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ESE-2017 : Prelims Exam

UPSC Engineering Services Examination

E & T ENGINEERING

Answer Key & Solutions

Test 1: Part Syllabus Technical

Network Theory

1. (b)
2. (b)
3. (b)
4. (c)
5. (a)
6. (d)
7. (b)
8. (b)
9. (c)
10. (c)
11. (b)
12. (b)
13. (c)
14. (d)
15. (b)
16. (a)
17. (b)
18. (b)
19. (a)
20. (a)
21. (d)
22. (a)
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24. (c)
25. (c)
26. (c)
27. (c)
28. (a)
29. (a)
30. (b)
31. (b)
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46. (b)
47. (c)
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53. (a)
54. (d)
55. (a)
56. (b)
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60. (a)
61. (a)
62. (b)
63. (c)
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66. (b)
67. (b)
68. (c)
69. (c)
70. (d)
71. (b)
72. (d)
73. (a)
74. (c)
75. (a)

DETAILED EXPLANATIONS

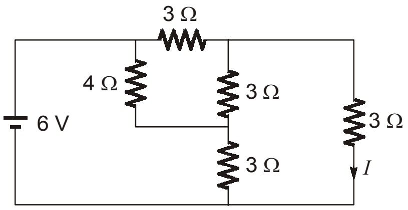
2. (b)

For parallel resonant circuit

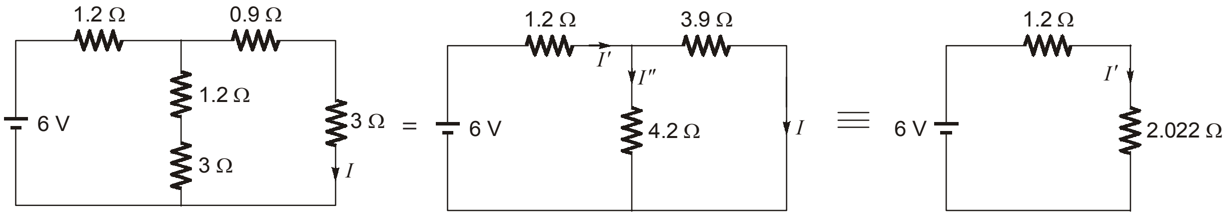
$$Q = R\sqrt{\frac{C}{L}} = 100\sqrt{\frac{10^{-5}}{10^{-3}}}$$

$$= \frac{100}{10} = 10$$

3. (b)



Converting Δ into Y

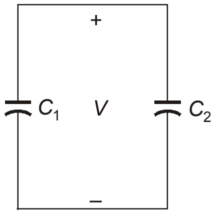


Here $$I' = \frac{6}{3.22} = 1.86\text{ A}$$

Using current division rule $$I = \frac{I' \times 4.2}{4.2 + 3.9} = \frac{1.86 \times 4.2}{8.1\,\Omega} = 0.966\text{A} \simeq 1\text{ A}$$

4. (c)

For parallely connected capacitors C_1 and C_2, let the voltage across their terminal at steady state be V.



where, $$V = \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

or $$\frac{C_1}{C_2} = \frac{Q_1}{Q_2} = \frac{70}{280} = \frac{1}{4} \qquad \text{...(i)}$$

Also, the charge shared by C_1 and C_2 is

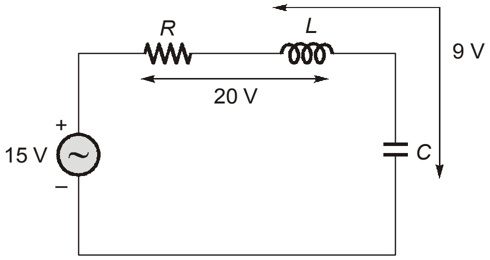
$$Q_1 + Q_2 = 100\,\mu\text{C} \qquad \text{...(ii)}$$

From equation (i) and (ii)

$$Q_1 = 20\,\mu\text{C and } Q_2 = 80\,\mu\text{C}$$

∴ In steady state C_1 will have charge of 20 μC and C_2 will have charge of 80 μC.

