30 Years
Previous Solved Papers

GATE 2021

Electrical Engineering

- Fully solved with explanations
- Analysis of previous papers
- Topicwise presentation
- Thoroughly revised & updated

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GATE - 2021 : Electrical Engineering Topicwise Previous GATE Solved Papers (1991-2020)

First Edition	:	2008
Second Edition	:	2009
Third Edition	:	2010
Fourth Edition	:	2011
Fifth Edition	:	2012
Sixth Edition	:	2013
Seventh Edition	:	2014
Eighth Edition	:	2015
Ninth Edition	:	2016
Tenth Edition	:	2017
Eleventh Edition	:	2018
Twelfth Edition	:	2019

Thirteenth Edition : 2020

Preface

Over the period of time the GATE examination has become more challenging due to increasing number of candidates. Though every candidate has ability to succeed but competitive environment, in-depth knowledge, quality guidance and good source of study is required to achieve high level goals.

B. Singh (Ex. IES)

The new edition of **GATE 2021 Solved Papers : Electrical Engineering** has been fully revised, updated and edited. The whole book has been divided into topicwise sections.

At the beginning of each subject, analysis of previous papers are given to improve the understanding of subject.

I have true desire to serve student community by way of providing good source of study and quality guidance. I hope this book will be proved an important tool to succeed in GATE examination. Any suggestions from the readers for the improvement of this book are most welcome.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

Contents

Unit .I

Electric Circuits

Contents

UNIT I Electric Circuits

Syllabus : Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

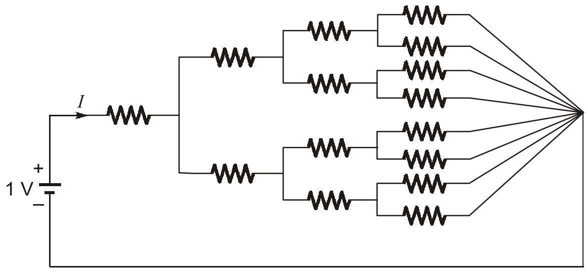
Analysis of Previous GATE Papers

Exam Year	1 Mark Ques.	2 Marks Ques.	5 Marks Ques.	Total Marks
1991	–	–	–	**–**
1992	4	2	–	**8**
1993	2	–	–	**2**
1994	4	2	–	**8**
1995	2	–	–	**2**
1996	3	1	–	**5**
1997	4	6	2	**26**
1998	3	2	3	**28**
1999	4	5	2	**24**
2000	1	3	1	**12**
2001	5	1	1	**12**
2002	1	7	3	**30**
2003	3	6	–	**15**
2004	1	7	–	**15**
2005	4	7	–	**18**
2006	2	6	–	**14**
2007	–	7	–	**14**
2008	2	6	–	**14**
2009	2	6	–	**14**

Exam Year	1 Mark Ques.	2 Marks Ques.	Total Marks
2010	3	4	**11**
2011	3	5	**13**
2012	5	6	**17**
2013	2	3	**8**
2014 Set-1	2	2	**6**
2014 Set-2	3	2	**7**
2014 Set-3	3	3	**9**
2015 Set-1	4	3	**10**
2015 Set-2	3	3	**9**
2016 Set-1	4	5	**14**
2016 Set-2	5	4	**13**
2017 Set-1	2	3	**8**
2017 Set-2	2	2	**6**
2018	3	4	**11**
2019	1	3	**7**
2020	2	2	**6**

1 Basics

1.1 All resistances in figure are 1 Ω each. The value of current 'I' is

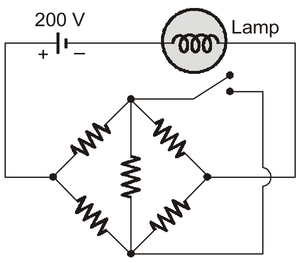


(a) $\frac{1}{15}$ A (b) $\frac{2}{15}$ A

(c) $\frac{4}{15}$ A (d) $\frac{8}{15}$ A

[1992 : 1 Mark]

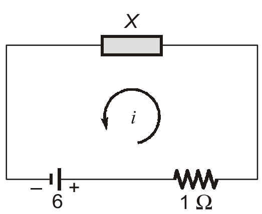
1.2 All resistances in the circuit in figure are of R ohms each. The switch is initially open. What happens to the lamp's intensity when the switch is closed?



