2020

RANK Improvement WORKBOOK

Answer key and Hint of Objective & Conventional *Questions*

Electronics Engineering

Network Theory

MADE EASY Publications

1 Basics of Network Analysis

LEVEL 1 Objective Solutions

1. (b)
2. (b)
3. (a)
4. (a)
5. (80)
6. (c)
7. (b)
8. (25)

LEVEL 2 Objective Solutions

9. (100)
10. (c)
11. (1.71)
12. (a)
13. (a)
14. (a)
15. (c)
16. (0.196)

■■■■

LEVEL 3 Conventional Solutions

Solution : 1

$$\frac{P_{out}}{P_{in}} = 1.064 \times 10^6 \text{ W}$$

Solution : 2

$$I_1 = 0.25 \text{ A}, I_2 = -0.417 \text{ A}$$

Independent sources delivering the power and dependent sources absorbing the power.

Solution : 3

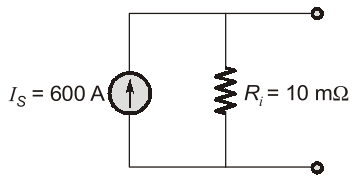
$$\frac{V_L}{V_S} = 0.9375$$

Solution : 4

$P_{12\,\Omega} = 192$ W, $P_{8\,\Omega} = 288$ W and $P_{16\,\Omega} = 144$ W

Solution : 5

Constant current source



Solution : 6

$$\alpha = \frac{I_2}{I_1} = -0.786$$

Solution: 7

$$P = 100 \text{ mW}$$

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2 Steady State Sinusoidal Analysis

LEVEL 1 Objective Solutions

1. (d)

2. (1)

3. (a)

4. (a)

5. (c)

6. (b)

7. (b)

LEVEL 2 Objective Solutions

8. (a)

9. (c)

10. (c)

11. (d)

12. (c)

13. (89.44)

14. (b)

15. (b)

16. (1)

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LEVEL 3 Conventional Solutions

Solution : 1

$$R = 1\ \text{k}\Omega$$

Solution : 2

$$C = \frac{L}{R^2 + (\omega L)^2}$$

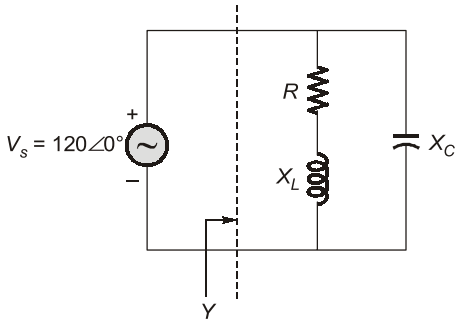
Solution : 3

Voltmeter reading $\approx$ 152 V

Solution : 4

Q factor = 0.03 and ω_0 = 1414 rad/sec.

Solution : 5



Y = equivalent admittance of the parallel circuit

Hint:

For unity power factor resonance, imaginary term must be zero

$$\frac{1}{X_C} - \frac{X_L}{R^2 + X_L^2} = 0$$

$$X_L^2 - X_C X_L + R^2 = 0$$

Minimum value of the current drawn from the supply $I_{s_1} = 3\ \text{A}$.

Solution : 6

$$\tan\theta = \frac{\left(\omega L - \frac{1}{\omega C}\right)}{R}$$

(i) f = 19.57 Hz

(ii) f = 21.56 Hz

Solution : 7

$L = 0.2481$ mH

$R = 222.73\ \Omega$ and $R_g = 11.13\ k\Omega$

Solution : 8

(i) Resonant frequency $\omega_0 = 10.05$ rad/sec

(ii) Q factor $Q = 5.02$

(iii) Bandwidth $\beta = 2$

(iv) Impedance under resonance $Z_0 = R = 40\ \Omega$

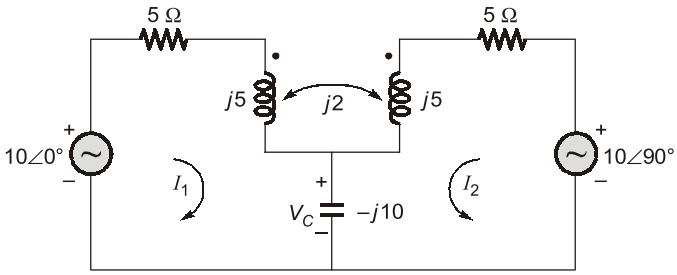
Solution : 9

(i) $$\omega_0 = \frac{1}{\sqrt{LC}}$$

(ii) $$Z_{xy} = R_1 + R_2$$

$$i(t) = \frac{V}{R_1 + R_2}\sin\omega t$$

Solution : 10



and $V_C = 10.15\angle 24°$ Volts

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3 Network Theorems

LEVEL 1 Objective Solutions

1. (b)

