

# 1.4

# Circuit Theorems

1.  $v_{TH}$ ,  $R_{TH}$  = ?

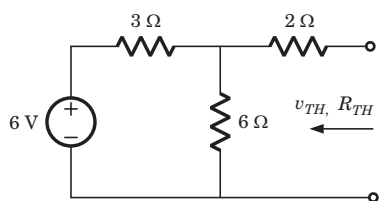


Fig. P.1.4.1

- (A) 2 V, 4 Ω                      (B) 4 V, 4 Ω  
 (C) 4 V, 5 Ω                      (D) 2 V, 5 Ω

2.  $i_N$ ,  $R_N$  = ?

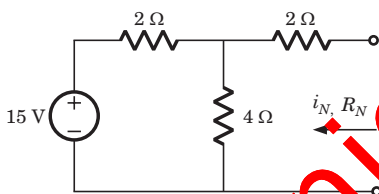


Fig. P.1.4.2

- (A) 3 A,  $\frac{10}{3}$  Ω                      (B) 10 A, 4 Ω  
 (C) 1.5 A, 6 Ω                      (D) 1.5 A, 4 Ω

3.  $v_{TH}$ ,  $R_{TH}$  = ?

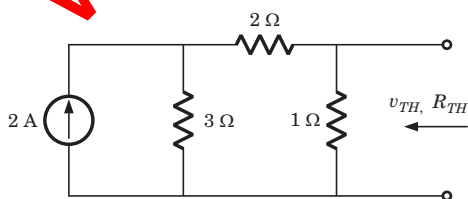


Fig. P.1.4.3

- (A) -2 V,  $\frac{6}{5}$  Ω                      (B) 2 V,  $\frac{5}{6}$  Ω

- (C) 1 V,  $\frac{5}{6}$  Ω                      (D) -1 V,  $\frac{6}{5}$  Ω

4. A simple equivalent circuit of the 2 terminal network shown in fig P.1.4.4 is

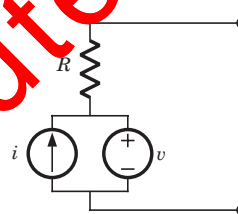
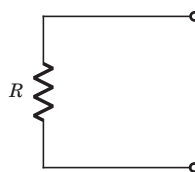
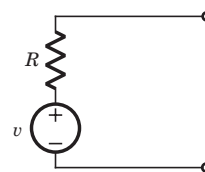


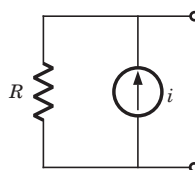
Fig. P.1.4.4



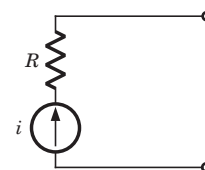
(A)



(B)



(C)



(D)

5.  $i_N$ ,  $R_N$  = ?

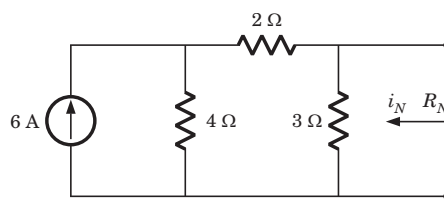


Fig. P.1.4.5

- (A) 4 A, 3 Ω                      (B) 2 A, 6 Ω  
 (C) 2 A, 9 Ω                      (D) 4 A, 2 Ω

6.  $v_{TH}, R_{TH} = ?$

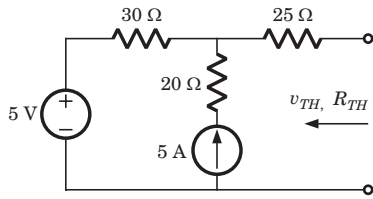


Fig. P.1.4.6

- (A) -100 V, 75 Ω
- (B) 155 V, 55 Ω
- (C) 155 V, 37 Ω
- (D) 145 V, 75 Ω

7.  $R_{TH} = ?$

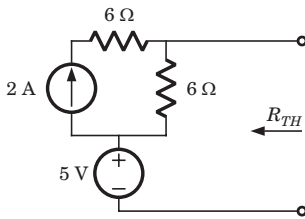


Fig. P.1.4.7

- (A) 3 Ω
- (B) 12 Ω
- (C) 6 Ω
- (D) ∞

8. The Thevenin impedance across the terminals  $ab$  of the network shown in fig. P.1.4.8 is

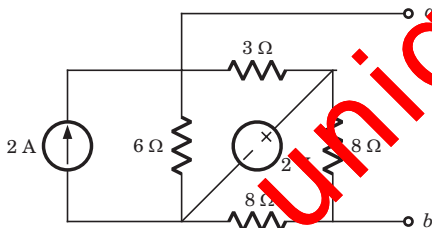


Fig. P.1.4.8

- (A) 2 Ω
- (B) 6 Ω
- (C) 6.16 Ω
- (D)  $\frac{4}{3}$  Ω

9. For In the the circuit shown in fig. P.1.4.9 a network and its Thevenin and Norton equivalent are given

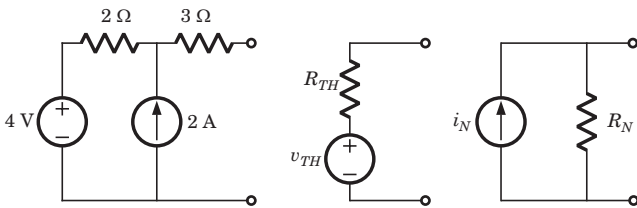


Fig. P.1.4.9

The value of the parameter are

$v_{TH}$	$R_{TH}$	$i_N$	$R_N$
(A) 4 V	2 Ω	2 A	2 Ω
(B) 4 V	2 Ω	2 A	3 Ω
(C) 8 V	1.2 Ω	$\frac{30}{3}$ A	1.2 Ω
(D) 8 V	5 Ω	$\frac{8}{5}$ A	5 Ω

