Fully Solved

4000 MCQs

For

ESE, GATE, PSUs

Electronics Engineering

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PREFACE

B. Singh (Ex. IES)

This Electronics Engineering practice book containing nearly 4000 MCQs focuses in-depth understanding of subjects which has been segregated topicwise to disseminate all kind of exposure to students in terms of quick learning and deep apt. The topicwise segregation has been done to align with contemporary competitive examination pattern. Attempt has been made to bring out all kind of probable competitive questions for the aspirants preparing for ESE, GATE and PSUs. The content of this book ensures threshold level of learning and wide range of practice questions which is very much essential to boost the exam time confidence level and ultimately to succeed in all prestigious engineers' examinations. It has been ensured from MADE EASY team to have broad coverage of subjects at chapter level.

While preparing this book utmost care has been taken to cover all the chapters and variety of concepts which may be asked in the exams. The solutions and answers provided are upto the closest possible accuracy. The full efforts have been made by MADE EASY Team to provide error free solutions and explanations.

I have true desire to serve student community by way of providing good sources of study and quality guidance. I hope, this book will be proved an important tool to succeed in competitive examinations. 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

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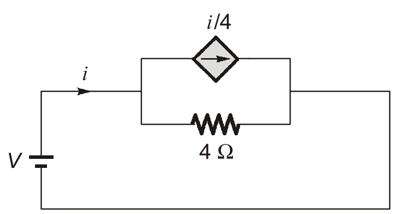
UNIT 1

Network Theory

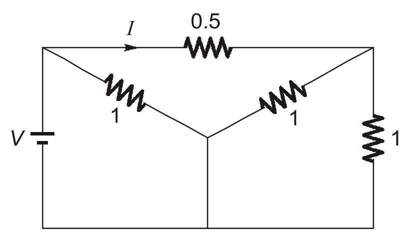
1. Basic of Network Analysis

Q.1 In the network shown below, the effective resistance faced by the voltage source is



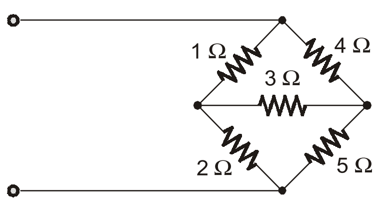
(a) 4 Ω (b) 3 Ω
(c) 2 Ω (d) 1 Ω

Q.2 In the circuit shown in the figure, if I = 2 A, then the value of the battery voltage V will be



(a) 5 V (b) 3 V
(c) 2 V (d) 1 V

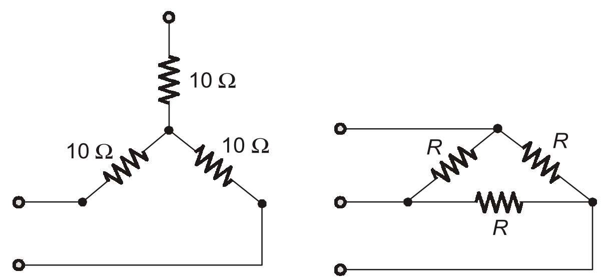
Q.3 The input resistance of the circuit shown is



(a) 1 Ω (b) 3.36 Ω
(c) 2.24 Ω (d) 1.12 Ω

Q.4 In a network made up of linear resistors and ideal voltage sources, values of all resistors are doubled. Then the voltage across each resistor is
(a) Doubled
(b) Halved
(c) Decreased four times
(d) Not changed

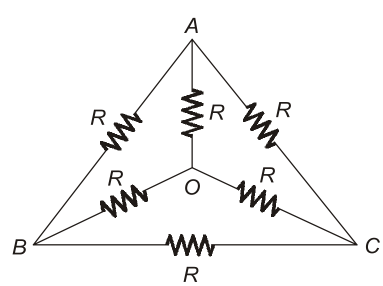
Q.5 Star connected load is shown in the figure. The equivalent delta connection has a value of R in Ω is



(a) 10 Ω (b) 30 Ω
(c) 10/3 Ω (d) 20/3 Ω

Q.6 Kirchhoff's current law is valid for
(a) DC circuit only
(b) AC circuit only
(c) Both DC and AC circuits
(d) Sinusoidal source only

Q.7 The effective resistance between the terminals A and B in the circuit shown in the figure is



(a) R (b) $R - 1$
(c) $R/2$ (d) $6R/11$

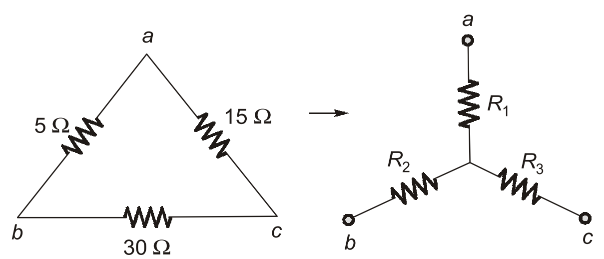
Q.8 The nodal method of circuit analysis is based on
(a) KVL and Ohm's law
(b) KCL and Ohm's law
(c) KCL and KVL
(d) KCL and KVL and Ohm's law

Q.9 Twelve 1 Ω resistances are used as edge to form a cube. The resistance between two diagonally opposite corners of the cube is

(a) $\frac{5}{6}\Omega$ (b) $1\ \Omega$

(c) $\frac{6}{5}\Omega$ (d) $\frac{3}{2}\Omega$

Q.10 A delta connected network with its Y-equivalent is shown in figure. The resistances R_1, R_2 and R_3 (in ohms) are respectively



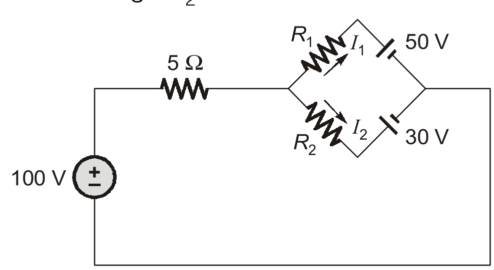
(a) 1.5 Ω, 3 Ω and 9 Ω
(b) 3 Ω, 9 Ω and 1.5 Ω
(c) 9 Ω, 3 Ω and 1.5 Ω
(d) 3 Ω, 1.5 Ω and 9 Ω

Q.11 If each branch of a delta circuit has impedance $\sqrt{3}\,Z$, then each branch of equivalent Y-circuit has impedance

(a) $\frac{Z}{\sqrt{3}}$ (b) Z

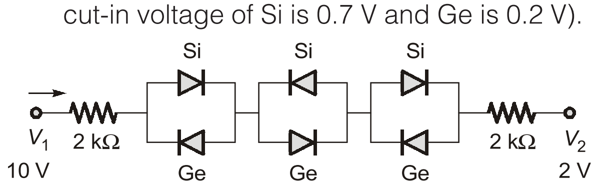
(c) $2\sqrt{3}\,Z$ (d) $\frac{Z}{3}$

Q.12 In the circuit shown, what are the values of R_1 and R_2 when the current flowing through R_1 is 1 A and through R_2 is 5 A?



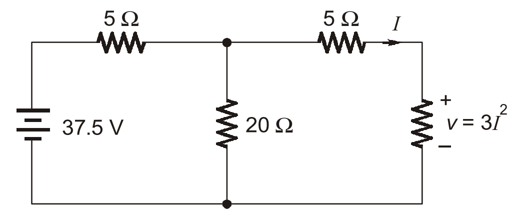
(a) 20 Ω, 8 Ω (b) 12 Ω, 5 Ω
(c) 8 Ω, 12 Ω (d) 8 Ω, 20 Ω

Q.13 Determine the current in the network (Assume cut-in voltage of Si is 0.7 V and Ge is 0.2 V).



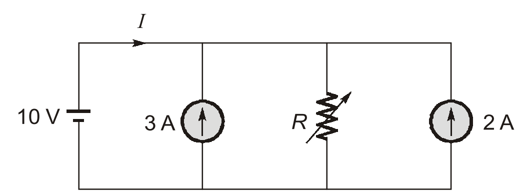
(a) 1.6 mA (b) 1.575 mA
(c) 1.557 mA (d) None of these

Q.14 The value of 'I' in the circuit given below is



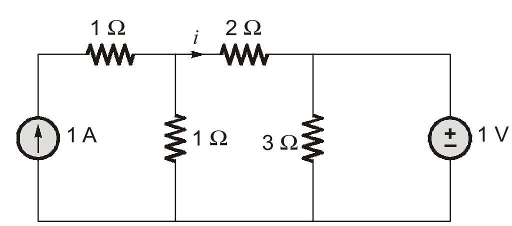
(a) –5 A (b) 5 A
(c) –2 A (d) 2 A

Q.15 Consider the electrical network shown below.



