CHAPTER

1.4

NETWORKS THEOREM

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

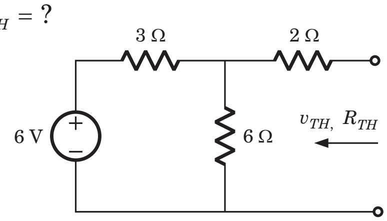


Fig. P.1.4.1

(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 = ?

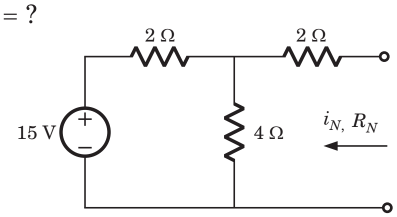


Fig. P.1.4.2

(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} = ?

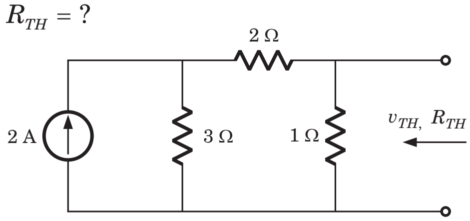


Fig. P.1.4.3

(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. P1.4.4 is

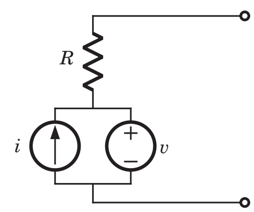
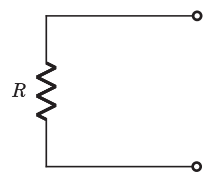
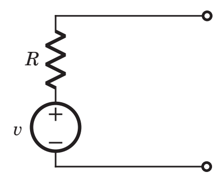


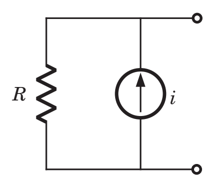
Fig. P.1.4.4



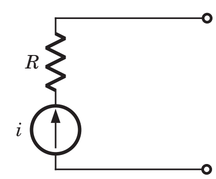
(A)



(B)



(C)



(D)

5. i_N , R_N = ?

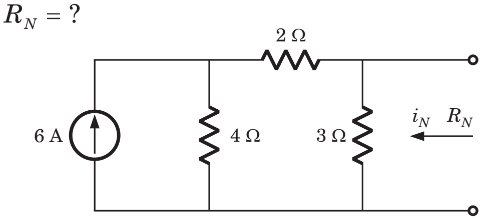


Fig. P.1.4.5

(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} = ?

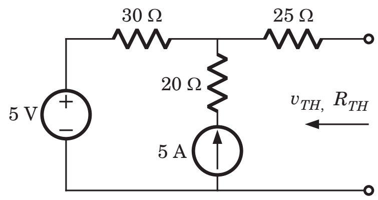


Fig. P.1.4.6

(A) –100 V, 75 Ω (B) 155 V, 55 Ω

(C) 155 V, 37 Ω (D) 145 V, 75 Ω

7. R_{TH} = ?

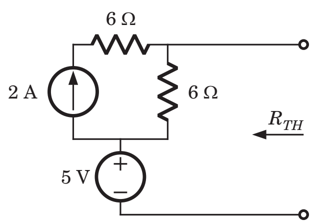


Fig. P.1.4.7

(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

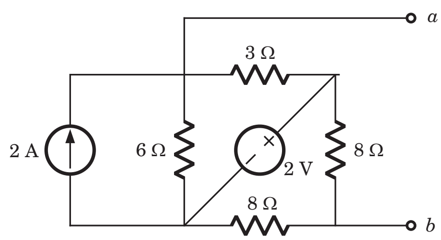


Fig. P.1.4.8

(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

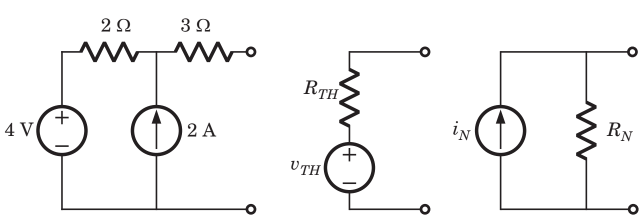


Fig. P.1.4.9

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 = ?