5. (a)



For series RLC circuit

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$15 = \sqrt{V_R^2 + 9^2}$$

or $$225 - 81 = V_R^2$$

or $$V_R = \sqrt{144}\text{ V} = 12\text{ V}$$

$\because$ $$V_R^2 + V_L^2 = (20)^2$$

$\therefore$ $$144 + V_L^2 = (400)$$

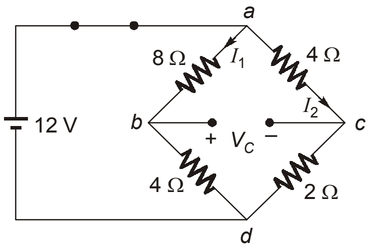
or $$V_L = 16\text{ V}$$

Therefore $$V_L - V_C = 9\text{ V}$$

$\Rightarrow$ $$V_C = 7\text{ V}$$

6. (d)

At steady state, for dc excitation, the capacitor acts as an open circuit



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

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

In the loop *bcd*

$$-V_C + 2I_2 - 4I_1 = 0$$

or $$V_C = 2 \times 2 - 4 \times 1 = 0\text{ V}$$

thus, the charge accumulated with be = 0

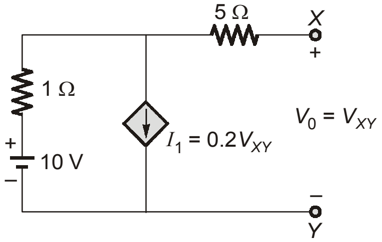
7. (b)

To find the Thevenin's equivalent make *X* - *Y* open circuit, then V_{X-Y} is the open circuit voltage V_0,

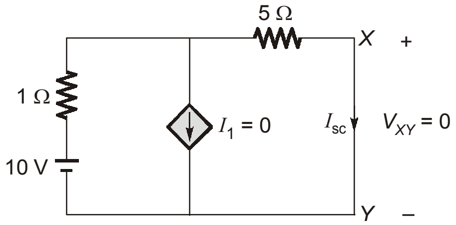
Here, $$-10 + 0.2V_0 + V_0 = 0$$

$$1.2\,V_0 = 10$$

$$V_0 = 8.33\text{ V}$$



Next, short circuit is applied across X-Y



$$I_{sc} = \frac{10}{1+5} = 1.67 \text{ A}$$

∴ $$R_{Th} = \frac{V_0}{I_{sc}} = \frac{8.33}{1.67} = 5\ \Omega$$

8. (b)

Let current-I enters from 'a' in the mesh network and comes out at 'b'. At 'a' after entering network, it will be equally divided in four paths to proceed further in the network. Thus, current flowing through ab is $\left(\frac{I}{4}\right)$. Similarly, we can say at 'b' node currents converge from its adjacent four branches to come out finally as I. Thus, current coming out through ab branch is $\left(\frac{I}{4}\right)$. Hence the total current flowing through branch ab is $\left(\frac{I}{4}+\frac{I}{4}\right)=\frac{I}{2}$. The voltage drop across ab branch is thus $\left(R\times\frac{I}{2}\right)$ as R is the resistance of ab branch. The effective resistance between a and b is thus given by

$$R_{eff} = \frac{R\times\frac{I}{2}}{I} = \frac{R}{2}\ \Omega$$

9. (c)

The h-parameter "h_{21}" can be determined by using Z-parameters

$$Z_{11} = \frac{Z_A+Z_B}{2} = \frac{2+4}{2}\ \Omega = 3\ \Omega = Z_{22}$$

$$Z_{12} = \frac{Z_B-Z_A}{2} = \frac{4-2}{2}\ \Omega = 1\ \Omega = Z_{21}$$

∴ $$V_1 = Z_{11}I_1 + Z_{12}I_2$$

$$V_1 = 3I_1 + I_2$$

and $$V_2 = I_1 + 3I_2$$

$$h_{21} = \frac{-Z_{21}}{Z_{22}} = +\left.\frac{I_2}{I_1}\right|_{V_2=0} = -\frac{1}{3}$$

