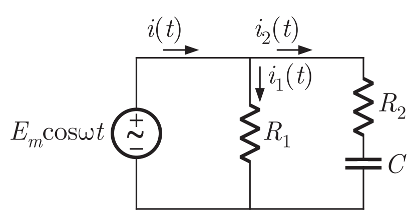


(A) 48 V (B) 24 V

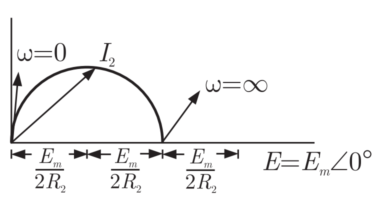
(C) 36 V (D) 28 V

MCQ 2.80

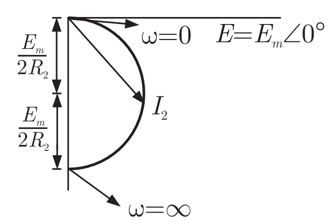
When the angular frequency ω in the figure is varied 0 to ∞, the locus of the current phasor I_2 is given by



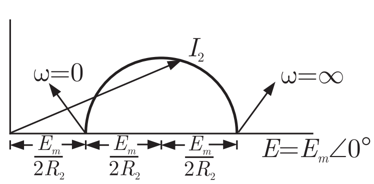
(A)



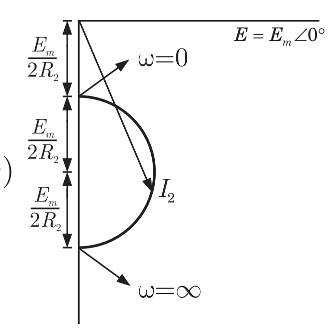
(B)



(C)



(D)



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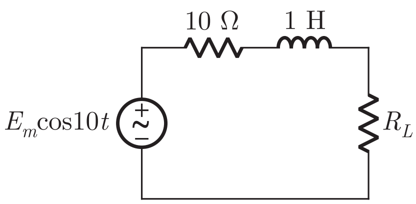
MCQ 2.81

In the figure, the value of the load resistor R_L which maximizes the power delivered to it is

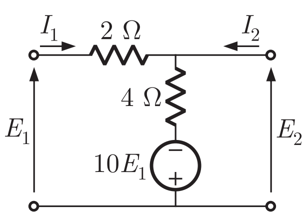


(A) 14.14 Ω (B) 10 Ω

(C) 200 Ω (D) 28.28 Ω

MCQ 2.82

The z parameters z_{11} and z_{21} for the 2-port network in the figure are



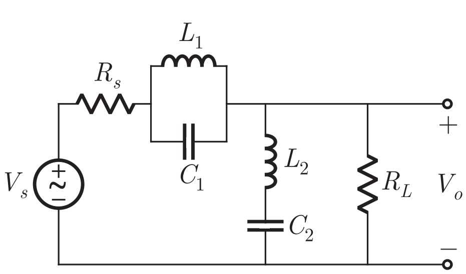
(A) $z_{11} = \frac{6}{11}\,\Omega;\ z_{21} = \frac{16}{11}\,\Omega$ (B) $z_{11} = \frac{6}{11}\,\Omega;\ z_{21} = \frac{4}{11}\,\Omega$

(C) $z_{11} = \frac{6}{11}\,\Omega;\ z_{21} = -\frac{16}{11}\,\Omega$ (D) $z_{11} = \frac{4}{11}\,\Omega;\ z_{21} = \frac{4}{11}\,\Omega$

GATE 2000 ONE MARK

MCQ 2.83

The circuit of the figure represents a



(A) Low pass filter (B) High pass filter

(C) band pass filter (D) band reject filter

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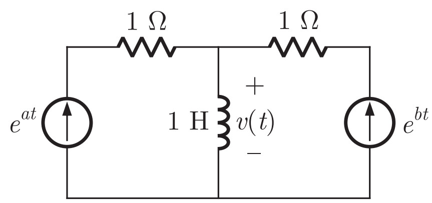
MCQ 2.84

In the circuit of the figure, the voltage $v(t)$ is

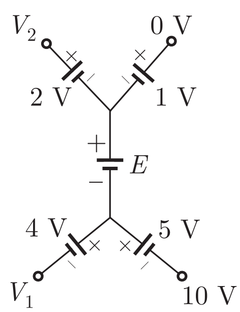


(A) $e^{at} - e^{bt}$ (B) $e^{at} + e^{bt}$

(C) $ae^{at} - be^{bt}$ (D) $ae^{at} + be^{bt}$

MCQ 2.85

In the circuit of the figure, the value of the voltage source E is



(A) −16 V (B) 4 V

(C) −6 V (D) 16 V

GATE 2000 **TWO MARKS**

MCQ 2.86

Use the data of the figure (a). The current i in the circuit of the figure (b)

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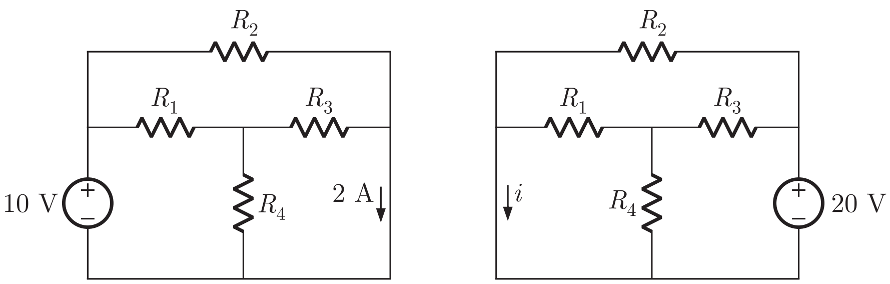


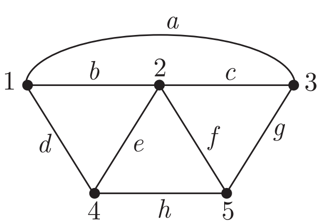
(a) (b)

(A) -2 A
(B) 2 A
(C) -4 A
(D) 4 A

GATE 1999 ONE MARK

MCQ 2.87

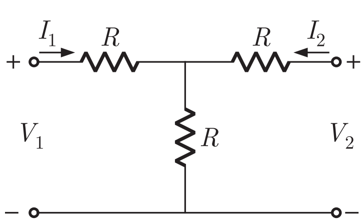
Identify which of the following is NOT a tree of the graph shown in the given figure is



(A) *begh*
(B) *defg*
(C) *abfg*
(D) *aegh*

MCQ 2.88

A 2-port network is shown in the given figure. The parameter h_{21} for this network can be given by



(A) $-1/2$
(B) $+1/2$
(C) $-3/2$
(D) $+3/2$

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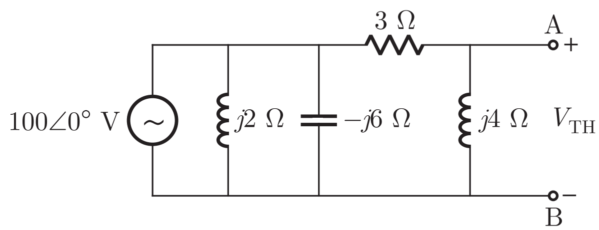
GATE 1999 **TWO MARK**

MCQ 2.89

The Thevenin equivalent voltage V_{TH} appearing between the terminals A and B of the network shown in the given figure is given by

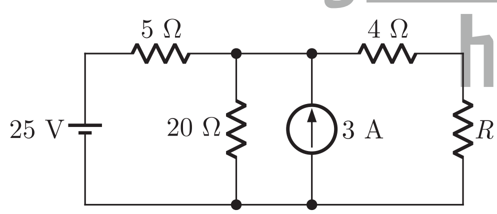


(A) $j16(3-j4)$ (B) $j16(3+j4)$

(C) $16(3+j4)$ (D) $16(3-j4)$

MCQ 2.90

The value of R (in ohms) required for maximum power transfer in the network shown in the given figure is

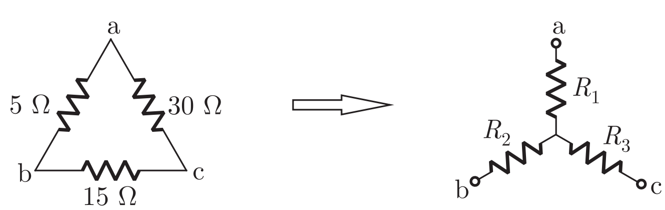


(A) 2 (B) 4

(C) 8 (D) 16

MCQ 2.91

A Delta-connected network with its Wye-equivalent is shown in the given figure. The resistance R_1, R_2 and R_3 (in ohms) are respectively



(A) 1.5, 3 and 9 (B) 3, 9 and 1.5

(C) 9, 3 and 1.5 (D) 3, 1.5 and 9

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GATE 1998 ONE MARK

MCQ 2.92

A network has 7 nodes and 5 independent loops. The number of branches in the network is

(A) 13
(B) 12
(C) 11
(D) 10

MCQ 2.93

The nodal method of circuit analysis is based on

(A) KVL and Ohm's law
(B) KCL and Ohm's law
(C) KCL and KVL
(D) KCL, KVL and Ohm's law

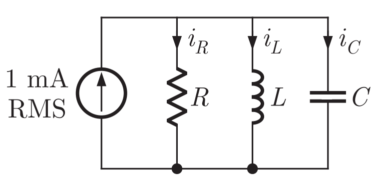
MCQ 2.94

Superposition theorem is NOT applicable to networks containing

(A) nonlinear elements
(B) dependent voltage sources
(C) dependent current sources
(D) transformers

MCQ 2.95

The parallel RLC circuit shown in the figure is in resonance. In this circuit



(A) $|I_R| < 1$ mA
(B) $|I_R + I_L| > 1$ mA
(C) $|I_R + I_C| < 1$ mA
(D) $|I_R + I_C| > 1$ mA

MCQ 2.96

The short-circuit admittance matrix a two-port network is $\begin{bmatrix} 0 & -1/2 \\ 1/2 & 0 \end{bmatrix}$

The two-port network is

(A) non-reciprocal and passive
(B) non-reciprocal and active
(C) reciprocal and passive
(D) reciprocal and acitve

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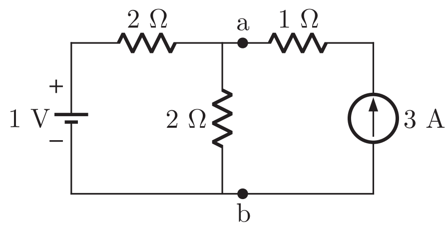
MCQ 2.97

The voltage across the terminals a and b in the figure is



(A) 0.5 V
(B) 3.0 V
(C) 3.5 V
(D) 4.0 V

MCQ 2.98

A high-Q quartz crystal exhibits series resonance at the frequency ω_s and parallel resonance at the frequency ω_p. Then

(A) ω_s is very close to, but less than ω_p

(B) $\omega_s << \omega_p$

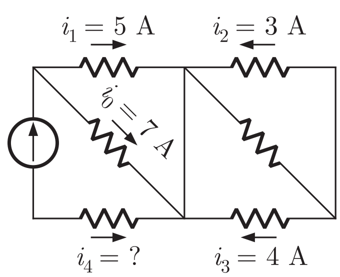
(C) ω_s is very close to, but greater than ω_p

(D) $\omega_s >> \omega_p$

GATE 1997 **ONE MARK**

MCQ 2.99

The current i_4 in the circuit of the figure is equal to



(A) 12 A
(B) −12 A
(C) 4 A
(D) None or these

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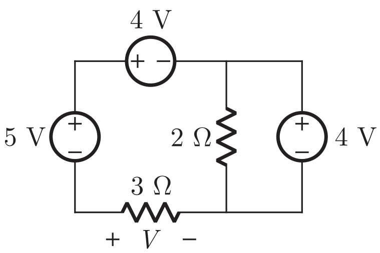
MCQ 2.100

