Network Theorems (Part II)-MCQs

1. If an impedance Z_L is connected across a voltage source V with source impedance Z_S, then for maximum power transfer, the load impedance must be equal to
   (a) source impedance Z_S
   (b) complex conjugate of Z_S
   (c) real part of Z_S
   (d) imaginary part of Z_S

[GATE 1988: 2 Marks]

Ans. (b)

According to maximum power transfer $Z_L = Z_S^*$

2. A load, $Z_L=R_L+jX_L$ is to be matched, using an ideal transformer, to a generator of internal impedance, $Z_S=R_S+jX_S$. The turns ration of the transformer required is
   (a) $\sqrt{|Z_L/Z_S|}$
   (b) $\sqrt{|R_L/R_S|}$
   (c) $\sqrt{|R_L/Z_S|}$
   (d) $\sqrt{|Z_L/R_S|}$

[GATE 1989: 2 Marks]

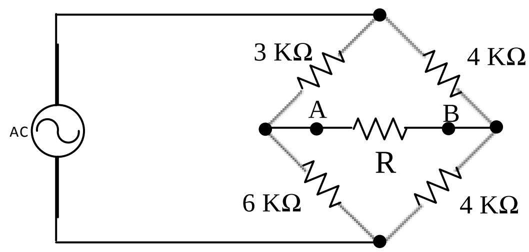
Ans. (a)

$$\frac{Z_L}{Z_S} = \left(\frac{n_2}{n_1}\right)^2$$

or

$$\frac{n_2}{n_1} = \sqrt{\frac{Z_L}{Z_S}}$$

3. The value of the resistance, R, connected across the terminals, A and B, (ref. Fig.) which will absorb the maximum power, is



(a) 4.00kΩ
(b) 4.11kΩ
(c) 8.00kΩ
(d) 9.00kΩ

[GATE 1995: 1 Mark]

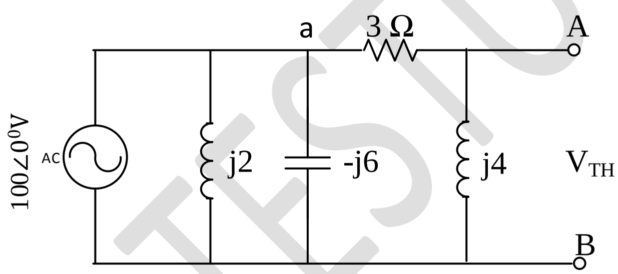
Ans. (a)

For maximum power transfer $R = R_{th}$ finding Thevenin's equivalent between point A, B replace voltage source by it's internal impedance

$$R_{th} = 3K \| 6K + 4K \| 4K$$

$$= 2K + 2K = 4K$$

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) j 16(3-j4)
(b) j 16(3+j4)
(c) 16(3+j4)
(d) 16(3-j4)

[GATE 1999: 2 Marks]

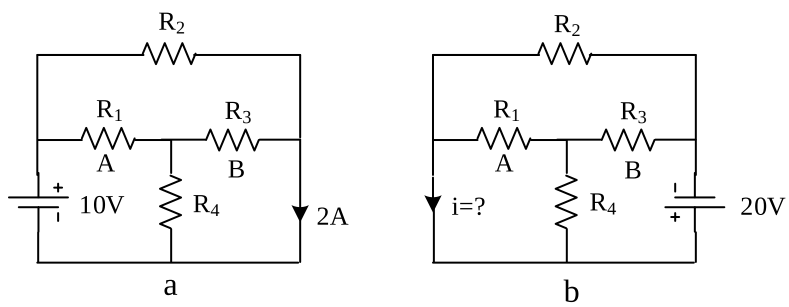
Ans. (a)

The voltage at the node a is $100\angle0^0$

$$V_{th} = \frac{100}{3+j4} \times j4 = \frac{100 \times j4(3-j4)}{25}$$

$$= j16(3-j4)$$

5. Use the data of the figure (a). The current I in the circuits of the figure (b)



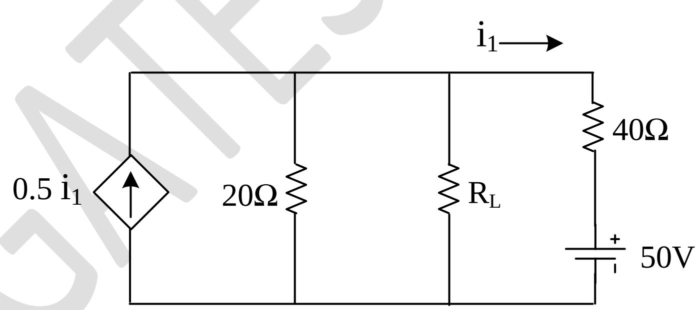
(a) -2 A
(b) 2 A
(c) -4 A
(d) +4 A

[GATE 2000: 2 Marks]

