UPPSC-AE 2021

Uttar Pradesh Public Service Commission

Combined State Engineering Services Exam

Assistant Engineer

2700+ MCQs

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Practice Book

Electrical Engineering

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2700+ MCQs for UPPSC-AE (Combined State Engineering Services Examination): Electrical Engineering

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PREFACE

B. Singh (Ex. IES)

With the announcement of vacancies by Uttar Pradesh Public Service Commission (UPPSC) for the post of Assistant Engineer, it has given hope for many engineers between jobs. MADE EASY has always been a success partner for engineers right from the onset of engineering education up to they get a formal tag of engineer.

Owing to needs of students to utilise this opportunity in a fruitful way, it gives me great happiness to introduce Electrical Engineering Practice book for UPPSC-AE Examination. While preparing this book utmost care has been taken to cover all the chapters and variety of concepts which may be asked in the exam. It contains more than 2700+ multiple choice questions with answer key and detailed explanations, segregated in subject wise manner to disseminate all kind of exposure to students in terms of quick learning. Attempt has been made to bring out all kind of probable competitive questions for the aspirants preparing for UPPSC. This book also help every student to perform in an extraordinary way.

Full efforts have been made by MADE EASY team to provide error free solutions and explanations. The book not only covers the syllabus of UPPSC but also useful for other examinations conducted by various Public Service Commissions.

Our team has made their best efforts to make the book error-free. Nonetheless, we would highly appreciate and acknowledge if you find and share any printing/conceptual error. It is impossible to thank all individuals who helped us, but I would like to sincerely acknowledge all the authors, editors and reviewers for putting in their efforts to publish this book.

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

Uttar Pradesh Public Service Commission
Combined State Engineering Services Examination

Assistant Engineer

Electrical Engineering

Paper-I

Networks and Systems:
Steady-state and Transient-state Analysis of systems, Thevenin's-, Norton's-, Superposition- and Maximum Power Transfer-theorems, Driving point Transfer functions, Two-port networks, Laplace and Fourier transforms and their applications in Network analysis, Z-transforms for discrete systems, R-L, R-C & L-C network synthesis.

E.M. Theory:
Analysis of electrostatic and magnetostatic fields, Laplace, Poission and Maxwell equations, solution of boundary value problems, electromagnetic wave propagation, ground and space waves, Propagation between Earth Station and Satellites.

Control systems:
Mathematical modelling of dynamic linear continuous systems, Block diagrams and Signal flow graphs, time-response specifications, steady-state error, Routh-Hurwitz criterion, Nyquist techniques, Root Loci, Bode Plots, Polar Plot, and stability analysis, Lag-, Lead-, Lag-Lead-compensation, state-space modelling, state transition matrix, controllability and observability.

Elements of Electronics:
Basics of semiconductor diodes, BJT, FET and their chracteristics, different types of transistors and FET amplifiers equivalent circuits and frequency response, feedback oscillators, colpitts oscillator and Hartley Oscillator, Operational amplifiers-chracteristics and applications.

Power System Analysis and Design:
Line parameters and calculations, Performance of Transmission lines, Mechanical design of overhead lines and Insulators, Corona and radio interference Parameters of single- and three-core Cables, Bus admittance matrix, Load flow equations and methods of solutions, Fast-decoupled load flow, Balance- and Unbalanced-faults analysis, Power system stability, Power system transients and travailing Waves, EHV Transmission, HVDC transmission, Concepts of FACTS, Voltage Control and Economic operation, Concepts of distributed generation, solar and wind power, smart grid concepts.

Elements of Electrial Machines:
General concepts of E.m.f., m.m.f., and torque in rotating machines,DCMachines: motor and generator characteristics, equivalent circuits, commutation and amature reaction, starting and speed controls of motors; Synchronous Machines: performance, regulation, Parallel operation of generators, motor starting, characteristics and applications, Transformers: phasor-diagram and equivalent circuit, efficiency, and voltage regulation, auto-transformers, 3-phase transformers.

Measurement:
Basic methods of measurement, Precision and standards, error analysis, Bridges and Poteniometers; moving coil, Moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy, and power factor, Instrument transformers, digital voltmeters and multimeters, phase-, time- and frequencymeasurement, Q-meters Oscilloscopes, Basics of sensors, and data acquisition system, Instrumentation systems for pressure and temperature measurements.

Paper-II

Power Electronics and Drives:

Semiconductor, power, diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs static characteristics and principles of operation, triggering circuits single phase and threephase controlled rectifiers-fully controlled and half controlled, smoothing and filters regulated power supplies, DC-DC choppers and inverters, speed control circuits for DC and A.C. drives, Basics of electric drives: types, quadrant operation, reversing and braking of electric motors, estimation of power ratings, traction motors.

Digital Electronics:
Boolean algebra, logic gates, combinational and sequencial logic circuits, multiplexers, muiltivibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, active filters, semiconductor memories.

Microwaves and Communication systems:

Electromagnetic wave in guided media, wave guide components, resonators, microwave tubes, microwave generators and amplifiers.

Analog Communication basics:

Modulation and demodulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling, quantizing, coding frequency- and time-domain multiplexing, sound and vision broadcast, antennas, transmission lines at audio and ultra-high frequencies.

Induction and special Machines:

Three-phase Induction motors Rotating magnetic field, Torque-slip characterstics, Equivalent Circuit and determination of its parameters, starters, speed control, Induction generators. Single phase Induction motors: Theory and phasor diagrams, characteristics, starting and applications, repulsion motor, series motor: E.m.f. equation and phasor diagram and performance, servomotors, stepper motors, reluctance motors, brushlessDCmotors (BLDC).

Power system protection and Switch gear:

Methods of Arc Extinction, Restriking voltages and recovery voltage, testing of circuit breakers, Protective relays, protective schemes for power system equipment, surges in transmission lines and protection.

Numerical Methods:

Solution of non liner algebraic equations, single and multisteps methods for solution of differential equations.

Electrical Engineering Materials :

Crystal structure and defects, conducting, insulating and magneting materials, super-conductors.

Elements of Microprocessors:

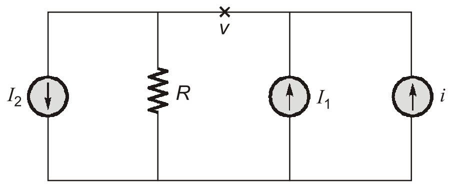
Data representation and representation of integer and floating point-numbers. Organization and programming of a microprocessor, ROM and RAM memories CPU of a microcomputer, interfacing memory and I/O devices, Programmable peripheral and communication interface. Application of microprocessors.