The voltage V in the figure equal to

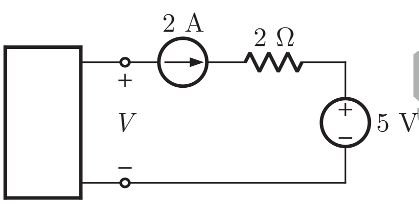


(A) 3 V (B) -3 V

(C) 5 V (D) None of these

MCQ 2.101

The voltage V in the figure is always equal to

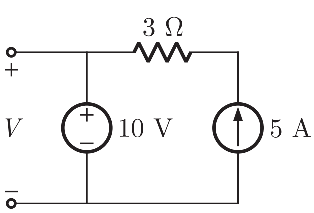


(A) 9 V (B) 5 V

(C) 1 V (D) None of the above

MCQ 2.102

The voltage V in the figure is



(A) 10 V (B) 15 V

(C) 5 V (D) None of the above

MCQ 2.103

In the circuit of the figure is the energy absorbed by the 4 Ω resistor

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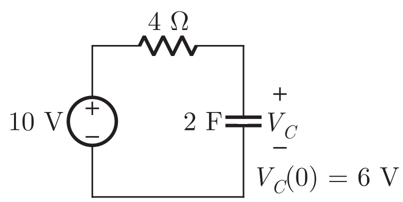
in the time interval $(0, \infty)$ is



(A) 36 Joules

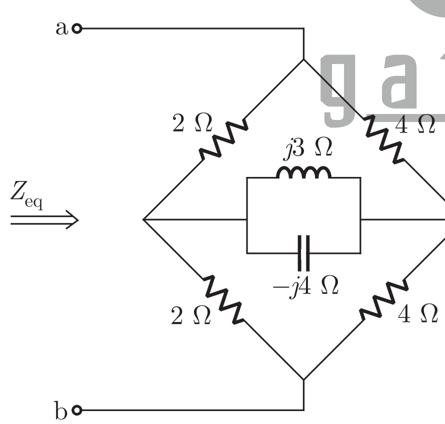
(B) 16 Joules

(C) 256 Joules

(D) None of the above

MCQ 2.104

In the circuit of the figure the equivalent impedance seen across terminals a, b, is



(A) $\left(\frac{16}{3}\right) \Omega$

(B) $\left(\frac{8}{3}\right) \Omega$

(C) $\left(\frac{8}{3} + 12j\right) \Omega$

(D) None of the above

GATE 1996 **ONE MARK**

MCQ 2.105

In the given figure, A_1, A_2 and A_3 are ideal ammeters. If A_2 and A_3 read 3 A and 4 A respectively, then A_1 should read

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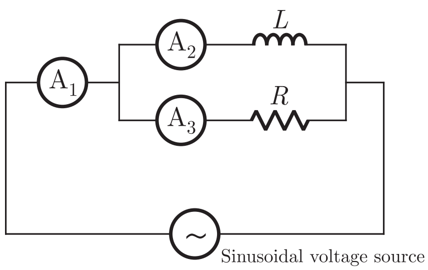


(A) 1 A
(B) 5 A
(C) 7 A
(D) None of these

MCQ 2.106

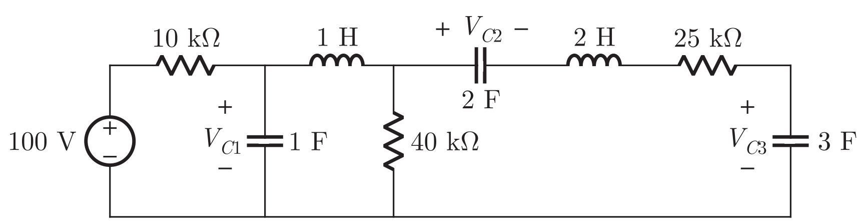
The number of independent loops for a network with n nodes and b branches is

(A) $n-1$
(B) $b-n$
(C) $b-n+1$
(D) independent of the number of nodes

GATE 1996 **TWO MARKS**

MCQ 2.107

The voltages V_{C1}, V_{C2}, and V_{C3} across the capacitors in the circuit in the given figure, 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

****

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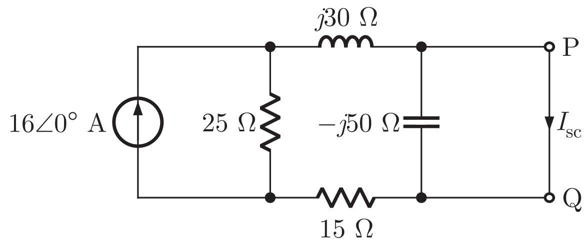
SOLUTIONS

SOL 2.1

Replacing $P-Q$ by short circuit as shown below we have



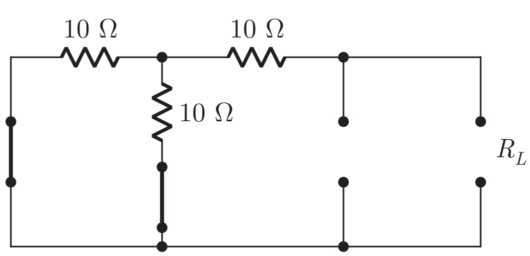
Using current divider rule the current I_{sc} is

$$I_{SC} = \frac{25}{25+15+j30}(16\angle 0) = (6.4 - j4.8)\text{ A}$$

Hence (A) is correct option.

SOL 2.2

Power transferred to R_L will be maximum when R_L is equal to the thevenin resistance. We determine thevenin resistance by killing all source as follows :



$$R_{TH} = \frac{10\times 10}{10+10} + 10 = 15\,\Omega$$

Hence (C) is correct option.

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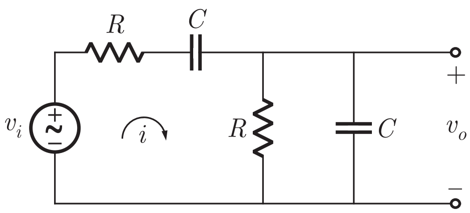
SOL 2.3

The given circuit is shown below



For parallel combination of R and C equivalent impedance is

$$Z_p = \frac{R \cdot \frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{R}{1 + j\omega RC}$$

Transfer function can be written as

$$\frac{V_{out}}{V_{in}} = \frac{Z_p}{Z_s + Z_p} = \frac{\frac{R}{1 + j\omega RC}}{R + \frac{1}{j\omega C} + \frac{R}{1 + j\omega RC}}$$

$$= \frac{j\omega RC}{j\omega RC + (1 + j\omega RC)^2}$$

$$= \frac{j}{j + (1 + j)^2} \qquad \text{Here } \omega = \frac{1}{RC}$$

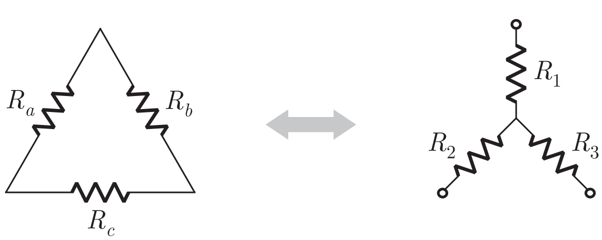
$$\frac{V_{out}}{V_{in}} = \frac{j}{(1 + j)^2 + j} = \frac{1}{3}$$

Thus $\quad v_{out} = \left(\frac{V_p}{3}\right)\cos(t/RC)$

Hence (A) is correct option.

SOL 2.4

From star delta conversion we have



Thus $\quad R_1 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{6.6}{6 + 6 + 6} = 2\,\Omega$

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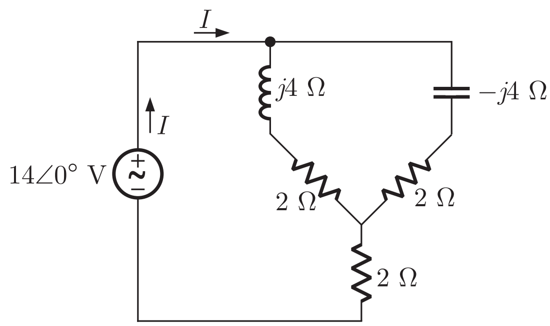
Here $$R_1 = R_2 = R_3 = 2\,\Omega$$

Replacing in circuit we have the circuit shown below :



Now the total impedance of circuit is

$$Z = \frac{(2+j4)(2-j4)}{(2+j4)(2-j4)} + 2 = 7\,\Omega$$

Current $$I = \frac{14\angle 0^\circ}{7} = 2\angle 0^\circ$$

Hence (B) is correct option.

SOL 2.5

From given admittance matrix we get

$$I_1 = 0.1\,V_1 - 0.01\,V_2 \text{ and} \qquad ...(1)$$

$$I_2 = 0.01\,V_1 + 0.1\,V_2 \qquad ...(2)$$

Now, applying KVL in outer loop;

$$V_2 = -100 I_2$$

or $$I_2 = -0.01\,V_2 \qquad ...(3)$$

From eq (2) and eq (3) we have

$$-0.01\,V_2 = 0.01\,V_1 + 0.1\,V_2$$

$$-0.11\,V_2 = 0.01\,V_1$$

$$\frac{V_2}{V_1} = \frac{-1}{11}$$

Hence (D) is correct option.

SOL 2.6

Here we take the current flow direction as positive.

At $t = 0^-$ voltage across capacitor is

$$V_C(0^-) = -\frac{Q}{C} = -\frac{2.5 \times 10^{-3}}{50 \times 10^{-6}} = -50\text{ V}$$

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Thus $V_C(0^+) = -50$ V

In steady state capacitor behave as open circuit thus

$$V(\infty) = 100 \text{ V}$$

Now, $$V_C(t) = V_C(\infty) + (V_C(0^+) - V_C(\infty))\, e^{-t/RC}$$

$$= 100 + (-50 - 100)\, e^{\frac{-t}{10 \times 50 \times 10^{-6}}}$$

$$= 100 - 150 e^{-(2 \times 10^3 t)}$$

Now $$i_c(t) = C\frac{dV}{dt}$$

$$= 50 \times 10^{-6} \times 150 \times 2 \times 10^3 e^{-2 \times 10^3 t} \text{ A}$$

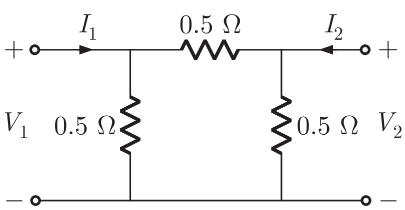
$$= 15 e^{-2 \times 10^3 t}$$

$$i_c(t) = 15 \exp(-2 \times 10^3 t) \text{ A}$$

Hence (A) is correct option.

SOL 2.7

Given circuit is as shown below



By writing node equation at input port

$$I_1 = \frac{V_1}{0.5} + \frac{V_1 - V_2}{0.5} = 4V_1 - 2V_2 \quad ...(1)$$

By writing node equation at output port

$$I_2 = \frac{V_2}{0.5} + \frac{V_2 - V_1}{0.5} = -2V_1 + 4V_2 \quad ...(2)$$

From (1) and (2), we have admittance matrix

$$Y = \begin{bmatrix} 4 & -2 \\ -2 & 4 \end{bmatrix}$$

Hence (A) is correct option.

SOL 2.8

A parallel RLC circuit is shown below :

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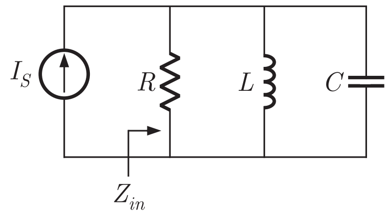


Input impedance $Z_{\text{in}} = \dfrac{1}{\frac{1}{R} + \frac{1}{j\omega L} + j\omega C}$

At resonance $\dfrac{1}{\omega L} = \omega C$

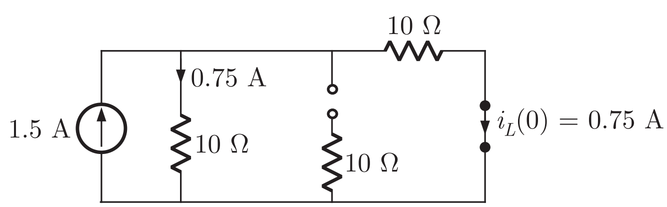
So, $Z_{\text{in}} = \dfrac{1}{1/R} = R$ (maximum at resonance)

Thus (D) is not true.