Ans. (c)

This is a reciprocal and linear network. According to reciprocity theorem, an ideal voltage source in loop A, produces current I in loop B. By interchanging the positions of voltage source and ammeter produces the same current in loop A. When voltage source is doubled and is negative current also doubles with opposite direction $i = -4A$

6. In the network of the figure, the maximum power is delivered to R_L if its value is

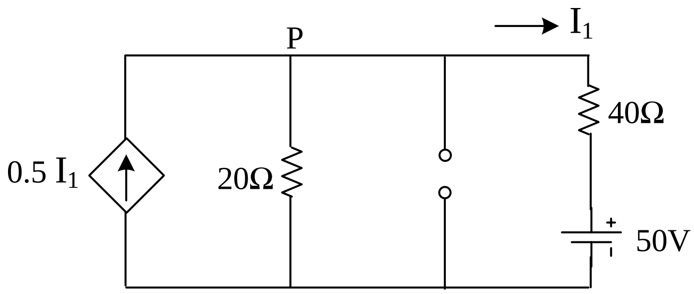


(a) 16 Ω
(b) 40/3 Ω
(c) 60 Ω
(d) 20 Ω

[GATE 2002: 2 Marks]

Ans. (a)

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



Writing KCL at node P, let V_{th} be the open circuit voltage

$$0.5\, I_1 = \frac{V_{th}}{20} + \frac{V_{th} - 50}{40} \qquad (i)$$

$$I_1 = \frac{V_{th} - 50}{40} \qquad (ii)$$

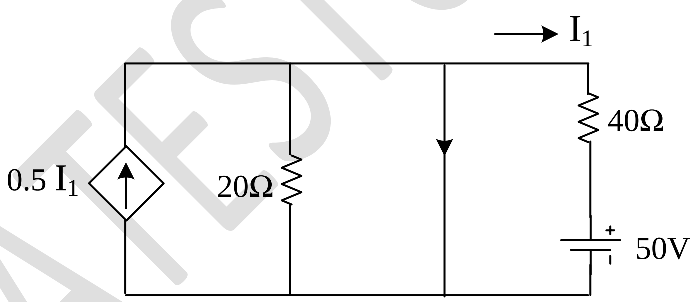
Solving equation (i) and (ii)

$V_{th} = 10V, \;\; I_1 = -1$

$R_{th} = \frac{V_{th}}{I_{SC}},$

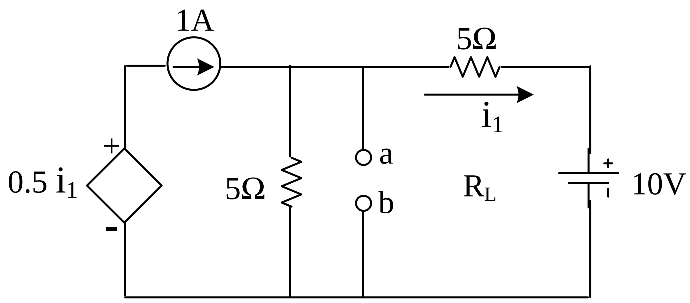
I_{SC} **is short circuit current when R_L is shorted**

$$I_{SC} = 0.5\, I_1 + \frac{50}{40} = 0.5(-1) + 1.25 = 0.625\, A$$



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

7. 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: 2 Marks]

Ans. (b)

$\boldsymbol{V_{th} = V_{ab}}$

KCL at node a

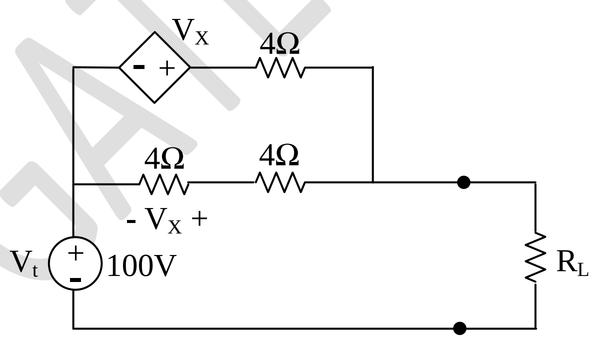
$$\frac{V_{ab}}{5} + \frac{V_{ab} - 10}{5} = 1$$

