Serial No. : 1. JP_EC_A_240616_Network

CLASS TEST - 2016

Electronics Engineering

Networks Theory

Date : 24/06/2016

ANSWERS

1. (c)	7. (a)	13. (d)	19. (d)	25. (c)
2. (b)	8. (a)	14. (d)	20. (b)	26. (d)
3. (a)	9. (c)	15. (c)	21. (c)	27. (d)
4. (d)	10. (d)	16. (c)	22. (c)	28. (d)
5. (b)	11. (d)	17. (c)	23. (a)	29. (c)
6. (d)	12. (d)	18. (c)	24. (a)	30. (c)

Explanation

1. (c)

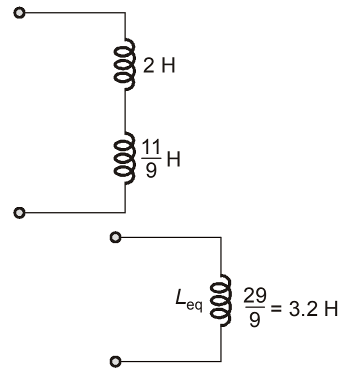
The circuit consisting of parallel opposing inductors so equivalent inductance.

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

$$L = \frac{(3 \times 4) - 1^2}{3 + 4 + 2(1)}$$

$$L = \frac{11}{9} H$$

$$L_{eq} = \frac{11}{9} + 2 = \frac{29}{9} = 3.2 \text{ H}$$



2. (b)

$$Z = |Z| e^{j\theta}$$

where $|Z| = \sqrt{6^2 + 8^2} = 10$

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right) = \tan^{-1}\left(\frac{8}{6}\right) \simeq 53° \quad \text{(approximately)}$$

$$I = \frac{100 e^{j30}}{10 e^{j53}} = 10\, e^{-j23} \text{ A} \quad \text{(approximately)}$$

3. (a)

Value of Z_L for maximum power transfer is

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

Here $Z_{TH} = Z_S$

$$= 30 + j40$$

$$Z_L = 30 - j40$$

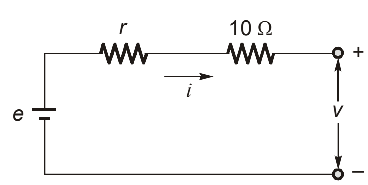
$$|Z_L| = \sqrt{(30)^2 + (40)^2} = 50\Omega$$

$$\text{Power factor} = \frac{R}{|Z_L|} = \frac{30}{50} = 0.6$$

As reactance is capacitive in nature (negative imaginary part), therefore, power factor is leading.

4. (d)

Let internal resistance of source is r.

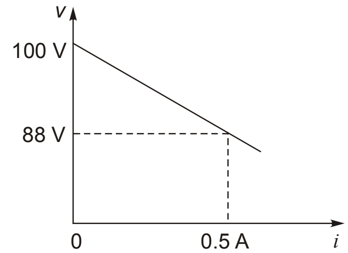


$$e - i(10 + r) = v$$

$$i = 0$$

$\Rightarrow$ $e = v = 100$ V

$$100 - i(10 + r) = v \quad ...(i)$$



From graph, $v - i$ relation is

$$v = -24i + 100 \quad ...(ii)$$

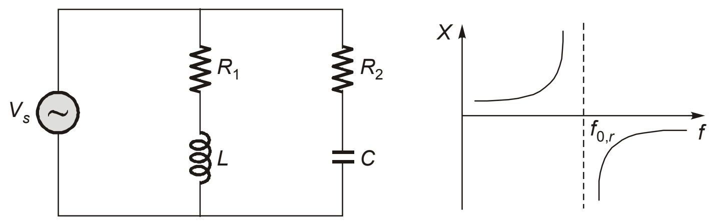
From (i) and (ii)

$$24 = 10 + r$$

⇒ Internal resistance of source,

$$r = 14\ \Omega$$

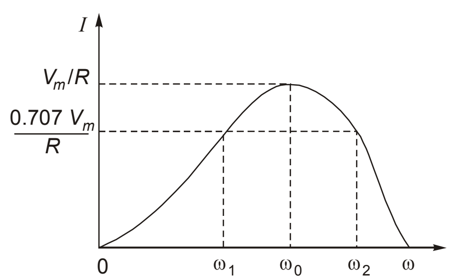
5. (b)



before resonant frequency $f_{o,r}$ the reactance is inductive in nature and after resonant frequency the reactance is capacitive in nature.