(a) Increases
(b) Decreases
(c) Remains same
(d) Answer depends on the value of R

[1992 : 1 Mark]

1.3 In the circuit shown in figure, X is an element which always absorbs power. During a particular operation, it sets up a current of 1 amp in the direction shown and absorbs a power P_x. It is possible that X can absorb the same power P_x for another current i. Then the value of this current is



(a) $(3-\sqrt{14})$ amps (b) $(3+\sqrt{14})$ amps

(c) 5 amps (d) None of these

[1996 : 1 Mark]

1.4 A practical current source is usually represented by

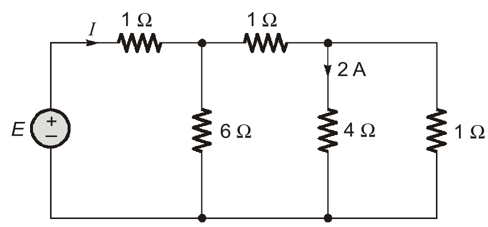
(a) a resistance in series with an ideal current source.
(b) a resistance in parallel with an ideal current source.
(c) a resistance in parallel with an ideal voltage source.
(d) none of these

[1997 : 1 Mark]

1.5 A 10 V battery with an internal resistance of 1 Ω is connected across a non-linear load whose V-I characteristic is given by $7I = V^2 + 2$ V. The current delivered by the battery is .... A.

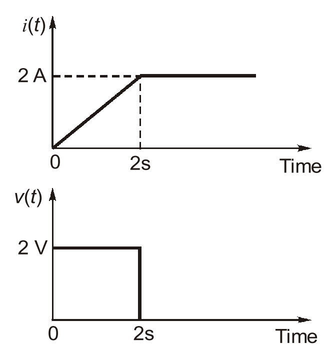
[1997 : 2 Marks]

1.6 The value of E and I for the circuit shown in figure, are .... V and .... A.



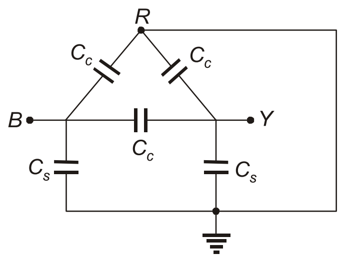
[1997 : 2 Marks]

1.7 The voltage and current waveforms for an element are shown in figure. The circuit element is _____ and its value is _______



[1997 : 2 Marks]

1.8 For the circuit shown in figure, the capacitance measured between terminals B and Y will be



(a) $C_c + \left(\frac{C_s}{2}\right)$ (b) $C_s + \left(\frac{C_c}{2}\right)$

(c) $\frac{(C_s + 3C_c)}{2}$ (d) $3C_c + 2C_s$

[1999 : 1 Mark]

1.9 When a resistor R is connected to a current source, it consumes a power of 18 W. When the same R is connected to a voltage source having the same magnitude as the current source, the power absorbed by R is 4.5 W. The magnitude of the current source and the value of R are

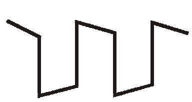
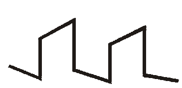
(a) $\sqrt{18}$ A and 1 Ω (b) 3 A and 2 Ω

(c) 1 A and 18 Ω (d) 6 A and 0.5 Ω

[1999 : 2 Marks]

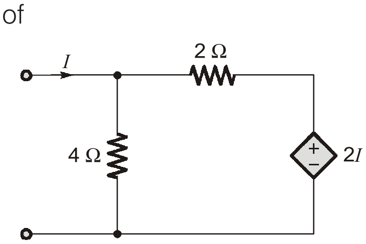
1.10 When a periodic triangular voltage of peak amplitude 1 V and frequency 0.5 Hz is applied to a parallel combination of 1 Ω resistance and 1 F capacitance, the current through the voltage source has waveform.

(a)  (b) 

(c)  (d) 

[1999 : 2 Marks]

1.11 The circuit shown in the figure is equivalent to a load of



(a) $\frac{4}{3}$ ohms (b) $\frac{8}{3}$ ohms

(c) 4 ohms (d) 2 ohms

[2000 : 2 Marks]

1.12 Two incandescent light bulbs of 40 W and 60 W ratings are connected in series across the mains. Then

(a) the bulbs together consume 100 W.