10. (c)

for an ideal transformer, $K = 1$

$$M = \sqrt{L_1 L_2}$$

$$X_M = \sqrt{X_1 X_2}$$

where, X_1 = Reactance of the primary coil

X_2 = Reactance of the secondary coil

X_M = Mutual reactance

$$\therefore \quad X_M = \sqrt{2 \times 8} = 4\ \Omega$$

$$\because \quad X = 2\pi f L$$

$$M = \frac{X_M}{2\pi f} = \frac{4}{100} = 40\text{ mH}$$

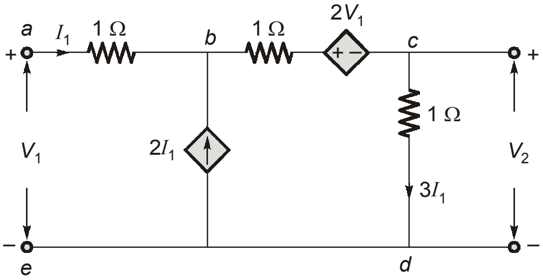
11. (b)

$$Z(s) = \frac{K(s+3)}{(s-(-1+j))(s-(-1-j))} = \frac{K(s+3)}{s^2+2s+2}$$

Given, $$Z(0) = \frac{3K}{2} = 3$$

$$\Rightarrow \quad K = 2$$

12. (b)



In loop *abcde*, applying KVL

$$V_1 = I_1 + 3I_1 + 2V_1 + 3I_1$$

$$-V_1 = 7I_1 \qquad \text{...(i)}$$

Again in branch *cd* $V_2 = 3I_1$ ...(ii)

Using equation (i) and (ii)

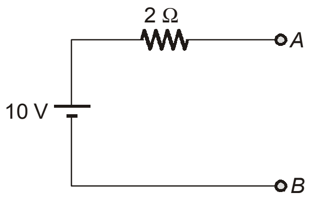
$$\frac{V_2}{V_1} = -\frac{3}{7}$$

14. (d)

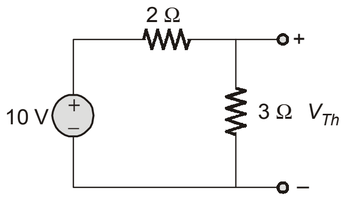
A short in any type of circuit causes the total circuit resistance to decrease and thereby the current to increase.

15. (b)

Thevenin's equivalent of network "*A*" ⇒

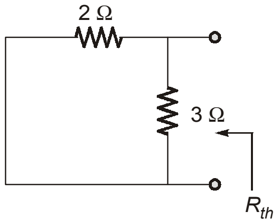


equivalent of the network shown in the Fig. (ii) ⇒



$$V_{TH} = \frac{10}{3+2}\times 3 = 6 \text{ V}$$

R_{TH}: Deactivate independent source



$$R_{TH} = \frac{3\times 2}{3+2} = \frac{6}{5} = 1.2\ \Omega$$

16. (a)

$$V_c = V_{\text{final}} + (V_{\text{initial}} - V_{\text{final}})\, e^{-t/RC} = 0 + (5-0)\, e^{-t/RC}$$

$$\frac{5}{e} = 5e^{-\left(\frac{0.1}{40\text{k}\times C}\right)}$$

$$\frac{0.1}{40\text{k}\times C} = 1$$

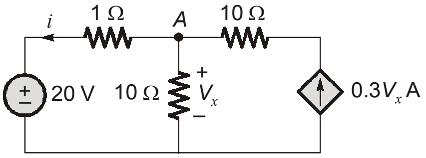
or $$C = 2.5\ \mu\text{F}$$

17. (b)

All the three conditions are true, but in question minimal set of conditions asked. As without condition 2, condition 1 or condition 3 is not supportable, so option (b) is the correct choice.

Note : due to ambiguity marks has been given to all.