2. (a)

3. (160)

4. (5)

5. (b)

6. (d)

LEVEL 2 Objective Solutions

7. (257.99)

8. (1)

9. (c)

10. (b)

11. (1.797)

12. (c)

13. (c)

14. (0.8)

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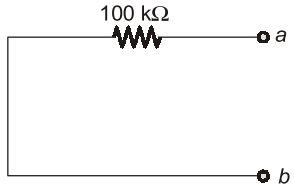
LEVEL 3 Conventional Solutions

Solution : 1



Solution : 2

$$R_L = R_N = 2.5\ \Omega \text{ and } P_{max} = 15.625\ \text{W}$$

Solution : 3

$$i_0 = -0.4706\,\text{A}$$

Solution : 4

$$I_L = \frac{V_{0.c}}{R_{Th} + R_L} = -46.15\ \text{mA} \qquad \text{(i.e., 46.15 mA anticlockwise)}$$

Solution : 5

Meter current = 0.255 mA

Solution : 6

$$i_L(t) = (82.848 - 84.50e^{-0.243t} + 1.654e^{-12.418})u(t)\ \text{A}$$

Solution : 7

$$P_{R_L} = 4.05\ \text{W},\ P_{R_L/2} = 8.1\ \text{W and } P_{R_L/3} = 12.15\ \text{W}$$

Solution : 8

$$I = \frac{4}{3}\text{A}$$

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4 Transient State Analysis

LEVEL 1 Objective Solutions

1. (b)
2. (b)
3. (a)
4. (b)
5. (c)
6. (d)
7. (b)
8. (d)
9. (b)
10. (6.99)

LEVEL 2 Objective Solutions

11. (2.54)
12. (a)
13. (5.41)
14. (54.14)
15. (b)
16. (b)
17. (c)
18. (c)
19. (d)
20. (1)
21. (0.25)
22. (c)

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LEVEL 3 Conventional Solutions

Solution : 1

$$v_0(t) = 80\sin(2t)\ \text{V}$$

Solution : 2

$$i(t) = 5te^{-2t}\,u(t)\ A$$

Solution : 3

$$i = e^{-200t}(2.04 \sin 979.8\ t)\ \text{Amp}$$

Solution : 4

$$\frac{di(0^+)}{dt} = -40\ \text{A/s} \quad \text{and} \quad \frac{d^2i(0^+)}{dt^2} = 800\ \text{A/s}^2$$

Solution : 5

$$V_C(t) = (e^{-(t-1)} + e^{-t})\ \text{V}$$

Solution : 6

$$I(s)_{ss} = 2\ \text{mA} \quad \text{and} \quad \tau = 0.3125\ \text{msec.}$$

Solution : 7

$$V_0(t) = 75e^{-10(t-t_0)}\,V$$

At $t = t_0$, $V_0 = 75\ \text{V}$

At $t = 25\text{m sec}$, $V_0 = 75e^{-10\left(25\times10^{-3}-t_0\right)}\,V$

At $t \to \infty$, $V_0 = 0\ \text{V}$

Solution : 8

$$i_1(t) = (5 - e^{-t/5})\,u(t)\ A$$

Solution : 9

$$i_R(t) = 0.1\ e^{-2000t} \quad \text{for} \quad t > 0$$

Solution : 10

$$V_C(0^+) = V_C(0^-) = 2\ \text{V}$$
$$i_L(0^-) = i_L(0^+) = 0\ \text{A}$$
$$\frac{dV_C(0^+)}{dt} = 16\ \text{V/S}$$
$$\frac{di_L(0^+)}{dt} = 2\ \text{A/S}$$

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5 Two-Port Network Parameters

LEVEL 1 Objective Solutions

1. (a)

2. (4)

3. (85)

4. (0.5)

5. (d)

6. (c)

7. (d)

8. (c)

LEVEL 2 Objective Solutions

9. (d)

10. (c)

11. (d)

12. (11.11)

13. (d)

14. (b)

15. (c)

16. (b)

17. (3)

18. (c)

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LEVEL 3 Conventional Solutions

Solution : 1

$$R_{11} = 13\ \Omega$$

Solution : 2

$$y_{11} = 0.233\ \text{S}$$

Solution : 3

Reciprocal network : A network is reciprocal when the ratio of response at port 2 to the excitation at port '1' is same as the ratio of response at port 1 to the excitation at port 2.

$$Y = \begin{bmatrix} 2 & -\frac{1}{2} \\ -\frac{1}{2} & +\frac{1}{2} \end{bmatrix}$$

Here, $Y_{12} = Y_{21}$ (Given network is reciprocal)