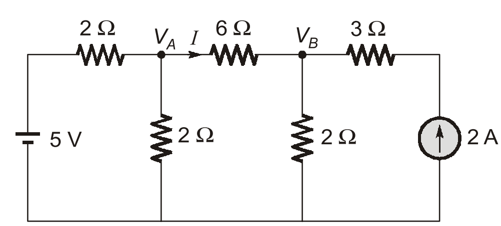
What is the value of R so that current I is zero?
(a) 2 Ω (b) 5 Ω
(c) 4 Ω (d) 3 Ω

Q.16 The current i in the network given below is



(a) 1 A (b) 2 A
(c) 3 A (d) 0 A

Q.17 Node voltages V_A and V_B are as shown in the circuit below

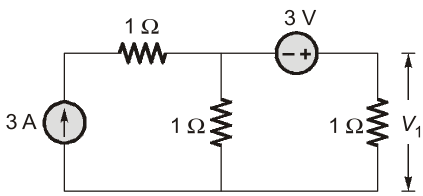


V_A and V_B are respectively

(a) $\frac{11}{3}$ V and $\frac{8}{3}$ V (b) 6 V and 8 V

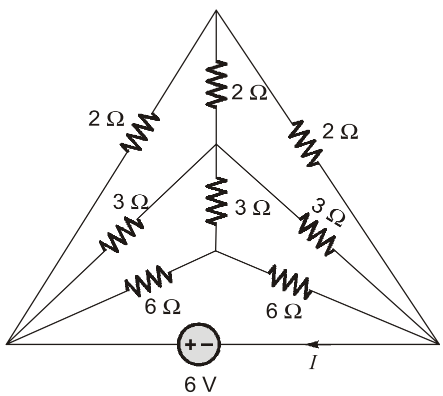
(c) $\frac{24}{9}$ V and $\frac{33}{9}$ V (d) None of these

Q.18 The value of V_1 in the circuit shown in the given figure is



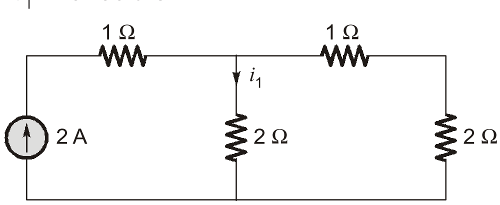
(a) 1 V (b) 2 V
(c) 3 V (d) 4 V

Q.19 Consider the following circuit:



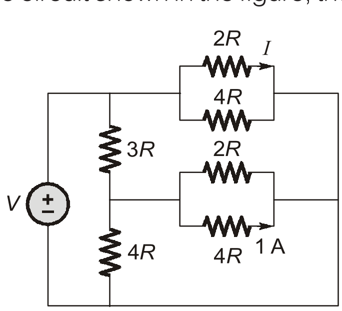
What is the value of the current I in the above circuit?
(a) 1 A (b) 2 A
(c) 3 A (d) 4 A

Q.20 i_1 in circuit is



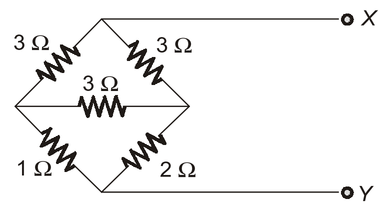
(a) 4/5 A (b) 6/5 A
(c) 2/5 A (d) 7/5 A

Q.21 For the circuit shown in the figure, the current 'I' is



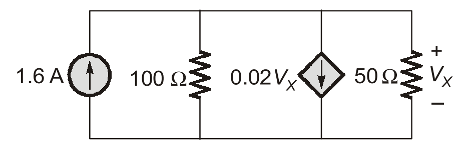
(a) indeterminable due to inadequate data
(b) zero
(c) 4 A
(d) 8 A

Q.22 Equivalent resistance between X and Y in given circuit



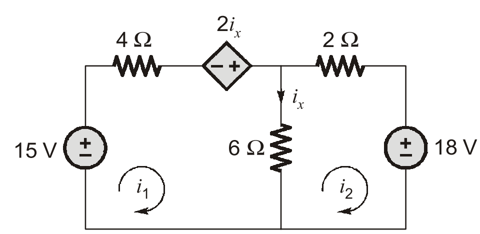
(a) 9 Ω (b) 3 Ω
(c) 11/5 Ω (d) 5/11 Ω

Q.23 In given network find V_X?



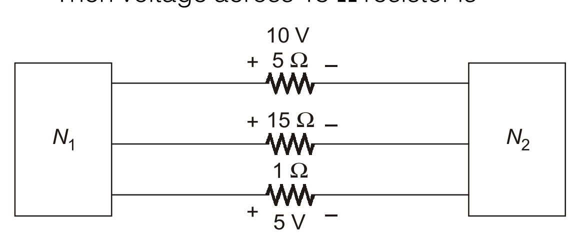
(a) 32 V (b) –32 V
(c) 12 V (d) –12 V

Q.24 For given circuit i and i_2 is



(a) 2.6 A, 1.4 A (b) 2.6 A, –1.4 A
(c) 1.6 A, 1.35 A (d) 1.2 A, –1.35 A

Q.25 The two electrical subnetworks N_1 and N_2 are connected through three resistors as shown in figure. The voltage across 5 Ω resistor and 1 Ω resistor are given to be 10 V and 5 V respectively. Then voltage across 15 Ω resistor is



(a) –105 V (b) 105 V
(c) –15 V (d) 15 V

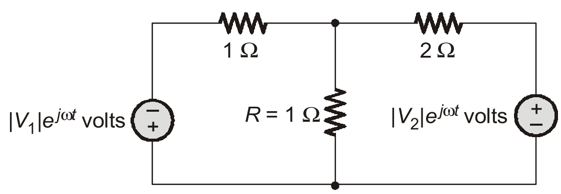
Q.26 For a given voltage, four heating coils will produce maximum heat, when connected
(a) all in parallel
(b) all in series
(c) with two parallel pairs in series
(d) one pair in parallel with the other two in series

Q.27 A long uniform coil of an inductance L Henries and associated resistance R ohms is physically cut into two exact halves which are then rewound in parallel. The resistance and inductance of the combination are

(a) R and L (b) $\frac{R}{2}$ and $\frac{L}{2}$

(c) $\frac{R}{4}$ and $\frac{L}{4}$ (d) $2R$ and $2L$

Q.28 In the circuit shown, the power dissipated in the resistor R is 1 W when only source '1' is present and '2' is replaced by short circuit. The power dissipated in the same resistor R is 4 W when only source '2' is present and '1' is replaced by a short circuit. When both the sources '1' and '2' are present, the power dissipated in R will be



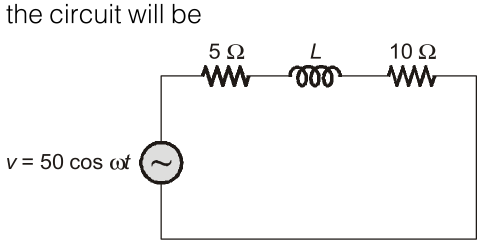
(a) 5 W (b) 4 W
(c) 3 W (d) 1 W

Q.29 A circuit possesses resistance R and inductive reactance X_L in series. Its susceptance is given by

(a) $\frac{R}{Z}$ (b) $\frac{X_L}{Z}$

(c) $\frac{R}{Z^2}$ (d) $\frac{X_L}{Z^2}$

Q.30 In the circuit shown below, if the power consumed by the 5 Ω resistor is 10 W, then power factor of the circuit will be



(a) zero (b) 0.5
(c) 0.8 (d) 0.6

Q.31 Two heaters, rated at 1000 W, 250 V each are connected in series across a 250 V, 50 Hz ac mains. The total power drawn from the supply would be

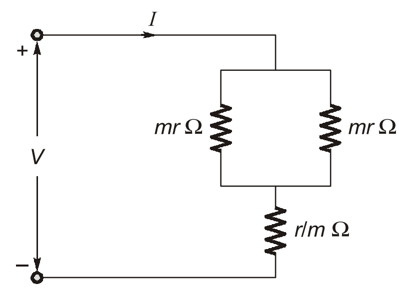
(a) 2000 W (b) 1000 W
(c) 250 W (d) 500 W

Q.32 **Assertion (A):** A network in which the circuit elements like resistance, inductance etc. cannot be physically separated for analysis purposes, is called lumped network.