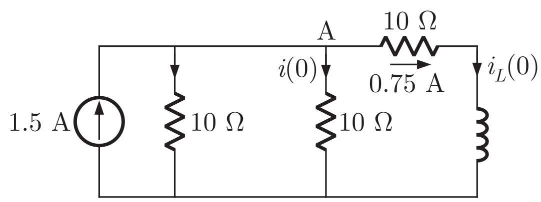
Furthermore bandwidth is ω_B i.e $\omega_B \propto \dfrac{1}{R}$ and is independent of L,
Hence statements A, B, C, are true.
Hence (D) is correct option.

SOL 2.9

Let the current $i(t) = A + Be^{-t/\tau}$ $\tau \rightarrow$ Time constant
When the switch S is open for a long time before $t < 0$, the circuit is



At $t = 0$, inductor current does not change simultaneously, So the circuit is



Current is resistor (AB)

$$i(0) = \frac{0.75}{2} = 0.375 \text{ A}$$

Similarly for steady state the circuit is as shown below

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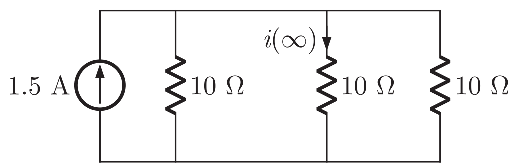


$$i(\infty) = \frac{15}{3} = 0.5 \text{ A}$$

$$\tau = \frac{L}{R_{eq}} = \frac{15 \times 10^{-3}}{10 + (10 \,||\, 10)} = 10^{-3} \text{ sec}$$

$$i(t) = A + Be^{-\frac{t}{1 \times 10^{-3}}} = A + Be^{-100t}$$

Now $\quad i(0) = A + B = 0.375$

and $\quad i(\infty) = A = 0.5$

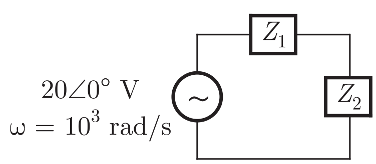
So, $\quad B = 0.375 - 0.5 = -0.125$

Hence $\quad i(t) = 0.5 - 0.125e^{-1000\,t} \text{ A}$

Hence (A) is correct option.

SOL 2.10

Circuit is redrawn as shown below



Where, $\quad Z_1 = j\omega L = j \times 10^3 \times 20 \times 10^{-3} = 20j$

$$Z_2 = R \,||\, X_C$$

$$X_C = \frac{1}{j\omega C} = \frac{1}{j \times 10^3 \times 50 \times 10^{-6}} = -20j$$

$$Z_2 = \frac{1(-20j)}{1 - 20j} \qquad R = 1\,\Omega$$

Voltage across Z_2

$$V_{Z_2} = \frac{Z_2}{Z_1 + Z_2} \cdot 20\angle 0 = \frac{\left(\frac{-20j}{1-20j}\right)}{\left(20j - \frac{20j}{1-20j}\right)} \cdot 20$$

$$= \left(\frac{(-20j)}{20j + 400 - 20j}\right) \cdot 20 = -j$$

Current in resistor R is

$$I = \frac{V_{Z_2}}{R} = -\frac{j}{1} = -j \text{ A}$$

Hence (A) is correct option.

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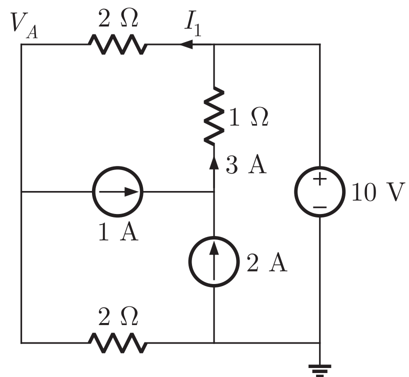
SOL 2.11

The circuit can be redrawn as



Applying nodal analysis

$$\frac{V_A - 10}{2} + 1 + \frac{V_A - 0}{2} = 0$$

$$2V_A - 10 + 2 = 0 = V_4 = 4 \text{ V}$$

Current, $$I_1 = \frac{10 - 4}{2} = 3 \text{ A}$$

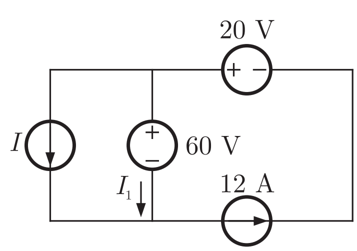
Current from voltage source is

$$I_2 = I_1 - 3 = 0$$

Since current through voltage source is zero, therefore power delivered is zero.
Hence (A) is correct option.

SOL 2.12

Circuit is as shown below



Since 60 V source is absorbing power. So, in 60 V source current flows from + to - ve direction

So, $$I + I_1 = 12$$

$$I = 12 - I_1$$

I is always less then 12 A So, only option (A) satisfies this conditions.
Hence (A) is correct option.

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SOL 2.13

For given network we have

$$V_0 = \frac{(R_L \| X_C)\, V_i}{R + (R_L \| X_C)}$$

$$\frac{V_0(s)}{V_i(s)} = \frac{\frac{R_L}{1 + sR_L C}}{R + \frac{R_L}{1 + sR_L C}} = \frac{R_L}{R + RR_L sC + R_L}$$

$$= \frac{R_L}{R + RR_L sC + R_L} = \frac{1}{1 + \frac{R}{R_L} + RsC}$$

But we have been given

$$T.F. = \frac{V_0(s)}{V_i(s)} = \frac{1}{2 + sCR}$$

Comparing, we get

$$1 + \frac{R}{R_L} = 2 \quad \Rightarrow R_L = R$$

Hence (C) is correct option.

SOL 2.14

The energy delivered in 10 minutes is

$$E = \int_0^t VIdt = I\int_0^t Vdt = I \times Area$$

$$= 2 \times \frac{1}{2}(10 + 12) \times 600 = 13.2 \text{ kJ}$$

Hence (C) is correct option.

SOL 2.15

From given circuit the load current is

$$I_L = \frac{V}{Z_s + Z_L} = \frac{20\angle 0^\circ}{(1 + 2j) + (7 + 4j)} = \frac{20\angle 0^\circ}{8 + 6j}$$

$$= \frac{1}{5}(8 - 6j) = \frac{20\angle 0^\circ}{10\angle \phi} = 2\angle - \phi \qquad \text{where } \phi = \tan^{-1}\frac{3}{4}$$

The voltage across load is

$$V_L = I_L Z_L$$

The reactive power consumed by load is

$$P_r = V_L I_L^* = I_L Z_L \times I_L^* = Z_L |I_L|^2$$

$$= (7 \times 4j)\left|\frac{20\angle 0^\circ}{8 + 6j}\right|^2 = (7 + 4j) = 28 + 16j$$

Thus average power is 28 and reactive power is 16.
Hence (B) is correct option.

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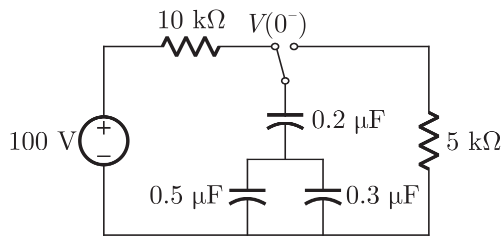
SOL 2.16

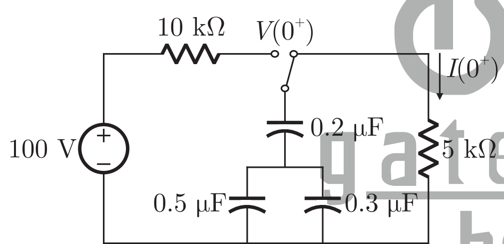
At $t = 0^-$, the circuit is as shown in fig below :



$$V(0^-) = 100 \text{ V}$$

Thus $$V(0^+) = 100 \text{ V}$$

At $t = 0^+$, the circuit is as shown below



$$I(0^+) = \frac{100}{5k} = 20 \text{ mA}$$

At steady state i.e. at $t = \infty$ is $I(\infty) = 0$

Now $$i(t) = I(0^+)\, e^{-\frac{t}{RC_{eq}}} u(t)$$

$$C_{eq} = \frac{(0.5\mu + 0.3\mu)0.2\mu}{0.5\mu + 0.3\mu + 0.2\mu} = 0.16\, \mu\text{F}$$

$$\frac{1}{RC_{eq}} = \frac{1}{5 \times 10^3 \times 0.16 \times 10^{-6}} = 1250$$

$$i(t) = 20e^{-1250t}u(t) \text{ mA}$$

Hence (B) is correct option.

SOL 2.17

For $P_{\max}$ the load resistance R_L must be equal to thevenin resistance R_{eq} i.e. $R_L = R_{eq}$. The open circuit and short circuit is as shown below

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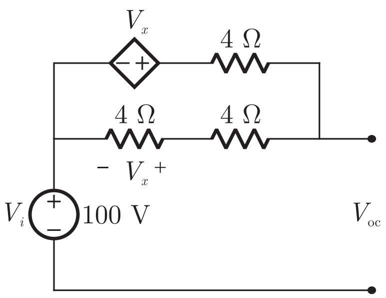
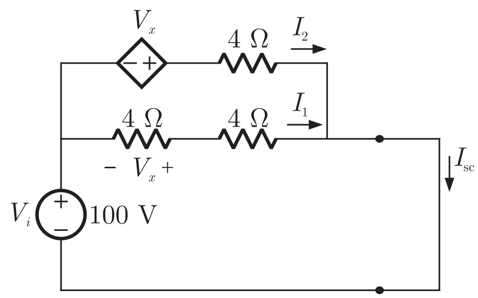




The open circuit voltage is

$$V_{oc} = 100 \text{ V}$$

From fig $$I_1 = \frac{100}{8} = 12.5 \text{ A}$$

$$V_x = -4 \times 12.5 = -50 \text{ V}$$

$$I_2 = \frac{100 + V_x}{4} = \frac{100 - 50}{4} = 12.5 \text{ A}$$

$$I_{sc} = I_1 + I_2 = 25 \text{ A}$$

$$R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{100}{25} = 4\,\Omega$$

Thus for maximum power transfer $R_L = R_{eq} = 4\,\Omega$

Hence (C) is correct option.

SOL 2.18

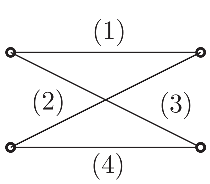
Steady state all transient effect die out and inductor act as short circuits and forced response acts only. It doesn't depend on initial current state. From the given time domain behavior we get that circuit has only R and L in series with V_0. Thus at steady state

$$i(t) \to i(\infty) = \frac{V_0}{R}$$

Hence (A) is correct option.

SOL 2.19

The given graph is



There can be four possible tree of this graph which are as follows:

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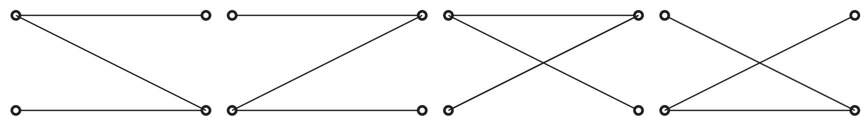
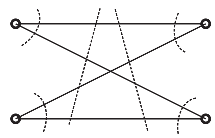


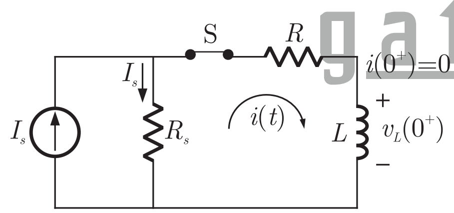
There can be 6 different possible cut-set.



Hence (C) is correct option.

SOL 2.20

Initially $i(0^-) = 0$ therefore due to inductor $i(0^+) = 0$. Thus all current I_s will flow in resistor R and voltage across resistor will be $I_s R_s$. The voltage across inductor will be equal to voltage across R_s as no current flow through R.