Contents

UNIT 1

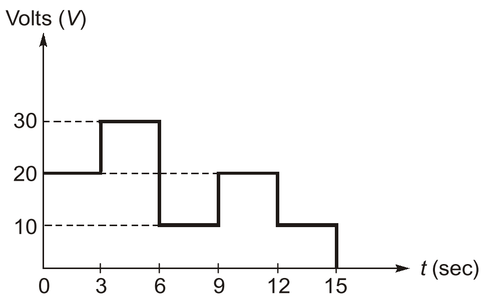
Electric Circuits

Q.1 In the network of figure shown below, $I_1 = 0.05$ A, $I_2 = 0.1$ A, $R = 50\ \Omega$. The unknown current source has strength of i. If 100 J of energy is delivered to I_2 in 1 min, the magnitude of i will be



(a) 0.38 A (b) 0.50 A
(c) –0.25 A (d) 0.05 A

Q.2 Given figure shows a plot of d.c. voltage applied to a resistor of 5 Ω for 15 seconds. The total energy consumed by the resistor is



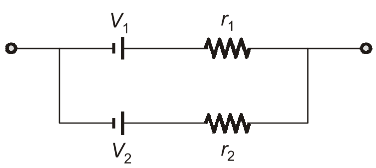
(a) 540 J (b) 625 J
(c) 1220 J (d) 1140 J

Q.3 The charge in a capacitor is given by

$$q = \left(v + \frac{1}{3}v^3\right)$$

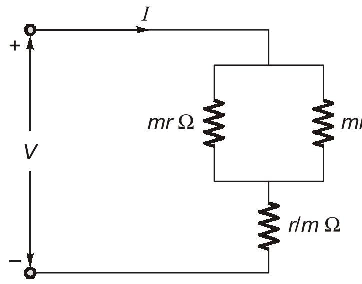
If the voltage across this capacitor be $v(t) = \sin t$, the current $i(t)$ through the capacitor is
(a) $(1 + \sin^2 t)\cos t$ (b) $(1 + \sin^2 t)$
(c) $(1 + \cos^2 t)\sin t$ (d) $\sin^2 t \cos t$

Q.4 The two voltage sources connected in parallel as shown below, must satisfy the conditions



(a) $V_1 = V_2$, $r_1 = r_2$
(b) $V_1 \neq V_2$ but $r_1 = r_2$
(c) $V_1 \neq V_2$, $r_1 \neq 0$ or $r_2 \neq 0$
(d) $V_1 = V_2$, $r_1 \neq r_2$

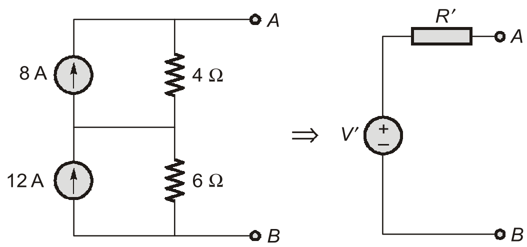
Q.5 What is the value of m so that the current I in the circuit shown below is maximum?



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

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

Q.6 The given circuit shown below is converted to an equivalent voltage source V' connected in series with an equivalent resistance R'.

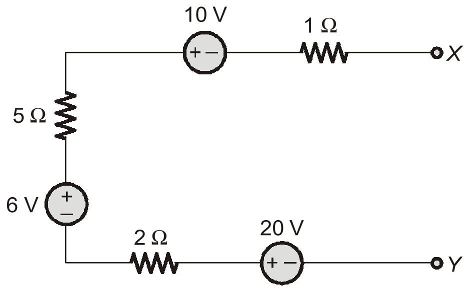


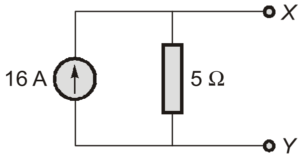
The values of V' and R' are respectively
(a) 40 volts and 2.4 Ω
(b) 104 volts and 2.4 Ω
(c) 104 volts and 10 Ω
(d) 40 volts and 10 Ω

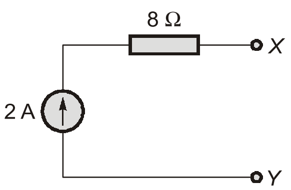
Q.7 A voltage of 100 V is applied to an impedance of $Z = (3 + j4)\ \Omega$. What are the values of active power, reactive power and volt-amperes respectively?
(a) 1200 W, 1200 VAR and 2000 VA
(b) 1200 W, 1600 VAR and 2200 VA

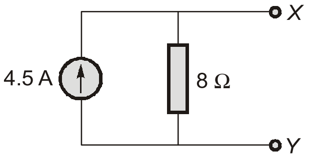
(c) 1200 W, 1600 VAR and 2000 VA
(d) 1600 W, 1200 VAR and 2200 VA

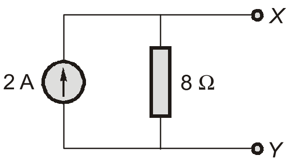
Q.8 The equivalent current source for the circuit shown below will be represented as



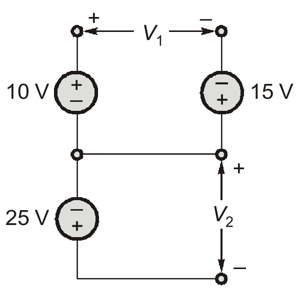
(a) 

(b) 

(c) 

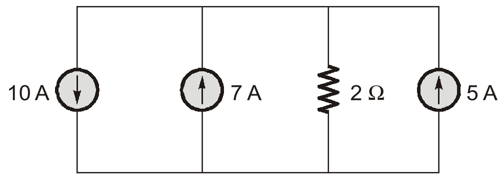
(d) 

Q.9 For the circuit shown below, the value of ($V_1 + V_2$) is



(a) 50 volts (b) –25 volts
(c) 0 volts (d) 25 volts

Q.10 The voltage drop across the 2 Ω resistor for the circuit shown below is



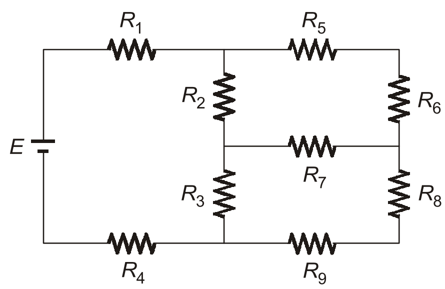
(a) 2 volts (b) 14 volts
(c) 4 volts (d) –20 volts

Q.11 A network has 10 nodes and 17 branches. The number of different node pair voltage would be
(a) 10 (b) 45
(c) 7 (d) 9

Q.12 Kirchhoff's laws are not applicable to circuits with
(a) passive elements
(b) lumped parameters
(c) distributed parameters
(d) non-linear resistances

Q.13 Of the two methods of loop and node variable analysis
(a) loop analysis is always preferable.
(b) node analysis is always preferable.
(c) loop analysis may be preferable in some situations while node analysis may be preferable in other situations.
(d) there is nothing to choose between them.