10.  $v_1 = ?$

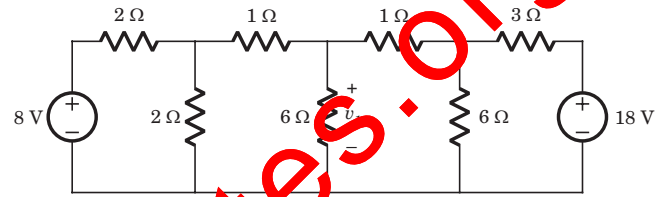


Fig. P.1.4.10

- (A) 6 V
- (B) 7 V
- (C) 8 V
- (D) 10 V

11.  $i_1 = ?$

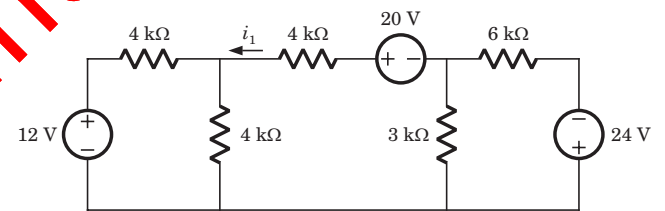


Fig. P.1.4.11

- (A) 3 A
- (B) 0.75 mA
- (C) 2 mA
- (D) 1.75 mA

**Statement for Q.12-13:**

A circuit is given in fig. P.1.4.12-13. Find the Thevenin equivalent as given in question..

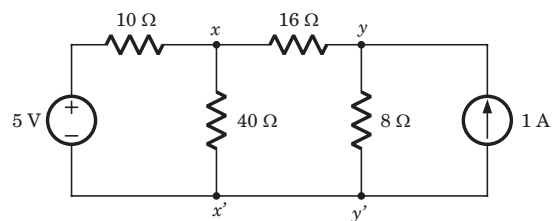


Fig. P.1.4.12-13

12. As viewed from terminal  $x$  and  $x'$  is

- (A) 8 V, 6 Ω
- (B) 5 V, 6 Ω
- (C) 5 V, 32 Ω
- (D) 8 V, 32 Ω

13. As viewed from terminal  $y$  and  $y'$  is

- (A) 8 V, 32  $\Omega$
- (B) 4 V, 32  $\Omega$
- (C) 5 V, 6  $\Omega$
- (D) 7 V, 6  $\Omega$

14. A practical DC current source provide 20 kW to a 50  $\Omega$  load and 20 kW to a 200  $\Omega$  load. The maximum power, that can drawn from it, is

- (A) 22.5 kW
- (B) 45 kW
- (C) 30.3 kW
- (D) 40 kW

**Statement for Q.15–16:**

In the circuit of fig. P.1.4.15–16 when  $R = 0 \Omega$ , the current  $i_R$  equals 10 A.

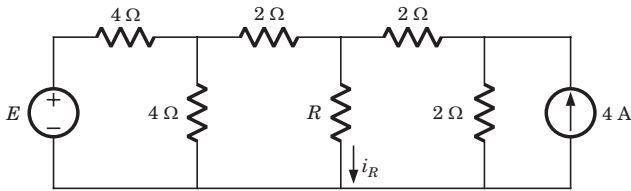


Fig. P.1.4.15–16.

15. The value of  $R$ , for which it absorbs maximum power, is

- (A) 4  $\Omega$
- (B) 3  $\Omega$
- (C) 2  $\Omega$
- (D) None of the above

16. The maximum power will be

- (A) 50 W
- (B) 100 W
- (C) 200 W
- (D) value of E is required

17. Consider a 24 V battery of internal resistance  $r = 4 \Omega$  connected to a variable resistance  $R_L$ . The rate of heat dissipated in the resistor is maximum when the current drawn from the battery is  $i$ . The current drawn from the battery will be  $i/2$  when  $R_L$  is equal to

- (A) 2  $\Omega$
- (B) 4  $\Omega$
- (C) 8  $\Omega$
- (D) 12  $\Omega$

18.  $i_N, R_N = ?$

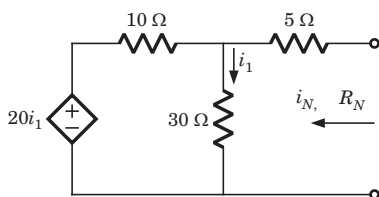


Fig. P.1.4.18

- (A) 2 A, 20  $\Omega$
- (B) 2 A, -20  $\Omega$

- (C) 0 A, 20  $\Omega$
- (D) 0 A, -20  $\Omega$

19.  $v_{TH}, R_{TH} = ?$

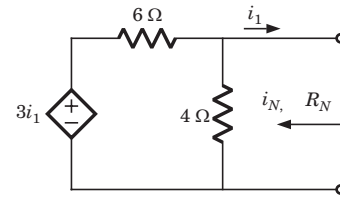


Fig. P.1.4.19

- (A) 0  $\Omega$
- (B) 1.2  $\Omega$
- (C) 2.4  $\Omega$
- (D) 3.6  $\Omega$

20.  $v_{TH}, R_{TH} = ?$

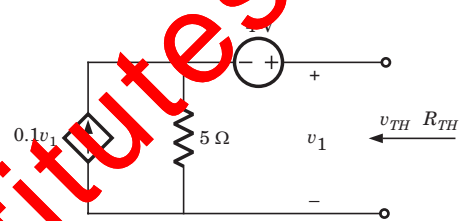


Fig. P.1.4.20

- (A) 8 V, 5  $\Omega$
- (B) 8 V, 10  $\Omega$
- (C) 4 V, 5  $\Omega$
- (D) 4 V, 10  $\Omega$