At $t(0^+)=0$

Thus $\qquad v_L(0^+) = I_s R_s$

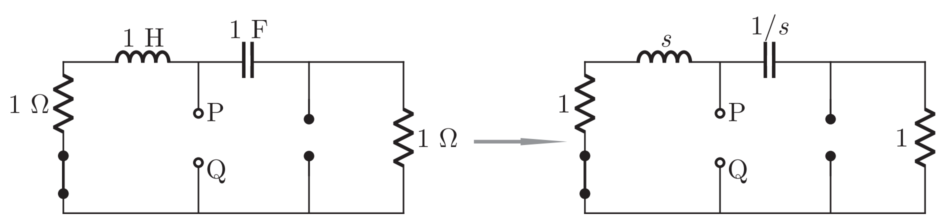
but $\qquad v_L(0^+) = L\dfrac{di(0^+)}{dt}$

Thus $\qquad \dfrac{di(0^+)}{dt} = \dfrac{v_L(0^+)}{L} = \dfrac{I_s R_s}{L}$

Hence (B) is correct option.

SOL 2.21

Killing all current source and voltage sources we have,



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$$Z_{th} = (1+s) \| (\tfrac{1}{s}+1)$$
$$= \frac{(1+s)(\frac{1}{s}+1)}{(1+s)+(\frac{1}{s}+1)} = \frac{[\frac{1}{s}+1+1+s]}{s+\frac{1}{s}+1+1}$$

or $$Z_{th} = 1$$

Alternative :

Here at DC source capacitor act as open circuit and inductor act as short circuit. Thus we can directly calculate thevenin Impedance as 1 Ω

Hence (A) is correct option.

SOL 2.22

$$Z(s) = R \Big\| \frac{1}{sC} \Big\| sL = \frac{\frac{s}{C}}{s^2+\frac{s}{RC}+\frac{1}{LC}}$$

We have been given

$$Z(s) = \frac{0.2s}{s^2+0.1s+2}$$

Comparing with given we get

$$\frac{1}{C} = 0.2 \text{ or } C = 5 \text{ F}$$

$$\frac{1}{RC} = 0.1 \text{ or } R = 2\,\Omega$$

$$\frac{1}{LC} = 2 \text{ or } L = 0.1 \text{ H}$$

Hence (D) is correct option.

SOL 2.23

Voltage across capacitor is

$$V_c = \frac{1}{C}\int_0^t i\,dt$$

Here $C = 1$ F and $i = 1$ A. Therefore

$$V_c = \int_0^t dt$$

For $0 < t < T$, capacitor will be charged from 0 V

$$V_c = \int_0^t dt = t$$

At $t = T$, $V_c = T$ Volts

For $T < t < 2T$, capacitor will be discharged from T volts as

$$V_c = T - \int_T^t dt = 2T - t$$

At $t = 2T$, $V_c = 0$ volts

For $2T < t < 3T$, capacitor will be charged from 0 V

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$$V_c = \int_{2T}^{t} dt = t - 2T$$

At $t = 3T, V_c = T$ Volts

For $3T < t < 4T$, capacitor will be discharged from T Volts

$$V_c = T - \int_{3T}^{t} dt = 4T - t$$

At $t = 4T, V_c = 0$ Volts

For $4T < t < 5T$, capacitor will be charged from 0 V

$$V_c = \int_{4T}^{t} dt = t - 4T$$

At $t = 5T, V_c = T$ Volts

Thus the output waveform is

Only option C satisfy this waveform.

Hence (C) is correct option.

SOL 2.24

Writing in transform domain we have

$$\frac{V_c(s)}{V_s(s)} = \frac{\frac{1}{s}}{(\frac{1}{s} + s + 1)} = \frac{1}{(s^2 + s + 1)}$$

Since $V_s(t) = \delta(t) \rightarrow V_s(s) = 1$ and

$$V_c(s) = \frac{1}{(s^2 + s + 1)}$$

or $$V_c(s) = \frac{2}{\sqrt{3}}\left[\frac{\frac{\sqrt{3}}{2}}{(s + \frac{1}{2})^2 + \frac{3}{4}}\right]$$

Taking inverse laplace transform we have

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

Hence (D) is correct option.

SOL 2.25

Let voltage across resistor be v_R

$$\frac{V_R(s)}{V_S(s)} = \frac{1}{(\frac{1}{s} + s + 1)} = \frac{s}{(s^2 + s + 1)}$$

Since $v_s = \delta(t) \rightarrow V_s(s) = 1$ we get

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$$V_R(s) = \frac{s}{(s^2+s+1)} = \frac{s}{(s+\frac{1}{2})^2+\frac{3}{4}}$$
$$= \frac{(s+\frac{1}{2})}{(s+\frac{1}{2})^2+\frac{3}{4}} - \frac{\frac{1}{2}}{(s+\frac{1}{2})^2+\frac{3}{4}}$$

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

Hence (B) is correct option.

SOL 2.26

From the problem statement we have

$$z_{11} = \frac{v_1}{i_1}\Big|_{i_2=0} = \frac{6}{4} = 1.5\Omega$$
$$z_{12} = \frac{v_1}{i_2}\Big|_{i_1=0} = \frac{4.5}{1} = 4.5\Omega$$
$$z_{21} = \frac{v_2}{i_1}\Big|_{i_2=0} = \frac{6}{4} = 1.5\Omega$$
$$z_{22} = \frac{v_2}{i_2}\Big|_{i_2=0} = \frac{1.5}{1} = 1.5\Omega$$

Thus z-parameter matrix is
$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 1.5 & 4.5 \\ 1.5 & 1.5 \end{bmatrix}$$

Hence (C) is correct option.

SOL 2.27

From the problem statement we have

$$h_{12} = \frac{v_1}{v_2}\Big|_{i_1=0} = \frac{4.5}{1.5} = 3$$
$$h_{22} = \frac{i_2}{v_2}\Big|_{i_1=0} = \frac{1}{1.5} = 0.67$$

From z matrix, we have
$$v_1 = z_{11}i_1 + z_{12}i_2$$
$$v_2 = z_{21}i_1 + z_{22}i_2$$

If $v_2 = 0$

Then
$$\frac{i_2}{i_1} = \frac{-z_{21}}{z_{22}} = \frac{-1.5}{1.5} = -1 = h_{21}$$

or
$$i_2 = -i_1$$

Putting in equation for v_1, we get
$$v_1 = (z_{11} - z_{12})\,i_1$$

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$$\frac{v_1}{i_1}\bigg|_{v_2=0} = h_{11} = z_{11} - z_{12} = 1.5 - 4.5 = -3$$

Hence h −parameter will be

$$\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} -3 & 3 \\ -1 & 0.67 \end{bmatrix}$$

Hence (A) is correct option.

SOL 2.28

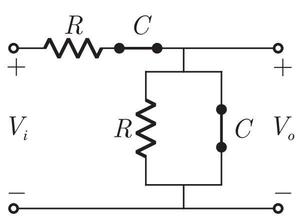
According to maximum Power Transform Theorem

$$Z_L = Z_s^* = (R_s - jX_s)$$

Hence (D) is correct option.

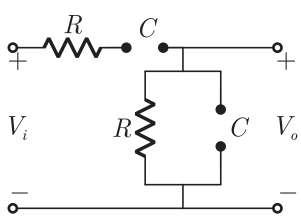
SOL 2.29

At $\omega \to \infty$, capacitor acts as short circuited and circuit acts as shown in fig below



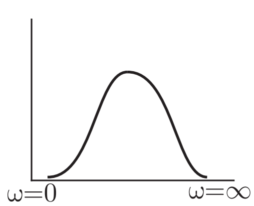
Here we get $\frac{V_0}{V_i} = 0$

At $\omega \to 0$, capacitor acts as open circuited and circuit look like as shown in fig below



Here we get also $\frac{V_0}{V_i} = 0$

So frequency response of the circuit is as shown in fig and circuit is a Band pass filter.



Hence (C) is correct option.

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SOL 2.30

We know that bandwidth of series RLC circuit is $\frac{R}{L}$. Therefore

Bandwidth of filter 1 is $B_1 = \frac{R}{L_1}$

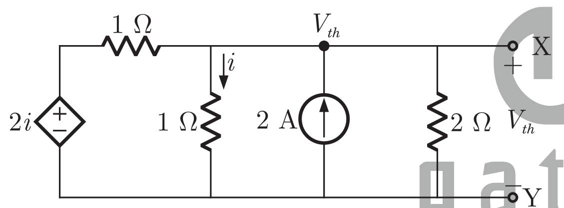
Bandwidth of filter 2 is $B_2 = \frac{R}{L_2} = \frac{R}{L_1/4} = \frac{4R}{L_1}$

Dividing above equation $\frac{B_1}{B_2} = \frac{1}{4}$

Hence (D) is correct option.

SOL 2.31

Here V_{th} is voltage across node also. Applying nodal analysis we get



$$\frac{V_{th}}{2} + \frac{V_{th}}{1} + \frac{V_{th} - 2i}{1} = 2$$

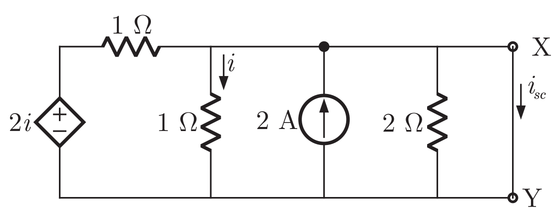
But from circuit $\quad i = \frac{V_{th}}{1} = V_{th}$

Therefore

$$\frac{V_{th}}{2} + \frac{V_{th}}{1} + \frac{V_{th} - 2V_{th}}{1} = 2$$

or $\quad V_{th} = 4$ volt

From the figure shown below it may be easily seen that the short circuit current at terminal XY is $i_{sc} = 2$ A because $i = 0$ due to short circuit of 1 Ω resistor and all current will pass through short circuit.



Therefore $\quad R_{th} = \frac{V_{th}}{i_{sc}} = \frac{4}{2} = 2\,\Omega$

Hence (D) is correct option.

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SOL 2.32

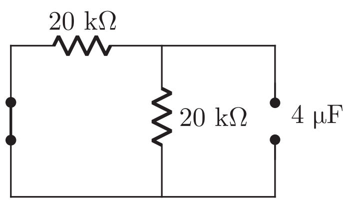
The voltage across capacitor is

At $t = 0^+$, $V_c(0^+) = 0$

At $t = \infty$, $V_C(\infty) = 5$ V

The equivalent resistance seen by capacitor as shown in fig is

$$R_{eq} = 20 \| 20 = 10k\Omega$$



Time constant of the circuit is

$$\tau = R_{eq}C = 10k \times 4\mu = 0.04 \text{ s}$$

Using direct formula

$$V_c(t) = V_C(\infty) - [V_c(\infty) - V_c(0)]\,e^{-t/\tau}$$

$$= V_C(\infty)(1 - e^{-t/\tau}) + V_C(0)\,e^{-t/\tau} = 5(1 - e^{-t/0.04})$$

or $$V_c(t) = 5(1 - e^{-25t})$$

Now $$I_C(t) = C\frac{dV_C(t)}{dt}$$

$$= 4 \times 10^{-6} \times (-5 \times 25e^{-25t}) = 0.5e^{-25t} \text{ mA}$$

Hence (A) is correct option.

SOL 2.33

Impedance $$= (5 - 3j)\|(5 + 3j) = \frac{(5-3j)\times(5+3j)}{5 - 3j + 5 + 3j}$$

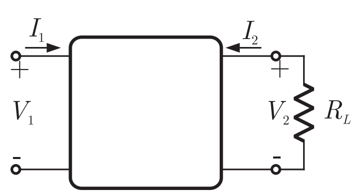
$$= \frac{(5)^2 - (3j)^2}{10} = \frac{25 + 9}{10} = 3.4$$

$$V_{AB} = \text{Current} \times \text{Impedance} = 5\angle 30° \times 34 = 17\angle 30°$$

Hence (D) is correct option.

SOL 2.34

The network is shown in figure below.