2 V_{ab} = 7.5

For R_{th} deactivate independent sources (10V, voltage source by zero impedance and 1A current source by open circuit)

$$R_{th} = 5\Omega \| 5\Omega = 2.5\Omega$$

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



(a) 2.4 Ω
(b) 8/3 Ω
(c) 4 Ω
(d) 6 Ω

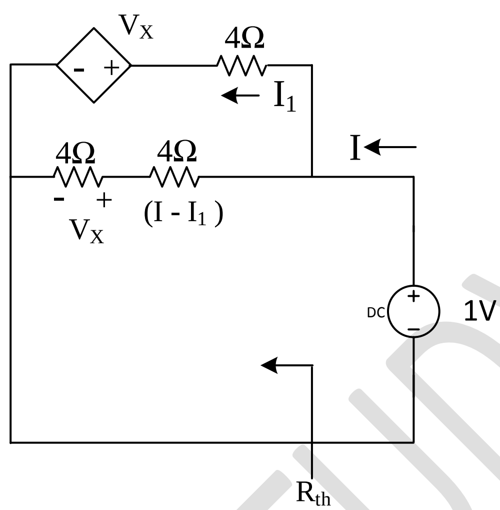
[GATE 2009: 2 Marks]

Ans. (c)

For maximum power delivered to R_L, $R_L = R_{th}$ of the network. (deactivate independent source V_i)

Removing R_L and connecting V_{test} = 1 volt supplying current I. then R_{th} = impedance looking into the network

$$= \frac{1\ volt}{I}$$



Using KVL in outer and inner 100p

$$1 = 4I_1 + V_X$$

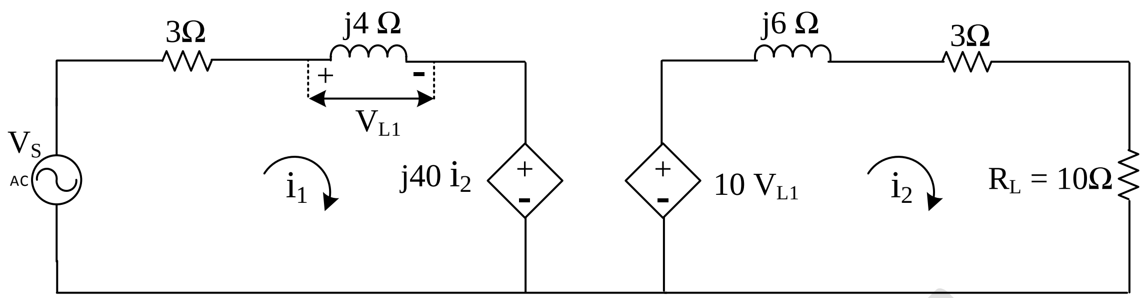
$$V_X = 4(I - I_1)$$

$$so, \quad 1 = 4I_1 + 4(I - I_1)$$

$$I = \frac{1}{4}$$

$$R_{th} = \frac{1}{I} = \frac{1}{1/4} = 4\Omega$$

9. In the circuit shown below, if the source voltage $V_S = 100 \angle 53.13^0$ V then the Thevenins's equivalent voltage in Volts as seen by load resistance R_L is



(a) $100\angle 90^0$

(b) $800\angle 0^0$

(c) $800\angle 90^0$

(d) $100\angle 60^0$

[GATE 2013: 2 Marks]

Ans. **(c)**

To find V_{th} or V_{oc} (open circuit voltage), detach R_L

$\boldsymbol{i_2 = 0}$, $\boldsymbol{V_{oc} = 10V_{L_1}}$

$\boldsymbol{i_2 = 0}$ **(dependent voltage source is zero),** $\boldsymbol{j40.\, i_2 = 0}$

$\boldsymbol{V_{L_1} = \frac{V_S}{3+j\,4} \times j\,4}$

$\boldsymbol{20 \times 4j}$

$\boldsymbol{V_{th} = 10\, V_{L_1} = 800\, \angle 90^0}$