21.  $R_{TH} = ?$

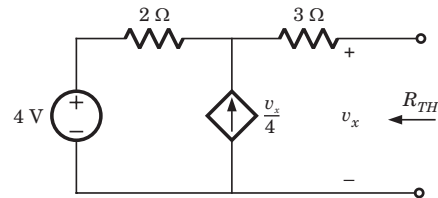


Fig. P.1.4.21

- (A) 3  $\Omega$
- (B) 1.2  $\Omega$
- (C) 5  $\Omega$
- (D) 10  $\Omega$

22. In the circuit shown in fig. P.1.4.22 the effective resistance faced by the voltage source is

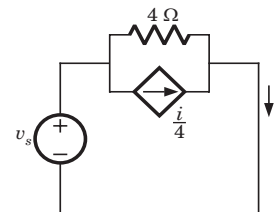


Fig. P.1.4.22

- (A) 4  $\Omega$
- (B) 3  $\Omega$
- (C) 2  $\Omega$
- (D) 1  $\Omega$

23. In the circuit of fig. P.1.4.23 the value of  $R_{TH}$  at terminal  $ab$  is

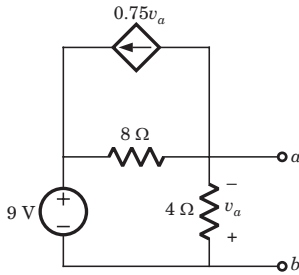


Fig. P.1.4.23

- (A)  $-3 \Omega$
- (B)  $\frac{9}{8} \Omega$
- (C)  $-\frac{8}{3} \Omega$
- (D) None of the above

24.  $R_{TH} = ?$

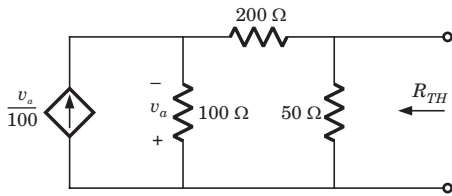


Fig. P.1.4.24

- (A)  $\infty$
- (B) 0
- (C)  $\frac{3}{125} \Omega$
- (D)  $\frac{125}{3} \Omega$

25. In the circuit of fig. P.1.4.25, the  $R_L$  will absorb maximum power if  $R_L$  is equal to

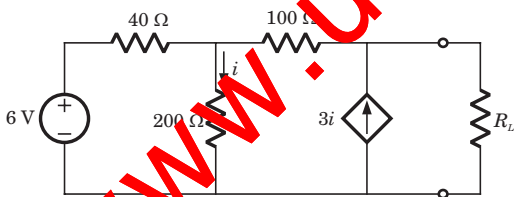


Fig. P.1.4.25

- (A)  $\frac{400}{3} \Omega$
- (B)  $\frac{2}{9} \text{ k}\Omega$
- (C)  $\frac{800}{3} \Omega$
- (D)  $\frac{4}{9} \text{ k}\Omega$

**Statement for Q.26-27:**

In the circuit shown in fig. P.1.4.26-27 the maximum power transfer condition is met for the load  $R_L$ .

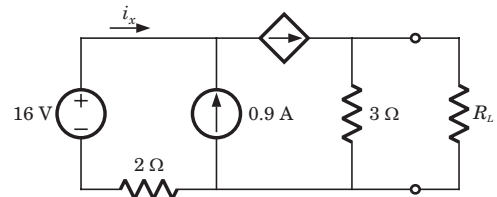


Fig. P.1.4.26-27

- 26. The value of  $R_L$  will be
- (A)  $2 \Omega$
- (B)  $3 \Omega$
- (C)  $1 \Omega$
- (D) None of the above

- 27. The maximum power is
- (A) 0.75 W
- (B) 1.5 W
- (C) 2.25 W
- (D) 1.125 W

28.  $R_{TH} = ?$

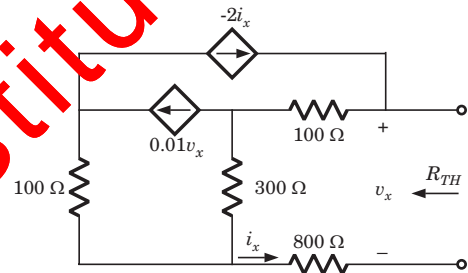


Fig. P.1.4.28

- (A)  $100 \Omega$
- (B)  $136.4 \Omega$
- (C)  $200 \Omega$
- (D)  $272.8 \Omega$

29. Consider the circuits shown in fig. P.1.4.29

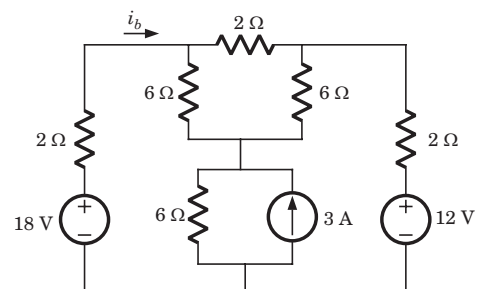
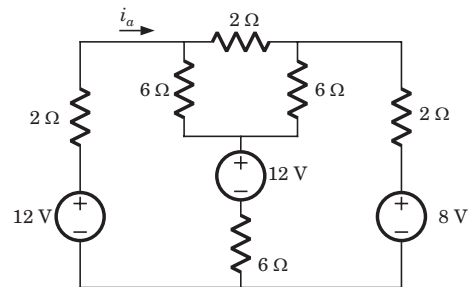