Reason (R): Most of the electric networks are lumped in nature.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.33 What is the value of m so that the current I in the circuit shown below is maximum?



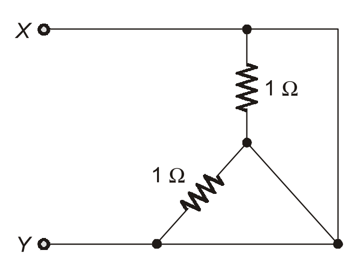
(a) $\sqrt{3}$ (b) $\frac{1}{\sqrt{2}}$

(c) $\frac{1}{\sqrt{3}}$ (d) $\sqrt{2}$

Q.34 Two 100 W, 220 V bulbs are required to be connected across a 400 volts supply. The value of resistance to be inserted in the line so that the voltage across the bulbs does not exceed 220 V is

(a) 198 Ω (b) 0 Ω
(c) 125.5 Ω (d) 76.2 Ω

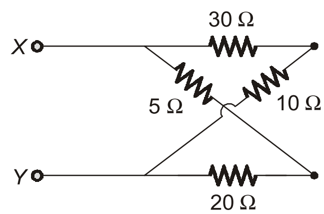
Q.35 The equivalent resistance across the terminal X-Y for the circuit shown below is



(a) 0 Ω (b) 1 Ω

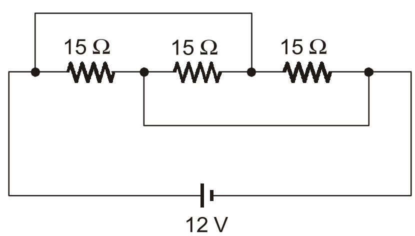
(c) $\frac{3}{2}$ Ω (d) $\frac{1}{2}$ Ω

Q.36 The value of voltage source to be connected across the terminals *X* and *Y* so that drop across the 10 Ω resistor is 45 V is



(a) 36 volts (b) 180 volts
(c) 95 volts (d) 120 volts

Q.37 For the circuit shown below, the equivalent resistance will be



(a) 45 Ω (b) 15 Ω
(c) 5 Ω (d) 7.5 Ω

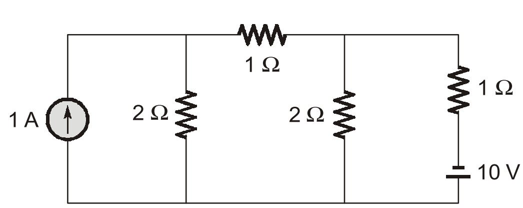
Q.38 Three resistors of *R* Ω each are connected to form a triangle. The resistance between any two terminals will be

(a) *R* Ω (b) 3*R* Ω

(c) $\frac{2}{3}R$ Ω (d) $\frac{3}{2}R$ Ω

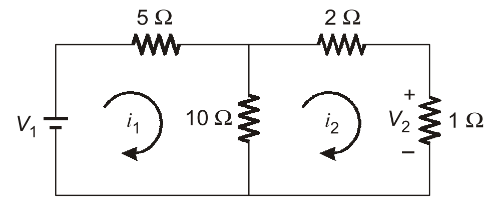
Q.39 Kirchhoff's laws are not applicable to circuits with
(a) passive elements
(b) lumped parameters
(c) distributed parameters
(d) non-linear resistances

Q.40 For the circuit shown below, the current through the 10 V battery is



(a) 2.36 A (b) 4.91 A
(c) –2.36 A (d) None of these

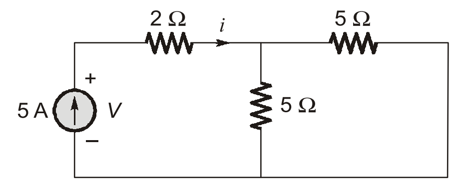
Q.41 In the circuit shown in figure below, the value of V_2/V_1 is



(a) $\frac{-19}{2}$ (b) $\frac{19}{2}$

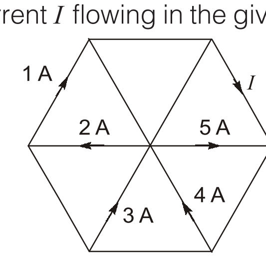
(c) 1.5 (d) $\frac{2}{19}$

Q.42 The value of *V* in volts for the circuit shown below is



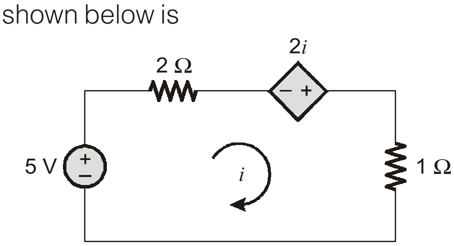
(a) zero (b) 16.65
(c) 22.50 (d) –3.6

Q.43 The current I flowing in the given figure is



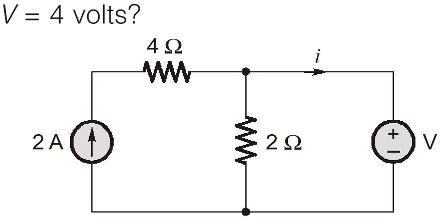
(a) 1 A (b) 2 A
(c) 3 A (d) 4 A

Q.44 The value of dependent source for the circuit shown below is



(a) 5 A (b) –10 V
(c) –5 A (d) 10 V

Q.45 In the circuit shown in figure below, what is the value of current *i* through source when *V* = 4 volts?

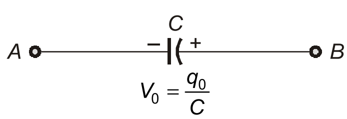


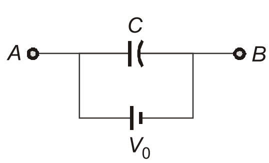
(a) 1 A (b) 2 A
(c) 3 A (d) 0 A

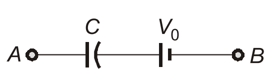
Q.46 The number of mess equations needed to solve an electrical network is $m = (b - n + 1)$, where b is the number of branches and n is the number of nodes in the electrical network.
Consider the following statements related to mesh and nodal-analysis for analysing an electrical network.
1. If $m < n$, the Mesh method offers less advantages.
2. If $m > n$, i.e. when the number of parallel paths in the network is more, mess method is preferred.

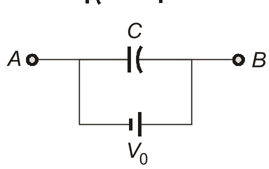
Which of the above statements is/are true?
(a) Neither 1 nor 2 (b) 1 only
(c) 2 only (d) Both 1 and 2

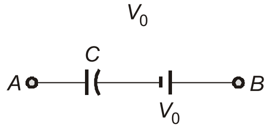
Q.47 The equivalent circuit of the capacitor shown below is



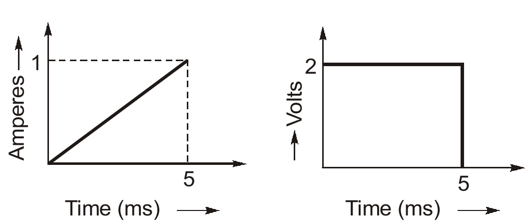
(a) 

(b) 

(c) 

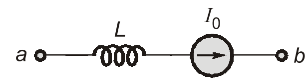
(d) 

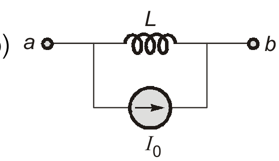
Q.48 The current and voltage profile of an element vs time has been shown in given figure. The element and its value are respectively