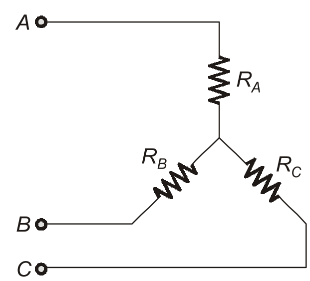
(b) the bulbs together consume 50 W.

(c) the 60 W bulb glows brighter.

(d) the 40 W bulb glows brighter.

[2001 : 1 Mark]

1.13 Consider the star network shown in figure. The resistance between terminals A and B with terminal C open is 6 Ω, between terminals B and C with terminal A open is 11 Ω, and between terminals C and A with terminal B open is 9 Ω. Then



(a) $R_A = 4\ \Omega$, $R_B = 2\ \Omega$, $R_C = 5\ \Omega$

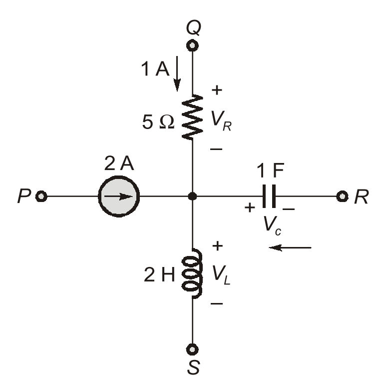
(b) $R_A = 2\ \Omega$, $R_B = 4\ \Omega$, $R_C = 7\ \Omega$

(c) $R_A = 3\ \Omega$, $R_B = 3\ \Omega$, $R_C = 4\ \Omega$

(d) $R_A = 5\ \Omega$, $R_B = 1\ \Omega$, $R_C = 10\ \Omega$

[2001 : 2 Marks]

1.14 A segment of a circuit is shown in figure $V_R = 5$ V, $V_C = 4 \sin 2t$. The voltage V_L is given by

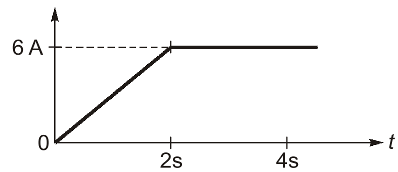


(a) $3 - 8 \cos 2t$ (b) $32 \sin 2t$

(c) $16 \sin 2t$ (d) $16 \cos 2t$

[2003 : 1 Mark]

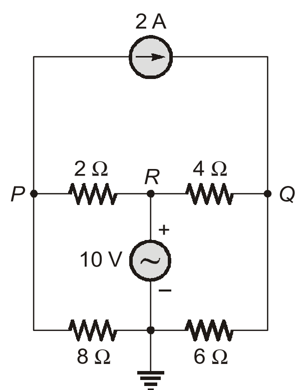
1.15 Figure shows the waveform of the current passing through an inductor of resistance 1 Ω and inductance 2 H. The energy absorbed by the inductor in the first four seconds is



(a) 144 J (b) 98 J
(c) 132 J (d) 168 J

[2003 : 1 Mark]

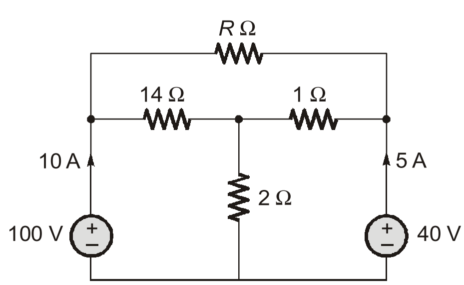
1.16 In figure, the potential difference between points *P* and *Q* is



(a) 12 V (b) 10 V
(c) –6 V (d) 8 V

[2003 : 2 Marks]

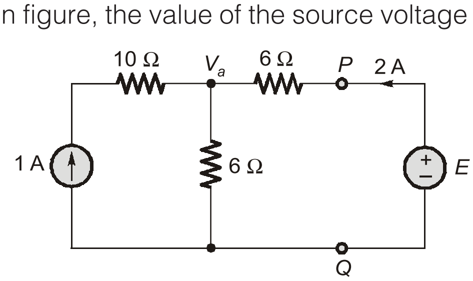
1.17 In figure, the value of *R* is



(a) 10 Ω (b) 18 Ω
(c) 24 Ω (d) 12 Ω

[2003 : 2 Marks]

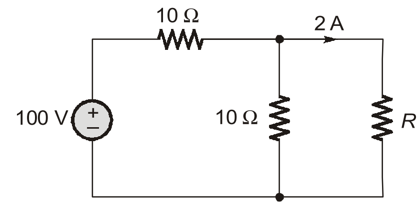
1.18 In figure, the value of the source voltage is