Fig. P.1.4.29a & b

The relation between  $i_a$  and  $i_b$  is

- (A)  $i_b = i_a + 6$
- (B)  $i_b = i_a + 2$
- (C)  $i_b = 1.5i_a$
- (D)  $i_b = i_a$

30.  $R_{eq} = ?$

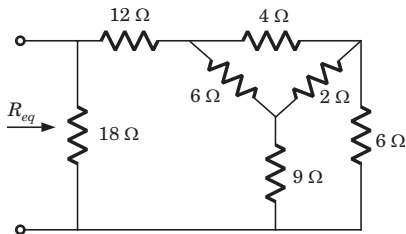


Fig. P.1.4.30

- (A)  $18 \Omega$
- (B)  $\frac{72}{13} \Omega$
- (C)  $\frac{36}{13} \Omega$
- (D)  $9 \Omega$

31. In the lattice network the value of  $R_L$  for the maximum power transfer to it is

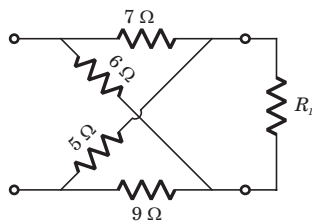


Fig. P.1.4.31

- (A)  $6.67 \Omega$
- (B)  $9 \Omega$
- (C)  $6.52 \Omega$
- (D)  $3 \Omega$

Statement for Q.32-33:

A circuit is shown in fig. P.1.4.32-33.

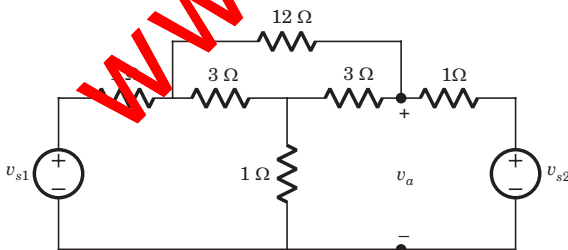


Fig. P.1.4.32-33

- 32. If  $v_{s1} = v_{s2} = 6 \text{ V}$  then the value of  $v_a$  is
  - (A)  $3 \text{ V}$
  - (B)  $4 \text{ V}$
  - (C)  $6 \text{ V}$
  - (D)  $5 \text{ V}$

33. If  $v_{s1} = 6 \text{ V}$  and  $v_{s2} = -6 \text{ V}$  then the value of  $v_a$  is

- (A)  $4 \text{ V}$
- (B)  $-4 \text{ V}$
- (C)  $6 \text{ V}$
- (D)  $-6 \text{ V}$

34. A network N feeds a resistance R as shown in fig. P1.4.34. Let the power consumed by R be P. If an identical network is added as shown in figure, the power consumed by R will be

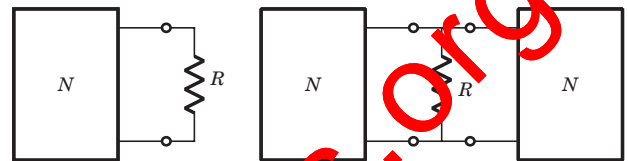


Fig. P.1.4.34

- (A) equal to P
- (B) less than P
- (C) between P and 4P
- (D) more than 4P

35. A certain network consists of a large number of ideal linear resistors, one of which is R and two constant ideal source. 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)  $(\sqrt{P_1} \pm \sqrt{P_2})^2$
- (D)  $(P_1 \pm P_2)^2$

36. A battery has a short-circuit current of 30 A and an open circuit voltage of 24 V. If the battery is connected to an electric bulb of resistance  $2 \Omega$ , the power dissipated by the bulb is

- (A) 80 W
- (B) 1800 W
- (C) 112.5 W
- (D) 228 W

37. The following results were obtained from measurements taken between the two terminal of a resistive network

Terminal voltage	12 V	0 V
Terminal current	0 A	1.5 A

The Thevenin resistance of the network is

- (A) 16  $\Omega$
- (B) 8  $\Omega$
- (C) 0
- (D)  $\infty$

38. A DC voltmeter with a sensitivity of  $20 \text{ k}\Omega/\text{V}$  is used to find the Thevenin equivalent of a linear network. Reading on two scales are as follows

- (a) 0 – 10 V scale : 4 V
- (b) 0 – 15 V scale : 5 V

The Thevenin voltage and the Thevenin resistance of the network is

- (A)  $\frac{16}{3} \text{ V}$ ,  $\frac{1}{15} \text{ M}\Omega$
- (B)  $\frac{32}{3} \text{ V}$ ,  $\frac{200}{3} \text{ k}\Omega$
- (C) 18 V,  $\frac{2}{15} \text{ M}\Omega$
- (D) 36 V,  $\frac{200}{3} \text{ k}\Omega$

39. Consider the network shown in fig. P.1.4.39.

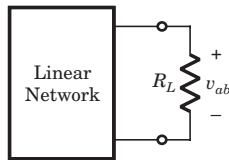


Fig. P.1.4.39

The power absorbed by load resistance  $R_L$  is shown in table :

$R_L$	10 k $\Omega$	30 k $\Omega$
$P$	3.6 MW	4.8 MW

The value of  $R_L$ , that would absorb maximum power, is

- (A) 60 k $\Omega$
- (B) 100 k $\Omega$
- (C) 300  $\Omega$
- (D) 30 k $\Omega$

40. Measurement made on terminal  $ab$  of a circuit of fig.P.1.4.40 yield the current-voltage characteristics shown in fig. P.1.4.40. The Thevenin resistance is