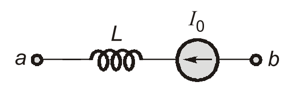


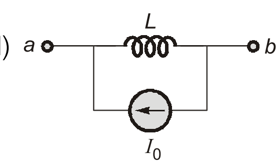
(a) a resistor with $R = 2\ \text{m}\Omega$
(b) a capacitor with $C = 2\ \mu\text{F}$
(c) an inductor with $L = 0.5$ H
(d) an inductor with $L = 10$ mH

Q.49 The equivalent circuit of the inductor shown below is

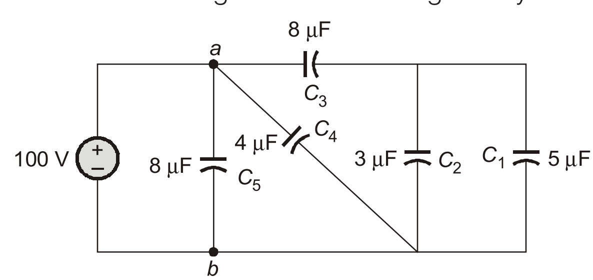
(a) 

(b) 

(c) 

(d) 

Q.50 The charging time required to charge the equivalent capacitance between the given terminals a - b by a steady direct current of constant magnitude of 10 A is given by



(a) 160 μsec (b) 80 μsec
(c) 21 μsec (d) 45 μsec

Q.51 An ac voltage of 220 V is applied to a pure inductance of 50 H. If the current is 5 A, the instantaneous value of voltage and current will be respectively given by
(a) $v = 622 \sin (314t)$ Volts
$i = 7.07 \cos (314t - 90°)$ Amps
(b) $v = 311 \sin (314t)$ Volts
$i = 14.14 \sin (314t - 90°)$ Amps
(c) $v = 311 \sin (314t)$ Volts
$i = 7.07 \sin (314t - 90°)$ Amps
(d) $v = 622 \sin (314t)$ Volts
$i = 14.14 \cos (314\ t - 90°)$ Amps

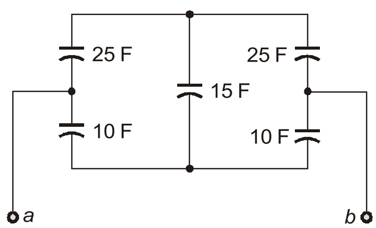
Q.52 The voltage and current through a circuit element is $v = 100 \sin (314\ t + 45°)$ volts and
$i = 10 \sin (314\ t - 45°)$ amps.
The type of circuit element and its value will be respectively

(a) an inductor with L = 31.8 mH
(b) a capacitor with C = 10 F
(c) an inductor with L = 10 H
(d) a capacitor with C = 31.8 μF

Q.53 There inductances, 1 H, 2 H and L H are in parallel. The maximum value of equivalent inductance will be

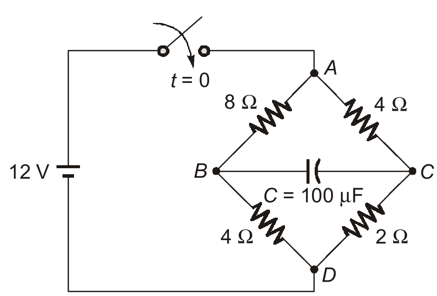
(a) $\frac{3}{2}$ H (b) 0 H
(c) 3 H (d) none of these

Q.54 The equivalent capacitance between the terminals a-b for the capacitive circuit shown below is



(a) 25.25 F (b) 16.80 F
(c) 12.25 F (d) 17.50 F

Q.55 For the bridge circuit shown below, the charge accumulated in the capacitor under steady state condition is



(a) zero (b) 12 μC
(c) infinite (d) 4 μC

Q.56 A current input, 5 δ(t) is flowing through a capacitor C. The voltage $V_c(t)$, across capacitor is given by

(a) $\frac{5}{C}t$ (b) 5 C $u(t)$

(c) 5t (d) $\frac{5}{C}u(t)$

Q.57 Potential difference across a capacitor of capacitance of 20 μF is increased uniformly from 0 to 240 V in 1 second. The charging current will be
(a) 9.6 mA (b) 1.2 mA
(c) 4.8 mA (d) 12 mA

Q.58 **Assertion (A):** Lower the self inductance of a coil more the delay in establishing steady current through it.
Reason (R): An inductor opposes a sudden change in current.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

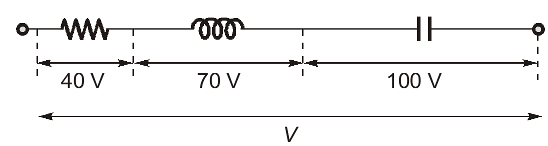
2. Steady State Sinusoidal Analysis

Q.59 A parallel plate capacitor is filled with two dielectrics of ϵ_1 and ϵ_2 lengthwise equally. The capacitance of the combination is

(a) $\frac{2\epsilon_0 \epsilon_1 \epsilon_2 A}{d}$ (b) $\frac{2\epsilon_0 \epsilon_1 \epsilon_2 A^2}{d^2}$

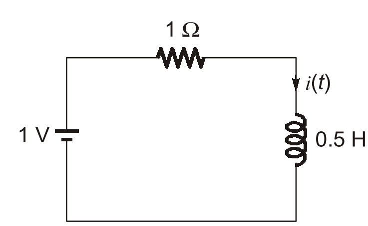
(c) $\frac{\epsilon_0 A(\epsilon_1 + \epsilon_2)}{2d}$ (d) $\frac{A \epsilon_1 \epsilon_2}{d}$