(a) 12 V (b) 24 V
(c) 30 V (d) 44 V

[2004 : 2 Marks]

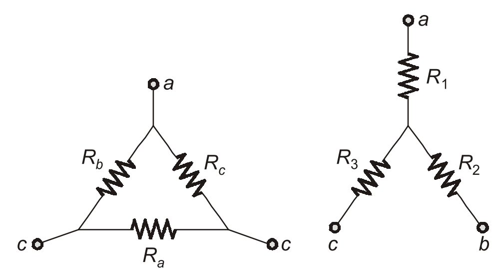
1.19 In figure, the value of resistance *R* in Ω is



(a) 10 (b) 20
(c) 30 (d) 40

[2004 : 2 Marks]

1.20 In figure, R_a, R_b and R_c are 20 Ω, 10 Ω and 10 Ω respectively. The resistances R_1, R_2 and R_3 in Ω of an equivalent star-connection are



(a) 2.5, 5, 5 (b) 5, 2.5, 5
(c) 5, 5, 2.5 (d) 2.5, 5, 2.5

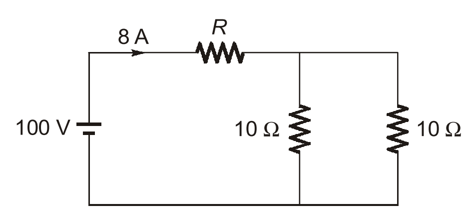
[2004 : 2 Marks]

1.21 The rms value of the current in a wire which carries a d.c. current of 10 A and a sinusoidal alternating current of peak value 20 A is

(a) 10 A (b) 14.14 A
(c) 15 A (d) 17.32 A

[2004 : 2 Marks]

1.22 In the figure given below the value of *R* is



(a) 2.5 Ω (b) 5.0 Ω
(c) 7.5 Ω (d) 10.0 Ω

[2005 : 1 Mark]

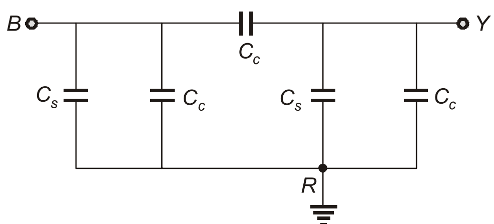
1.23 A 3 V dc supply with an internal resistance of 2 Ω supplies a passive non-linear resistance characterized by the relation $V_{NL} = I_{NL}^2$. The power dissipated in the non linear resistance is

(a) 1.0 W (b) 1.5 W
(c) 2.5 W (d) 3.0 W

[2007 : 2 Marks]

1.8 (c)

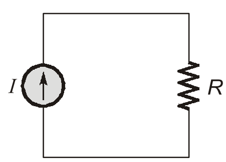
Given circuit can be redrawn as:



$$C_{BY} = \frac{C_s + C_c}{2} + C_c = \frac{C_s + 3C_c}{2}$$

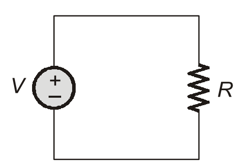
1.9 (b)

When resistor R is connected to a current source,



$P = I^2 R = 18$ W

When resistor R is connected to a voltage source,



$$P = \frac{V^2}{R} = 4.5 \text{ W}$$

Given, $V = I$ (in magnitude)

$\Rightarrow$ $I^2R = 18$ ...(i)

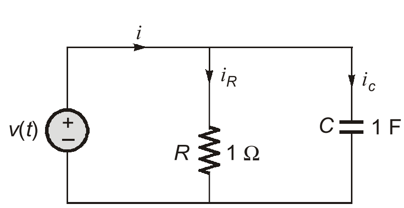
$$\frac{I^2}{R} = 4.5 \quad \text{...(ii)}$$

