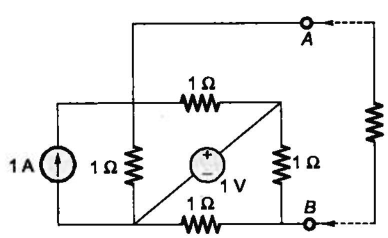
5 Network Theorems

Multiple Choice Questions

Q.1 **Assertion (A):** The Norton's equivalent of a given network is the dual of its Thevenin's equivalent.
Reason (R): The Thevenin's and Norton's equivalents of a given network are derivable only when the given network is linear.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R true but R is NOT a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true **[ESE-1996]**

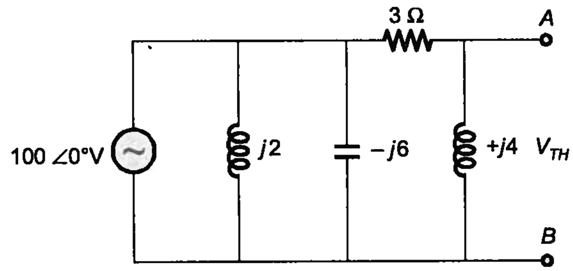
Q.2 In a linear network, a 1 Ω resistor consumes a power of 4 W when voltage source of 4 V is applied to the entire circuit, and 16 W when the voltage source is replaced by an 8 V source. The power consumed by the 1 Ω resistor when 12 V is applied will be
(a) 0 W (b) 20 W
(c) 36 W (d) 144 W **[ESE-2012]**

Q.3 If a resistance 'R' of 1 Ω is connected across the terminals AB as shown in the given figure, then the current flowing through R will be



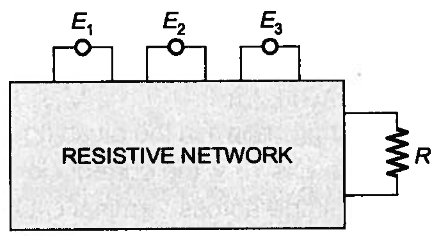
(a) 1 A (b) 0.5 A
(c) 0.25 A (d) 0.125 A **[ESE-1999]**

Q.4 The Thevenin equivalent voltage V_{TH} appearing between the terminals A and B of the network shown in the figure is given by



(a) $j16(3-j4)$ (b) $j16(3+j4)$
(c) $16(3+j4)$ (d) $16(3-j4)$
[GATE-1999]

Q.5 In the circuit shown in the figure below, the power consumed in the resistance R is measured when one source is acting at a time, these values are 18 W, 50 W and 98 W. When all the sources are acting simultaneously, the possible maximum and minimum values of power in R will be



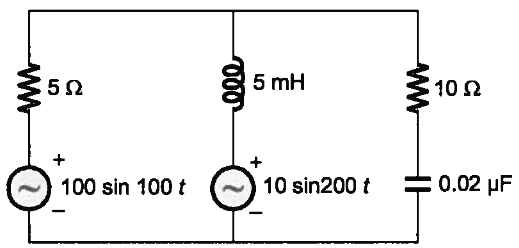
(a) 98 W and 18 W (b) 166 W and 18 W
(c) 450 W and 2 W (d) 166 W and 2 W
[ESE-2000]

Q.6 In a two-terminal network, the open-circuit voltage measured at the given terminals by an electronic voltmeter is 100 V. A short-circuit current measured at the same terminals by an ammeter of negligible resistance is 5 A. If a load resistor of 80 Ω is connected at the same terminals, then the current in the load resistor will be

(a) 1 A (b) 1.25 A
(c) 6 A (d) 6.25 A

[ESE-2000]

Q.7 Which one of the following theorems can be conveniently used to calculate the power consumed by the 10 Ω resistor in the network shown in the figure below?