Q.60 The supply voltage $|V|$ in diagram below is



(a) 210 V (b) 70 V
(c) 50 V (d) 230 V

Q.61 Steady state value of the current in the circuit is



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

(c) 2 A (d) 1 A

Q.62 In 220 V, 50 Hz AC supply the rms value of a.c. voltage wave form is

(a) $220\sqrt{2}$ V (b) $\frac{200}{\sqrt{2}}$ V

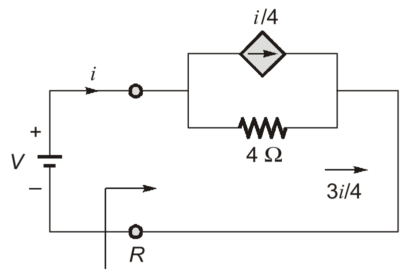
(c) 220 V (d) none of these

Answers Network Theory

1. (b)	2. (c)	3. (c)	4. (d)	5. (b)	6. (c)	7. (c)	8. (b)
9. (a)	10. (a)	11. (a)	12. (a)	13. (b)	14. (d)	15. (a)	16. (d)
17. (c)	18. (c)	19. (c)	20. (b)	21. (d)	22. (c)	23. (a)	24. (d)
25. (a)	26. (a)	27. (c)	28. (d)	29. (d)	30. (d)	31. (d)	32. (d)
33. (d)	34. (a)	35. (a)	36. (b)	37. (c)	38. (c)	39. (c)	40. (b)
41. (d)	42. (c)	43. (a)	44. (d)	45. (d)	46. (a)	47. (d)	48. (d)
49. (b)	50. (a)	51. (c)	52. (a)	53. (d)	54. (d)	55. (a)	56. (d)
57. (c)	58. (d)	59. (c)	60. (c)	61. (d)	62. (c)	63. (d)	64. (b)
65. (c)	66. (b)	67. (c)	68. (b)	69. (c)	70. (c)	71. (a)	72. (c)
73. (c)	74. (c)	75. (b)	76. (d)	77. (d)	78. (d)	79. (a)	80. (b)
81. (c)	82. (d)	83. (b)	84. (c)	85. (d)	86. (a)	87. (c)	88. (d)
89. (d)	90. (a)	91. (b)	92. (b)	93. (d)	94. (c)	95. (b)	96. (b)
97. (d)	98. (c)	99. (c)	100. (d)	101. (b)	102. (c)	103. (d)	104. (d)
105. (a)	106. (c)	107. (b)	108. (b)	109. (c)	110. (c)	111. (a)	112. (c)
113. (c)	114. (b)	115. (a)	116. (b)	117. (a)	118. (b)	119. (c)	120. (a)
121. (c)	122. (d)	123. (c)	124. (b)	125. (a)	126. (a)	127. (d)	128. (d)
129. (d)	130. (b)	131. (b)	132. (b)	133. (c)	134. (d)	135. (d)	136. (c)
137. (c)	138. (b)	139. (c)	140. (d)	141. (d)	142. (c)	143. (d)	144. (c)
145. (b)	146. (a)	147. (d)	148. (a)	149. (c)	150. (b)	151. (c)	152. (c)
153. (b)	154. (c)	155. (a)	156. (b)	157. (c)	158. (a)	159. (b)	160. (d)
161. (a)	162. (c)	163. (b)	164. (a)	165. (c)	166. (c)	167. (b)	168. (d)
169. (c)	170. (c)	171. (a)	172. (c)	173. (c)	174. (c)	175. (d)	176. (b)
177. (b)	178. (c)	179. (b)	180. (d)	181. (a)	182. (c)	183. (d)	184. (c)
185. (d)	186. (b)	187. (c)	188. (a)	189. (c)	190. (b)	191. (a)	192. (c)
193. (c)	194. (c)	195. (b)	196. (d)	197. (b)	198. (c)	199. (a)	200. (c)
201. (b)	202. (c)	203. (c)	204. (c)	205. (c)	206. (a)	207. (b)	208. (d)
209. (a)	210. (b)	211. (a)	212. (a)	213. (a)	214. (b)	215. (b)	216. (d)
217. (d)	218. (b)	219. (c)	220. (d)	221. (a)	222. (d)	223. (c)	224. (d)
225. (b)	226. (a)	227. (d)	228. (b)	229. (a)	230. (d)	231. (d)	232. (a)
233. (a)	234. (d)	235. (d)	236. (b)	237. (b)	238. (d)	239. (a)	240. (d)
241. (d)	242. (b)	243. (a)	244. (c)	245. (b)	246. (c)	247. (c)	248. (a)
249. (a)	250. (c)	251. (d)	252. (c)	253. (b)	254. (b)	255. (b)	256. (c)
257. (c)	258. (a)	259. (c)	260. (b)	261. (c)	262. (d)	263. (d)	264. (a)
265. (b)	266. (a)	267. (a)	268. (c)	269. (c)	270. (c)	271. (d)	272. (c)
273. (b)	274. (b)	275. (b)	276. (c)	277. (b)	278. (c)	279. (b)	280. (d)
281. (d)	282. (a)	283. (d)	284. (c)	285. (d)	286. (c)	287. (b)	288. (b)
289. (a)	290. (c)	291. (c)	292. (b)	293. (b)	294. (a)	295. (a)	296. (d)
297. (c)							

Explanations

1. (b)



$$R = \frac{V}{i}$$

Using source transformation and KVL, we get,

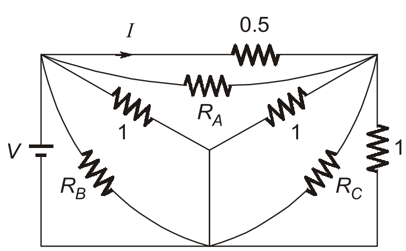
$$V + i = 4i$$

or, $$V = 3i$$

$$\Rightarrow \quad R = \frac{V}{i} = 3\ \Omega$$

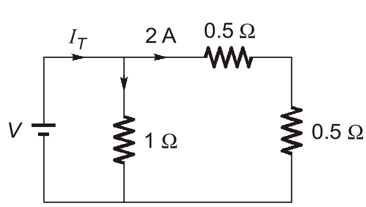
2. (c)

Given circuit:



Y-Δ transforming

$$R_A = \infty$$
$$R_B = 1\ \Omega$$
$$R_C = 1\ \Omega$$

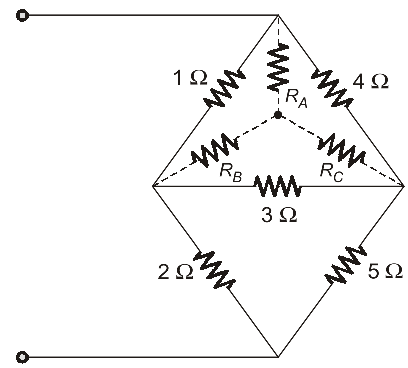


By current division rule

$$I_T = 2 \times 2 = 4\text{ A}.$$

$\because \quad V = I_T \times R = 4 \times 0.5 = 2\text{ V}$

3. (c)



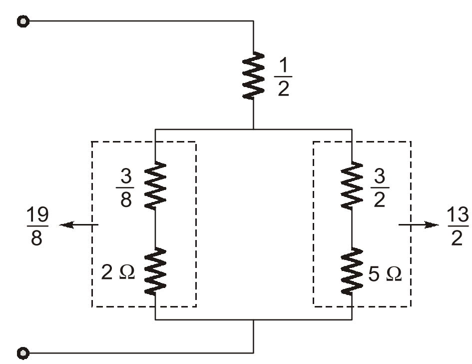
Δ-Y conversion:

$$R_A = \frac{4}{8} = \frac{1}{2}$$

$$R_B = \frac{3}{8}\ \Omega$$

$$R_C = \frac{12}{8}\ \Omega = \frac{3}{2}$$

Redrawing the circuit,



$$R_{in} = \frac{1}{2} + \left(\frac{19}{8} \parallel \frac{13}{2}\right)$$

$$R_{in} = 2.24\ \Omega$$

4. (d)

Ideal voltage source keeps the terminal voltage constant so accordingly current will change and the voltage across each resistor is unchanged following superposition principle.

5. (b)

$$R = \frac{1}{10}[(10 \times 10) + (10 \times 10) + (10 \times 10)] = 30$$

7. (c)

Using Y-Δ conversion

$$R_{eff} = \frac{\frac{3}{4}R \times \frac{3}{2}R}{\frac{3}{4}R + \frac{3}{2}R} = \frac{R}{2}$$

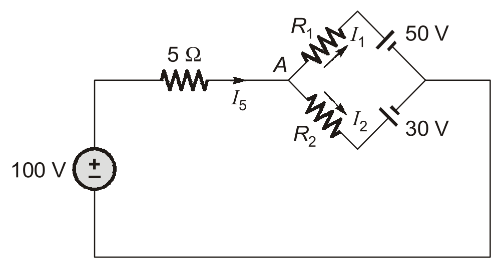
10. (a)

$$R_1 = \frac{15 \times 5}{50} = 1.5\ \Omega$$

$$R_2 = \frac{30 \times 5}{50} = 3\ \Omega$$

$$R_3 = \frac{15 \times 30}{50} = 9\ \Omega$$

12. (a)



The current through 5 Ω resistance is

$I_5 = I_1 + I_2 = 1 + 5 = 6$ A

Voltage across 5 Ω is $V_5 = 5 \times 6 = 30$ V

The voltage at node A is

$V_A = 100 - 30 = 70$ V

$$I_2 = \frac{V_A - 30}{R_2} = \frac{40}{R_2}$$

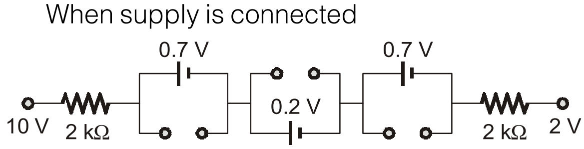
$$\therefore \quad R_2 = \frac{40}{5} = 8\ \Omega$$

$$\therefore \quad I_1 = \frac{V_A - 50}{R_1} = \frac{20}{R_1}$$

$$\therefore \quad R_1 = 20\ \Omega$$

13. (b)

When supply is connected



$$I = \frac{10 - 0.7 - 0.2 - 2 - 0.7}{4} = 1.6\ \text{mA}$$

Note: The cut-in voltage of Si is 0.7 V and Ge is 0.2 V.

14. (d)

Using source transformation we obtain equation circuit as

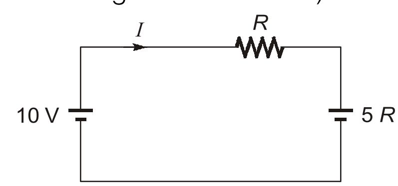
$\therefore\ 3I^2 + 9I - 30 = 0$

$$I = \frac{-9 \pm \sqrt{9^2 - 4(3)(-30)}}{2(3)} = 2, -5\ \text{A}$$

$I = 2$ A is possible as current must flow out of the positive terminal of only source.

15. (a)

The given circuit can be redrawn as shown below (By combining current sources).