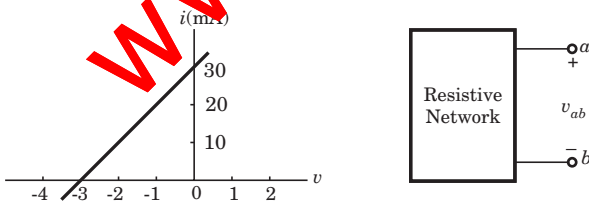


Fig. P.1.4.40

- (A) 300  $\Omega$
- (B) -300  $\Omega$
- (C) 100  $\Omega$
- (D) -100  $\Omega$

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# Solutions

1. (B)  $v_{TH} = \frac{(6)(6)}{3+6} = 4 \text{ V}$ ,  $R_{TH} = (3 \parallel 6) + 2 = 4 \Omega$

2. (A)

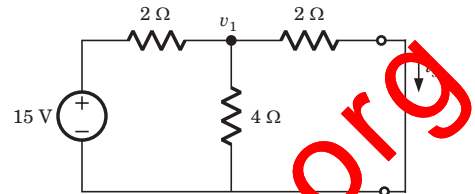


Fig. S1.4.2

$R_N = 2 \parallel 4 + 2 = \frac{10}{3} \Omega$ ,  $v_1 = \frac{\frac{15}{\frac{10}{3}}}{\frac{1}{2} + \frac{1}{\frac{10}{3}} + \frac{1}{4}} = 6 \text{ V}$

$i_{sc} = i_N = \frac{v_1}{2} = 3 \text{ A}$

3. (C)  $v_{TH} = \frac{(2)(3)(1)}{3+3} = 1 \text{ V}$ ,  $R_{TH} = 1 \parallel 5 = \frac{5}{6} \Omega$

4. (B) After killing all source equivalent resistance is  $R$   
Open circuit voltage =  $v_1$

5. (D)  $i_{sc} = \frac{6 \times 4}{4+2} = 4 \text{ A} = i_N$ ,  $R_N = 6 \parallel 3 = 2 \Omega$

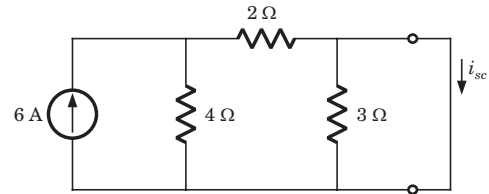


Fig. S1.4.5

6. (B)  $R_{TH} = 30 + 25 = 55 \Omega$ ,  $v_{TH} = 5 + 5 \times 30 = 155 \text{ V}$

7. (C) After killing the source,  $R_{TH} = 6 \Omega$

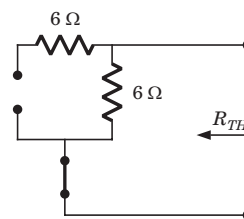


Fig. S.1.4.7

8. (B) After killing all source,  $R_{TH} = 3 \parallel 6 + 8 \parallel 8 = 6 \Omega$

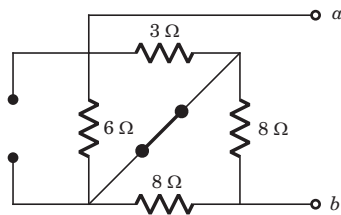


Fig. S1.4.8

9. (D)  $v_{oc} = 2 \times 2 + 4 = 8 \text{ V} = v_{TH}$

$$R_{TH} = 2 + 3 = 5 \Omega = R_N, \quad i_N = \frac{v_{TH}}{R_{TH}} = \frac{8}{5} \text{ A}$$

10. (A) By changing the LHS and RHS in Thevenin equivalent

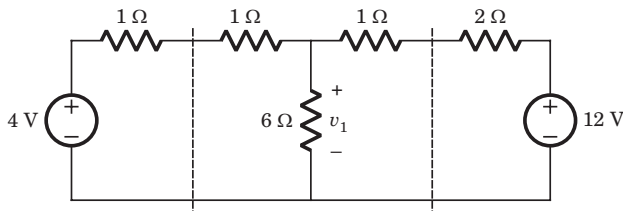


Fig. S1.4.10

$$v_1 = \frac{\frac{4}{1+1} + \frac{12}{1+2}}{\frac{1}{1+1} + \frac{1}{6} + \frac{1}{1+2}} = 6 \text{ V}$$

11. (B) By changing the LHS and RHS in Thevenin equivalent

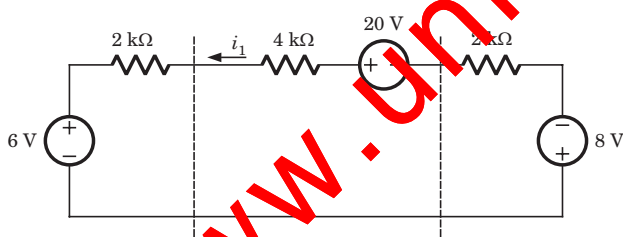


Fig. S1.4.11

$$i_1 = \frac{20 - 6 - 8}{2\text{k} + 4\text{k} + 2\text{k}} = 0.75 \text{ mA}$$

12. (B)

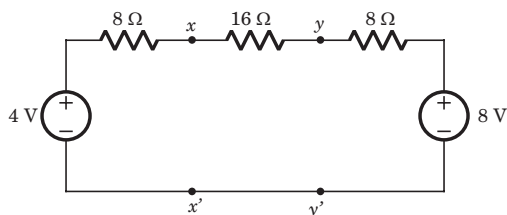


Fig. S1.4.12

If we Thevenized the left side of  $xx'$  and source transformed right side of  $yy'$

$$v_{xx'} = v_{TH} = \frac{\frac{4}{8} + \frac{8}{24}}{\frac{1}{8} + \frac{1}{24}} = 5 \text{ V}, \quad R_{TH} = 8 \parallel (16 + 8) = 6 \Omega$$

$$13. \text{ (D) } v_{yy'} = v_{TH} = \frac{\frac{24}{1} + \frac{8}{8}}{\frac{1}{24} + \frac{1}{8}} = 7 \text{ V}, \quad R_{TH} = (8 + 16) \parallel 8 = 6 \Omega$$