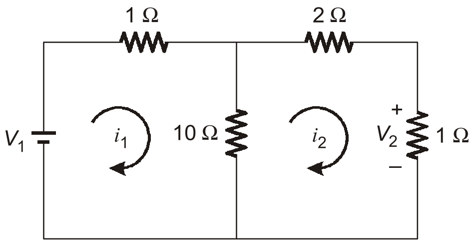
Q.14 Which of the following is not true about the circuit shown below?



(a) Number of nodes for the above circuit is 8.
(b) Number of branches for the above circuit is 6.
(c) Number of meshes for the above circuit is 3.
(d) Number of junction points for the above circuit is 6.

Q.15 An electric circuit with 8 branches and 4 nodes will have
(a) 5 loop equations
(b) 11 loop equations
(c) 3 loop equations
(d) 7 loop equations

Q.16 In the circuit shown in figure below, the value of V_2/V_1 is



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

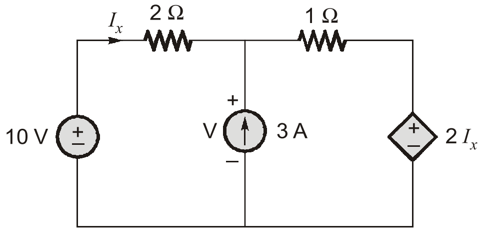
(c) 1.5 (d) $\frac{2}{19}$

Q.17 In nodal analysis, if there are N nodes in the circuit, then how many equations will be written to solve the network ?

(a) $N-1$ (b) N

(c) $N+1$ (d) $N-2$

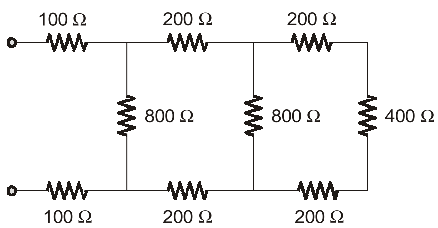
Q.18 In the circuit shown below, the value of I_x is



(a) 2 A (b) –0.6 A

(c) 2.6 A (d) 1.4 A

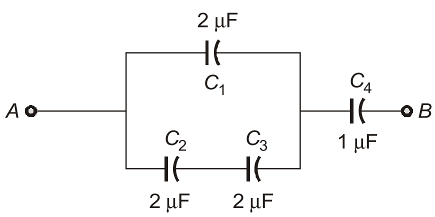
Q.19 The equivalent resistance of the given circuit is



(a) 200 Ω (b) 400 Ω

(c) 600 Ω (d) 1600 Ω

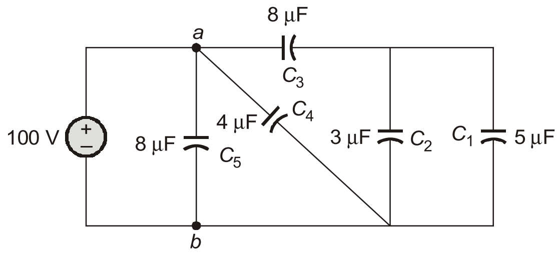
Q.20 The equivalent capacitance across the given terminals A-B is



(a) $\frac{1}{2}$ μF (b) $\frac{3}{4}$ μF

(c) $\frac{1}{8}$ μF (d) $\frac{4}{3}$ μF

Q.21 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.22 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

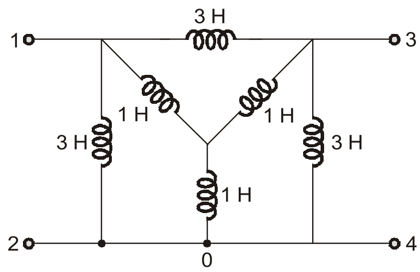
(a) an inductor with $L = 31.8$ mH

(b) a capacitor with $C = 10$ F

(c) an inductor with $L = 10$ H

(d) a capacitor with $C = 31.8$ μF

Q.23 The equivalent inductance for the inductive circuit shown below at terminal "1–2" is



(a) $\frac{1}{4}$ H (b) 1 H

(c) $\frac{3}{4}$ H (d) $\frac{1}{2}$ H

Q.24 Which of the following statements associated with capacitor is wrong?

(a) A capacitor resists an abrupt change in the voltage across it in a manner analogous to the way a spring resists abrupt change in its displacement.

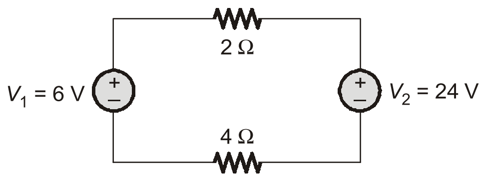
(b) A capacitor resists an abrupt change in the current flowing through it.
(c) It is impossible to change the voltage across a capacitor even if the current through the capacitor changes by a finite amount in zero time, for this requires infinite current through the capacitor.
(d) A finite amount of energy can be stored in a capacitor even if the current through the capacitor is zero, such as when the voltage across it is constant.