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Now $\quad V_1 = AV_2 - BI_2 \quad$ ...(1)

and $\quad I_1 = CV_2 - DI_2 \quad$ ...(2)

also $\quad V_2 = -I_2 R_L \quad$ ...(3)

From (1) and (2) we get

Thus $$\frac{V_1}{I_1} = \frac{AV_2 - BI_2}{CV_2 - DI_2}$$

Substituting value of V_2 from (3) we get

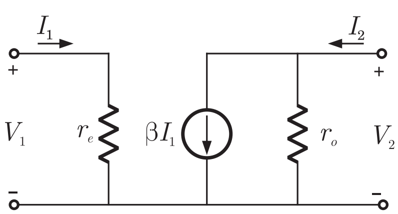
Input Impedance $$Z_{in} = \frac{-A \times I_2 R_L - BI_2}{-C \times I_2 R_L - DI_2}$$

or $$Z_{in} = \frac{AR_L + B}{CR_L + D}$$

Hence (D) is correct option.

SOL 2.35

The circuit is as shown below.



At input port $\quad V_1 = r_e I_1$

At output port $\quad V_2 = r_0(I_2 - \beta I_1) = -r_0 \beta I_1 + r_0 I_2$

Comparing standard equation

$$V_1 = z_{11} I_1 + z_{12} I_2$$

$$V_2 = z_{21} I_1 + z_{22} I_2$$

$$z_{12} = 0 \text{ and } z_{21} = -r_0 \beta$$

Hence (B) is correct option.

SOL 2.36

For series RC network input impedance is

$$Z_{ins} = \frac{1}{sC} + R = \frac{1 + sRC}{sC}$$

Thus pole is at origin and zero is at $-\frac{1}{RC}$

For parallel RC network input impedance is

$$Z_{in} = \frac{\frac{1}{sC} R}{\frac{1}{sC} + R} = \frac{sC}{1 + sRC}$$

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Thus pole is at $-\frac{1}{RC}$ and zero is at infinity.

Hence (B) is correct option.

SOL 2.37

We know $$v = \frac{Ldi}{dt}$$

Taking laplace transform we get

$$V(s) = sLI(s) - Li(0^+)$$

As per given in question

$$-Li(0^+) = -1 \text{ mV}$$

Thus $$i(0^+) = \frac{1 \text{ mV}}{2 \text{ mH}} = 0.5 \text{ A}$$

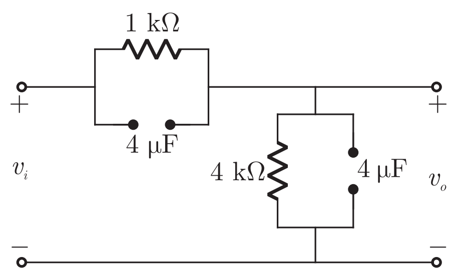
Hence (A) is correct option.

SOL 2.38

At initial all voltage are zero. So output is also zero.

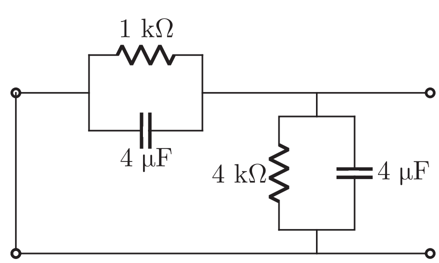
Thus $$v_0(0^+) = 0$$

At steady state capacitor act as open circuit.



Thus, $$v_0(\infty) = \frac{4}{5} \times v_i = \frac{4}{5} \times 10 = 8$$

The equivalent resistance and capacitance can be calculate after killing all source



$$R_{eq} = 1 \| 4 = 0.8 \text{ k}\Omega$$

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$$C_{eq} = 4 \| 1 = 5\ \mu\text{F}$$
$$\tau = R_{eq}C_{eq} = 0.8\text{k}\Omega \times 5\mu\text{F} = 4\ \text{ms}$$
$$v_0(t) = v_0(\infty) - [v_0(\infty) - v_0(0^+)]\,e^{-t/\tau}$$
$$= 8 - (8 - 0)\,e^{-t/0.004}$$
$$v_0(t) = 8(1 - e^{-t/0.004})\ \text{Volts}$$

Hence (B) is correct option.

SOL 2.39

Here $\quad Z_2(s) = R_{neg} + Z_1(s)$

or $\quad Z_2(s) = R_{neg} + \text{Re}\,Z_1(s) + j\text{Im}\,Z_1(s)$

For $Z_2(s)$ to be positive real, $\text{Re}\,Z_2(s) \geq 0$

Thus $\quad R_{neg} + \text{Re}\,Z_1(s) \geq 0$

or $\quad \text{Re}\,Z_1(s) \geq -R_{neg}$

But R_{neg} is negative quantity and $-R_{neg}$ is positive quantity. Therefore

$$\text{Re}\,Z_1(s) \geq |R_{neg}|$$

or $\quad |R_{neg}| \leq \text{Re}\,Z_1(j\omega) \qquad$ For all ω.

Hence (A) is correct option.

SOL 2.40

Transfer function is

$$\frac{Y(s)}{U(s)} = \frac{\frac{1}{sC}}{R + sL + \frac{1}{sC}} = \frac{1}{s^2LC + scR + 1} = \frac{\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$$

Comparing with $s^2 + 2\xi\omega_n s + \omega_n^2 = 0$ we have

Here $\quad 2\xi\omega_n = \frac{R}{L},$

and $\quad \omega_n = \frac{1}{\sqrt{LC}}$

Thus $\quad \xi = \frac{R}{2L}\sqrt{LC} = \frac{R}{2}\sqrt{\frac{C}{L}}$

For no oscillations, $\xi \geq 1$

Thus $\quad \frac{R}{2}\sqrt{\frac{C}{L}} \geq 1$

or $\quad R \geq 2\sqrt{\frac{L}{C}}$

Hence (C) is correct option.

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SOL 2.41

For given transformer

$$\frac{I_2}{I_1} = \frac{V_1}{V_2} = \frac{n}{1}$$

or $$I_1 = \frac{I_2}{n} \text{ and } V_1 = nV_2$$

Comparing with standard equation

$$V_1 = AV_2 + BI_2$$
$$I_1 = CV_2 + DI_2$$
$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} n & 0 \\ 0 & \frac{1}{n} \end{bmatrix}$$

Thus $$x = \frac{1}{n}$$

Hence (B) is correct option.

SOL 2.42

We have $L = 1H$ and $C = \frac{1}{400} \times 10^{-6}$

Resonant frequency

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = = \frac{1}{2\pi\sqrt{1 \times \frac{1}{400} \times 10^{-6}}}$$
$$= \frac{10^3 \times 20}{2\pi} = \frac{10^4}{\pi} \text{ Hz}$$

Hence (B) is correct option.

SOL 2.43

Maximum power will be transferred when $R_L = R_s = 100\Omega$

In this case voltage across R_L is 5 V, therefore

$$P_{\max} = \frac{V^2}{R} = \frac{5 \times 5}{100} = 0.25 \text{ W}$$

Hence (C) is correct option.

SOL 2.44

For stability poles and zero interlace on real axis. In RC series network the driving point impedance is

$$Z_{ins} = R + \frac{1}{Cs} = \frac{1 + sRC}{sC}$$

Here pole is at origin and zero is at $s = -1/RC$, therefore first critical frequency is a pole and last critical frequency is a zero.

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For RC parallel network the driving point impedance is

$$Z_{inp} = \frac{R\frac{1}{Cs}}{R + \frac{1}{Cs}} = \frac{R}{1 + sRC}$$

Here pole is $s = -1/RC$ and zero is at ∞, therefore first critical frequency is a pole and last critical frequency is a zero.
Hence (C) is correct option.

SOL 2.45

Applying KCL we get

$$i_1(t) + 5\angle 0^\circ = 10\angle 60^\circ$$

or $$i_1(t) = 10\angle 60^\circ - 5\angle 0^\circ = 5 + 5\sqrt{3j} - 5$$

or $$i_1(t) = 5\sqrt{3}\angle 90^\circ = \frac{10}{2}\sqrt{3}\angle 90^\circ$$

Hence (A) is correct option.

SOL 2.46

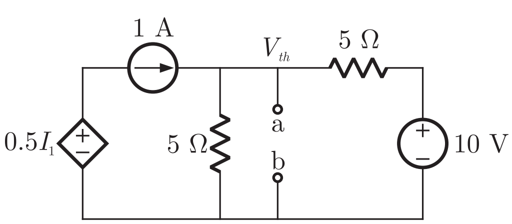
If $L_1 = j5\Omega$ and $L_3 = j2\Omega$ the mutual induction is subtractive because current enters from dotted terminal of $j2\Omega$ coil and exit from dotted terminal of $j5\Omega$. If $L_2 = j2\Omega$ and $L_3 = j2\Omega$ the mutual induction is additive because current enters from dotted terminal of both coil.

Thus $$Z = L_1 - M_{13} + L_2 + M_{23} + L_3 - M_{31} + M_{32}$$
$$= j5 + j10 + j2 + j10 + j2 - j10 + j10 = j9$$

Hence (B) is correct option.

SOL 2.47

Open circuit at terminal ab is shown below



Applying KCL at node we get

$$\frac{V_{ab}}{5} + \frac{V_{ab} - 10}{5} = 1$$

or $$V_{ab} = 7.5 = V_{th}$$

Short circuit at terminal ab is shown below

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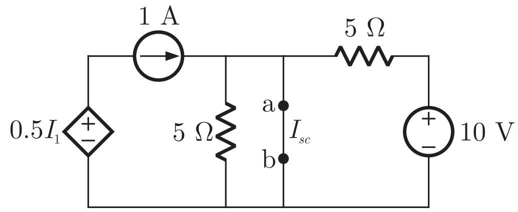

Short circuit current from terminal ab is

$$I_{sc} = 1 + \frac{10}{5} = 3 \text{ A}$$

Thus $$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{7.5}{3} = 2.5\,\Omega$$

Here current source being in series with dependent voltage source make it ineffective.
Hence (B) is correct option.

SOL 2.48

Here $V_a = 5$ V because $R_1 = R_2$ and total voltage drop is 10 V.

Now $$V_b = \frac{R_3}{R_3 + R_4} \times 10 = \frac{1.1}{2.1} \times 10 = 5.238 \text{ V}$$

$$V = V_a - V_b = 5 - 5.238 = -0.238 \text{ V}$$

Hence (C) is correct option.

SOL 2.49

For h parameters we have to write V_1 and I_2 in terms of I_1 and V_2.

$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$

Applying KVL at input port

$$V_1 = 10 I_1 + V_2$$

Applying KCL at output port

$$\frac{V_2}{20} = I_1 + I_2$$

or $$I_2 = -I_1 + \frac{V_2}{20}$$

Thus from above equation we get

$$\begin{bmatrix} h_{11} & h_{12} \\ h_{12} & h_{22} \end{bmatrix} = \begin{bmatrix} 10 & 1 \\ -1 & 0.05 \end{bmatrix}$$

Hence (D) is correct option.

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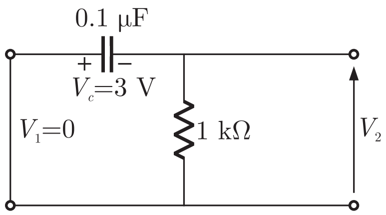
SOL 2.50

Time constant $RC = 0.1 \times 10^{-6} \times 10^{3} = 10^{-4}$ sec

Since time constant RC is very small, so steady state will be reached in 2 sec. At $t = 2$ sec the circuit is as shown in fig.



$$V_c = 3 \text{ V}$$
$$V_2 = - V_c = - 3 \text{ V}$$

Hence (B) is correct option.

SOL 2.51

For a tree there must not be any loop. So a, c, and d don't have any loop. Only b has loop.

Hence (B) is correct option.

SOL 2.52

The sign of M is as per sign of L If current enters or exit the dotted terminals of both coil. The sign of M is opposite of L If current enters in dotted terminal of a coil and exit from the dotted terminal of other coil.

Thus $$L_{eq} = L_1 + L_2 - 2M$$

Hence (D) is correct option.

SOL 2.53

Here $\omega = 2$ and $V = 1\angle 0^\circ$

$$Y = \frac{1}{R} + j\omega C + \frac{1}{j\omega L}$$
$$= 3 + j2 \times 3 + \frac{1}{j2 \times \frac{1}{4}} = 3 + j4$$
$$= 5\angle \tan^{-1}\frac{4}{3} = 5\angle 53.11^\circ$$
$$I = V * Y = (1\angle 0^\circ)(5\angle 53.1^\circ) = 5\angle 53.1^\circ$$

Thus $$i(t) = 5\sin(2t + 53.1^\circ)$$

Hence (A) is correct option.