14. (A)

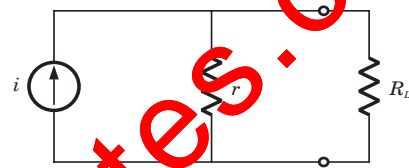


Fig. S1.4.14

$$\left(\frac{ir}{r+50}\right)^2 20 = 20\text{k}, \quad \left(\frac{ir}{r+200}\right)^2 200 = 20\text{k}$$

$$(r-200)^2 = 4(r+50)^2 \Rightarrow r = 100 \Omega$$

$$i = 30 \text{ A}, \quad P_{max} = \frac{(30)^2 \times 100}{4} = 22.5 \text{ kW}$$

15. (C) Thevenized the circuit across  $R$ ,  $R_{TH} = 2 \Omega$

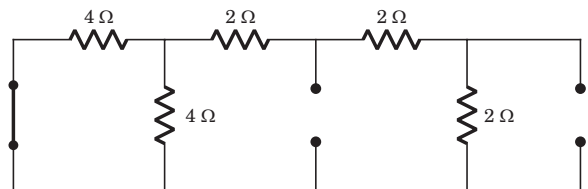


Fig. S1.4.15

$$16. \text{ (A) } i_{sc} = 10 \text{ A}, \quad R_{TH} = 2 \Omega, \quad P_{max} = \left(\frac{10}{2}\right)^2 \times 2 = 50 \text{ W}$$

$$17. \text{ (D) } R_L = r = 4 \Omega, \quad i = \frac{24}{4+4} = 3 \text{ A}$$

$$\frac{24}{R'_L + 4} = \frac{3}{2} \Rightarrow R'_L = 12 \Omega$$

18. (C)  $i_N = 0$ ,

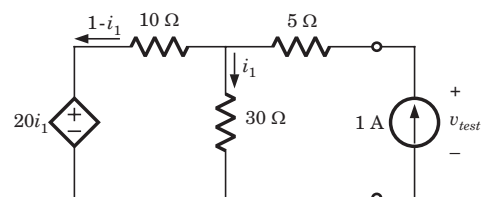


Fig. S1.4.18

$$20i_1 = 30i_1 - 10(1 - i_1) \Rightarrow i_1 = 0.5 \text{ A}$$

$$v_{test} = 5 \times 1 + 30 \times 0.5 = 20 \text{ V}$$

$$R_N = \frac{v_{test}}{1} = 20 \Omega$$

19. (B) Circuit does not contain any independent source,  $v_{TH} = 0$

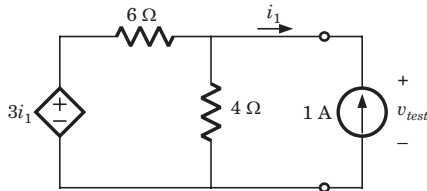


Fig. S1.4.19

Applying 1 A at terminal,  $i_1 = -1 \text{ A}$

$$\frac{v_{test}}{4} + \frac{v_{test} - 3(-1)}{6} = 1 \Rightarrow v_{test} = 12 \text{ V}$$

$$R_{TH} = \frac{v_{test}}{1} = 12 \Omega$$

20. (B)

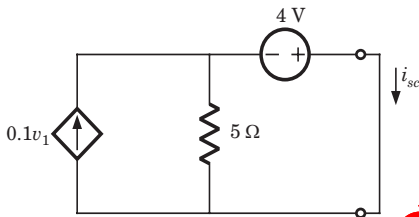


Fig. S1.4.20

$$v_1 = 4 + 5 \times 0.1v_1 \Rightarrow v_1 = 8 \text{ V}$$

$$v_1 = v_{oc} = v_{TH}$$

For  $i_{sc}$ ,  $v_1 = 0$

$$i_{sc} = \frac{4}{5} \text{ A}, R_{TH} = \frac{v_{oc}}{i_{sc}} = 10 \Omega$$

21. (D)  $v_x = 2 \frac{v_x}{2} + 4 \Rightarrow v_x = 8 \text{ V} = v_{oc}$

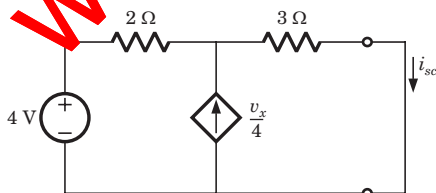


Fig. S1.4.21

If terminal is short circuited,  $v_x = 0$

$$i_{sc} = \frac{4}{2 + 3} = 0.8 \text{ A}, R_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{8}{0.8} = 10 \Omega$$

22. (B)  $v_s = 4 \times \frac{3i}{4} \Rightarrow \frac{v_s}{i} = 3 \Omega$

23. (C)  $v_{oc} = v_{ab} = -v_a, \frac{v_{oc}}{4} + \frac{v_{oc} - 9}{8} + 0.75v_a = 0$

$$2v_{oc} + v_{oc} - 9 + 6(-v_{oc}) = 0, v_{oc} = -3 \text{ V}$$

If terminal  $ab$  is short circuited,  $v_a = 0$

$$i_{sc} = \frac{9}{8} \text{ A and } R_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{-3}{9/8} = \frac{-8}{3} \Omega$$