Q.25 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.26 An open coil has
(a) zero resistance and zero inductance
(b) infinite resistance and infinite inductance
(c) infinite resistance and zero inductance
(d) zero resistance and infinite inductance

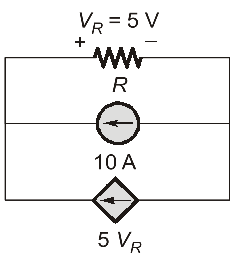
Q.27 An impedance of (3 +*j*4) Ω is connected in parallel with a resistance of 10 Ω. The ratio of power loss in these parallel circuits is
(a) 1 : 5 (b) 6 : 5
(c) 3 : 2 (d) 5 : 6

Q.28 The power delivered by the two voltage sources of 6 V and 24 V as shown below will be



(a) 72 W and 0 W (b) 18 W and 72 W
(c) 0 W and 72 W (d) None of these

Q.29 The power loss in watts in the resistor *R* shown below is



(a) 175 watts (b) 25 watts
(c) 225 watts (d) 62.5 watts

Q.30 In a purely resistive circuit, the average power P_{av} is _______the peak power P_{max}.
(a) double (b) non-half of
(c) one-fourth of (d) equal to

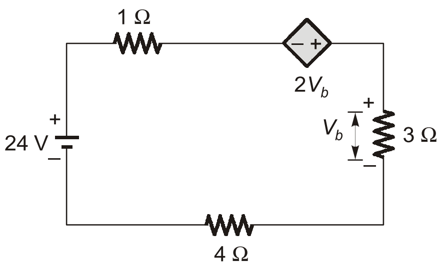
Q.31 A series circuit containing passive elements has the following current and applied voltage:

$$v = A\sin\left(\omega t + \frac{\pi}{4}\right), i = B\sin\left(\omega t - \frac{\pi}{6}\right)$$

The circuit elements
(a) may be resistance and inductance
(b) may be inductance, capacitance and resistance
(c) either (a) or (b)
(d) may be resistance and capacitance

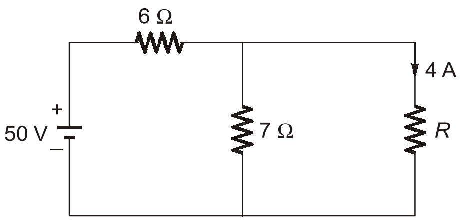
Q.32 If the impulse response is realisable by delaying it appropriately and is bounded for bounded excitation, then the system is said to be
(a) causal but unstable
(b) non-causal but stable
(c) causal and stable
(d) non-causal and unstable

Q.33 The current in the given circuit with a dependent voltage source is



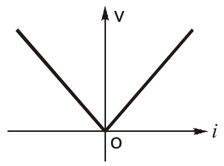
(a) 10 A (b) 12 A
(c) 14 A (d) 16 A

Q.34 The value of resistance '*R*' shown in the given figure is



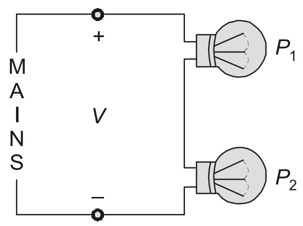
(a) 3.5 Ω (b) 2.5 Ω
(c) 1 Ω (d) 4.5 Ω

Q.35 The v-i characteristic of an element is shown in the figure given below. The element is



(a) non-linear, active, non-bilateral
(b) linear, active, non-bilateral
(c) non-linear, passive, non-bilateral
(d) non-linear, active, bilateral

Q.36 The incandescent bulbs rated respectively as P_1 and P_2 for operation at a specified mains voltage are connected in series across the mains as shown in the above figure. Then the total power supplied by the mains to the two bulbs are



(a) $\frac{P_1 P_2}{P_1 + P_2}$ (b) $\sqrt{P_1^2 + P_2^2}$
(c) $(P_1 + P_2)$ (d) $\sqrt{P_1 \times P_2}$

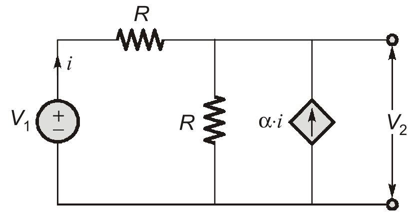
Q.37 A certain network consists of a large number of ideal linear resistances, one of which is designated as R and two constant ideal sources. The power consumed by R is P_1 when only the first source is active, and P_2 when only the second source is active. If both sources are active simultaneously, 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) $(P_1 \pm P_2)^2$

Q.38 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

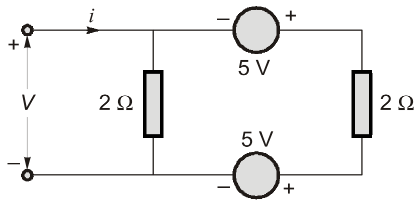
(a) Doubled
(b) Halved
(c) Decreases four times
(d) Not changed

Q.39 Consider the circuit as shown below which has a current-dependent current source. The value V_2/V_1 is



(a) 1 (b) 2
(c) $\frac{1+\alpha}{2+\alpha}$ (d) $\frac{\alpha}{2+\alpha}$

Q.40 Consider the following circuit:



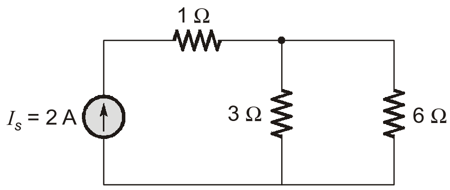
Which one of the following statements is correct? The circuit shown above is

(a) passive and linear
(b) active and linear
(c) passive and non-linear
(d) active and non-linear

Q.41 Three parallel resistive branches are connected across a d. c supply. What will be the ratio of the branch currents $I_1 : I_2 : I_3$ if the branch resistances are in the ratio $R_1 : R_2 : R_3 :: 2 : 4 : 6$?

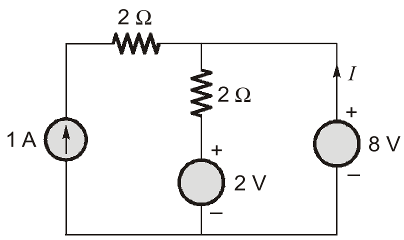
(a) 3 : 2 : 6 (b) 2 : 4 : 6
(c) 6 : 3 : 2 (d) 6 : 2 : 4

Q.42 For the circuit shown below, what is the voltage across the current source I_s?



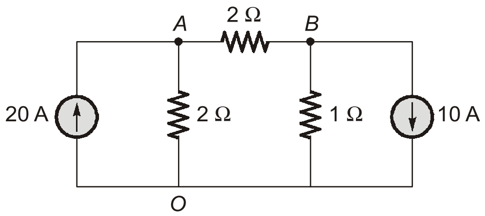
(a) 0 (b) 2 V
(c) 3 V (d) 6 V

Q.43 In the circuit shown below, what is the value of the current-I?