18. (b)



Applying KCL at node *A*

$$\begin{aligned}\frac{V_x-20}{1}+\frac{V_x}{10} &= 0.3\,V_x\\ 10\,V_x-200+V_x &= 3\,V_x\\ 8V_x &= 200\\ V_x &= 25\text{ V}\\ i &= \frac{25-20}{1}=5\text{ A}\end{aligned}$$

Since current is entering the voltage source therefore, power absorbed by voltage source is

$$\begin{aligned}P &= 20i\\ &= 20\times 5 = 100\text{ W}\end{aligned}$$

19. (a)

$$\begin{aligned}i_x &= i_2+i_3=3\text{ A}\\ i_1+i_4+i_x &= 0\\ i_4 &= -i_1-i_x\\ &= -4\text{ A}\end{aligned}$$

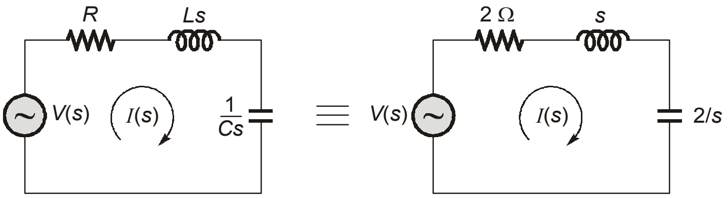
20. (a)

$$P_{\text{av}} = \frac{V_{rms}^2}{10\,\Omega}$$

$$V_{rms}^2 = \left(4^2+\frac{4^2}{2}+\frac{2^2}{2}+\frac{2^2}{2}+\frac{2^2}{2}\right)\text{V}^2 = 30\text{ V}^2$$

$$P_{\text{av}} = \frac{30}{10} = 3\text{ W}$$

21. (d)



The voltage across the inductor

$$\begin{aligned}V_L(s) &= Ls\times I(s)\\ &= \frac{s}{s^2+2s+2} = \frac{s+1-1}{(s+1)^2+1}\end{aligned}$$

using inverse Laplace transform

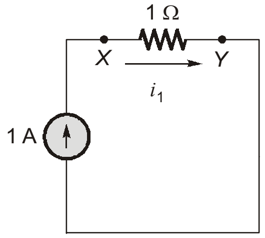
we get, $v_L(t) = e^{-t}\,[\cos t-\sin t]\;u(t)\text{ V}$

22. (a)

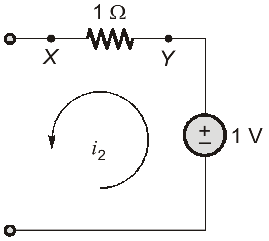
For RL driving point impedance function the lowest critical frequency is zero.

23. (b)

Using super position theorem



$$i_1 = 1\text{ A}$$

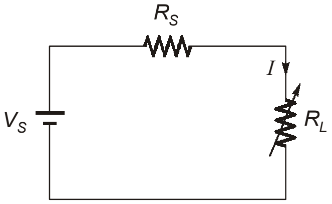


$$i_2 = 0\text{ A}$$

$$i = i_1 - i_2 = 1\text{ A}$$

24. (c)

From maximum power transfer theorem;



$$P = I^2 \times R_L$$

or $$P = \frac{V_S^2}{(R_S + R_L)^2} \times R_L \quad \text{...(i)}$$

Hence P_{max} at $$R_L = R_S$$

$$P_{max} = \frac{V_S^2}{4R_S}$$

From equation (i), we see first as R_L increases the power delivered to the load (P) is increased upto a maximum value P_{max} then P starts declining for further increament in R_L.

25. (c)

Here P and Q comprising one node

∴ applying KCL, we get

$$20 + I_1 = 25 + I_2 \quad \text{...(i)}$$

Also R and S comprising one node

∴ $$15 - I_1 - 10 + 30 = 0$$

$$I_1 = 45 - 10 = 35\text{ A} \quad \text{...(ii)}$$

from (i) and (ii)

$$I_2 = 20 + 35 + (-25)$$
$$I_2 = 30 \text{ A}$$

26 (c)

Since $Z(0)$ = constant so R_0 is present and pole at $\omega = \infty$ so L_∞ is also present.

27. (c)

Poles and zeros of an LC function must lie on $j\omega$-axis and also they should interlace.

Hint: Always find residue to check LC driving point immittances.

28. (a)

Whenever an ideal voltage source and ideal current source are connected in series, they will behave like an ideal current source alone and if they are connected in parallel, they will behave like an ideal voltage source alone.

30. (b)

For reciprocal networks,

$$Z_{12} = Z_{21}$$
$$Y_{12} = Y_{21}$$
$$\begin{vmatrix} A & B \\ C & D \end{vmatrix} = 1$$
$$h_{12} = -h_{21}$$

31. (b)

Duality means, the mathematical representation of both the networks should be identical (KVL and KCL).