Now, $\quad I = 0 \quad$ (Given)

i.e. $$\frac{10 - 5R}{R} = 0$$

or, $\quad R = 2\ \Omega$

16. (d)

By superposition theorem

$$I = I' + I'' = \frac{1}{3} - \frac{1}{3} = 0$$

where $I' \rightarrow$ current due to 1 A source after 1 V is short circuit.

and $I'' \rightarrow$ current due to 1 V source after 1 A source is open circuit.

17. (c)

Taking KCL at V_A

$$\frac{V_A - 5}{2} + \frac{V_A}{2} + \frac{V_A - V_B}{6} = 0$$

$\therefore\ 3V_A - 15 + 3V_A + V_A - V_B = 0$

$7V_A - V_B = 15 \quad \text{... (i)}$

Taking KCL at V_B :

$$\frac{V_B}{2} + \frac{V_B - V_A}{6} + (-2) = 0$$

$3V_B + V_B - V_A - 12 = 0$

$4V_B - V_A = 12 \quad \text{... (ii)}$

Solving V_A and V_B we get

$$V_A = \frac{8}{3} = \frac{24}{9}\ \text{V}$$

$$V_B = \frac{11}{3} = \frac{33}{9}\ \text{V}$$

18. (c)

Writing KCL at supernode

$$V_1 + V = 3 \quad \text{...(1)}$$

$$V - V_1 = 3 \quad \text{...(2)}$$

From equation (1) and (2) 2 V = 6 $\Rightarrow$ V = 3 volt

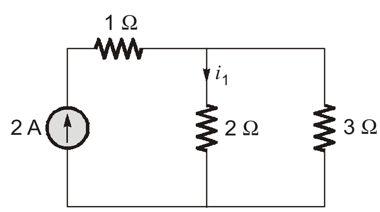
19. (c)

Circuit is symmetric, so using reciprocity property.

$$I = \frac{6}{2+2} + \frac{6}{3+3} + \frac{6}{6+6} = 3\text{ A}$$

20. (b)

The equivalent network is

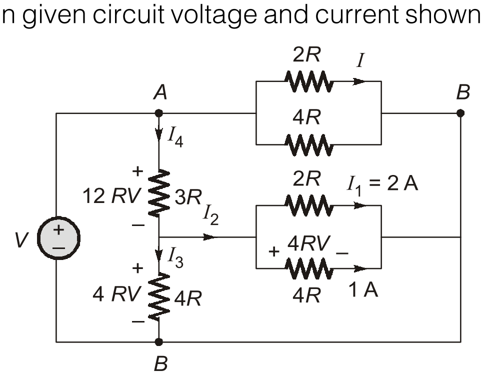


By current division rule,

$$i_1 = \frac{3}{5} \times 2 = \frac{6}{5}\text{ A}$$

21. (d)

In given circuit voltage and current shown



$$I_1 = \frac{4R}{2R} = 2\text{ A}$$

$$I_2 = 2 + 1 = 3\text{ A}$$

$$I_3 = \frac{4R}{4R} = 1\text{ A}$$

$$I_4 = I_2 + I_3 = 4\text{ A}$$

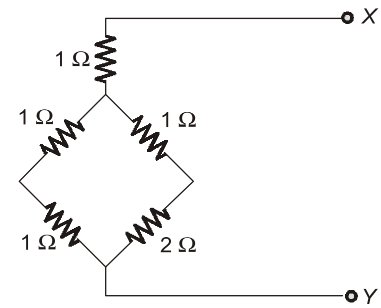
$$V_{AB} = 12RV + 4RV = 16RV$$

$$I = \frac{16RV}{2R} = 8\text{ A}$$

$\Rightarrow$ $I = 8$ A

22. (c)

Convert 3 Ω, Δ resistors network into Y network than circuit is



$$\Rightarrow \frac{2 \times 3}{2+3} + 1 = \frac{11}{5}$$

23. (a)

By the nodal equation

$$\frac{V_X}{50} + \frac{V_X}{100} + 0.02V_X = 1.6$$

$$V_X = 32\text{ V}$$

24. (d)

$$i_x = i_1 - i_2$$

$$15 = 4i_1 - 2(i_1 - i_2) + 6(i_1 - i_2)$$

$$\Rightarrow \quad 8i_1 - 4i_2 = 15$$

$$\Rightarrow \quad -18 = 2i_2 + 6(i_2 - i_1)$$

$$\Rightarrow \quad 3i_1 - 4i_2 = 9$$

$$i_1 = 1.2\text{ A and } i_2 = -1.35\text{A}$$

25. (a)

Current coming to N_2 must be equal to the current leaving N_2 therefore current in 15 Ω resistance is 7 amp from N_2 to N_1

$$V_5 = -15 \times 7 = -105\text{ V}$$

26. (a)

Maximum heat produced is

$$P = \frac{V^2}{R_{eq}}$$

For P to be maximum, R_{eq} should be minimum which is minimum if all four coils are connected in parallel.

27. (c)

We know that,

$$R \propto \frac{l}{A}$$

and $L = \frac{N^2 \mu A}{l}$ or $L \propto \frac{N^2}{l}$

when coil is cut into two equal halves,

$$l' = \frac{l}{2} \text{ and } N' = \frac{N}{2}$$

(Area of cross-section = constant)

So, $\frac{R'}{R} = \frac{l'}{l} = \frac{l/2}{l}$ or $\left[R' = \frac{R}{2}\right]$

Also, $\frac{L'}{L} = \left(\frac{N'}{N}\right)^2 \times \left(\frac{l}{l'}\right)$

$$= \left(\frac{N/2}{N}\right)^2 \times \left(\frac{l}{l/2}\right)$$

$$= \frac{1}{4} \times 2 = \frac{1}{2}$$

So, $\left[L' = \frac{L}{2}\right]$

Hence, new values of resistance and inductance which are reconnected in parallel is

$$R_{eq} = R' \,||\, R' = \frac{R'}{2} = \frac{R}{4}\,\Omega$$

and $L_{eq} = L' \,||\, L' = \frac{L'}{2} = \frac{L}{4}\text{H}$

28. (d)

We have; $P_1 = I_1^2 R$

or, $I_1 = \sqrt{\frac{P_1}{R}}$; $P_1 = 1$ W

$$P_2 = I_2^2 R$$

or, $I_2 = \sqrt{\frac{P_2}{R}}$; $P_2 = 4$ W

When both the sources are present, net current through R will be

$$I = (I_2 - I_1)$$

[as polarity of $|V_1|$ is reverse]

So, power loss in R is

$$P = I^2 R = (I_2 - I_1)^2 R$$

$$= \left(\sqrt{\frac{P_2}{R}} - \sqrt{\frac{P_1}{R}}\right)^2 \times R$$

$$= \left(\sqrt{P_2} - \sqrt{P_1}\right)^2$$

$$= \left(\sqrt{4} - \sqrt{1}\right)^2 = (2-1)^2$$

= 1 Watt

29. (d)

Susceptance is the imaginary part of admittance,

$$Y = \frac{1}{Z} = \frac{1}{R + jX_L} = \frac{R - jX_L}{R^2 + X_L^2}$$

$$= \frac{R - jX_L}{Z^2}$$

or, $Y = \left[\frac{R}{Z^2} - j\frac{X_L}{Z^2}\right] = [G - jS]$

Here, G = Conductance

$$= \frac{R}{Z^2} \text{ mho}$$

and S = Susceptance

$$= \frac{X_L}{Z^2} \text{ Simen}$$

30. (d)

Given, power consumed is

$$P = I^2 R_{eq}$$

or, $I = \sqrt{\frac{P}{R_{eq}}} = \sqrt{\frac{10}{5}} = \sqrt{2}$ A

Also, $I = \frac{V}{|Z|}$ or $\sqrt{2} = \frac{(50/\sqrt{2})}{|Z|}$

or, $|Z| = 25\ \Omega$

or, $\sqrt{X_L^2 + 15^2} = 25$

or, $X_L = \sqrt{25^2 - 15^2} = 20\ \Omega$

Hence, p.f. of given circuit is

$$\cos\phi = \frac{R_{eq}}{|Z|} = \frac{15}{25} = \frac{3}{5} = 0.6 \text{ (lag)}$$

31. (d)

For series connection,

$$R_{eq} = R_1 + R_2$$

or, $\frac{R_{eq}}{V_r^2} = \frac{R_1}{V_r^2} + \frac{R_2}{V_r^2}$

or, $\frac{1}{P_{eq}} = \frac{1}{P_1} + \frac{1}{P_2}$

or, $P_{eq} = \frac{P_1 P_2}{P_1 + P_2}$

Given, $P_1 = P_2 = 1000$ W

∴ $P_{eq} = 500$ Watt

32. (d)

Assertion is false because a network in which the circuit elements like resistance, inductance etc. cannot be physically separated for analysis purposes, is called a distributed network. The best example of a distributed network is a transmission line.