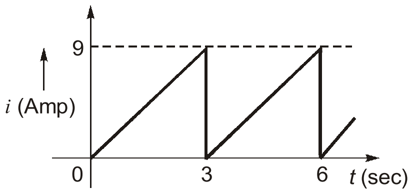
(a) 1 A (b) 2 A
(c) 3 A (d) 4 A

Q.44 Find the voltage of the node A with respect to 'O' for the circuit as shown in below.



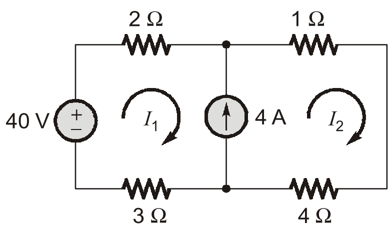
(a) 40 V (b) 20 V
(c) 50 V (d) 60 V

Q.45 The current waveform as shown below, is applied in a pure resistor of 10 Ω. What is the power dissipated in the resistor?



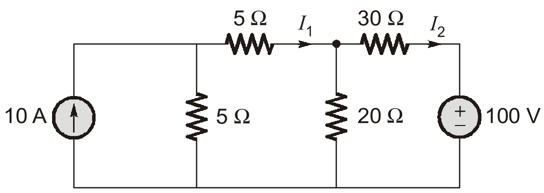
(a) 270 W (b) 135 W
(c) 52 W (d) 7 W

Q.46 The currents I_1 and I_2 in the below circuit are respectively.



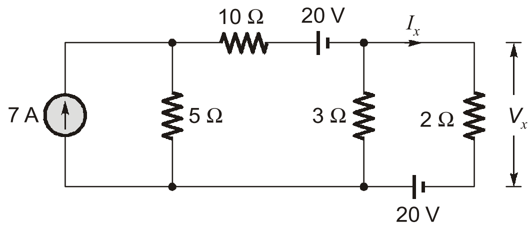
(a) 4 A; 4 A (b) 3 A; 5 A
(c) 2 A; 6 A (d) 6 A; 2 A

Q.47 The currents I_1 and I_2 in the below circuit are respectively



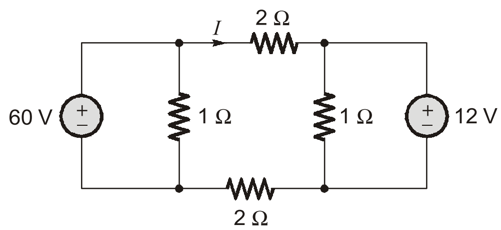
(a) 1.818 A; –0.4545 A
(b) 2.451 A; –1.568 A
(c) 0.4545 A; –1.818 A
(d) 1.56 A; –2.45 A

Q.48 The currents I_x and V_x in the below circuit are respectively



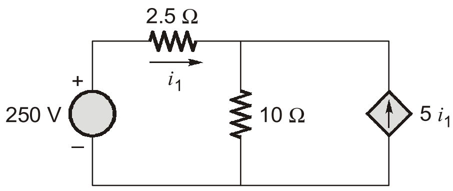
(a) 5 A; 10 V (b) 10 A; 20 V
(c) 6 A; 12 V (d) 4 A; 8 V

Q.49 For the circuit shown in figure below, the value of current, I is



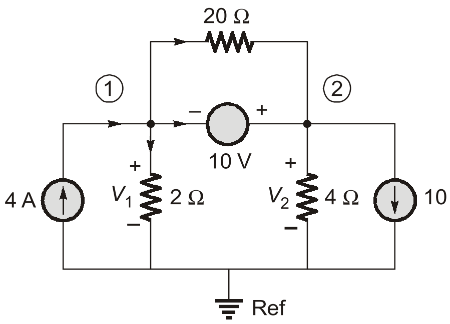
(a) 2 A (b) 3 A
(c) 6 A (d) 12 A

Q.50 In the circuit shown, the current i_1 is



(a) 4 A (b) 2 A
(c) 4.76 A (d) 20 A

Q.51 When KCL is applied at the super node in the below circuit, the current equation in terms of node voltages V_1 and V_2 is



(a) $-6 = \frac{V_1}{2} + \frac{V_2}{4}$ (b) $4 = \frac{V_1 - V_2}{2} + \frac{V_1 - V_2}{20}$

(c) $4 = \frac{V_1}{2} + \frac{V_1 - V_2}{20}$ (d) $4 = \frac{V_1}{2} + \frac{V_2}{4}$

Answers Electric Circuits

1. (a)	2. (d)	3. (a)	4. (c)	5. (d)	6. (c)	7. (c)	8. (d)
9. (c)	10. (c)	11. (d)	12. (c)	13. (b)	14. (d)	15. (a)	16. (d)
17. (a)	18. (d)	19. (c)	20. (b)	21. (a)	22. (a)	23. (b)	24. (b)
25. (c)	26. (c)	27. (b)	28. (c)	29. (a)	30. (b)	31. (c)	32. (b)
33. (b)	34. (a)	35. (a)	36. (a)	37. (c)	38. (d)	39. (c)	40. (a)
41. (c)	42. (d)	43. (b)	44. (b)	45. (a)	46. (c)	47. (c)	48. (a)
49. (d)	50. (a)	51. (a)	52. (b)	53. (c)	54. (d)	55. (b)	56. (a)
57. (c)	58. (d)	59. (b)	60. (b)	61. (b)	62. (b)	63. (c)	64. (c)
65. (b)	66. (c)	67. (b)	68. (c)	69. (b)	70. (b)	71. (c)	72. (d)
73. (d)	74. (b)	75. (b)	76. (d)	77. (d)	78. (b)	79. (c)	80. (d)
81. (d)	82. (d)	83. (d)	84. (c)	85. (c)	86. (a)	87. (d)	88. (c)
89. (b)	90. (d)	91. (b)	92. (c)	93. (a)	94. (a)	95. (b)	96. (c)
97. (a)	98. (c)	99. (b)	100. (a)	101. (b)	102. (b)	103. (b)	104. (b)
105. (b)	106. (d)	107. (c)	108. (b)	109. (b)	110. (b)	111. (c)	112. (d)
113. (a)	114. (b)	115. (a)	116. (a)	117. (d)	118. (d)	119. (a)	120. (a)
121. (b)	122. (c)	123. (a)	124. (b)	125. (c)	126. (d)	127. (a)	128. (c)
129. (b)	130. (a)	131. (c)	132. (c)	133. (d)	134.. (a)	135. (c)	136. (d)
137. (c)	138. (d)	139. (c)	140. (b)	141. (b)	142. (d)	143. (a)	144. (b)
145. (b)	146. (d)	147. (c)	148. (d)	149. (d)	150. (b)	151. (c)	152. (c)
153. (c)	154. (c)	155. (a)	156. (d)	157. (c)	158. (b)	159. (d)	160. (b)
161. (c)	162. (a)	163. (b)	164. (d)	165. (c)	166. (d)	167. (c)	168. (b)
169. (b)	170. (a)	171. (c)	172. (a)	173. (c)	174. (a)	175. (c)	176. (a)
177. (b)	178. (b)	179. (c)	180. (d)	181. (a)	182. (d)	183. (d)	184. (a)
185. (c)	186. (b)	187. (d)	188. (d)	189. (c)	190. (b)	191. (c)	192. (b)
193. (c)	194. (c)	195. (b)	196. (a)	197. (a)	198. (a)	199. (a)	200. (a)
201. (d)	202. (b)	203. (*)	204. (c)	205. (c)	206. (a)	207. (d)	208. (d)
209. (d)	210. (a)	211. (a)	212. (*)	213. (b)	214. (d)	215. (b)	216. (c)
217. (d)	218. (a)	219. (d)	220. (b)	221. (d)	222. (b)	223. (b)	224. (d)
225. (d)	226. (b)	227. (b)	228. (d)	229. (b)	230. (c)	231. (c)	232. (a)
233. (c)	234. (a)	235. (b)	236. (c)				