$\therefore$ Loop equations of one network are analogous to the node equations of the other.

32. (b)

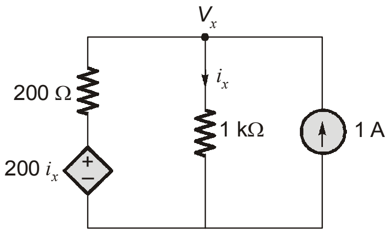
$$M = K\sqrt{L_1 L_2}$$

where K = coefficient of coupling

$\because$ $K_{\max} = 1$

$$M_{\max} = \sqrt{81 \times 49} \text{ mH}$$
$$= \sqrt{9 \times 9 \times 7 \times 7} \text{ mH}$$
$$= 63 \text{ mH}$$

33. (b)



$$i_x = \frac{V_x}{1\text{k}}$$

$\Rightarrow$ $200\, i_x = 0.2\, V_x$

and $$\frac{V_x}{1\text{k}}+\frac{V_x-0.2V_x}{200} = 1\text{ A}$$

∴ $$V_x = 200\text{ V}$$

$$R_{\text{eq}} = \frac{V_x}{1\text{ A}} = 200\ \Omega$$

34. (c)

Ideal voltage sources of different values cannot be connected in parallel, because voltage across a parallel paths will be equal.

Ideal current sources of different values cannot be connected in series, because current through a series circuit path is same.

35. (c)

$$v(t) = 2[u(t)-u(t-2)]\text{ V}$$

$$i(t) = [r(t)-r(t-2)]\text{ A}$$

$$v(t) = 2\frac{di(t)}{dt} \qquad \text{...(i)}$$

for inductor, $$v(t) = L\frac{di(t)}{dt} \qquad \text{...(ii)}$$

from (i) and (ii), element is inductor with an inductance of 2 H

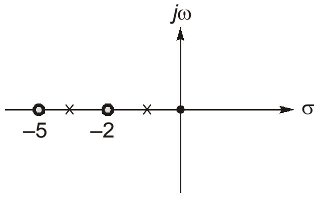
36. (a)

37. (b)

From final value theorem

$$v_C(\infty) = \lim_{s\to 0}\frac{s(2s+6)}{s(s+3)} = 2\text{ V}$$

38. (b)



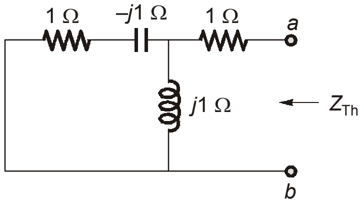
For RC driving point impedance function, the poles and zeros are alternate on negative real axis with a pole located near to the origin.

41. (c)

For maximum power transfer

$$Z_L = Z_{Th}^*$$

Calculating Z_{TH} across *ab*



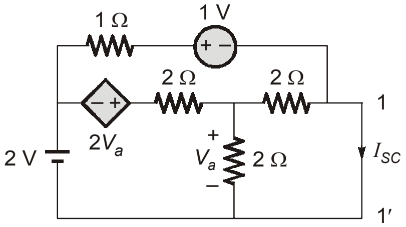
$$
\begin{aligned}
Z_{Th} &= [1j \,||\, (1-j)] + 1\ \Omega \\
&= \frac{j(1-j)}{1+j-j} + 1\Omega \\
&= j(1-j) + 1 \\
&= j + 1 + 1 \\
&= 2 + j
\end{aligned}
$$

$$\therefore \quad Z_L = Z_{Th}^* = 2 - j$$

42. (b)

$$
\begin{aligned}
i(t) &= \frac{1}{L}\int_0^t v(t)\,dt + i(0) \\
i(t=4) &= \frac{1}{2}\int_0^4 10(1-t)\,dt + 2\text{A} \\
&= \frac{10}{2}\left(t - \frac{t^2}{2}\right)\Bigg|_0^4 + 2\text{ A} \\
&= 5\left(4 - \frac{16}{2}\right) + 2\text{A} \\
&= 5(4-8) + 2\text{ A} \\
&= -18\text{ A}
\end{aligned}
$$