6. (d)

The graph of series RLC is



Where, ω_1 and ω_2 are called the half power frequencies.

At $\omega = \omega_0$

$$I = \frac{V_m}{R}$$

At $\omega = \omega_1, \omega_2$

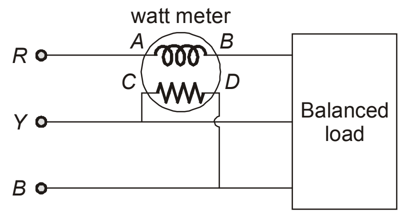
$$I = \frac{V_m}{\sqrt{2}R} = \frac{I_m}{\sqrt{2}}$$

At the half power frequencies,

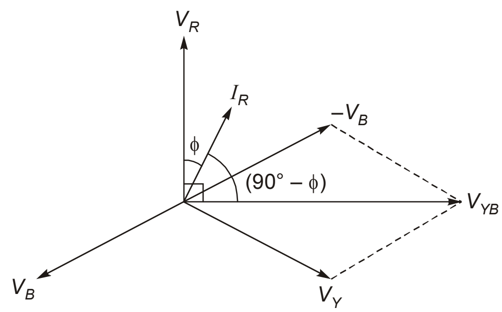
$$Z = \sqrt{2}\ R$$

∴ At half power frequencies, the current in the RLC series circuit is = $\left(\frac{1}{\sqrt{2}}\right)$ × current at resonance.

7. (a)



Current through the wattmeter is I_R
Voltage is taken across Y and B.
∴ The phase angle is between V_{YB} and I_R



angle between V_{YB} and I_R = $(90° - \phi)$

The reading of wattmeter, $W = V_{YB} I_R \cos(90° - \phi)$

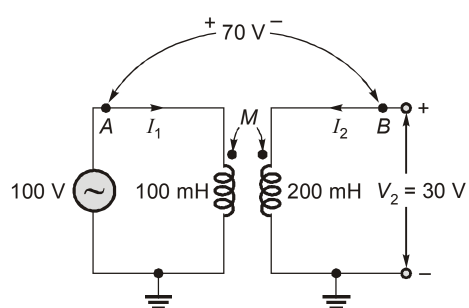
$= V_{YB} I_R \sin\phi$

$W = V_L I_L \sin\phi = 100$ W

the total reactive volt-amperes of the load are

$$Q = \sqrt{3} \times 100 = 173.2 \text{ VAR}$$

8. (a)



∴ $V_2 = 100 - 70 = 30$ V

∴ Secondary is open circuit hence $I_2 = 0$.

At primary, the magnitude of loop voltage is

$$\omega . I_1 (100 \text{ mH}) = 100 \text{ V} \quad ...(i)$$

At secondary, the voltage developed due to I_1 only

i.e., mutual inductance considered.

$$\omega . M . I_1 = 30 \text{ V} \quad ...(ii)$$

From equation (i) and (ii) we get

$$\Rightarrow \qquad \frac{100\text{mH}}{M} = \frac{100}{30}$$

$$\Rightarrow \qquad M = 30\text{ mH}$$

9. (c)

$$V_C = Q\,V_s$$
$$V_L = Q\,V_s$$

Where V_C = Voltmeter across capacitor

V_L = Voltage across inductor

V_s = source voltage

Q = Quality factor

$Q >$ 1 at resonant frequency

∴ The voltage across both L and C are greater than the applied voltage

10. (d)

For any series circuit (AC or DC) same current flows in all elements.

11. (d)

Given waveform is a periodic function having a period of 20 ms.