Explanations

1. (a)

Energy dissipated in $R = \int_0^\infty p\,dt$ where, $p = vi$

$\therefore \quad \frac{d}{dt}(\text{Energy}) = p = vi$

Since power is constant, therefore

Power, $P = \frac{\text{Energy}}{\text{Time}} = \frac{100\text{ J}}{1 \times 60\text{ sec}} = \frac{5}{3}\text{ W}$

Hence, $v = \frac{P}{I_2} = \frac{5/3}{0.1} = \frac{50}{3}$ Volts

Applying KCL at node v, we have

$$-I_1 + I_2 + \frac{50/3}{50} - i = 0$$

or, $-0.05 + 0.1 + 0.333 - i = 0$

or, $i = 0.383\text{ A} \approx 0.38\text{ A}$

2. (d)

Energy = Power × time

$$\therefore \quad W = \Sigma P.t = \sum \frac{V^2}{R} \times t$$

$$= \left[\frac{20^2}{5} \times 3 + \frac{30^2}{5} \times (6-3) + \frac{10^2}{5} \times (9-6) + \frac{20^2}{5} \times (12-9) + \frac{10^2}{5} \times (15-12)\right]$$

$$= \frac{3}{5}[400 + 900 + 100 + 400 + 100]$$

$$= \frac{5700}{5} = 1140\text{ J}$$

Hence, the heat consumed by the resistor = 1140 J.

3. (a)

The current through the capacitor is

$$i = \frac{dq}{dt} = \frac{dq}{dv} \cdot \frac{dv}{dt}$$

Now, $\frac{dq}{dv} = (1 + v^2)$ and $\frac{dv}{dt} = \cos t$

$\therefore \quad i = (1 + v^2) \cdot \cos t$

$= (1 + \sin^2 t) \cdot \cos t$

5. (d)

The equivalent resistance of the given circuit is

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

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

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

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

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

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

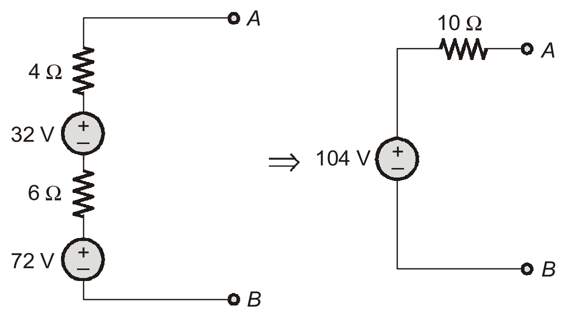
or, $4m^2 - 2m^2 - 4 = 0$

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

or $m = \sqrt{2}$

6. (c)

Converting the current sources into equivalent voltage sources, the circuit is reduced as shown below.



7. (c)

$V = 100$ volts,

$z = (3 + j4)\ \Omega$

$\because \quad |S| = \frac{V^2}{z} = \frac{100^2}{5} = 2000\text{ VA}$

Real power $P = S\cos\left[\tan^{-1}\left(\frac{4}{3}\right)\right]$

$= 2000 \times \frac{3}{5} = 1200\text{ W}$

Reactive power,

$Q = S\sin\left[\tan^{-1}\left(\frac{4}{3}\right)\right]$

$= 2000 \times \frac{4}{5} = 1600\text{ VAR}$

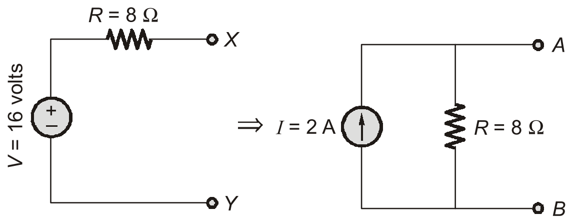
8. (d)

Equivalent voltage in the given circuit is

$$V = 6 + 20 - 10 = 16 \text{ volt}$$

And equivalent resistance is

$$R = 1 + 5 + 2 = 8\ \Omega$$



9. (c)

Using KVL in the loop, we have

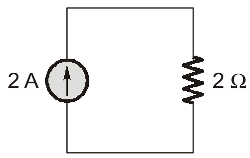
$$V_1 = 10 + 15 = 25 \text{ volts}$$

Also, $V_2 = -25$ volts

$\therefore$ $V_1 + V_2 = 25 - 25 = 0$ volts

10. (c)

On combining the current sources, the circuit is reduced as shown below.



Hence, voltage drop across the 2 Ω resistor

$$= 2 \times 2 = 4 \text{ volts}$$

11. (d)

Number of different node-pair voltage = Number of KCL equations = $n - 1 = 10 - 1 = 9$

14. (d)

Number of junction point for the given circuit is 6.