(a) Thevenin's theorem
(b) Maximum power transfer theorem
(c) Millman's theorem
(d) Superposition theorem [ESE-2000]

Q.8 Use the data of the figure (a). The current i in the circuit of the figure (b)

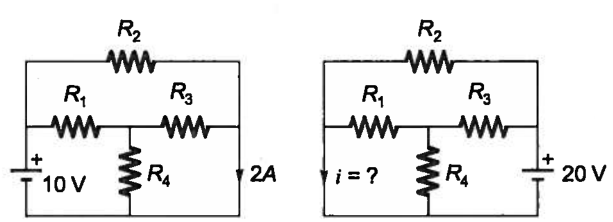
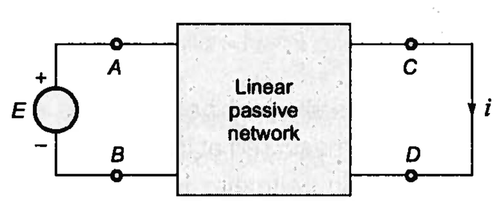


Fig. (a) Fig. (b)

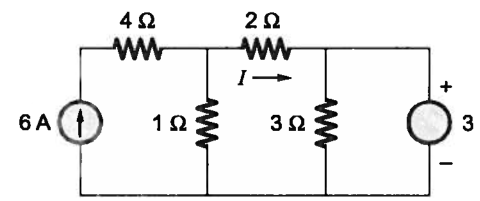
(a) –2 A (b) 2 A
(c) –4 A (d) +4 A [GATE-2000]

Q.9 For the circuit shown in the given figure, when the voltage E is 10 V, the current i is 1 A. If the applied voltage across terminal C-D is 100 V, the short circuit current flowing through the terminal A-B will be



(a) 0.1 A (b) 1 A
(c) 10 A (d) 100 A [ESE-2001]

Q.10 For the circuit shown in the given figure the current I is given by



(a) 3 A (b) 2 A
(c) 1 A (d) zero [ESE-2001]

Q.11 An input voltage

$v(t) = 10\sqrt{2}\cos(t + 10°) + 10\sqrt{5}\cos(2t + 10°)$V

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

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

(b) $10\cos(t + 55°) + 10\sqrt{\frac{3}{2}}\cos(2t + 55)$

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

(d) $10\cos(t - 35) + 10\sqrt{\frac{3}{2}}\cos(2t - 35°)$

Q.12 The Norton's equivalent of circuit shown in Figure-I is drawn in the circuit shown in Figure-II. The value of I_{SC} and R_{eq} in Figure II are respectively

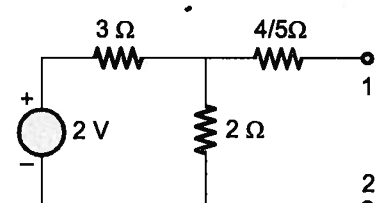


Figure-I

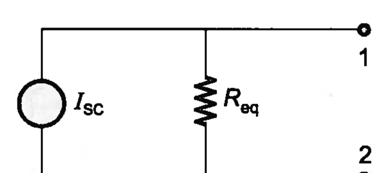
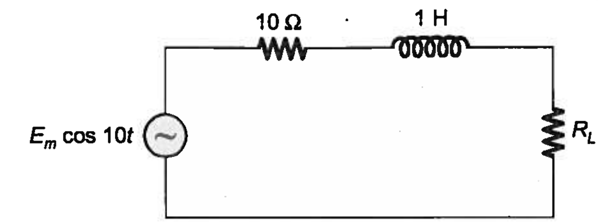


Figure-I

(a) 5/2 A and 2Ω
(b) 2/5 A and 1Ω
(c) 4/5 A and 12/5 Ω
(d) 2/5 A and 2 Ω [ESE-2001]

Q.13 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

[GATE-2001]

Q.14 Consider the following statements associated with the superposition theorem:

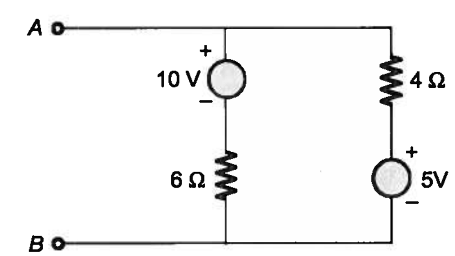
1. It is applicable to d.c. circuits only
2. It can be used to determine the current in a branch or voltage across a branch
3. It is applicable to networks consisting of more than one source
4. It is applicable to networks consisting of linear and bilateral elements

Which of these statements are correct?