43. (b)



Using Nodal analysis,

$$
\begin{aligned}
\frac{V_a - 2V_a - 2}{2} + \frac{V_a}{2} + \frac{V_a - 0}{2} &= 0 \\
\frac{-V_a}{2} + I_{SC} + \frac{1-2}{1} &= 0
\end{aligned}
$$

after solving, $I_{SC} = 2\text{ A}$

44. (d)

Given graph is a complete graph

$\therefore$ the maximum number of possible trees = n^{n-2}

where n = total number of nodes

$\because$ $n = 4$

$$\text{Total number of trees} = 4^{(4-2)} = 4^2 = 16$$

45. (d)

Given

$$f = 1.5 \text{ MHz}$$
$$C = 150 \text{ pF}$$
$$BW = 10 \text{ kHz}$$

For series RLC circuit

$$Q = \frac{f_0}{BW} = \frac{1.5\times10^3}{10} = 150$$

also,

$$Q = \frac{1}{\omega RC}$$

$$\frac{1}{150} = 2\pi \times 1.5 \times 10^6 \times 150 \times 10^{-12} \times R$$

$$R = \frac{10^6}{2\pi\times1.5\times150\times150} = 4.71\ \Omega$$

46. (b)

$$Z_{AB} = \left(\frac{23}{6}\right) + \left((3+j4)\,\|\,(3-j4)\right)\ \Omega$$
$$= \frac{23}{6} + \frac{(3+j4)(3-j4)}{6}\ \Omega$$
$$= \frac{23}{6} + \frac{25}{6} = \frac{48}{6}\ \Omega$$
$$= 8\ \Omega$$

47. (c)

$$v(t) = 160\sin(\omega t + 10°)\text{ V}$$
$$i(t) = 5\sin(\omega t - 20°)\text{ A}$$

Phase difference between $v(t)$ and $i(t) = 30°$

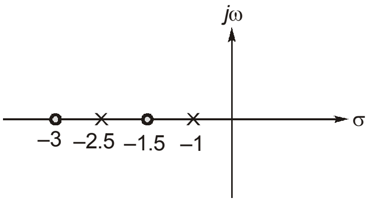
Reactive power absorbed by the network N is,

$$Q = \left(\frac{160}{\sqrt{2}}\right)\left(\frac{5}{\sqrt{2}}\right)\sin(30°)\text{ VAR}$$
$$= 200\text{ VAR}$$

48. (a)

$$F(s) = \frac{s^2 + 4.5s + 4.5}{2.5 + 3.5s + s^2}$$

$$F(s) = \frac{(s+3)(s+1.5)}{(s+1)(s+2.5)}$$



Singularity nearer to the origin is pole, then $F(s)$ is RC impedance or *RL* admittance.

49. (d)

$$F(s) = \frac{K(s+\sigma)(s+1)}{(s+2)(s+8)}$$

Given

$$F(0) = \frac{K \cdot 1 \cdot \sigma}{16} = 1$$

and $$F(\infty) = K = 4$$

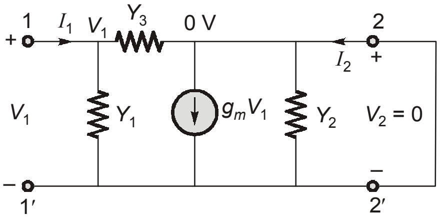
∴ $$\sigma = 4$$

hence $$F(s) = \frac{4(s+4)(s+1)}{(s+2)\,(s+8)}$$

Zero is nearer to the origin, poles and zeros are interlace, hence $F(s)$ can be either *RL* impedance function or RC admittance function.

In the Question it is given that, the function is an RC function. So, it can be an admittance function.