15. (a)

Number of loop equation

$$= b - (n - 1)$$
$$= 8 - (4 - 1)$$
$$= 8 - 3 = 5$$

16. (d)

Applying KVL in the loops, we get

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

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

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

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

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

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

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

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

18. (d)

Applying nodal analysis at the given node, we have

$$-I_x - 3 + \frac{V - 2I_x}{1} = 0$$

or, $3I_x = V - 3$ ...(*i*)

Also, $10 = 2I_x + V$

or, $V = 10 - 2I_x$ ...(*ii*)

Putting V from equation (*ii*) into equation (*i*),

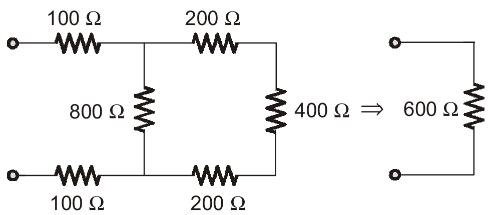
$$3I_x = 10 - 2I_x - 3$$

or, $5I_x = 7$

or, $I_x = \frac{7}{5} = 1.4$ A

19. (c)

Given circuit can be reduced as shown below.



$\therefore$ $R_{eq} = 600\ \Omega$

20. (b)

The equivalent combination of C_2 and C_3

$$= \frac{C_2 \times C_3}{C_2 + C_3} = 1\ \mu\text{F}$$

The equivalent combination of this 1 μF and $C_1 = 2$ μF is

$$C_1 + 1\ \mu\text{F} = 3\ \mu\text{F}$$

Hence, the equivalent capacitance between terminals A and B is

$$C_{AB} = \frac{3 \times C_4}{3 + C_4} = \frac{3 \times 1}{3 + 1} = \frac{3}{4}\ \mu\text{F}$$

21. (a)

Equivalent capacitance between terminals *a-b* is

$$C_{eq} = C_{a\text{-}b}$$

$$= \left[\frac{(C_1+C_2)C_3}{C_1+C_2+C_3} \,||\, C_4\right] || \, C_5 = 16\ \mu\text{F}$$

$$\therefore \quad Q_{net} = C_{a\text{-}b} \times V$$

$$= 16 \times 10^{-6} \times 100$$

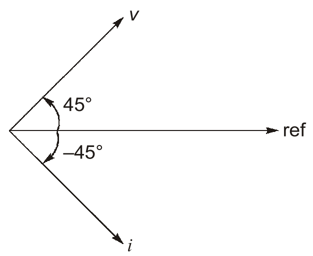
$$= 1600\ \mu\text{C}$$

Hence, the charging time required is

$$t = \frac{Q_{net}}{I} = \frac{1600 \times 10^{-6}}{10}$$

$$= 160\ \mu\text{sec}$$

22. (a)



The phase difference between v and i is

$$\phi = (45° + 45°) = 90°$$

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

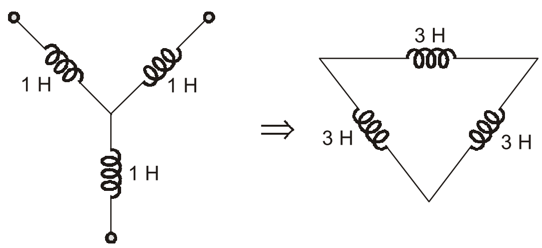
$$\therefore \quad X_L = \frac{V_m}{I_m} = \frac{100}{10} = 10\ \Omega = 2\pi f L$$

or,

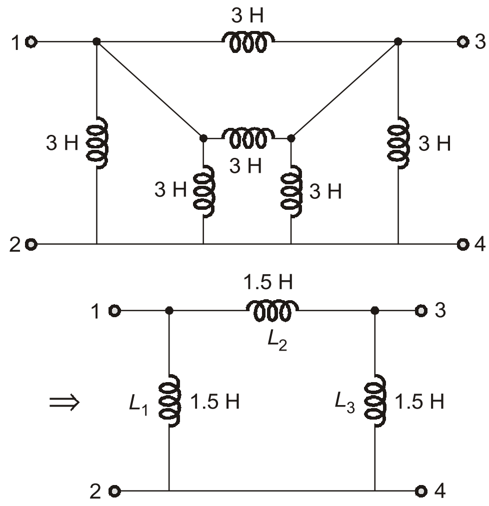
$$L = \frac{X_L}{2\pi f} = \frac{10}{2\pi \times 50}\ \text{H} = 31.8\ \text{mH}$$

23. (b)

Converting the internal star connected inductance to an equivalent delta, the circuit reduces as shown below.



Hence, equivalent circuit becomes as shown below.



Hence, $L_{1\text{-}2} = L_1 \,||\, (L_2 + L_3)$

$$= \frac{1.5 \times 3}{1.5 + 3} = 1\ \text{H}$$

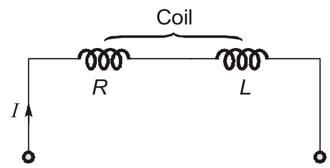
24. (b)

Statement (b) holds true for an inductor not for a capacitor.

25. (c)

$$I_C = C\frac{dv}{dt} = 20 \times 10^{-6} \times \left(\frac{240-0}{1}\right) = 4.8\ \text{mA}$$

26. (c)



A coil acts as open circuit i.e $I = 0$ if $R = \infty$ or $L = 0$ (so that $X_L = 0\ \Omega$).

27. (b)

$$|Z_1| = \sqrt{3^2 + 4^2} = 5\ \Omega$$

and $|Z_2| = 10\ \Omega$

Now, $|I_1| = \dfrac{V}{Z_1} = \dfrac{V}{5}$

and $|I_2| = \dfrac{V}{Z_2} = \dfrac{V}{10}$

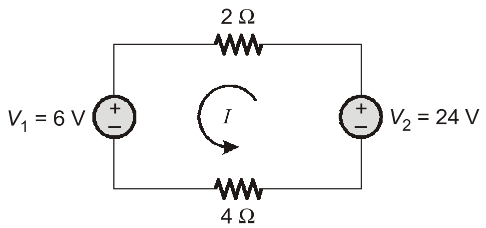
Thus, $\dfrac{|I_1|}{|I_2|} = 2$

$$\therefore \quad \frac{P_1}{P_2} = \frac{I_1^2 R_1}{I_2^2 R_2} = \left(\frac{I_1}{I_2}\right)^2 \times \frac{R_1}{R_2}$$

$$= 4 \times \frac{3}{10} = \frac{6}{5}$$

28. (c)