(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 3, 4 and 1 (d) 4, 1 and 2

[ESE-2002]

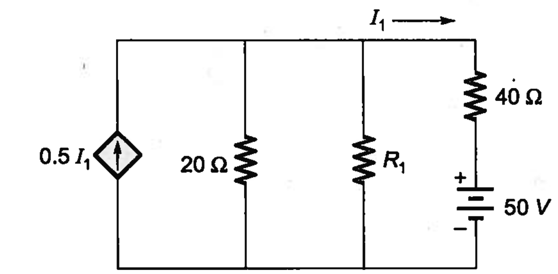
Q.15 In the circuit given below, viewed from AB, the circuit can be reduced to an equivalent circuit as



(a) 5 volt source in series with 10 Ω resistor
(b) 7 volt source in series with 2.4 Ω resistor
(c) 15 volt source in series with 2.4 Ω resistor
(d) 1 volt source in series with 10 Ω resistor

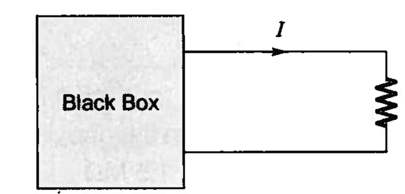
[ESE-2002]

Q.16 In the network of the figure, the maximum power is delivered to R_1 if its value is



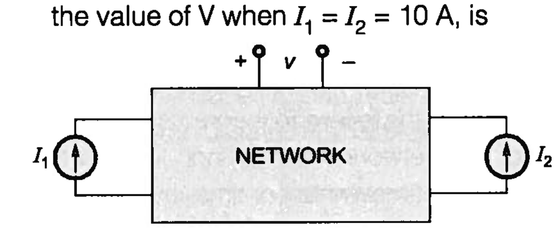
(a) 16 Ω (b) $\frac{40}{3}$ Ω
(c) 60 Ω (d) 20 Ω [GATE-2002]

Q.17 The black box as shown in the circuit below contains resistors and independent sources. For R = 0 Ω and 2 Ω, the value of current I is 3 A and 1.5 A respectively. The value of I for R = 1 Ω will be



(a) 0.5 A (b) 1.5 A
(c) 2.0 A (d) 3.0 A [ESE-2003]

Q.18 The linear network as shown below has only resistors. If I_1 = 8 A and I_2 = 12 A; V is found to be 80 V. V = 0 when I_1 = –8 A and I_2 = 4 A. Then the value of V when $I_1 = I_2$ = 10 A, is



(a) 25 V (b) 50 V
(c) 75 V (d) 100 V [ESE-2003]

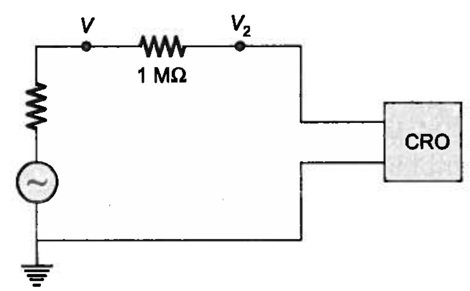
Q.19 A certain network consists of a large number of ideal linear resistances, one of which is designated as R and two constant ideal sources. The power consumed by R is P_1 when only the first source is active, and P_2 when only the second source is active. If both sources are active simultaneously, then the power consumed by R is

(a) $P_1 \pm P_2$ (b) $\sqrt{P_1} \pm \sqrt{P_2}$
(c) $\left(\sqrt{P_1} \pm \sqrt{P_2}\right)^2$ (d) $(P_1 \pm P_2)^2$

[ESE-2003]

Q.20 A source of angular frequency 1 rad/sec has a source impedance consisting of 1Ω resistance in series with 1H 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
[GATE-2003]

Q.21 Consider the following circuit:

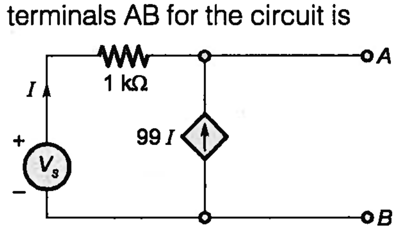


If V_1 = 5 V and V_2 = 3 V, then what is the input impedance of the CRO in the above circuit?
(a) 1 MΩ (b) 1.5 MΩ
(c) 3 MΩ (d) 5 MΩ **[ESE-2004]**