50. (b)



$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2 = 0}$$

when $V_2 = 0$

$$V_1 Y_3 + I_2 = g_m V_1$$

$$\frac{I_2}{V_1} = Y_{21} = g_m - Y_3$$

51. (b)

For maximum power to be transferred

$$R_L' = \left(\frac{n_1}{n_2}\right)^2 \times R_L = R_{Th}$$

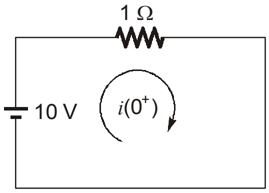
$$45 = \left(\frac{1}{n}\right)^2 \times 5$$

$$9 = \left(\frac{1}{n}\right)^2$$

or $$n = \frac{1}{3}$$

52. (a)

At $t = 0^+$, switch is closed, capacitor acts as a short circuit and inductor acts as an open circuit.



$$i(0^+) = \frac{10}{1} = 10\text{ A}$$

At $t = \infty$; capacitor acts as an open circuit and inductor acts as a short circuit.

$$i(\infty) = \frac{10}{1} = 10\text{ A}$$

$$i(0^+) = 10\text{ A}$$

⇒ $$i(\infty) = 10\text{ A}$$

53. (a)

$$M = K\sqrt{L_1 L_2}$$

$$M = 0.25\sqrt{0.6 \times 0.6} = 0.15\text{ H}$$

$$V_2 = M\frac{di_1}{dt}$$

$$= 0.15 \times \frac{d}{dt}(6\sin 100t)$$

$$= 15 \times 6 \times \cos 100t$$

$$= 90\cos 100t\text{ V}$$

54. (d)

For series resonant circuit

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$L \to 4L$$

$$C \to C/4$$

$$Q' = \frac{4}{R}\sqrt{\frac{L}{C}} = 4Q$$

selectivity $\propto$ Q of the circuit

$\therefore$ option (d) is the correct option.

55. (a)

For RLC circuit

$$Q = \frac{1}{R}\sqrt{L/C} = \frac{1}{2\xi}$$

$$\xi = \frac{R}{2}\sqrt{C/L}$$

For undamped response, $\xi = 0$

so, $R = 0$

For underdamped response, $\xi < 1$

so, $$\frac{R}{2}\sqrt{C/L} < 1$$

or $$R < 2\sqrt{\frac{L}{C}}$$

for critically damped response, $\xi = 1$

so, $$R = 2\sqrt{\frac{L}{C}}$$

for overdamped response, $\xi > 1$

so, $$R > 2\sqrt{\frac{L}{C}}$$

57. (c)

$$q_1 = \frac{\omega L_1}{R_1}$$

$$q_2 = \frac{\omega L_2}{R_2}$$

$$\omega L_1 = q_1 R_1$$

$$\omega L_2 = q_2 R_2$$

Coils are connected in series

So, $$q \cdot R = \omega L_1 + \omega L_2 = q_1 R_1 + q_2 R_2$$

$$q = \frac{q_1 R_1 + q_2 R_2}{R}$$

$$R = R_1 + R_2$$

$$q = \frac{q_1 R_1 + q_2 R_2}{R_1 + R_2}$$

58. (b)

$$V_2 = \frac{V_s \times j\omega L}{R + \omega L}$$

$$|V_2| = \frac{\sqrt{V_s^2 (\omega L)^2}}{\sqrt{R^2 + (\omega L)^2}} = \frac{|V_s| \times 300\,L}{\sqrt{100^2 \times (300\,L)^2}}$$

$$150 = \frac{250 \times 300\,L}{\sqrt{100^2 + (300\,L)^2}}$$

$$\sqrt{100^2 + (300L)^2} = \frac{250 \times 300}{150} L = 500\,L$$

$$10000 + 90000\,L^2 = 250000\,L^2$$

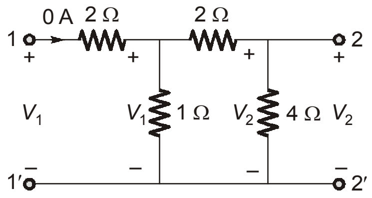
$$160000\,L^2 = 10000$$

$$L^2 = \frac{1}{16}$$

$$L = \sqrt{\frac{1}{16}} = \frac{1}{4} = 0.25\text{ H}$$

59. (b)

$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1 = 0}$$



when $I_1 = 0$,
$$V_1 = \frac{1}{1+2} V_2 = \frac{V_2}{3}$$

$$h_{12} = \frac{V_1}{V_2} = \frac{1}{3}$$

60. (a)