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SOL 2.54

$$v_i(t) = \sqrt{2}\sin 10^3 t$$

Here $\omega = 10^3$ rad and $V_i = \sqrt{2}\angle 0^\circ$

Now
$$V_0 = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}}.V_t = \frac{1}{1 + j\omega CR}V_i$$
$$= \frac{1}{1 + j\times 10^3 \times 10^{-3}}\sqrt{2}\angle 0^\circ$$
$$= 1\angle -45^\circ$$
$$v_0(t) = \sin(10^3 t - 45^\circ)$$

Hence (A) is correct option.

SOL 2.55

Input voltage $\quad v_i(t) = u(t)$

Taking laplace transform $\quad V_i(s) = \frac{1}{s}$

Impedance $\quad Z(s) = s + 2$

$$I(s) = \frac{V_i(s)}{s+2} = \frac{1}{s(s+2)}$$

or
$$I(s) = \frac{1}{2}\left[\frac{1}{s} - \frac{1}{s+2}\right]$$

Taking inverse laplace transform

$$i(t) = \frac{1}{2}(1 - e^{-2t})\,u(t)$$

At $t = 0$, $\quad i(t) = 0$

At $t = \frac{1}{2}$, $\quad i(t) = 0.31$

At $t = \infty$, $\quad i(t) = 0.5$

Graph (C) satisfies all these conditions.

Hence (C) is correct option.

SOL 2.56

We know that

$$V_1 = z_{11}I_1 + z_{12}I_2$$
$$V_2 = z_{11}I_1 + z_{22}I_2$$

where
$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2 = 0}$$
$$z_{21} = \left.\frac{V_2}{I_1}\right|_{I_1 = 0}$$

Consider the given lattice network, when $I_2 = 0$. There is two similar

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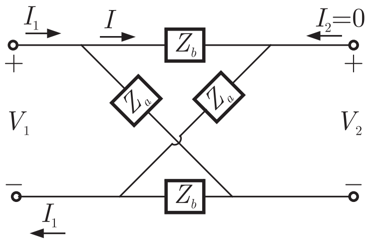
path in the circuit for the current I_1. So $I = \frac{1}{2} I_1$



For z_{11} applying KVL at input port we get

$$V_1 = I(Z_a + Z_b)$$

Thus $$V_1 = \frac{1}{2} I_1 (Z_a + Z_b)$$

$$z_{11} = \frac{1}{2}(Z_a + Z_b)$$

For Z_{21} applying KVL at output port we get

$$V_2 = Z_a \frac{I_1}{2} - Z_b \frac{I_1}{2}$$

Thus $$V_2 = \frac{1}{2} I_1 (Z_a - Z_b)$$

$$z_{21} = \frac{1}{2}(Z_a - Z_b)$$

For this circuit $z_{11} = z_{22}$ and $z_{12} = z_{21}$. Thus

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} \frac{Z_a + Z_b}{2} & \frac{Z_a - Z_b}{2} \\ \frac{Z_a - Z_b}{2} & \frac{Z_a + Z_b}{2} \end{bmatrix}$$

Here $Z_a = 2j$ and $Z_b = 2\Omega$

Thus $$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} 1+j & j-1 \\ j-1 & 1+j \end{bmatrix}$$

Hence (D) is correct option.

SOL 2.57

Applying KVL,

$$v(t) = Ri(t) + \frac{Ldi(t)}{dt} + \frac{1}{C}\int_0^{\infty} i(t)\,dt$$

Taking L.T. on both sides,

$$V(s) = RI(s) + LsI(s) - Li(0^+) + \frac{I(s)}{sC} + \frac{v_c(0^+)}{sC}$$

$$v(t) = u(t) \text{ thus } V(s) = \frac{1}{s}$$

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Hence $$\frac{1}{s} = I(s) + sI(s) - 1 + \frac{I(s)}{s} - \frac{1}{s}$$

$$\frac{2}{s} + 1 = \frac{I(s)}{s}[s^2 + s + 1]$$

or $$I(s) = \frac{s+2}{s^2 + s + 1}$$

Hence (B) is correct option.

SOL 2.58

Characteristics equation is

$$s^2 + 20s + 10^6 = 0$$

Comparing with $s^2 + 2\xi\omega_n s + \omega_n^2 = 0$ we have

$$\omega_n = \sqrt{10^6} = 10^3$$

$$2\xi\omega = 20$$

Thus $$2\xi = \frac{20}{10^3} = 0.02$$

Now $$Q = \frac{1}{2\xi} = \frac{1}{0.02} = 50$$

Hence (B) is correct option.

SOL 2.59

$$H(s) = \frac{V_0(s)}{V_i(s)}$$

$$= \frac{\frac{1}{sC}}{R + sL + \frac{1}{sC}} = \frac{1}{s^2 LC + sCR + 1}$$

$$= \frac{1}{s^2(10^{-2} \times 10^{-4}) + s(10^{-4} \times 10^4) + 1}$$

$$= \frac{1}{10^{-6}s^2 + s + 1} = \frac{10^6}{s^2 + 10^6 s + 10^6}$$

Hence (D) is correct option.

SOL 2.60

Impedance of series RLC circuit at resonant frequency is minimum, not zero. Actually imaginary part is zero.

$$Z = R + j\left(\omega L - \frac{1}{\omega C}\right)$$

At resonance $\omega L - \frac{1}{\omega C} = 0$ and $Z = R$ that is purely resistive. Thus S_1 is false

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Now quality factor $Q = R\sqrt{\frac{C}{L}}$

Since $G = \frac{1}{R}$, $\qquad Q = \frac{1}{G}\sqrt{\frac{C}{L}}$

If $G\uparrow$ then $Q\downarrow$ provided C and L are constant. Thus S_2 is also false.
Hence (D) is correct option.

SOL 2.61

$$\text{Number of loops} = b - n + 1$$
$$= \text{minimum number of equation}$$
$$\text{Number of branches} = b = 8$$
$$\text{Number of nodes} = n = 5$$

Minimum number of equation

$$= 8 - 5 + 1 = 4$$

Hence (B) is correct option.

SOL 2.62

For maximum power transfer

$$Z_L = Z_S^* = R_s - jX_s$$

Thus $\qquad Z_L = 1 - 1j$

Hence (C) is correct option.

SOL 2.63

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

When R, L and C are doubled,

$$Q' = \frac{1}{2R}\sqrt{\frac{2L}{2C}} = \frac{1}{2R}\sqrt{\frac{L}{C}} = \frac{Q}{2}$$

Thus $\qquad Q' = \frac{100}{2} = 50$

Hence (B) is correct option.

SOL 2.64

Applying KVL we get,

$$\sin t = Ri(t) + L\frac{di(t)}{dt} + \frac{1}{C}\int i(t)\,dt$$

or $\qquad \sin t = 2i(t) + 2\frac{di(t)}{dt} + \int i(t)\,dt$

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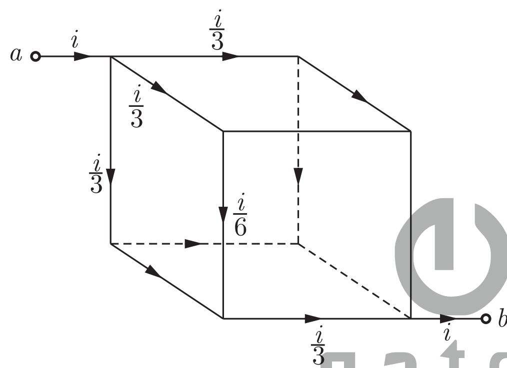
Differentiating with respect to t, we get

$$\cos t = \frac{2di(t)}{dt} + \frac{2d^2 i(t)}{dt^2} + i(t)$$

Hence (C) is correct option.

SOL 2.65

For current i there is 3 similar path. So current will be divide in three path



so, we get

$$V_{ab} - \left(\frac{i}{3} \times 1\right) - \left(\frac{i}{6} \times 1\right) - \left(\frac{1}{3} \times 1\right) = 0$$

$$\frac{V_{ab}}{i} = R_{eq} = \frac{1}{3} + \frac{1}{6} + \frac{1}{3} = \frac{5}{6}\,\Omega$$

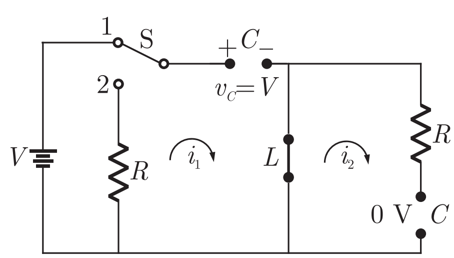
Hence (A) is correct option.

SOL 2.66

Data are missing in question as $L_1 \& L_2$ are not given.

SOL 2.67

At $t = 0^-$ circuit is in steady state. So inductor act as short circuit and capacitor act as open circuit.



At $t(0^-)$

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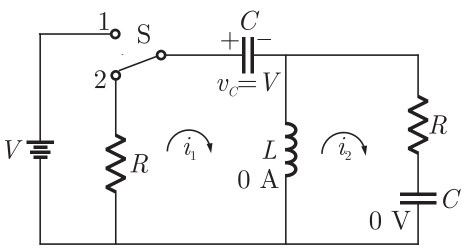
At $t = 0^-$, $\quad i_1(0^-) = i_2(0^-) = 0$

$v_c(0^-) = V$

At $t = 0^+$ the circuit is as shown in fig. The voltage across capacitor and current in inductor can't be changed instantaneously. Thus



At $t(0^+)$

At $t = 0^+$, $\quad i_1 = i_2 = -\frac{V}{2R}$

Hence (A) is correct option.

SOL 2.68

When switch is in position 2, as shown in fig in question, applying KVL in loop (1),

$$RI_1(s) + \frac{V}{s} + \frac{1}{sC}I_1(s) + sL[I_1(s) - I_2(s)] = 0$$

or $$I_1(s)\left[R + \frac{1}{sc} + sL\right] - I_2(s)\,sL = \frac{-V}{s}$$

$$z_{11}I_1 + z_{12}I_2 = V_1$$

Applying KVL in loop 2,

$$sL[I_2(s) - I_1(s)] + RI_2(s) + \frac{1}{sC}I_2(s) = 0$$

$$Z_{12}I_1 + Z_{22}I_2 = V_2$$

or $$-sLI_1(s) + \left[R + sL + \frac{1}{sc}\right]I_2(s) = 0$$

Now comparing with

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

we get

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

Hence (C) is correct option.

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SOL 2.69

$$\text{Zeros} = -3$$
$$\text{Pole}_1 = -1 + j$$
$$\text{Pole}_2 = -1 - j$$
$$Z(s) = \frac{K(s+3)}{(s+1+j)(s+1-j)}$$
$$= \frac{K(s+3)}{(s+1)^2 - j^2} = \frac{K(s+3)}{(s+1)^2 + 1}$$

From problem statement $Z(0)|_{\omega=0} = 3$

Thus $\frac{3K}{2} = 3$ and we get $K = 2$

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

Hence (B) is correct option.

SOL 2.70

$$v(t) = \underbrace{10\sqrt{2}\cos(t + 10^\circ)}_{v_1} + \underbrace{10\sqrt{5}\cos(2t + 10^\circ)}_{v_2}$$

Thus we get $\omega_1 = 1$ and $\omega_2 = 2$

Now
$$Z_1 = R + j\omega_1 L = 1 + j1$$
$$Z_2 = R + j\omega_2 L = 1 + j2$$
$$i(t) = \frac{v_1(t)}{Z_1} + \frac{v_2(t)}{Z_2}$$
$$= \frac{10\sqrt{2}\cos(t + 10^\circ)}{1 + j} + \frac{10\sqrt{5}\cos(2t + 10^\circ)}{1 + j2}$$
$$= \frac{10\sqrt{2}\cos(t + 10^\circ)}{\sqrt{1^2 + 2^2}\angle\tan^{-1}1} + \frac{10\sqrt{5}\cos(2t + 10^\circ)}{\sqrt{1^2 + 2^2}\tan^{-1}2}$$
$$= \frac{10\sqrt{2}\cos(t + 10^\circ)}{\sqrt{2}\angle\tan^{-1}45^\circ} + \frac{10\sqrt{5}\cos(2t + 10^\circ)}{\sqrt{5}\tan^{-1}2}$$
$$i(t) = 10\cos(t - 35^\circ) + 10\cos(2t + 10^\circ - \tan^{-1}2)$$

Hence (C) is correct option.