Solution : 4

$$h_{12} = 1.2,\ Z_{12} = 9.6\ \Omega \text{ and } Y_{12} = -0.24\ \text{℧}$$

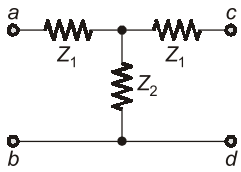
Solution : 5

$$[h] = \begin{bmatrix} 0.375 & 3 \\ -0.25 & 0.667 \end{bmatrix}$$

Solution : 6

$$I_1 = 24\ \text{A},\ I_2 = 1.5\ \text{A and } I_3 = 6.5\ \text{A}$$

Solution : 7



$Z_1 = Z_2 = 400\ \Omega$

Solution : 8

Parameter	Condition for reciprocal
Z	$Z_{12} = Z_{21}$
Y	$y_{12} = y_{21}$
h	$h_{12} = -h_{21}$
$ABCD$	$AD - BC = 1$

Solution : 9

$$v_2(t) = (0.037 + 0.0456\, e^{-1.902t} - 0.083\, e^{-7.098t})u(t)$$

Solution : 10

$$[Z_n] = \begin{bmatrix} 1.72 & 1.22 \\ 1.22 & 2.22 \end{bmatrix}$$

Solution : 11

$$[y] = \begin{bmatrix} \frac{5s}{3} & -\frac{4s}{3} \\ -\frac{4s}{3} & \frac{5s}{3} \end{bmatrix}$$

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6 Network Synthesis and Graph Theory

LEVEL 1 Objective Solutions

1. (c)
2. (b)
3. (d)
4. (c)
5. (c)

LEVEL 2 Objective Solutions

6. (c)
7. (a)
8. (c)
9. (b)
10. (c)

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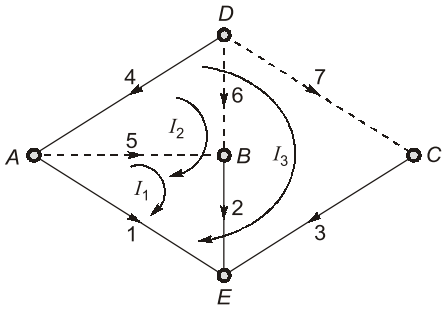
LEVEL 3 Conventional Solutions

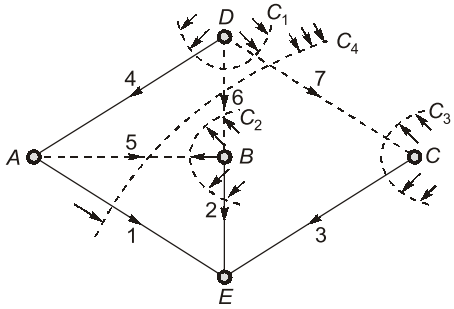
Solution : 1

The Tie-set matrix is shown below:



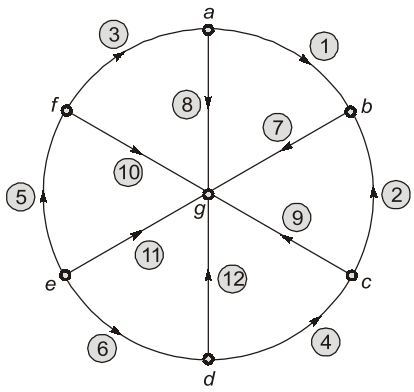
Loop currents	Branches						
	1	2	3	4	5	6	7
I_1	–1	1	0	0	1	0	0
I_2	–1	1	0	–1	0	1	0
I_3	–1	0	1	–1	0	0	1

The necessary cut-set matrix is shown below:



Cut-Sets	Branches						
	1	2	3	4	5	6	7
C_1	0	0	0	1	0	1	1
C_2	0	1	0	0	–1	–1	0
C_3	0	0	1	0	0	0	–1
C_4	1	0	0	0	1	1	1

Solution : 2



Fundamental cut set matrix:

	Branches											
f cut set	1	2	3	4	5	6	7	8	9	10	11	12
f-1	1	0	–1	0	0	0	0	1	0	0	0	0
f-2	–1	–1	0	0	0	0	1	0	0	0	0	0
f-3	0	1	0	–1	0	0	0	0	1	0	0	0
f-4	0	0	0	1	0	–1	0	0	0	0	0	1
f-5	0	0	0	0	1	1	0	0	0	0	1	0
f-6	0	0	1	0	–1	0	0	0	0	1	0	0

Solution : 3

$$I(t) = 2t - 12e^{-2t} + 24e^{-3t}\ \text{A}$$

Solution : 4

$$Y_{12}(s) = -\left(\frac{R_1 + R_2 + Ls}{R_1 R_2}\right)$$

$$Z_{12}(s) = -\frac{(R_2 + Ls)}{R_1}$$

$$Z_{11}(s) = \frac{R_1(R_2 + Ls)}{R_1 + R_2 + Ls}$$

$$Z_{22}(s) = -R_2$$

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