For parallel circuit

$$\omega_0 = \frac{1}{\sqrt{LC}} \sqrt{\frac{R_L^2 - L/C}{R_C^2 - L/C}}$$

$$\frac{L}{C} = 50\text{ (ohm)}^2$$

$$R_L^2 = 36\text{ (ohm)}^2$$

In order to get resonance, the quantity within the square root should be positive

since $R_L^2 < \frac{L}{C}$, R_C^2 also should be less than $\frac{L}{C}$.

$$R_C^2 < 50\,(\text{ohm})^2$$

$$\therefore \quad R_C < 7.07\ \Omega$$

only option (a) is less than 7.07 Ω

61. (a)

$$Z(j\omega) = 10 + \frac{\frac{1}{4\,j\omega}\times\left(8\,j\omega + \frac{1}{4\,j\omega}\right)}{\frac{1}{4\,j\omega}+\frac{1}{4\,j\omega}+8\,j\omega} = 10 + \frac{1-32\omega^2}{4\,j\omega(2-32\omega^2)}$$

$$\text{Under resonant condition} = 1 - 32\,\omega^2 = 0$$

$$\omega^2 = \frac{1}{32}$$

$$\omega = \frac{1}{4\sqrt{2}}\ \text{rad/sec}$$

63. (c)

$$L_1 + L_2 + 2\,M = 7\,\text{H}$$

$$L_1 + L_2 - 2\,M = 1.8\,\text{H}$$

$$\therefore \quad L_1 + L_2 = 4.4\,\text{H}$$

$$M = 1.3\,\text{H}$$

65. (b)

the impedance matrix for figure - 1 is,

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} j\omega L_1 & +j\omega M \\ +j\omega M & j\omega L_2 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

so,

$$[L] = \begin{bmatrix} L_1 & M \\ M & L_2 \end{bmatrix}$$

By comparing with given inductance matrix,

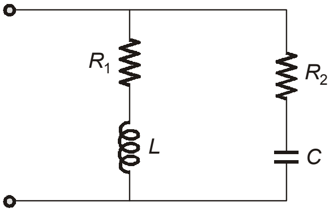
$M = 4,\ L_1 = 5,\ L_2 = 7$

for figure - 2,

$$L_{eq} = L_1 + L_2 - 2M$$

$$= 4\,\text{H}$$

66. (b)



$$\omega_0 = \frac{1}{\sqrt{LC}}\sqrt{\frac{R_1^2 - \frac{L}{C}}{R_2^2 - \frac{L}{C}}}$$

Parallel resonance will occur at all frequencies when

$$R_1^2 = R_2^2 = L/C$$

67. (b)

Any four terminal passive network can be converted to equivalent T or π network. Thevenin's theorem or Norton's theorem can also be used to get a transfer function.

But R is not correct explanation of A.

68. (c)

A is true but R is false.

In reason (R), it should be purely resistive.

69. (c)

Power factor generally does not change with temperature directly.

72. (d)

A capacitor has one pole at $s = 0$ and driving point impedance is

$$Z(s) = \frac{1}{sC}$$

73. (a)

$$\because \qquad \int_{-\infty}^{+\infty} i(t)\, dt = Q$$

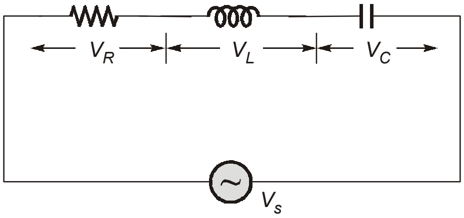
For unit impulse current,

$$\int_{-\infty}^{+\infty} \delta(t)\, dt = \int_{0^-}^{0^+} \delta(t)\, dt = 1$$

$$\Rightarrow \qquad Q = 1\ C$$

$$\Rightarrow \qquad W_E = \frac{Q^2}{2C} = \frac{1}{2C}\ \text{J}$$

74. (c)



$$V_s = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$= \sqrt{300^2 + (100 - 500)^2} = 500 \text{ V}$$

Statement given in R is wrong.

75. (a)

At resonance, the voltage across the inductor and across the capacitor are equal in magnitude but are opposite in phase. So that, the net voltage across inductor and capacitor combination is zero.

Hence, option (a) is correct.

❍❍❍❍