Here, $$\frac{dv}{dt} = \frac{10}{20\times10^{-3}} = 0.5\times10^3\text{ V/sec}$$

$$\therefore \qquad i = C\frac{dv}{dt} = 30\times10^{-6}\times0.5\times10^3$$

$$= 15\text{ mA}$$

12. (d)

The impedance of the inductor for n^{th} harmonic is n times the impedance of the fundamental. But, since the n^{th} harmonic voltage is n times the fundamental each harmonic gives the same current I_0. Hence, A reads

$$\sqrt{I_0^2+I_0^2+I_0^2+I_0^2} = 2I_0$$

13. (d)

Let the input impedance of N be r and o.c. voltage is V.

$$P = \left(\frac{V}{r+R}\right)^2 R$$

and $$P_1 = \left(\frac{V}{r/2+R}\right)^2 R$$

$$\frac{P_1}{P} = \left(\frac{r+R}{r/2+R}\right)^2$$

$$\Rightarrow \qquad P_1 = P\left(\frac{r+R}{r/2+R}\right)^2$$

If r is very small i.e. approximately tending to zero then

$$P_1 = P$$

If r is very large when compared to R then

$$P_1 = 4P$$

Hence, power consumed lies between P and 4 P.

14. (d)

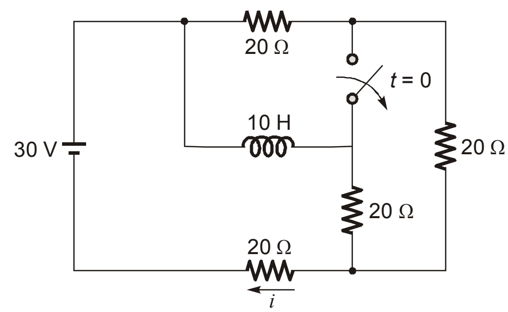
Initially the voltage across the capacitor is zero (voltage across a capacitor cannot change instantaneously). Thus, the voltage must include a homogeneous term of the form shown in option (b).

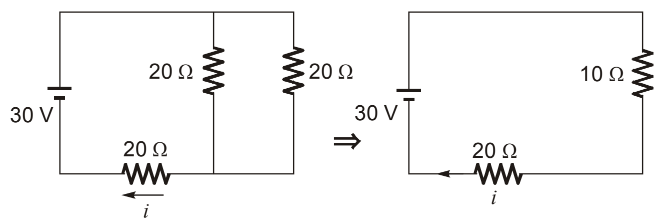
Since the circuit's excited by sinusoidal signal, the response must be sinusoidal as in (c). Thus no one solution both so, (d) is the correct option.

15. (c)

at $t = 0^-$

The inductor will be short,

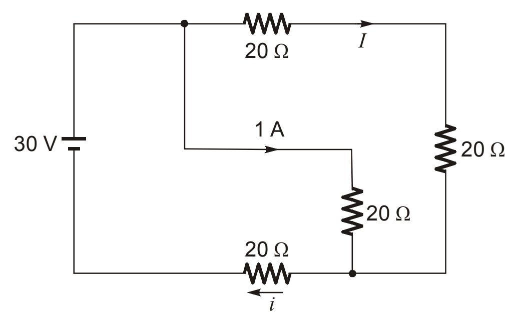




$$\therefore \qquad i = \frac{30}{20+10} A = 1 A$$

and current through inductor at $t = 0^+$

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



from the figure,

Applying KVL in outer loop.

$$30 = (20 + 20)\, I + 20\, i \qquad \text{...(i)}$$

As the current through the inductor does not change instantaneously. The current the inductor will be 1 A at $t = 0^+$

$$i = (I + 1)$$

$$30 = 40I + 20I + 20$$

$$I = \frac{10}{60} = \frac{1}{6} \text{ A}$$

Hence current,

$$i = I + 1 = \frac{1}{6} + 1 = \frac{7}{6}\text{ A}$$

16. (c)
Number of independent loops

$$= b - N + 1$$
$$= 18 - 7 + 1 = 12$$

17. (c)
The line currents are,

$$I_a = \frac{100\angle 0°}{15} = 6.67\angle 0°\text{ A}$$

$$I_b = \frac{100\angle 120°}{10 + j5} = 8.94\angle 93.43°\text{ A}$$

$$I_c = \frac{100\angle -120°}{6 - j8} = 10\angle -66.87°\text{ A}$$

the current in the neutral line is

$$I_n = -(I_a + I_b + I_c)$$
$$= -(6.67\angle 0° + 8.94\angle 93.43° + 10\angle -66.87°)$$
$$= 10.06\angle 178.4°\text{ A}$$