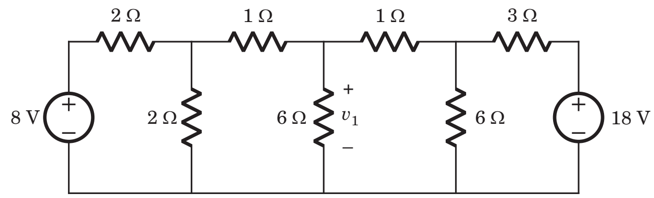


Fig. P.1.4.10

(A) 6 V (B) 7 V

(C) 8 V (D) 10 V

11. i_1 = ?

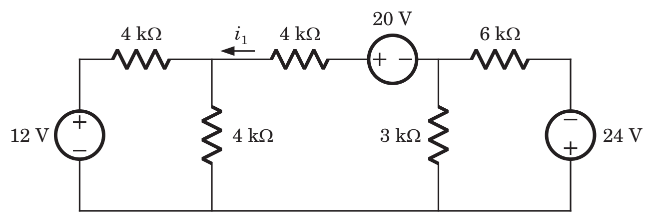


Fig. P.1.4.11

(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..

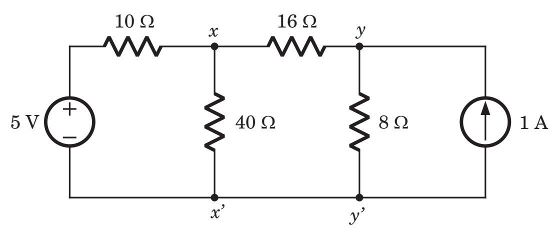


Fig. P.1.4.12–13

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 Ω (B) 4 V, 32 Ω

(C) 5 V, 6 Ω (D) 7 V, 6 Ω

14. A practical DC current source provide 20 kW to a 50 Ω load and 20 kW to a 200 Ω 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.

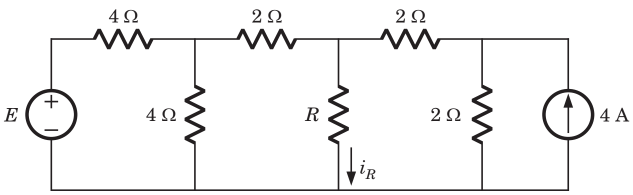


Fig. P.1.4.15–16.

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

(A) 4 Ω (B) 3 Ω

(C) 2 Ω (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 form the battery will be $i/2$ when R_L is equal to

(A) 2 Ω (B) 4 Ω

(C) 8 Ω (D) 12 Ω

18. i_N, R_N = ?