Q.22 If two identical 3 A, 4 Ω Norton equivalent circuits are connected in parallel with like polarity, the combined Norton equivalent circuit will be:
(a) 3 A, 8 Ω (b) 6 A, 8 Ω
(c) 0 A, 2 Ω (d) 6 A, 2 Ω
[ESE-2005]

Q.23 Which of the following theorems can be applied to any network-linear or non-linear, active or passive, time-variant or time-invariant?
(a) Thevenin theorem
(b) Norton theorem
(c) Tellegen theorem
(d) Superposition theorem **[ESE-2006]**

Q.24 Thevenin's equivalent resistance as seen from the terminals AB for the circuit is

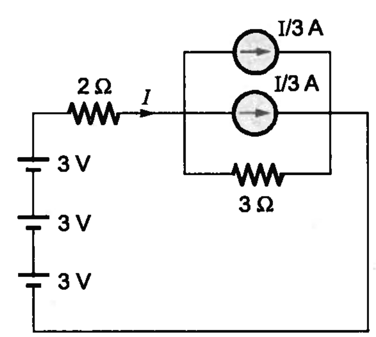


(a) 1 kΩ (b) 10 Ω
(c) 100 Ω (d) 10 kΩ **[ESE-2012]**

Q.25 Consider the following properties of a particular network theorem:
1. The theorem is not concerned with type of elements.
2. The theorem is only based on the two Kirchoff's laws.
3. The reference directions of the branch voltages and currents are arbitrary except that they have to satisfy Kirchoff's laws.

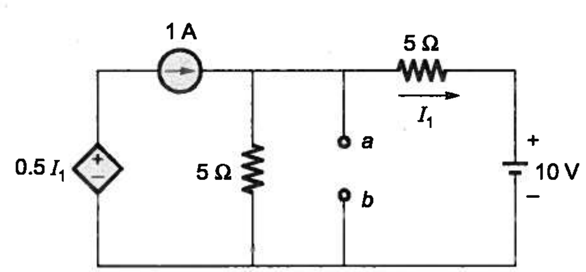
Which one of the following theorems has the above characteristics?
(a) Thevenin's theorem
(b) Norton's theorem
(c) Tellegen's theorem
(d) Superposition theorem **[ESE-2005]**

Q.26 In the circuit, the voltage across 3 Ω resistance is



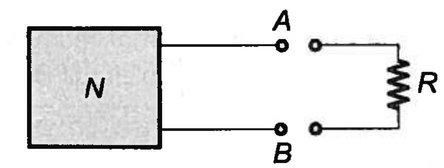
(a) 1 V (b) 3 V
(c) 6 V (d) 9 V
[ESE-2012]

Q.27 For the circuit shown in the figure, Thevenin's voltage and Thevenin's equivalent resistance at terminals a-b is



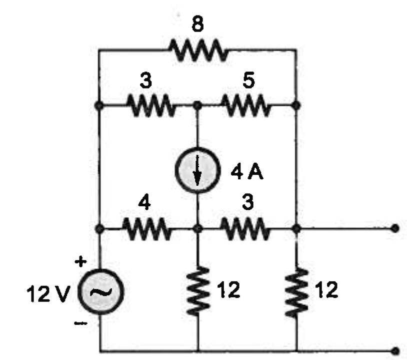
(a) 5 V and 2 Ω (b) 7.5 V and 2.5 Ω
(c) 4 V and 2 Ω (d) 3 V and 2.5 Ω
[GATE-2005]

Q.28 Norton equivalent to the network N to the left of AB is a current source I_N = 4 A from B to A, R_N = 2 Ω. The current through R when it is connected across AB = 2 A. What is the value of resistance R?