24. (D) Using source transform

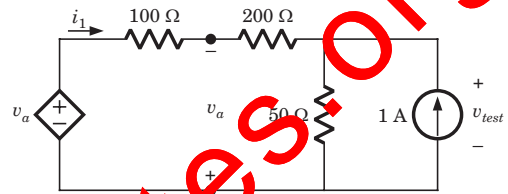


Fig. S1.4.24

$$v_a = 100i_1 + 200i_1 = 50(i_1 + 1)$$

$$v_a = 100i_1 - v_a \Rightarrow v_a = 50i_1$$

$$50i_1 = 30i_1 + 50i_1 + 50 \Rightarrow i_1 = -\frac{1}{6} \text{ A}$$

$$v_{test} = 50 \left( 1 - \frac{1}{6} \right) = \frac{125}{3} \Omega$$

25. (C)

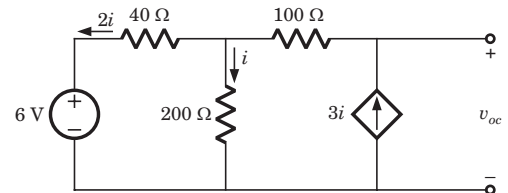


Fig. S1.4.25a

$$6 = 200i - 40 \times 2i \Rightarrow i = \frac{1}{20} \text{ A}$$

$$v_{oc} = 100 \times 3i + 200 \times i = 25 \text{ V}$$

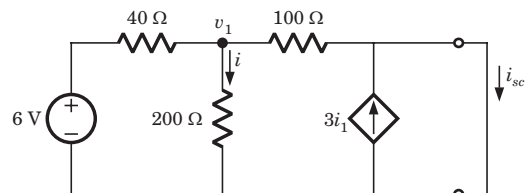


Fig. S1.4.25b

$$v_1 = \frac{\frac{6}{40}}{\frac{1}{40} + \frac{1}{200} + \frac{1}{100}} = \frac{15}{4} \text{ V}, i = \frac{15}{4 \times 200} = \frac{3}{160} \text{ A}$$

$$i_{sc} = \frac{16}{4 \times 100} + \frac{3 \times 3}{160} = \frac{3}{32} \text{ A}, \quad R_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{25}{3/32} = \frac{800}{3} \Omega$$

26. (B)  $i_x + 0.9 = 10i_x \Rightarrow i_x = 0.1 \text{ A}$

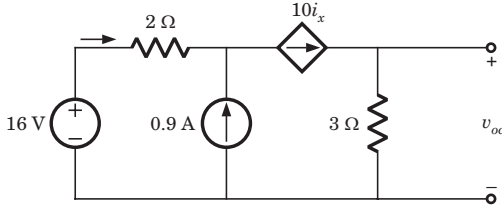


Fig. S1.4.26

$$v_{oc} = 3 \times 10i_x = 30i_x \Rightarrow v_{oc} = 3 \text{ V}$$

$$i_{sc} = 10i_x = 1 \text{ A}, \quad R_{TH} = \frac{3}{1} = 3 \Omega$$

27. (A)  $v_{TH} = v_{oc} = 3 \text{ V}, R_L = 3 \Omega, P_{max} = \frac{3^2}{4 \times 3} = 0.75 \text{ W}$

28. (A)  $i_x = 1 \text{ A}, v_x = v_{test}$

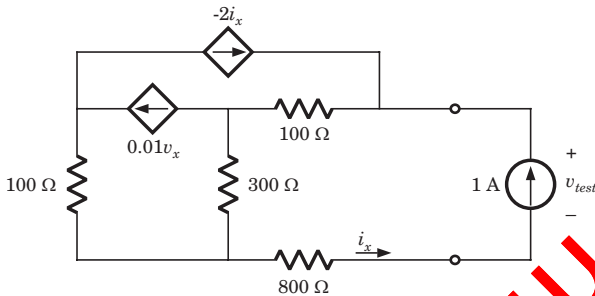


Fig. S1.4.28

$$v_{test} = 100(1 - 2i_x) + 300(1 - 2i_x - 0.01v_x) + 800$$

$$\Rightarrow v_{test} = 1200 - 800i_x - 3v_{test}$$

$$4v_{test} = 1200 - 800 = 400 \Rightarrow v_{test} = 100 \text{ V}$$

$$R_{TH} = \frac{v_{test}}{1} = 100 \Omega$$

29. (C) In circuit (b) transforming the 3 A source in to 18 V source all source are 1.5 times of that in circuit (a). Hence  $i_b = 1.5i_a$ .

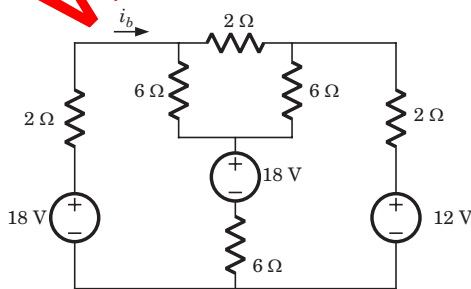


Fig. S1.4.29

30. (D) Changing the  $\Delta$  to Y

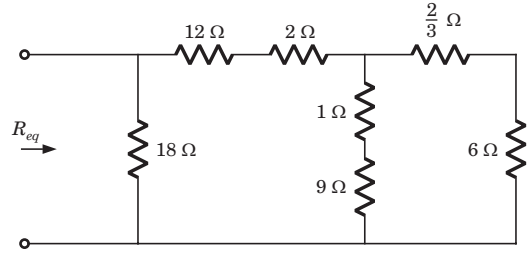


Fig. S1.4.30

$$R_{eq} = 18 \parallel \left( 14 + 10 \parallel \left( 6 + \frac{2}{3} \right) \right) = 18 \parallel (14 + 4) = 9 \Omega$$

31. (C)  $R_{TH} = 7 \parallel 5 + 6 \parallel 9 = 6.52 \Omega$

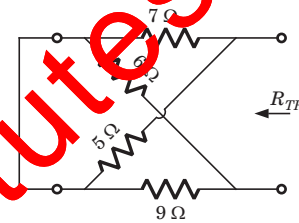


Fig. S1.4.31

For maximum power transfer  $R_L = R_{TH} = 6.52 \Omega$

32. (D) The given circuit has mirror symmetry. It is modified and redrawn as shown in fig. S.1.4.32a.