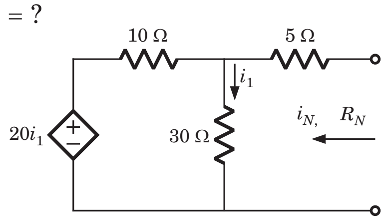


Fig. P.1.4.18

(A) 2 A, 20 Ω (B) 2 A, –20 Ω

(C) 0 A, 20 Ω (D) 0 A, –20 Ω

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

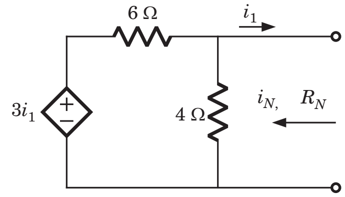


Fig. P1.4.19

(A) 0 Ω (B) 1.2 Ω

(C) 2.4 Ω (D) 3.6 Ω

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

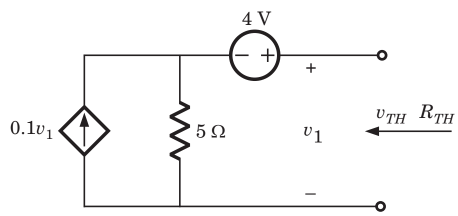


Fig. P.1.4.20

(A) 8 V, 5 Ω (B) 8 V, 10 Ω

(C) 4 V, 5 Ω (D) 4 V, 10 Ω

21. R_{TH} = ?

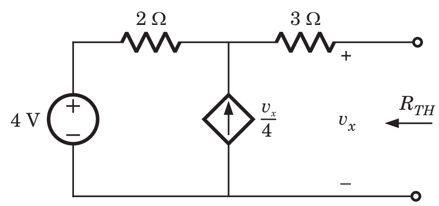


Fig. P.1.4.21

(A) 3 Ω (B) 1.2 Ω

(C) 5 Ω (D) 10 Ω

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

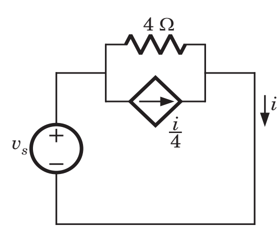


Fig. P.1.4.22

(A) 4 Ω (B) 3 Ω

(C) 2 Ω (D) 1 Ω

23. In the circuit of fig. P1.4.23 the value of R_{TH} at terminal ab is

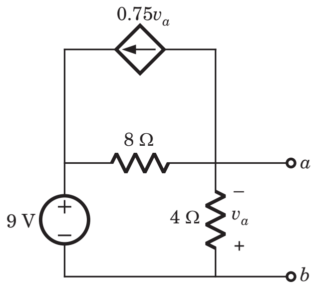


Fig. P.1.4.23

(A) –3 Ω (B) $\frac{9}{8}$ Ω

(C) $-\frac{8}{3}$ Ω (D) None of the above

24. R_{TH} = ?

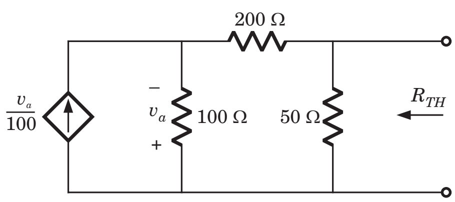


Fig. P.1.4.24

(A) ∞ (B) 0

(C) $\frac{3}{125}$ Ω (D) $\frac{125}{3}$ Ω

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

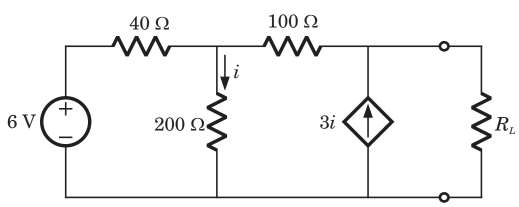


Fig. P.1.4.25

(A) $\frac{400}{3}$ Ω (B) $\frac{2}{9}$ kΩ

(C) $\frac{800}{3}$ Ω (D) $\frac{4}{9}$ kΩ

Statement for Q.26–27:

In the circuit shown in fig. P1.4.26–27 the maximum power transfer condition is met for the load R_L .

26. The value of R_L will be

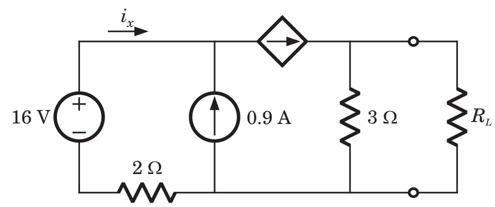


Fig. P.1.4.26–27

(A) 2 Ω (B) 3 Ω

(C) 1 Ω (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} = ?