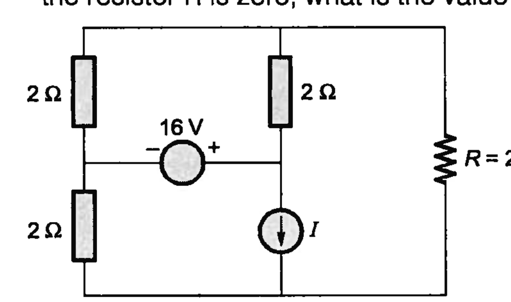
(a) 1 Ω (b) 2 Ω
(c) 3 Ω (d) 4 Ω **[ESE-2006]**

Q.29 What is the Thevenin resistance seen from the terminals AB of the circuit shown in the figure below?



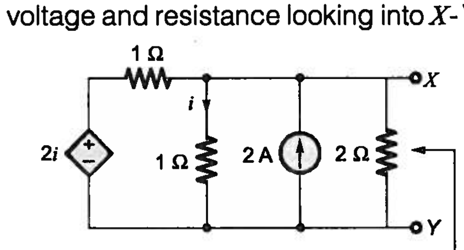
(a) 2 Ω (b) 4 Ω
(c) 8 Ω (d) 12 Ω **[ESE-2006]**

Q.30 In the circuit shown below, if the current through the resistor R is zero, what is the value of I?



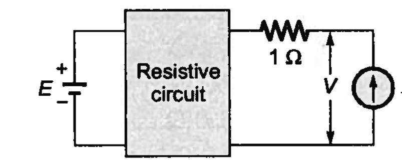
(a) 1 A (b) 2 A
(c) 3 A (d) 4 A **[ESE-2006]**

Q.31 For the circuit shown in the figure, the Thevenin voltage and resistance looking into X-Y are



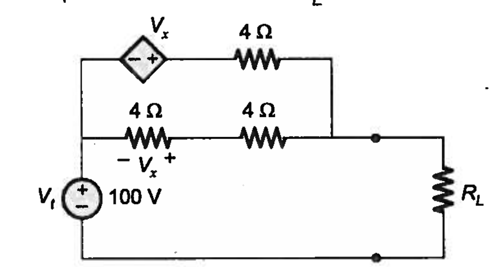
(a) 4/3 V, 2 Ω (b) 4 V, 2/3 Ω
(c) 4/3 V, 2/3 Ω (d) 4 V, 2 Ω
[GATE-2007]

Q.32 For the circuit as shown below, if $E = E_1$ and I is removed, then V = 5 volts. If E = 0 and I = 1 A, then V = 5 volts. For $E = E_1$ and I replaced by a resistor of 5 Ω, what is the value of V in volts?



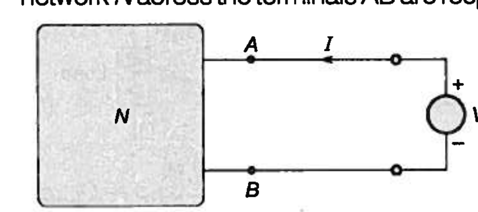
(a) 5.0 (b) 2.5
(c) 7.5 (d) 3.5 **[ESE-2009]**

Q.33 In the circuit shown, what value of R_L maximizes the power delivered to R_L?



(a) 2.4 Ω (b) $\frac{8}{3}$ Ω
(c) 4 Ω (d) None **[GATE-2009]**

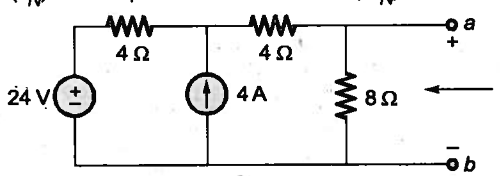
Q.34 For the network shown below I = (0.2 V−2) A, (I = the current delivered by the voltage source V). The Thevenin voltage V_{th} and resistance R_{th} for the network N across the terminals AB are respectively



(a) −10 V, 5 Ω (b) 10 V, 5 Ω
(c) −10 V, 0.2 Ω (d) 10 V, 0.2 Ω
[ESE-2010]

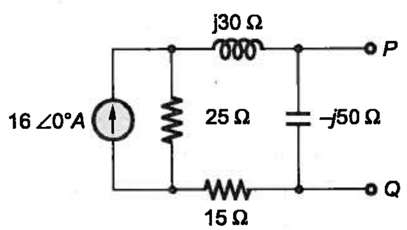
Q.35 A voltage source of 240 V having an internal impedance of (3 − j4) Ω is supplying power to a complex load impedance Z_1. What will be the maximum power transferred to the load?
(a) 2.4 kW (b) 3.6 kW
(c) 4.8 kW (d) 6.0 kW **[ESE-2010]**