SOL 2.71

Using $\Delta - Y$ conversion

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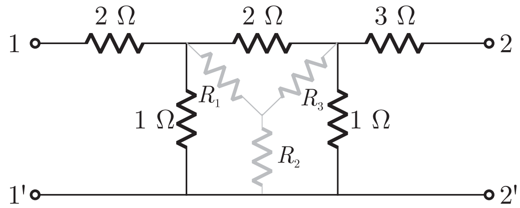
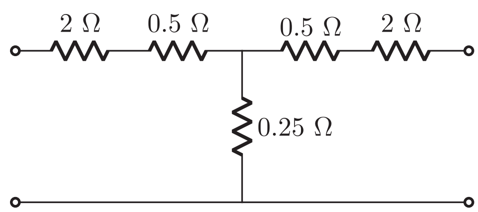


$$R_1 = \frac{2\times 1}{2+1+1} = \frac{2}{4} = 0.5$$

$$R_2 = \frac{1\times 1}{2+1+1} = \frac{1}{4} = 0.25$$

$$R_3 = \frac{2\times 1}{2+1+1} = 0.5$$

Now the circuit is as shown in figure below.



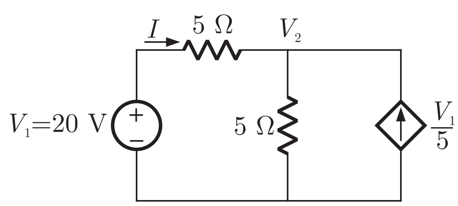
Now $$z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} = 2+0.5+0.25 = 2.75$$

$$z_{12} = R_3 = 0.25$$

Hence (A) is correct option.

SOL 2.72

Applying KCL at for node 2,



$$\frac{V_2}{5} + \frac{V_2 - V_1}{5} = \frac{V_1}{5}$$

or $$V_2 = V_1 = 20 \text{ V}$$

Voltage across dependent current source is 20 thus power delivered by it is

$$P V_2 \times \frac{V_1}{5} = 20\times\frac{20}{5} = 80 \text{ W}$$

It deliver power because current flows from its +ive terminals.

Hence (A) is correct option.

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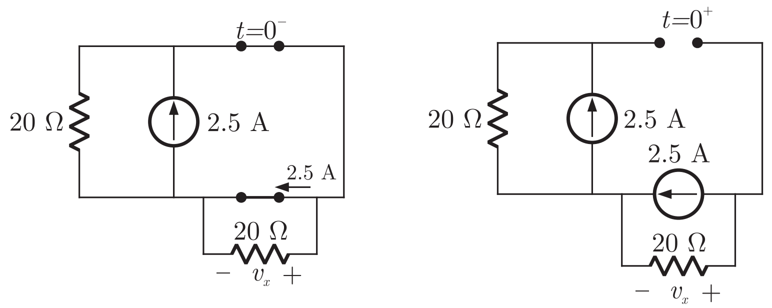
SOL 2.73

When switch was closed, in steady state, $i_L(0^-) = 2.5$ A



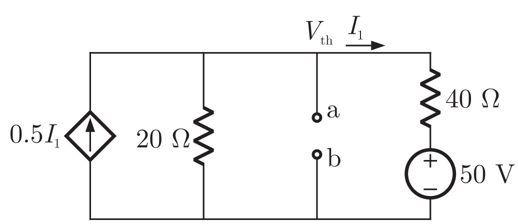
At $t = 0^+$, $i_L(0^+) = i_L(0^-) = 2.5$ A and all this current of will pass through 2 Ω resistor. Thus

$$V_x = -2.5 \times 20 = -50 \text{ V}$$

Hence (C) is correct option.

SOL 2.74

For maximum power delivered, R_L must be equal to R_{th} across same terminal.



Applying KCL at Node, we get

$$0.5I_1 = \frac{V_{th}}{20} + I_1$$

or $$V_{th} + 10I_1 = 0$$

but $$I_1 = \frac{V_{th} - 50}{40}$$

Thus $$V_{th} + \frac{V_{th} - 50}{4} = 0$$

or $$V_{th} = 10 \text{ V}$$

For I_{sc} the circuit is shown in figure below.

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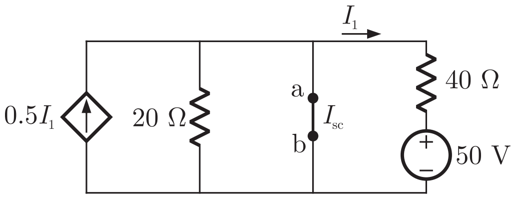

$$I_{sc} = 0.5I_1 - I_1 = -0.5I_1$$

but $$I_1 = -\frac{50}{40} = -1.25 \text{ A}$$

$$I_{sc} = -0.5 \times -12.5 = 0.625 \text{ A}$$

$$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{10}{0.625} = 16\,\Omega$$

Hence (A) is correct option.

SOL 2.75

$I_P, V_P \rightarrow$ Phase current and Phase voltage
$I_L, V_L \rightarrow$ Line current and line voltage

Now $$V_P = \left(\frac{V_L}{\sqrt{3}}\right) \text{ and } I_P = I_L$$

So, $$\text{Power} = 3\,V_P\,I_L\cos\theta$$

$$1500 = 3\left(\frac{V_L}{\sqrt{3}}\right)(I_L)\cos\theta$$

also $$I_L = \left(\frac{V_L}{\sqrt{3}\,Z_L}\right)$$

$$1500 = 3\left(\frac{V_L}{\sqrt{3}}\right)\left(\frac{V_L}{\sqrt{3}\,Z_L}\right)\cos\theta$$

$$Z_L = \frac{(400)^2(.844)}{1500} = 90\,\Omega$$

As power factor is leading

So, $$\cos\theta = 0.844 \rightarrow \theta = 32.44$$

As phase current leads phase voltage

$$Z_L = 90\angle -\theta = 90\angle -32.44^\circ$$

Hence (D) is correct option.

SOL 2.76

Applying KCL, we get

$$\frac{e_0 - 12}{4} + \frac{e_0}{4} + \frac{e_0}{2+2} = 0$$

or $$e_0 = 4 \text{ V}$$

Hence (C) is correct option.

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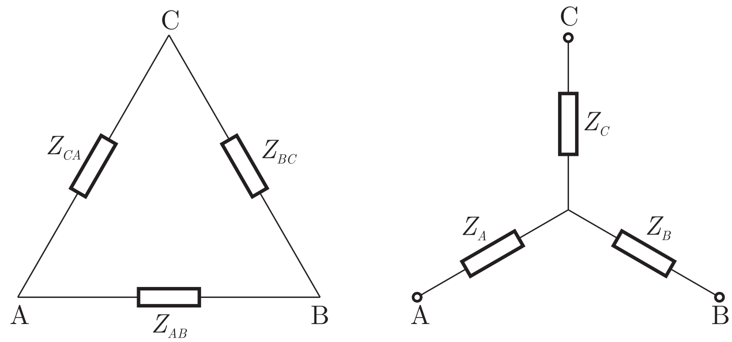
SOL 2.77

The star delta circuit is shown as below



Here $$Z_{AB} = Z_{BC} = Z_{CA} = \sqrt{3}\,Z$$

and $$Z_A = \frac{Z_{AB}Z_{CA}}{Z_{AB} + Z_{BC} + Z_{CA}}$$

$$Z_B = \frac{Z_{AB}Z_{BC}}{Z_{AB} + Z_{BC} + Z_{CA}}$$

$$Z_C = \frac{Z_{BC}Z_{CA}}{Z_{AB} + Z_{BC} + Z_{CA}}$$

Now $$Z_A = Z_B = Z_C = \frac{\sqrt{3}\,Z\sqrt{3}\,Z}{\sqrt{3}\,Z + \sqrt{3}\,Z + \sqrt{3}\,Z} = \frac{Z}{\sqrt{3}}$$

Hence (A) is correct option.

SOL 2.78

$$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} = \begin{bmatrix} y_1 + y_3 & -y_3 \\ -y_3 & y_2 + y_3 \end{bmatrix}$$

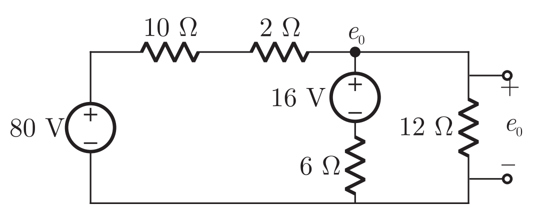
$$y_{12} = -y_3$$

$$y_{12} = -\frac{1}{20} = -0.05 \text{ mho}$$

Hence (C) is correct option.

SOL 2.79

We apply source conversion the circuit as shown in fig below.



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Now applying nodal analysis we have

$$\frac{e_0 - 80}{10+2} + \frac{e_0}{12} + \frac{e_0 - 16}{6} = 0$$

or
$$4e_0 = 112$$
$$e_0 = \frac{112}{4} = 28 \text{ V}$$

Hence (D) is correct option.

SOL 2.80

$$I_2 = \frac{E_m \angle 0^\circ}{R_2 + \frac{1}{j\omega C}} = E_m \angle 0^\circ \frac{j\omega C}{1 + j\omega C R_2}$$

$$\angle I_2 = \frac{\angle 90^\circ}{\angle \tan^{-1} \omega C R_2}$$

$$I_2 = \frac{E_m \omega C}{\sqrt{1 + \omega^2 C^2 R_2^2}} \angle (90^\circ - \tan^{-1} \omega C R_2)$$

At $\omega = 0$ $\qquad I_2 = 0$

and at $\omega = \infty$, $\qquad I_2 = \frac{E_m}{R_2}$

Only fig. given in option (A) satisfies both conditions.
Hence (A) is correct option.

SOL 2.81

$$X_s = \omega L = 10\,\Omega$$

For maximum power transfer

$$R_L = \sqrt{R_s^2 + X_s^2} = \sqrt{10^2 + 10^2} = 14.14\,\Omega$$

Hence (A) is correct option.

SOL 2.82

Applying KVL in LHS loop

$$E_1 = 2I_1 + 4(I_1 + I_2) - 10E_1$$

or
$$E_1 = \frac{6I_1}{11} + \frac{4I_2}{11}$$

Thus $z_{11} = \frac{6}{11}$

Applying KVL in RHS loop

$$E_2 = 4(I_1 + I_2) - 10E_1$$
$$= 4(I_1 + I_2) - 10\left(\frac{6I_1}{11} + \frac{4I_2}{11}\right)$$
$$= -\frac{16I_1}{11} + \frac{4I_2}{11}$$

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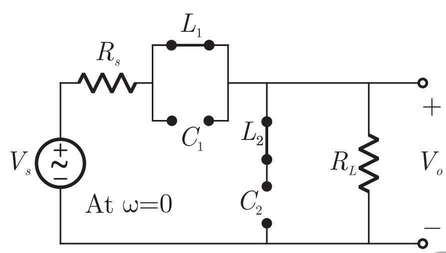
Thus $z_{21} = -\frac{16}{11}$

Hence (C) is correct option.

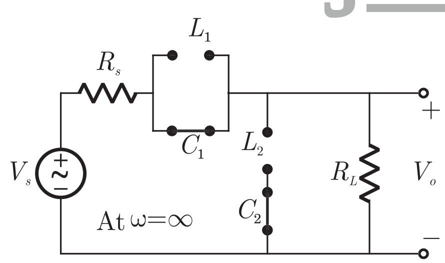
SOL 2.83

At $\omega = 0$, circuit act as shown in figure below.