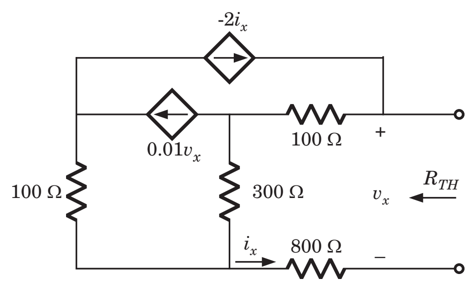


Fig. P.1.4.28

(A) 100 Ω (B) 136.4 Ω

(C) 200 Ω (D) 272.8 Ω

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

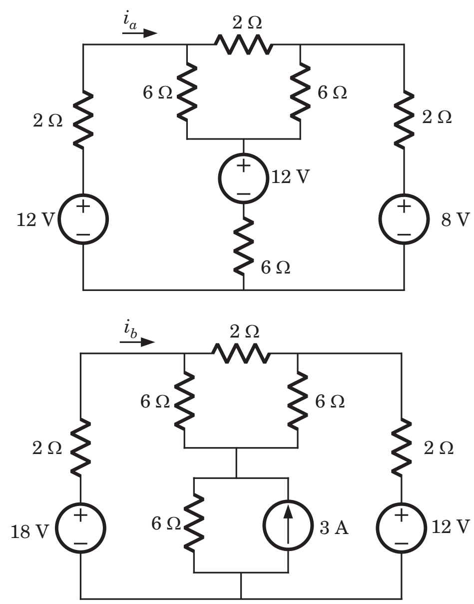


Fig. P.1.4.29a & b

The relation between i_a and i_b is

(A) $i_b = i_a + 6$ (B) $i_b = i_a + 2$

(C) $i_b = 1.5 i_a$ (D) $i_b = i_a$

30. $R_{eq} = ?$

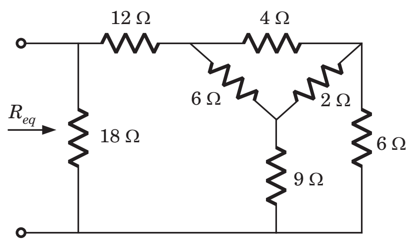


Fig. P.1.4.30

(A) 18 Ω (B) $\frac{72}{13}$ Ω

(C) $\frac{36}{13}$ Ω (D) 9 Ω

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

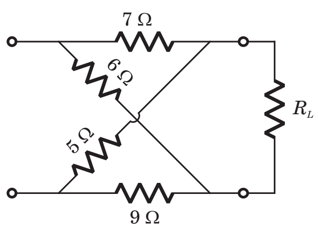


Fig. P.1.4.31

(A) 6.67 Ω (B) 9 Ω

(C) 6.52 Ω (D) 8 Ω

Statement for Q.32–33:

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

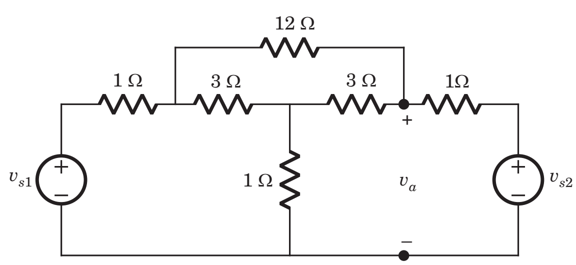


Fig. P.1.4.32–33

32. If $v_{s1} = v_{s2} = 6$ V then the value of v_a is

(A) 3 V (B) 4 V

(C) 6 V (D) 5 V

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

(A) 4 V (B) –4 V

(C) 6 V (D) –6 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

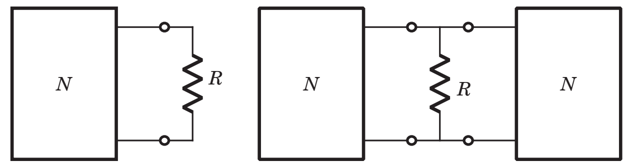


Fig. P.1.4.34

(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 2Ω, 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 Ω (B) 8 Ω

(C) 0 (D) ∞

38. A DC voltmeter with a sensitivity of 20 kΩ/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) $\frac{16}{3}$ V, $\frac{200}{3}$ kΩ (B) $\frac{32}{3}$ V, $\frac{1}{15}$ MΩ