Since $V_1 < V_2$, therefore the current will flow from V_2 to V_1 as shown below.



$$I = \frac{V_2 - V_1}{6} = \frac{24-6}{6} = \frac{18}{6} = 3 \text{ A}$$

Hence, the whole power in the circuit will be supplied by V_2 only. Total power delivered by the voltage source V_2 is

$$P_T = I^2 \times (2 + 4) + 6I$$
$$= 3^2 \times 6 + 6 \times 3 = 54 + 18$$
$$= 72 \text{ watts}$$

29. (a)

$$V_R = (10 + 5V_R) \times R$$

Given, $V_R = 5$ V

So, $5 = (10 + 5 \times 5)$ R

or, $R = \frac{5}{35} = \frac{1}{7}\,\Omega$

$\therefore$ Power loss in R is

$$P_{\text{loss}} = (10 + 5 \times 5)^2 \times \frac{1}{7}$$

$$= 35^2 \times \frac{1}{7} = 175 \text{ watts}$$

30. (b)

Instantaneous power in a purely resistive circuit is

$$p = \frac{V_m^2}{2R}(1 - \cos 2\omega t)$$

$$\therefore \quad P_{\text{av}} = \frac{1}{2\pi}\int_0^{2\pi} p dt = \frac{V_m^2}{2R} = \frac{P_{\max}}{2}$$

31. (c)

Phase difference between v and i is

$$\phi = \frac{\pi}{4} - \left(-\frac{\pi}{6}\right) = 45° + 35° = 75°$$

$\therefore$ power factor $= \cos\phi = \cos 75°$ lag

Since, i lags v therefore, the circuit elements may be resistance and inductance ($Z = R + jX_L$) or it may be resistance, inductance and capacitance $Z = R + j(X_L - X_C)$, so that p.f. becomes lagging.

32. (b)

Since system is bounded for bounded excitation therefore, it will be stable.

Since the system is delayed therefore, output may exist before the input is applied.

Hence, the system will be non-causal.

33. (b)

Applying KVL in the loop

$$24 - 1I + 2V_b - V_b - 4I = 0$$

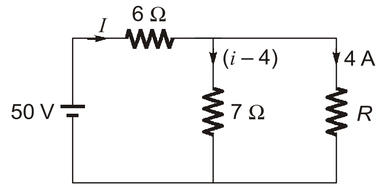
where, $V_b = 3I$

$\Rightarrow \quad 24 - 5I + V_b = 0$

$\Rightarrow \quad 24 - 5I + 3I = 0$

$I = 12$ A

34. (a)



By applying KVL in 1st loop

$$50 = 6i + 7(i - 4)$$

$\Rightarrow \quad 13i = 78$

$\Rightarrow \quad i = 6$ A

Now, by applying KVL in 2nd loop

$$7 \times 2 = 4 \times R$$
$$R = 3.5\,\Omega$$

36. (a)

$$R_1 = \frac{V^2}{P_1} \text{ and } R_2 = \frac{V^2}{P_2}$$

Bulbs are connected in series

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

$$= V^2\left[\frac{1}{P_1} + \frac{1}{P_2}\right] = V^2\left[\frac{P_1 + P_2}{P_1 P_2}\right]$$

$$\text{Total power} = \frac{V^2}{R_{eq}} = \frac{P_1 P_2}{P_1 + P_2}$$

37. (c)

$$i_1 = \sqrt{\frac{P_1}{R}} \text{ and } i_2 = \sqrt{\frac{P_2}{R}}$$

when both source are active

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

$$\text{Total power} = i^2 R$$

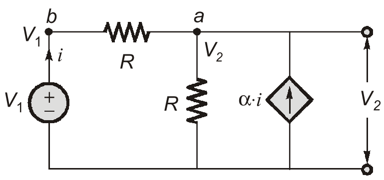
$$= \left(\sqrt{\frac{P_1}{R}} \pm \sqrt{\frac{P_2}{R}}\right)^2 R$$

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

38. (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.

39. (c)



$$\frac{V_1 - V_2}{R} = i \quad \ldots(i)$$

By applying KCL at node a

$$(1 + \alpha)i = \frac{V_2}{R} \quad \ldots(ii)$$

From equation (i),

$$(1+\alpha)\left(\frac{V_1 - V_2}{R}\right) = \frac{V_2}{R}$$

$$\therefore \quad \left(\frac{V_1}{V_2} - 1\right) = \frac{1}{1+\alpha}$$

$$\frac{V_1}{V_2} = \frac{2+\alpha}{1+\alpha}$$

$$\therefore \quad \frac{V_2}{V_1} = \frac{1+\alpha}{2+\alpha}$$

40. (a)

In the given circuit there are only resistor/inductor or capacitor and a voltage source, of $V = 5 - 5 = 0$ V. As these are passive elements and follow the superposition theorem. The circuit is passive and linear.

41. (c)

As all the resistive branches are in parallel.

$\therefore$ voltage across each branch will be constant and will be equal to the dc supply voltage

$$\therefore \quad V = IR = \text{constant}$$

$$\Rightarrow \quad I \propto \frac{1}{R}$$

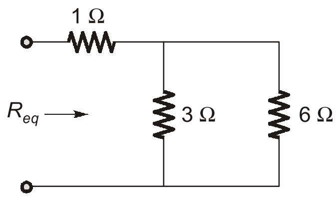
$$I_1 : I_2 : I_3 = \frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3}$$

$$= R_2R_3 : R_1R_3 : R_1R_2$$

$$= 24 : 12 : 8$$

$$= 6 : 3 : 2$$

42. (d)



$$R_{eq} = 1 + (3 \parallel 6) = 3\ \Omega$$

Voltage across current source

$$I_s R_{eq} = 2 \times 3 = 6\text{ V}$$

43. (b)

$$\text{Applying KCL,} \quad -1 + \frac{8-2}{2} - I = 0 \Rightarrow I = 2\text{ A}$$

44. (b)

Applying Nodal Analysis

$$20 = \frac{V_A}{2} + \frac{V_A - V_B}{2}$$

$$40 = 2V_A - V_B \quad \ldots(i)$$

$$\text{and} \quad \frac{V_A + V_B}{2} = \frac{V_B}{1} + 10$$

$$V_A - V_B = 2V_B + 20$$

$$\therefore \quad V_A - 3V_B = 20 \quad \ldots(ii)$$

Solving (i) and (ii),

$$V_A = 20\text{ V}$$