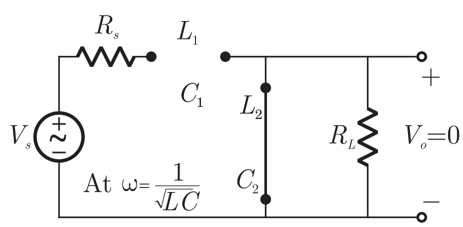
$$\frac{V_0}{V_s} = \frac{R_L}{R_L + R_s} \qquad \text{(finite value)}$$

At $w = \infty$, circuit act as shown in figure below:



$$\frac{V_0}{V_s} = \frac{R_L}{R_L + R_s} \qquad \text{(finite value)}$$

At resonant frequency $\omega = \sqrt{\frac{1}{LC}}$ circuit acts as shown in fig and $V_0 = 0$.



Thus it is a band reject filter.

Hence (D) is correct option.

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SOL 2.84

Applying KCL we get

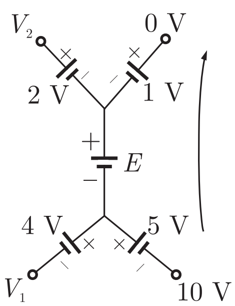
$$i_L = e^{at} + e^{bt}$$

Now $$V(t) = v_L = L\frac{di_L}{dt} = L\frac{d}{dt}[e^{at} + e^{bt}] = ae^{at} + be^{bt}$$

Hence (D) is correct option.

SOL 2.85

Going from 10 V to 0 V



$$10 + 5 + E + 1 = 0$$

or $$E = -16 \text{ V}$$

Hence (A) is correct option.

SOL 2.86

This is a reciprocal and linear network. So we can apply reciprocity theorem which states "Two loops A & B of a network N and if an ideal voltage source E in loop A produces a current I in loop B, then interchanging positions an identical source in loop B produces the same current in loop A. Since network is linear, principle of homogeneity may be applied and when volt source is doubled, current also doubles.

Now applying reciprocity theorem

$i = 2$ A for 10 V

$V = 10$ V, $i = 2$ A

$V = -20$ V, $i = -4$ A

Hence (C) is correct option.

SOL 2.87

Tree is the set of those branch which does not make any loop and

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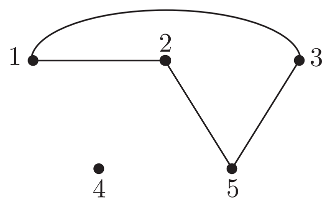
connects all the nodes.

abfg is not a tree because it contains a loop l node (4) is not connected

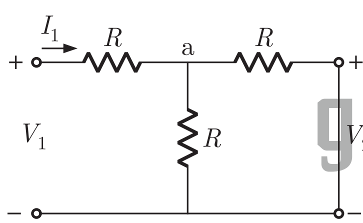


Hence (C) is correct option.

SOL 2.88

For a 2-port network the parameter h_{21} is defined as

$$h_{21} = \frac{I_2}{I_1}\bigg|_{V_2 = 0\,(\text{short circuit})}$$



Applying node equation at node a we get

$$\frac{V_a - V_1}{R} + \frac{V_a - 0}{R} + \frac{V_a - 0}{R} = 0$$

$$3\,V_a = V_1 \qquad \Rightarrow V_a = \frac{V_1}{3}$$

Now $\qquad I_1 = \frac{V_1 - V_a}{R} = \frac{V_1 - \frac{V_1}{3}}{R} = \frac{2\,V_1}{3R}$

and $\qquad I_2 = \frac{0 - V_a}{R} = \frac{0 - \frac{V_1}{3}}{R} = \frac{-\,V_1}{3R}$

Thus $\quad \frac{I_2}{I_1}\bigg|_{V_2 = 0} = h_{21} = \frac{-\,V_1/3R}{2\,V_1/3R} = \frac{-1}{2}$

Hence (A) is correct option.

SOL 2.89

Applying node equation at node A

$$\frac{V_{th} - 100\,(1 + j0)}{3} + \frac{V_{th} - 0}{4j} = 0$$

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$$\text{or} \quad 4jV_{th} - 4j100 + 3V_{th} = 0$$

$$\text{or} \quad V_{th}(3 + 4j) = 4j100$$

$$V_{th} = \frac{4j100}{3 + 4j}$$

By simplifying

$$V_{th} = \frac{4j100}{3 + 4j} \times \frac{3 - 4j}{3 - 4j}$$

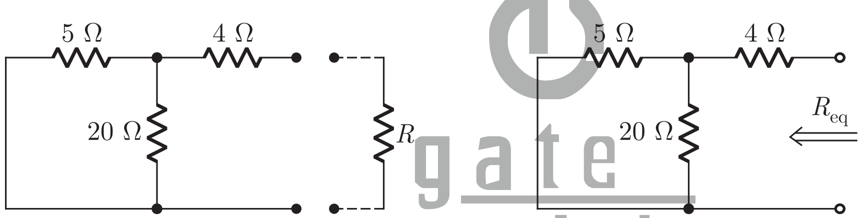
$$V_{th} = 16j(3 - j4)$$

Hence (A) is correct option.

SOL 2.90

For maximum power transfer R_L should be equal to R_{Th} at same terminal.

so, equivalent Resistor of the circuit is



$$R_{eq} = 5\Omega \parallel 20\Omega + 4\Omega$$

$$R_{eq} = \frac{5.20}{5 + 20} + 4 = 4 + 4 = 8\,\Omega$$

Hence (C) is correct option.

SOL 2.91

Delta to star conversion

$$R_1 = \frac{R_{ab}R_{ac}}{R_{ab} + R_{ac} + R_{bc}} = \frac{5 \times 30}{5 + 30 + 15} = \frac{150}{50} = 3\,\Omega$$

$$R_2 = \frac{R_{ab}R_{bc}}{R_{ab} + R_{ac} + R_{bc}} = \frac{5 \times 15}{5 + 30 + 15} = 1.5\,\Omega$$

$$R_3 = \frac{R_{ac}R_{bc}}{R_{ab} + R_{ac} + R_{bc}} = \frac{15 \times 30}{5 + 30 + 15} = 9\,\Omega$$

Hence (D) is correct option.

SOL 2.92

No. of branches $= n + l - 1 = 7 + 5 - 1 = 11$

Hence (C) is correct option.

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SOL 2.93

In nodal method we sum up all the currents coming & going at the node So it is based on KCL. Furthermore we use ohms law to determine current in individual branch. Thus it is also based on ohms law.
Hence (B) is correct option.

SOL 2.94

Superposition theorem is applicable to only linear circuits.
Hence (A) is correct option.

SOL 2.95

Hence (B) is correct option.

SOL 2.96

For reciprocal network $y_{12} = y_{21}$ but here $y_{12} = -\frac{1}{2} \neq y_{21} = \frac{1}{2}$. Thus circuit is non reciprocal. Furthermore only reciprocal circuit are passive circuit.
Hence (B) is correct option.

SOL 2.97

Taking b as reference node and applying KCL at a we get

$$\frac{V_{ab} - 1}{2} + \frac{V_{ab}}{2} = 3$$

or $$V_{ab} - 1 + V_{ab} = 6$$

or $$V_{ab} = \frac{6+1}{2} = 3.5 \text{ V}$$

Hence (C) is correct option.

SOL 2.98

Hence (A) is correct option.

SOL 2.99

The given figure is shown below.

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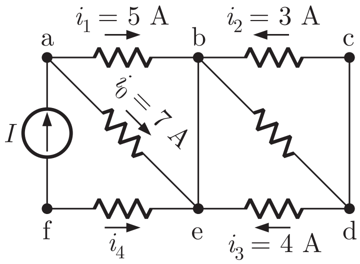


Applying KCL at node a we have

$$I = i_0 + i_1 = 7 + 5 = 12 \text{ A}$$

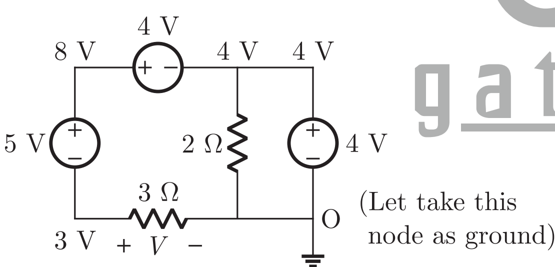
Applying KCL at node f

$$I = - i_4$$

so $\quad i_4 = - 12 \text{ amp}$

Hence (B) is correct option.

SOL 2.100



so $\quad V = 3 - 0 = 3 \text{ volt}$

Hence (A) is correct option.

SOL 2.101

Can not determined V without knowing the elements in box.
Hence (D) is correct option.

SOL 2.102

The voltage V is the voltage across voltage source and that is 10 V.
Hence (A) is correct option.

SOL 2.103

Voltage across capacitor

$$V_C(t) = V_C(\infty) + (V_C(0) - V_C(\infty))\, e^{\frac{-t}{RC}}$$

Here $V_C(\infty) = 10$ V and $(V_C(0) = 6$ V. Thus

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$$V_C(t) = 10 + (6-10)\,e^{\frac{-t}{RC}} = 10 - 4e^{\frac{-t}{RC}} = 10 - 4e^{\frac{-t}{8}}$$

Now $\quad V_R(t) = 10 - V_C(t)$

$$= 10 - 10 + 4e^{\frac{-t}{RC}} = 4e^{\frac{-t}{RC}}$$

Energy absorbed by resistor

$$E \int_0^{\infty} \frac{V_R^2(t)}{R} = \int_0^{\infty} \frac{16e^{\frac{-t}{4}}}{4} = \int_0^{\infty} 4e^{\frac{-t}{4}} = 16 \text{ J}$$

Hence (B) is correct option.

SOL 2.104

It is a balanced whetstone bridge

$$\left(\frac{R_1}{R_2} = \frac{R_3}{R_4}\right)$$

so equivalent circuit is

$$Z_{eq} = (4\Omega \parallel 8\Omega) = \frac{4\times 8}{4+8} = \frac{8}{3}$$

Hence (B) is correct option.

SOL 2.105

Current in A_2, $\quad I_2 = 3\,\text{amp}$

Inductor current can be defined as $I_2 = -3j$

Current in A_3, $\quad I_3 = 4$

Total current $\quad I_1 = I_2 + I_3$

$$I_1 = 4 - 3j$$

$$|I| = \sqrt{(4)^2 + (3)^2} = 5\,\text{amp}$$

Hence (B) is correct option.

SOL 2.106

For a tree we have $(n-1)$ branches. Links are the branches which from a loop, when connect two nodes of tree.

so if total no. of branches $= b$

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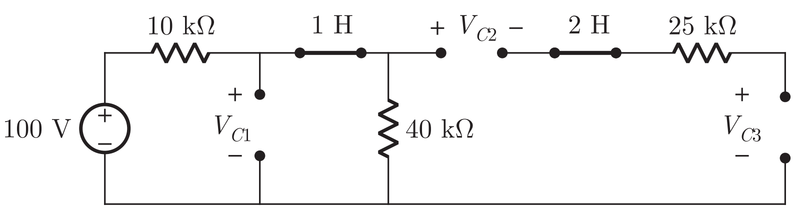
No. of links $= b - (n-1) = b - n + 1$

Total no. of links in equal to total no. of independent loops.

Hence (C) is correct option.

SOL 2.107

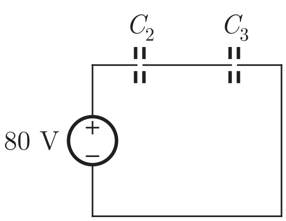
In the steady state condition all capacitors behaves as open circuit & Inductors behaves as short circuits as shown below :



Thus voltage across capacitor C_1 is

$$V_{C_1} = \frac{100}{10+40} \times 40 = 80 \text{ V}$$

Now the circuit faced by capacitor C_2 and C_3 can be drawn as below :



Voltage across capacitor C_2 and C_3 are

$$V_{C_2} = 80\frac{C_3}{C_2 + C_3} = 80 \times \frac{3}{5} = 48 \text{ volt}$$

$$V_{C_3} = 80\frac{C_2}{C_2 + C_3} = 80 \times \frac{2}{5} = 32 \text{ volt}$$

Hence (B) is correct option.

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