(C) 18 V, $\frac{2}{15}$ MΩ (D) 36 V, $\frac{200}{3}$ kΩ

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

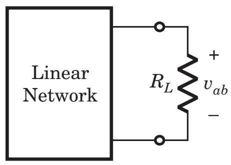


Fig. P.1.4.39

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

R_L	10 kΩ	30 kΩ
P	3.6 MW	4.8 MW

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

(A) 60 kΩ (B) 100 Ω

(C) 300 Ω (D) 30 kΩ

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

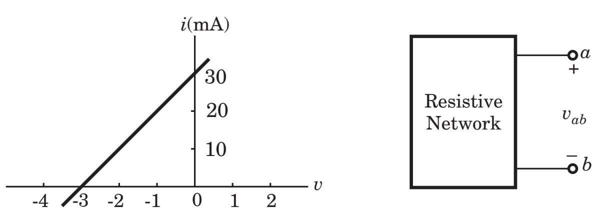


Fig. P.1.4.40

(A) 300 Ω (B) –300 Ω

(C) 100 Ω (D) –100 Ω

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SOLUTIONS

1. (B) $v_{TH} = \frac{(6)(6)}{3+6} = 4$ V,

$R_{TH} = (3 \| 6) + 2 = 4\ \Omega$

2. (A)

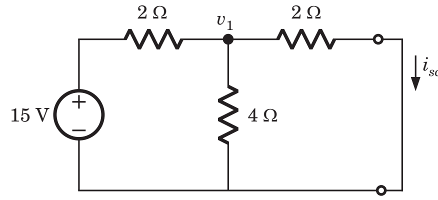

Fig. S.1.4.2

$R_N = 2 \| 4 + 2 = \frac{10}{3}\ \Omega$,

$$v_1 = \frac{\frac{15}{2}}{\frac{1}{2} + \frac{1}{2} + \frac{1}{4}} = 6 \text{ V}$$

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

3. (C) $v_{TH} = \frac{(2)(3)(1)}{3+3} = 1$ V,

$R_{TH} = 1 \| 5 = \frac{5}{6}\ \Omega$

4. (B) After killing all source equivalent resistance is R

Open circuit voltage $= v_1$

5. (D) The short circuit current across the terminal is

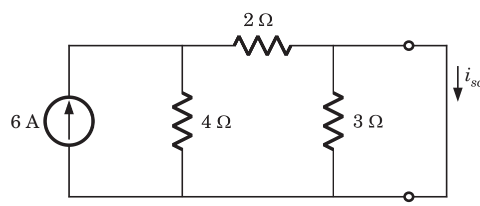

Fig. S1.4.5

$i_{sc} = \frac{6 \times 4}{4+2} = 4 \text{ A} = i_N$,

$R_N = 6 \| 3 = 2\ \Omega$

6. (B) For the calculation of R_{TH} if we kill the sources then $20\,\Omega$ resistance is inactive because 5 A source will be open circuit

$R_{TH} = 30 + 25 = 55\ \Omega$,

$v_{TH} = 5 + 5 \times 30 = 155$ V

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

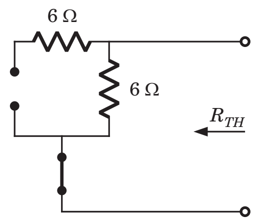

Fig. S.1.4.7

8. (B) After killing all source,

$R_{TH} = 3 \,||\, 6 + 8 \,||\, 8 = 6\,\Omega$

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

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

10. (A) If we solve this circuit direct, we have to deal with three variable. But by simple manipulation variable can be reduced to one. By changing the LHS and RHS in Thevenin equivalent

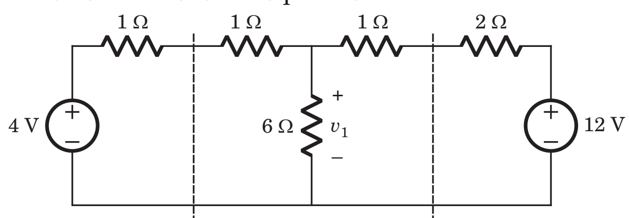

Fig. S1.4.10

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

11. (B) If we solve this circuit direct, we have to deal with three variable. But by simple manipulation variable can be reduced to one. By changing the LHS and RHS in Thevenin equivalent