Q.36 Applying Norton's Theorem, the Norton's equivalent circuit to the left of the terminals a and b in the below circuit is having equivalent current source (I_N) and equivalent resistance (R_N) as



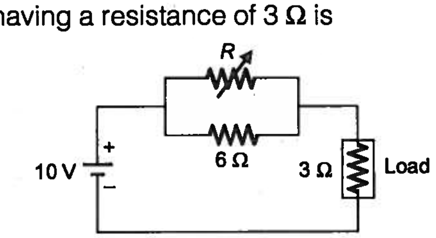
(a) $I_N = 5$ A; $R_N = 4\ \Omega$
(b) $I_N = 4$ A; $R_N = 60\ \Omega$
(c) $I_N = 9$ A; $R_N = 1.6\ \Omega$
(d) $I_N = 4$A; $R_N = 3.0\ \Omega$ **[ESE-2010]**

Q.37 In the circuit shown below, the Norton equivalent current in amperes with respect to the terminals *P* and *Q* is



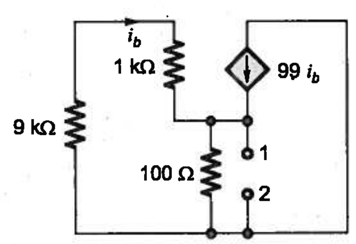
(a) $6.4 - j4.8$ (b) $6.56 - j7.87$
(c) $10 + j0$ (d) $16 + j0$
[GATE-2011]

Q.38 In the circuit given below, the value of *R* required for the transfer of maximum power to the load having a resistance of 3 Ω is



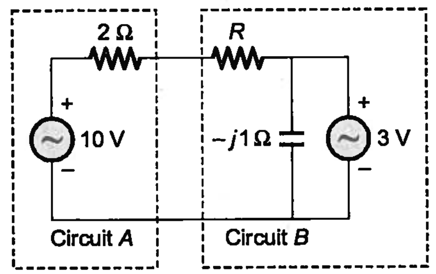
(a) zero (b) 3 Ω
(c) 6 Ω (d) infinity **[GATE-2011]**

Q.39 The impedance looking into nodes 1 and 2 in the given circuit is



(a) 50 Ω (b) 100 Ω
(c) 5 kΩ (d) 10.1 kΩ
[GATE-2012]

Q.40 Assuming both the voltage sources are in phase, the value of *R* for which maximum power is transferred from circuit *A* to circuit *B* is

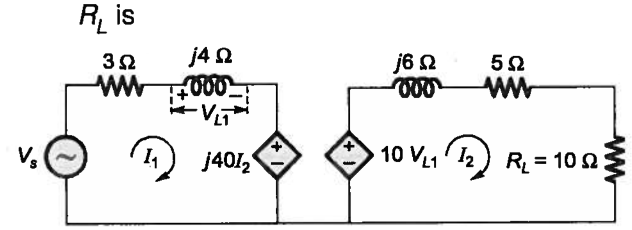


(a) 0.8 Ω (b) 1.4 Ω
(c) 2 Ω (d) 2.8 Ω
[GATE-2012]

Q.41 An AC source of voltage E_s and an internal impedance of $Z_s = (R_s + jX_s)$ is connected to a load of impedance $Z_L = (R_L + jX_L)$. Consider the following conditions in this regard:
1. $X_L = X_s$, if only X_L is varied.
2. $X_L = -X_s$ if only X_L is varied.
3. $R_L = \sqrt{\left[R_s^2 + (X_s + X_L)^2\right]}$, if only R_L is varied.
4. $|Z_L| = |Z_S|$, if the magnitude alone of Z_L is varied, keeping the phase angle fixed.