Reason is true because most of the electric networks are lumped in nature.

33. (d)

The equivalent resistance of the given circuit is

$$R = R_{eq}$$

$$= \left(\frac{mr}{2} + \frac{r}{m}\right) = \left(\frac{m^2r + 2r}{2m}\right)$$

Now, $$I = \frac{V}{R}$$

Hence, for current I to be maximum, R should be minimum.

i.e. $$\frac{dR}{dm} = 0$$

or, $$\frac{2m[2mr + 0] - (m^2r + 2r) \times 2}{(2m)^2} = 0$$

or, $2\ m\ (2\ mr) - 2\ (m^2r + 2r) = 0$

or, $4\ m^2 - 2\ m^2 - 4 = 0$

or, $2\ m^2 - 4 = 0$

or $$m = \sqrt{2}$$

34. (a)

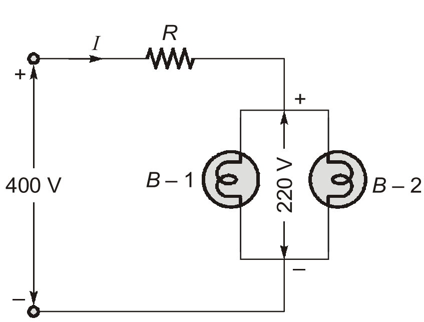
Total power drawn from the circuit

$$= 2 \times 100 = 200 \text{ watts}$$

Hence, supply current is

$$I = \frac{200}{220} = 0.91 \text{ A}$$

Let R be the series resistance to be inserted in the circuit such that the voltage across the bulbs is 220 V.



Applying KVL, we get

$$400 = IR + 220$$

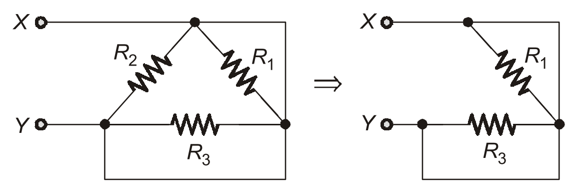
or, $$IR = 400 - 220 = 180$$

or, $$R = \frac{180}{I} = \frac{180}{0.91} = 197.8\ \Omega$$

$$\approx 198\ \Omega$$

35. (a)

Converting the star-connected resistors into Δ equivalent, the given circuit is reduced as shown below.



Here, $$R_1 = 1 + 0 + \frac{1 \times 0}{1} = 1\ \Omega$$

$$R_2 = 1 + 1 + \frac{1 \times 1}{0} = \infty\ \Omega$$

(i.e. open circuit)

$$R_3 = 1 + 0 + \frac{1 \times 0}{1} = 1\ \Omega$$

Hence, equivalent resistance between terminals X and Y is

$$R_{eq} = R_{XY} = \frac{0 \times R_1}{0 + R_1} + \frac{0 \times R_3}{0 + R_3}$$

$$= 0 + 0 = 0\ \Omega$$

36. (b)

Let the required voltage be V.

Then, voltage across 10 Ω resistor

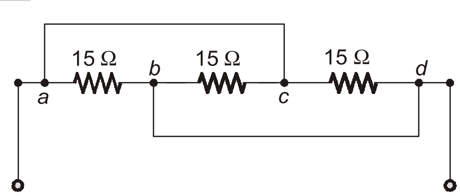
$$= \left(\frac{10}{30 + 10}\right) V = 45$$

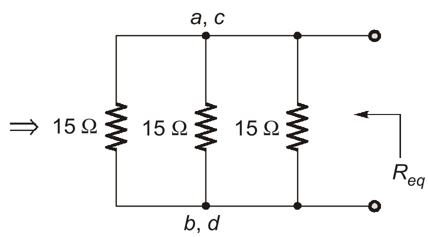
or, $$V = \frac{45 \times 40}{10} = 180 \text{ volts}$$

Hence, required voltage is

$$V = 180 \text{ volts}$$

37. (c)

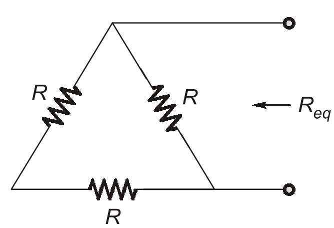




Here, *a* and *c* are at equipotential.
Also, *b* and *d* are at equipotential.

$$\therefore \quad R_{eq} = \frac{15}{3} = 5\ \Omega$$

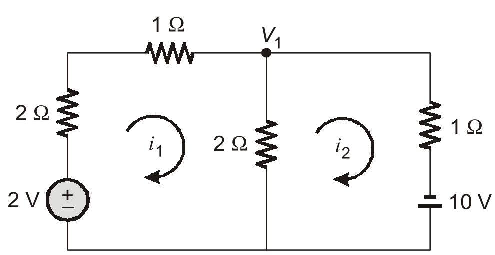
38. (c)



$$R_{eq} = 2R \,||\, R = \frac{2}{3}R$$

40. (b)

Using source transformation, first we convert the current source into an equivalent voltage source



Applying KVL in loop-1, we get

$-2 + 3\,i_1 + (i_1 - i_2)\cdot 2 = 0$

or, $\quad 5\,i_1 - 2\,i_2 = 2 \quad$ ...(*i*)

Applying KVL in loop-2, we get

$2\,(i_2 - i_1) + i_2 - 10 = 0$

or, $\quad 2\,i_1 - 3\,i_2 = 10 \quad$ ...(*ii*)

On solving equations (*i*) and (*ii*), we get

$$i_1 = 2.36\ \text{A} \text{ and } i_2 = 4.91\ \text{A}$$

Hence, the current through the battery of 10 V is

$$i_2 = 4.91\ \text{A}$$

41. (d)

Applying KVL in the loops, we get

$5\,i_1 + (i_1 - i_2)\,10 = V_1$

or, $\quad 15\,i_1 - 10\,i_2 = V_1 \quad$ ...(*i*)

Also, $2\,i_2 + i_2 \times 1 + (i_2 - i_1) \times 10 = 0$

or, $\quad -10i_1 + 13i_2 = 0 \quad$ ...(*ii*)

On solving equations (*i*) and (*ii*), we get

$$i_2 = \frac{10}{95}V_1$$

Also, $\quad V_2 = i_2 \times 1 = i_2 = \frac{10}{95}V_1$

or, $\quad \frac{V_2}{V_1} = \frac{10}{95} = \frac{2}{19}$

42. (c)

The equivalent resistance across the 5 A current source is

$$R_{eq} = 5\,||\,5 + 2 = \frac{5}{2} + 2$$

$$= 2.5 + 2 = 4.5\ \Omega$$

$$\therefore \quad V = R_{eq} \times 5 = 4.5 \times 5 = 22.5 \text{ volts}$$

44. (d)

Applying KVL in the loop,

$$5 = 2i - 2i + i \text{ or } i = 5\ \text{A}$$

$\therefore$ Value of dependent source

$$= 2i = 2 \times 5 = 10 \text{ volt}$$

45. (d)

Using nodal analysis,

$$-2 + \frac{V}{2} + i = 0$$

or, $\quad i = \left(-2 + \frac{4}{2}\right) = -2 + 2 = 0\ \text{A}$

$\therefore \quad i = 0\ \text{A}$

47. (d)

Due to initial condition, at $t = 0$ capacitor will act as a constant voltage source (at $t = 0$, capacitor acts as short-circuit). Hence, option (d) is correct.

48. (d)

⇒ Since *V* is not proportional to *R* therefore, the element can't be a resistor.

⇒ At $t = 5$ ms, even if $i \neq 0$, the element behaves as a short circuit therefore, the element can't be a capacitor (since at $t = 0$ only capacitor behaves as short circuit).