18. (c)
At $\omega = 0$ i.e. $s = 0$

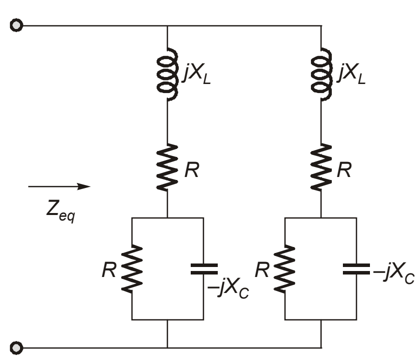
$X_L = 0, \quad X_C = \infty$

There is no connection between input and output.
so, $V_2 = 0$
At $\omega = \infty$ i.e. $s = \infty$

$X_L = \infty, \quad X_C = 0$

Then also, there is no connection between input and output.
so, $V_2 = 0$
⇒ Band pass filter

19. (d)
For current to be in phase with applied voltage imaginary part of impedance should be zero.
Redrawing the circuit



$$Z_{eq} = \frac{(R + jX_L) + (R \| -jX_C)}{2} = \frac{\left(R + jX_L + \dfrac{-jR \cdot X_C}{R - jX_C}\right)}{2}$$

$$= \frac{\left(R + jX_L - \frac{jR \cdot X_C}{R^2 + X_C^2}(R + jX_C)\right)}{2}$$

equating imaginary part to zero

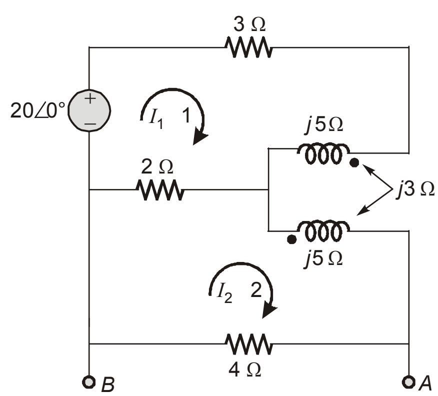
$$\frac{\left(X_L - \frac{R^2 X_C}{R^2 + X_C^2}\right)}{2} = 0$$

$$R^2 X_C = X_L \cdot \left(R^2 + X_C^2\right)$$

$$\Rightarrow \qquad X_L = \frac{R^2 X_C}{R^2 + X_C^2}$$

20. (b)

Redrawing the circuit



Applying Mesh Law

Mesh I

$$3I_1 + j5I_1 + j3I_2 + 2I_1 - 2I_2 = 20\angle 0°$$

$$(5 + j5)I_1 + (-2 + j3)I_2 = 20\angle 0° \qquad ...(i)$$

Mesh II

$$2I_2 + j5I_2 + j3I_1 + 4I_2 - 2I_1 = 0$$

$$(6 + j5)I_2 + (-2 + 3j)I_1 = 0 \qquad ...(ii)$$

From equations (i) and (ii)

$$I_1 = 2.30\angle{-41.70°}$$

$$I_2 = 1.064\angle{-137.8°}$$

$$V_{Th} = V_{AB} = I_2 \times (4) = 4.256\angle{-137.8°}$$

21. (c)

We know that,

$$I = \frac{P}{V}$$

$\therefore$ Current through the circuit,

$$I = \frac{60}{20} = 3 \text{ A}$$

Applying KVL in the loop, we have

$$20 = 4I + V + 12$$

or, $V = 20 - 12 - 4I$

$= 20 - 12 - 4 \times 3$

$= -4$ volts

$\therefore$ Power absorbed by unknown element

$= VI = -4 \times 3 = -12$ W

Hence, power supplied by it = 12 W

22. (c)

$$W = QV = 120 \times 3$$
$$= 360 \text{ J}$$

23. (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.

24. (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 $\frac{dv}{dt} = \cos t$

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

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

25. (c)

26. (d)

Given signal is a ramp signal ($f(t) = At$), which is neither an energy signal nor a power signal.

27. (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

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

and S = Susceptance

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

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

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

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

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

29. (c)

30. (c)

$$Z_0 = \sqrt{\frac{L}{C}}$$

$\Rightarrow$ $$100^2 = \frac{10^{-6}}{C}$$

$\Rightarrow$ $$C = 10^{-10} \text{ F}$$

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