The valid conditions for maximum power transfer from the source to the load are
(a) 1, 2, 3 and 4 (b) 1, 2 and 3 only
(c) 1 and 4 only (d) 2, 3 and 4 only
[ESE-2013]

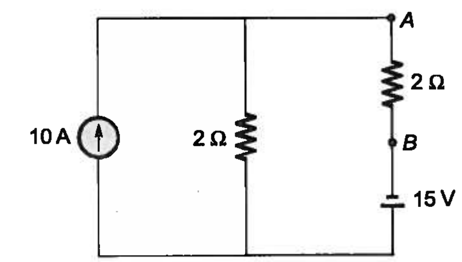
Q.42 In the circuit shown below, if the source voltage $V_s = 100\angle 53.13°$ V then the Thevenin's equivalent voltage in Volts as seen by the load resistance R_L is



(a) $100\angle 90°$ (b) $800\angle 0°$
(c) $800\angle 90°$ (d) $100\angle 60°$
[GATE-2013]

Q.43 A practical dc current source provides 20 kW to a 50 Ω load and 20 kW to a 200 Ω load. The maximum power that can be drawn from it, is
(a) 22.5 kW (b) 30.3 kW
(c) 40.5 kW (d) 45.0 kW
[ESE-2015]

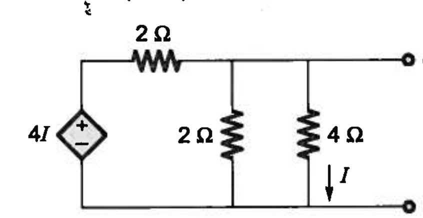
Q.44 The Thevenin equivalent voltage and resistance across *AB* shown in the figure respectively are



(a) 5 V and 5 Ω (b) 25 V and 3 Ω
(c) 35 V and 2 Ω (d) 25 V and 5 Ω
[ESE-2015]

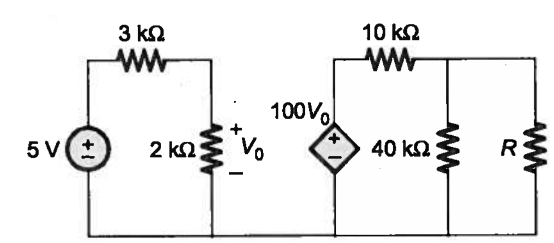
Numerical Data Type Questions

Q.45 In the circuit shown, the Norton equivalent resistance (in Ω) across terminals *a-b* is_____.



[GATE-2015]

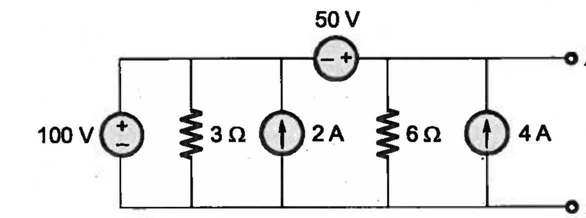
Q.46 In the circuit shown in the figure, the maximum power (in watt) delivered to the resistor *R* is _____



[GATE-2016]

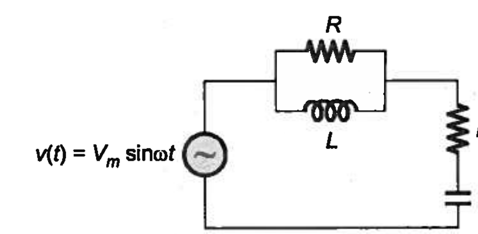
Try Yourself

T1. For the circuit shown. The Nortons equivalent circuit between terminals *A* and *B*



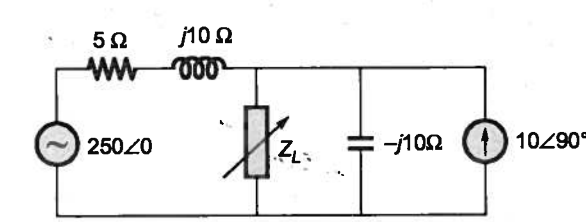
(a) 4 A, 2 Ω (b) 6 A, 2 Ω
(c) 4 A, 0 (d) Not exist

T2. In the network shown, the parallel combination of '*R*' and '*L*' constitute the internal impedance of the source where as series combination of *R* and *C* consitutes the impedance of the load. If load draws maximum power the value of R_1 and *C* interms of *R* and *L* are