⇒ The current at $t = 0$ is zero and at $t = 5$ ms voltage across the element is zero therefore, the element must be an inductor (at $t = 0$, an inductor acts as open circuit and at $t = \infty$ it behaves as short circuit).

From the given voltage and current profile, we have

$$\frac{di}{dt} = \frac{1}{5\times10^{-3}} = 0.2\times10^{3}\ \text{A/sec}$$

and $v(\text{initial}) = 2$ volt

$$\therefore \quad v = L\frac{di}{dt}$$

or, $$L = \frac{v}{\left(\frac{di}{dt}\right)} = \frac{2}{0.2\times10^{3}} = 10\,\text{mH}$$

50. (a)

Equivalent capacitance between terminals *a-b* is

$$C_{eq} = C_{a\text{-}b}$$
$$= \left[\frac{(C_1+C_2)C_3}{C_1+C_2+C_3}\,||\,C_4\right]||\,C_5$$
$$= 16\,\mu\text{F}$$
$$\therefore \quad Q_{net} = C_{a-b}\times V$$
$$= 16\times10^{-6}\times100$$
$$= 1600\,\mu\text{C}$$

Hence, the charging time required is

$$t = \frac{Q_{net}}{I} = \frac{1600\times10^{-6}}{10}$$
$$= 160\,\mu\text{sec}$$

51. (c)

Maximum value of current,

$$I_m = \sqrt{2}I = \sqrt{2}\times5 = 7.07\ \text{A}$$
$$\omega = 2\pi f = 2\pi\times50$$
$$= 314\ \text{rad/sec}$$
$$\therefore \quad i = I_m\sin\omega t = 7.07\sin 314t\ \text{A}$$

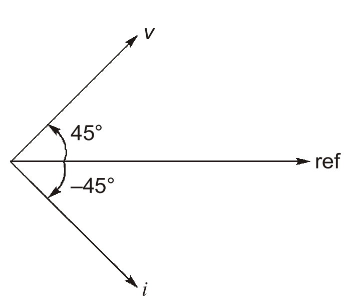
Also, $$V_m = \sqrt{2}V = \sqrt{2}\times220$$
$$= 311\ \text{volts}$$

Assuming voltage as the reference phasor,

$$v = 311\sin 314t\ \text{Volt}$$

and $$i = 7.07\sin(314t-90)^\circ\ \text{Amps}$$

52. (a)



The phase difference between v and i is

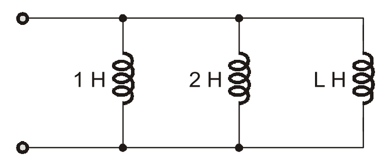
$$\phi = (45^\circ + 45^\circ) = 90^\circ$$

Since v leads i therefore, the circuit element is an inductor.

$$\therefore \quad X_L = \frac{V_m}{I_m} = \frac{100}{10} = 10\,\Omega = 2\pi fL$$

or, $$L = \frac{X_L}{2\pi f} = \frac{10}{2\pi\times50}\,\text{H}$$
$$= 31.8\,\text{mH}$$

53. (d)



Equivalent inductance,

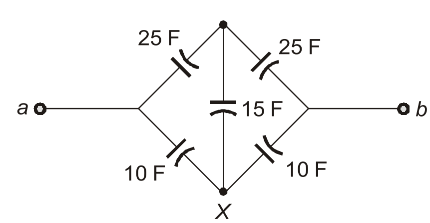
$$L_{eq} = (1\,||\,2\,||\,L) = \left(\frac{2}{3}\,||\,L\right)$$
$$= \left(\frac{\frac{2}{3}L}{L+\frac{2}{3}}\right) = \left(\frac{2/3}{1+\frac{2}{3L}}\right)$$

L_{eq} will be maximum of $L\to\infty$.

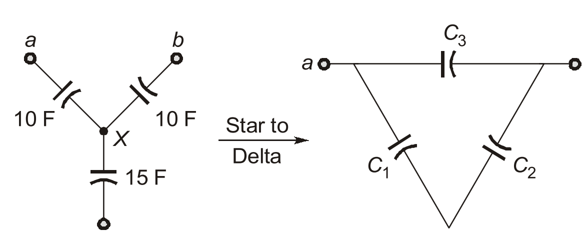
Hence, $$(L_{eq})_{max} = \frac{2}{3}\,\text{H}$$

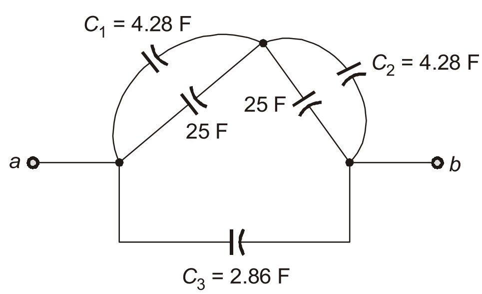
54. (d)

The given circuit can be redrawn as shown below.



The star at point X can be replaced by equivalent delta having delta branches as C_1, C_2 and C_3 as shown below.



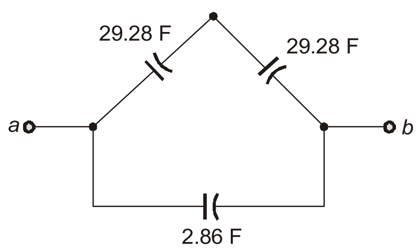


Hence, $$C_1 = \frac{10\times15}{10+15+10} = 4.28\text{ F}$$

$$C_2 = \frac{15\times10}{15+10+10} = 4.28\text{ F}$$

$$C_3 = \frac{10\times10}{10+10+15} = 2.86\text{ F}$$

Combining the parallel capacitances, the equivalent circuit reduces as shown below.



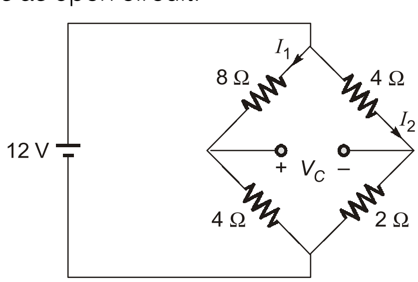
Hence, equivalent capacitance between terminals *a* and *b* is

$$C_{a-b} = \left(\frac{29.28\times29.28}{29.28+29.28}+2.86\right)$$

$$= 17.5\text{ F}$$

55. (a)

Under steady state condition, the capacitor will acts as open circuit.



$$I_1 = \frac{12}{8+4} = 1\text{ A}$$

$$I_2 = \frac{12}{4+2} = 2\text{ A}$$

Let the voltage across capacitor be V_C in steady state.

Then, $$V_C = -8\,I_1 + 4I_2$$
$$= -8\times1+4\times2$$
$$= -8+8 = 0$$

Hence, charge accumulated in the capacitor is

$$Q = CV_C = (100\ \mu\text{F})\times0 = 0$$

56. (d)

$$i_c(t) = C\frac{dV_c(t)}{dt}$$

or, $$V_c(t) = \frac{1}{C}\int i(t)dt = \frac{5}{C}\int\delta(t)\,dt$$

Now, $$\int\delta(t)\,dt = u(t)$$

So, $$V_c(t) = \frac{5}{C}\cdot u(t)$$

57. (c)

$$I_C = C\frac{dv}{dt}$$

$$= 20\times10^{-6}\times\left(\frac{240-0}{1}\right)$$

$$= 4.8\text{ mA}$$

58. (d)

Lower the self inductance of a coil less the delay in establishing steady current through it because lower will be the inductive reactance which will offer less opposition to the flow of current.

Hence, assertion is false.

59. (c)

Capacitance = $\dfrac{\epsilon A}{d}$ $\qquad \epsilon = \epsilon_0\epsilon_r$

Since the two dielectrics fill space equally, the area is $\dfrac{A}{2}$

So $$C_1 = \frac{\epsilon_0\,\epsilon_1\,A}{2d},\ C_2 = \frac{\epsilon_0\,\epsilon_2\,A}{2d}$$

$$C = C_1 + C_2 = \frac{\epsilon_0\,A(\epsilon_1+\epsilon_2)}{2d}$$

60. (c)

Voltage across inductor and capacitor will be in opposite direction so net voltage will be 30 V which will be 90° displaced from voltage across resistance.

So $$V = \sqrt{(40)^2+(30)^2} = 50\text{ V}$$