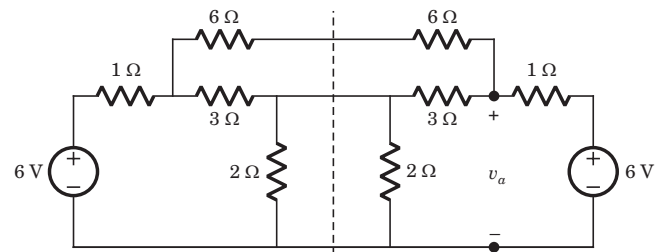


Fig. S.1.4.32a

Now in this circuit all straight-through connection have been cut as shown in fig. S1.4.32b

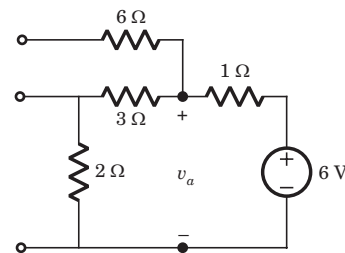


Fig. S.1.4.32b

$$v_a = \frac{6 \times (2 + 3)}{2 + 3 + 1} = 5 \text{ V}$$

33. (B) Since both source have opposite polarity, hence short circuit the all straight-through connection as shown in fig. S.1.4.33

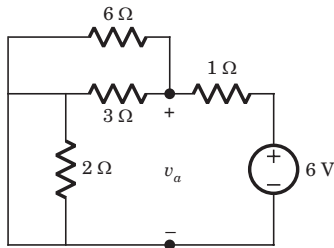


Fig. S1.4.33

$$v_a = -\frac{6 \times (6 \parallel 3)}{2 + 1} = -4 \text{ V}$$

34. (C) Let Thevenin equivalent of both network

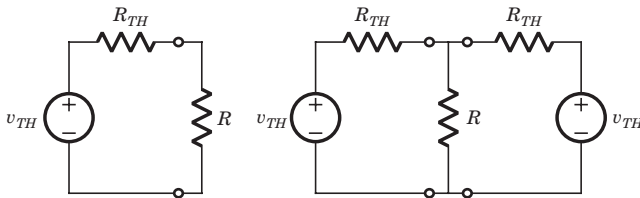


Fig. S1.4.34

$$P = \left( \frac{V_{TH}}{R_{TH} + R} \right)^2 R$$

$$P' = \left( \frac{V_{TH}}{R + \frac{R_{TH}}{2}} \right)^2 R = 4 \left( \frac{V_{TH}}{2R + R_{TH}} \right)^2 R$$

Thus  $P < P' < 4P$

35. (C)  $i_1 = \sqrt{\frac{P_1}{R}}$  and  $i_2 = \sqrt{\frac{P_2}{R}}$

using superposition  $i = i_1 + i_2 = \sqrt{\frac{P_1}{R}} \pm \sqrt{\frac{P_2}{R}}$

$$i^2 R = (\sqrt{P_1} \pm \sqrt{P_2})^2$$

36. (C)  $r = \frac{v_{oc}}{i_{sc}} = 1.2 \Omega$

$$P = \frac{24^2}{(1.2 + 2)^2} \times 2 = 112.5 \text{ W}$$

37. (B)  $R_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{12}{1.5} = 8 \Omega$

38. (A) Let  $\frac{1}{\text{sensitivity}} = \frac{1}{20k} = 50 \mu\text{A}$

For 0 -10 V scale  $R_m = 10 \times 20k = 200 \text{ k}\Omega$

For 0 -50 V scale  $R_m = 50 \times 20k = 1 \text{ M}\Omega$

For 4 V reading  $i = \frac{4}{10} \times 50 = 20 \mu\text{A}$

$$v_{TH} = 20 \mu R_{TH} + 20 \mu \times 200k = 4 + 20 \mu R_{TH} \quad \dots(i)$$

For 5 V reading  $i = \frac{5}{50} \times 50 \mu = 5 \mu\text{A}$

$$v_{TH} = 5 \mu \times R_{TH} + 5 \mu \times 1M = 5 + 5 \mu R_{TH} \quad \dots(ii)$$

Solving (i) and (ii)

$$v_{TH} = \frac{16}{3} \text{ V}, R_{TH} = \frac{200}{3} \text{ k}\Omega$$

39. (D)  $v_{10k} = \sqrt{10k \times 3.6m} = 6$

$$v_{30k} = \sqrt{30k \times 4.8m} = 12 \text{ V}$$

$$6 = \frac{10}{10 + R_{TH}} v_{TH} \Rightarrow 10 v_{TH} = 6 R_{TH} + 60$$

$$12 = \frac{30 v_{TH}}{30 + R_{TH}} \Rightarrow 5 v_{TH} = 2 R_{TH} + 60$$

$$R_{TH} = 30 \text{ k}\Omega$$

40. (D) At  $v = 0$ ,  $i_{sc} = 30 \text{ mA}$

At  $i = 0$ ,  $v_{oc} = -3 \text{ V}$

$$R_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{-3}{30m} = -100 \Omega$$

\*\*\*\*\*