On solving these two equations, we get,

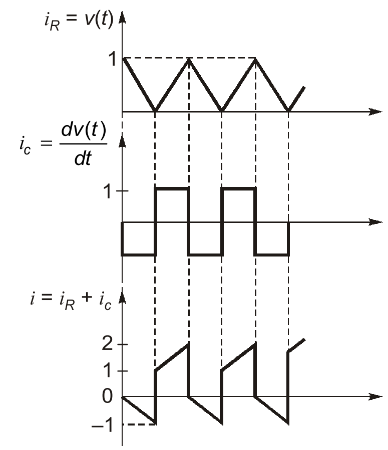
$I = 3$ A

$R = 2\ \Omega$

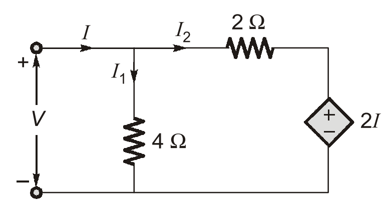
1.10 (d)



$$i = i_R + i_c = \frac{v(t)}{1} + 1 \cdot \frac{dv(t)}{dt}$$



1.11 (b)



Current through 4 Ω resistor,

$$I_1 = \frac{V}{4}$$

Current through 2 Ω resistor,

$$I_2 = \frac{V - 2I}{2}$$

Total current,

$$I = I_1 + I_2 = \frac{V}{4} + \frac{V - 2I}{2}$$

$$\Rightarrow \quad I = \frac{V}{4} + \frac{V}{2} - I$$

$$\Rightarrow \quad 2I = \frac{3}{4} V$$

$$\text{Load} = \frac{V}{I} = \frac{8}{3}\ \Omega$$

1.12 (d)

$$\because \quad P \propto \frac{1}{R}$$

Therefore resistance of 40 W bulb > resistance of 60 W bulb.

For series connection, current through both the bulbs will be same $P = I^2R$ (for series connection).

Power consumed by 40 W bulb > power consumed by 60 W bulb.

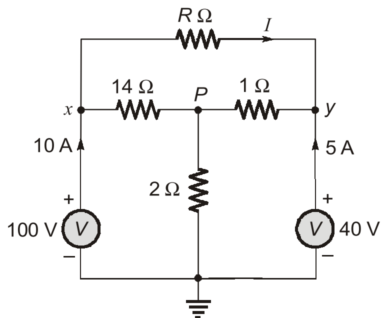
Hence, the 40 W bulb glows brighter.

1.17 (d)

By KCL,

$$\therefore \quad \frac{V_P - 40}{1} + \frac{V_P - 100}{14} + \frac{V_P}{2} = 0$$

$$22\,V_P = 660$$



$$\therefore \quad V_P = 30\text{ V}$$

Potential diffence between node x and y = 60 V

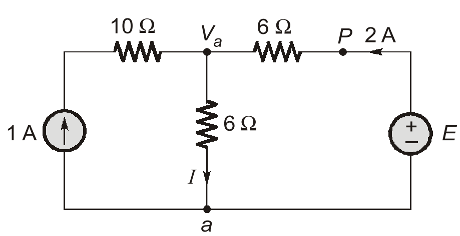
By taking KCL at node y

$$-I - 5 + \frac{40 - 30}{1} = 0$$

$$\therefore \quad I = 5\text{ A}$$

$$\therefore \quad I = \frac{60}{5} = 12\ \Omega$$

1.18 (c)



Method-1:

Using KCL,

$$\frac{V_a - E}{6} + \frac{V_a}{6} - 1 = 0$$

$$\Rightarrow \quad 2\,V_a - E = 6 \qquad \text{...(i)}$$

Where, $$\frac{E - V_a}{6} = 2$$

$$\Rightarrow \quad E - V_a = 12 \qquad \text{...(ii)}$$

Solving equation (i) and (ii), we get

$$V_a = 18\text{ V and } E = 30\text{ V}$$

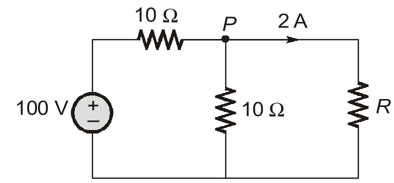
Method-2:

$$I = 2 + 1 = 3\text{ A}$$

Apply KVL in second loop,

$$E = 2 \times 6 + 3 \times 6 = 30\text{ V}$$

1.19 (b)