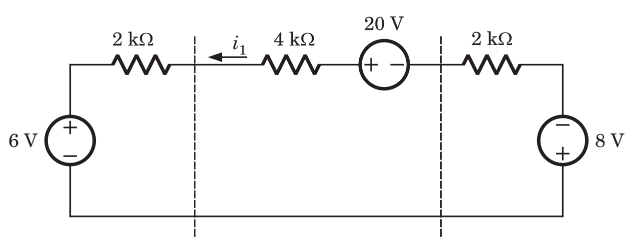

Fig. S1.4.11

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

12. (B) We Thevenized the left side of xx' and source transformed right side of yy'

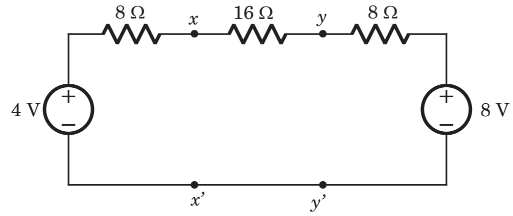

Fig. S1.4.12

$$v_{xx'} = v_{TH} = \frac{\dfrac{4}{8} + \dfrac{8}{24}}{\dfrac{1}{8} + \dfrac{1}{24}} = 5 \text{ V},$$

$R_{TH} = 8 \,||\, (16 + 8) = 6\,\Omega$

13. (D) Thevenin equivalent seen from terminal yy' is

$$v_{yy'} = v_{TH} = \frac{\dfrac{4}{24} + \dfrac{8}{8}}{\dfrac{1}{24} + \dfrac{1}{8}} = 7 \text{ V},$$

$R_{TH} = (8 + 16) \,||\, 8 = 6\,\Omega$

14. (A)

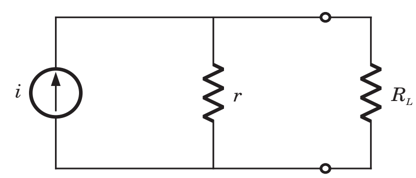

Fig. S1.4.14

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

$(r + 200)^2 = 4(r + 50)^2$

$\Rightarrow \quad r = 100\,\Omega$

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

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

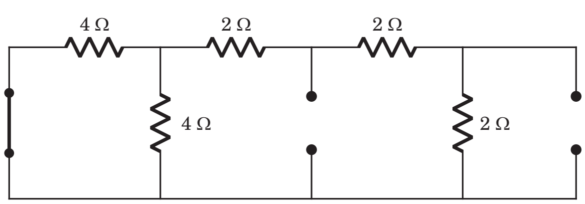

Fig. S1.4.15

16. (A) $i_{sc} = 10 \text{ A}, \; R_{TH} = 2\,\Omega,$

$$P_{\max} = \left(\frac{10}{2}\right)^2 \times 2 = 50 \text{ W}$$

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

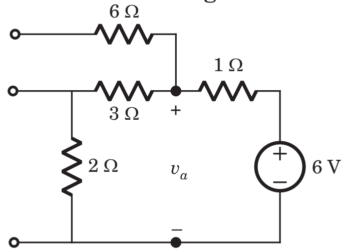

Fig. S.1.4.32b

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

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

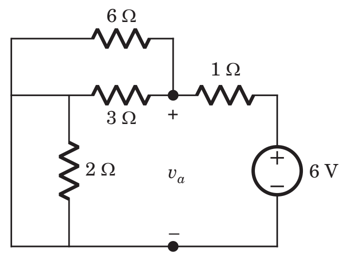

Fig. S1.4.33

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

34. (C) Let Thevenin equivalent of both network

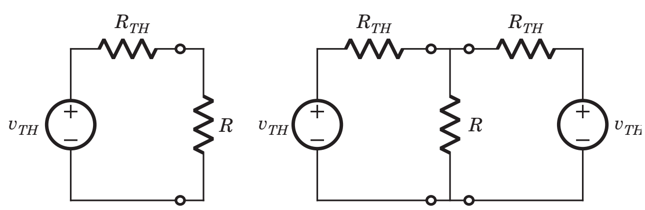

Fig. S1.4.34

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

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

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 $\frac{1}{\text{sensitivity}} = \frac{1}{20\text{k}} = 50 \ \mu\text{A}$

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

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

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

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

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

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

Solving (i) and (ii)

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

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

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

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

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

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

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

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

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

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