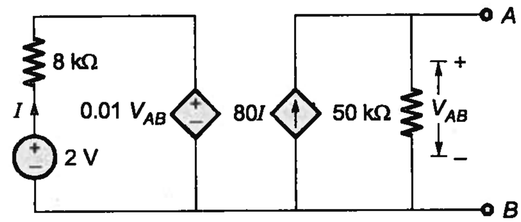


(a) $R_1 = \dfrac{R(\omega L)^2}{R^2 + (\omega L)^2}, C = \dfrac{R^2 + (\omega L)^2}{\omega^2 L R^2}$
(b) $R_1 = \dfrac{R^2(\omega L)^2}{(R\omega L)^2}, C = \dfrac{\omega^2 L^2 R^2}{R^2 + \omega^2 L^2}$
(c) $R_1 = \dfrac{R\omega L^2}{R^2 + (\omega L)^2}, C = \dfrac{R^2 + (\omega L)^2}{R^2 \omega^2 L}$
(d) $R_1 = \dfrac{R(\omega L)^2}{R^2 + (\omega L)^2}, C = \dfrac{R^2 + \omega L}{R^2 + \omega^2 L}$

T3. Find the maximum power absorbed by load

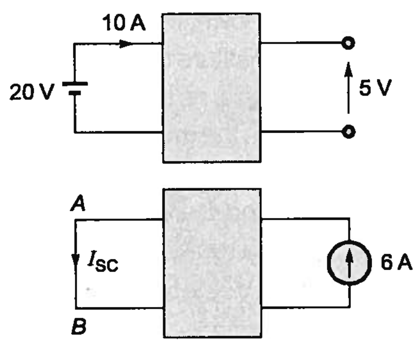


T4. Find 'V_{th}' with respect to A and B



(a) 222 V (b) 250 V
(c) 166.6 V (d) 200 V

T5. When given network satisfy the reciprocity. Find I_{sc} with respect to A and B



(a) 3 A (b) 1.5 A
(c) 2 A (d) None

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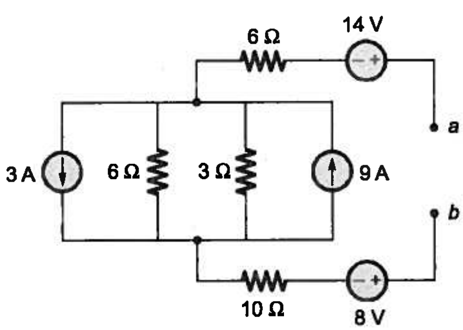
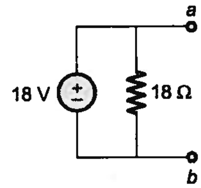
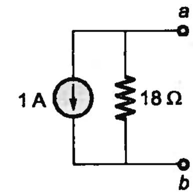
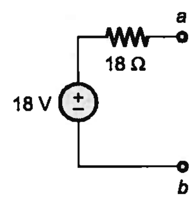
T6. Consider a circuit shown in the figure

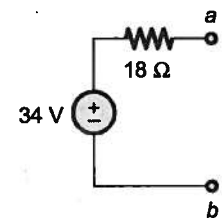


Which of the following circuit is equivalent to the above circuit?

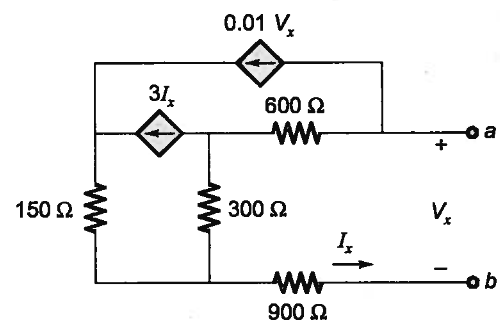
(a) 

(b) 

(c) 

(d) 

T7. In the following circuit the value of open circuit voltage and Thevenin resistance at terminals a, b are



(a) $V_{oc} = 100$ V, $R_{Th} = 1800\ \Omega$
(b) $V_{oc} = 0$ V, $R_{Th} = 270\ \Omega$
(c) $V_{oc} = 100$ V, $R_{Th} = 90\ \Omega$
(d) $V_{oc} = 0$ V, $R_{Th} = 90\ \Omega$