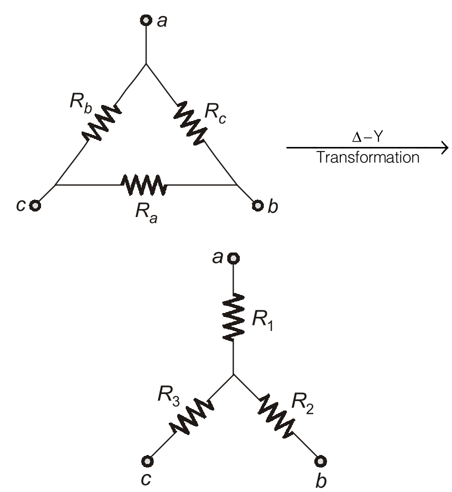
$$\frac{V_P - 100}{10} + \frac{V_P}{10} + 2 = 0$$

$$2V_P - 100 + 20 = 0$$

$$\therefore \quad V_P = \frac{80}{2} = 40\text{ V}$$

$$\therefore \quad R = \frac{V_P}{2} = \frac{40}{2} = 20\,\Omega$$

1.20 (a)



Given: $R_a = 20\ \Omega$

$R_b = 10\ \Omega$ and $R_c = 10\ \Omega$

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{10 \times 10}{20 + 10 + 10} = 2.5\ \Omega$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c} = \frac{10 \times 20}{20 + 10 + 10} = 5\ \Omega$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{20 \times 10}{20 + 10 + 10} = 5\ \Omega$$

Remember: If all the branches of Δ-connection has same impedance Z, then impedance of branch of Y-connection be $Z/3$.

1.21 (d)

R.M.S value of d.c current = 10 A = I_{dc}

R.M.S value of sinusoidal current = $\left(\frac{20}{\sqrt{2}}\right)$A $= I_{ac}$

R.M.S value of resultant,

$$I_R = \sqrt{I_{dc}^2 + I_{ac}^2}$$

$$= \sqrt{10^2 + \left(\frac{20}{\sqrt{2}}\right)^2} = 17.32 \text{ A}$$

1.22 (c)

The Resultant (R) when viewed from voltage source

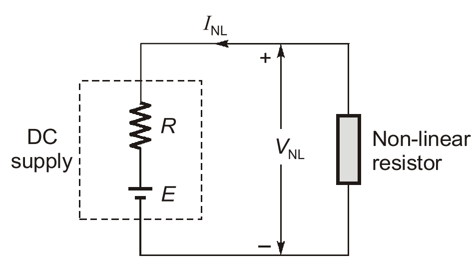
$$= \frac{100}{8} = 12.5$$

$$R + 10 || 10 = 12.5\ \Omega$$

$$\therefore \quad R = 12.5 - 10 || 10$$

$$= 12.5 - 5 = 7.5\ \Omega$$

1.23 (a)



$$V_{NL} = I_{NL}^2 \quad \text{...(i)}$$

$$V_{NL} = E - I_{NL}R$$

where, $E = 3$ V

and $R = 2\ \Omega$

$$V_{NL} = 3 - 2\, I_{NL} = I_{NL}^2$$

$$I_{NL}^2 + 2I_{NL} - 3 = 0$$

$$I_{NL} = -3 \text{ A or } 1 \text{ A}$$

–3 A is rejected, because the non-linear resistor is passive and the only active element in the circuit is 3 V DC supply. Which is supplying the power to the resistor.

So, I_{NL} = 1 A

Power dissipated in the non-linear resistor

$$= V_{NL} I_{NL} = I_{NL}^2 I_{NL}$$

$$= I_{NL}^3 = 1^3 = 1 \text{W}$$

1.24 (a)

$$i = 1 \text{ A}$$

Applying KVL,

$$V_{ab} - 2i + 5 = 0$$

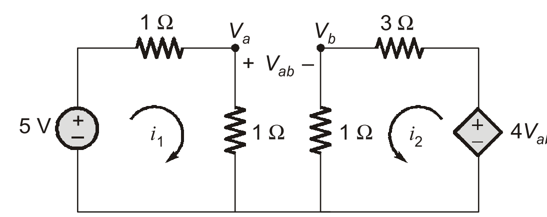
$$V_{ab} = -5 + 2i$$

$$= -5 + 2 \times 1$$

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

Note: KVL is based on the conservation of energy.

1.25 (b)



By KVL in Loop-1,

$$5 - i_1 - i_1 = 0$$

$$i_1 = \frac{5}{2} = 2.5 \text{ A}$$

$$\therefore \quad V_a = 2.5 \text{ V}$$

By KVL in Loop-2,

$$4V_{ab} = 3i_2 + i_2$$

$$i_2 = \frac{4V_{ab}}{4} = V_{ab}$$

$$\therefore \quad V_b = 1 \times i_2 = V_{ab}$$

$$V_b = V_a - V_b$$

$$V_b = \frac{V_a}{2} = \frac{2.5}{2}$$

$$= 1.25 \text{ V}$$

$$i_2 = V_{ab} = V_b$$

$$i_2 = 1.25 \text{ A}$$

1.26 (a)

Bridge is balanced i.e. node C and node D are at same potential. Therefore, no current flows through 2 kΩ resistor.

1.27 (d)

Let resistance of a single incandescent lamp = R.

Power consumed by a single lamp, P = 200 W.

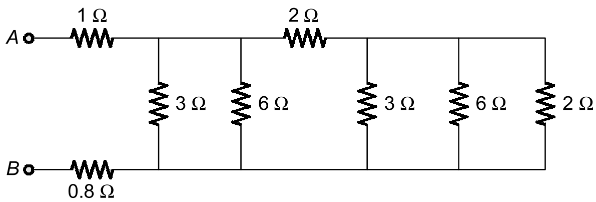
When connected across voltage, V = 220 V.

So, $$P = \frac{V^2}{R} \Rightarrow 200 = \frac{220^2}{R}$$

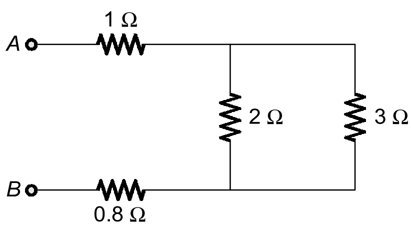
$$\Rightarrow \quad R = 242\ \Omega$$

1.49 Sol.

Consider the following circuit diagram,



After rearrangement we get,



Now, $R_{AB} = 1 + \frac{6}{5} + 0.8 = 3\ \Omega$

1.50 Sol.

Using KCL at node, we get

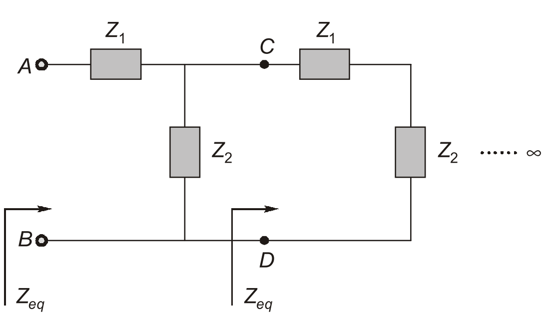
$$I + 0.4I = 14$$

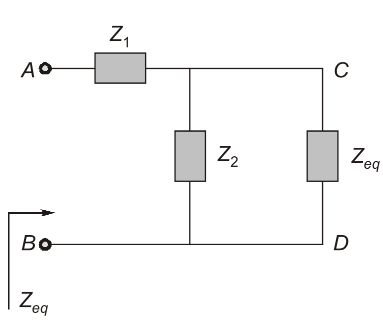
or $$I = 10\text{ A}$$

Now, power supplied,

$$P = 25 \times 10 = 250\text{ W}$$

1.51 (a)



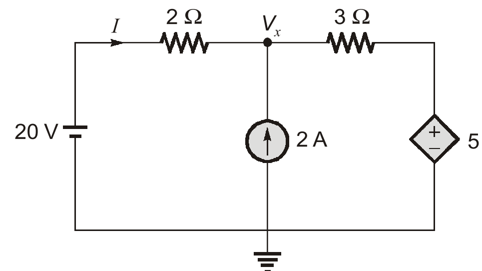


$$Z_1 = j9$$
$$Z_2 = j5 - j1 = j4$$
$$Z_{eq} = Z_1 + \frac{Z_2 Z_{eq}}{Z_2 + Z_{eq}}$$

By solving above equation,

$$Z_{eq} = j12$$

1.52 Sol.



Applying nodal at node x,

$$-I - 2 + \frac{V_x - 5I}{3} = 0$$
$$-3I - 6 + V_x - 5I = 0$$
$$\Rightarrow \quad 8I = V_x - 6 \quad ...(i)$$

As, $$I = \frac{20 - V_x}{2}$$

$$\Rightarrow \quad V_x = 20 - 2I \quad ...(ii)$$

Substituting (ii) in (i),

$$8I = 20 - 2I - 6$$
$$\Rightarrow \quad 10I = 14$$
$$I = 1.4\text{ A}$$

1.53 Sol.

$$I = 1\angle 10° + 1\angle 70°$$
$$I = 1.732\angle 40°$$

The ready of ammeter is 1.732 A.

■■■■