S.No. : 02 CH1_EE_B_190719
Networks Theory

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CLASS TEST 2019-2020

ELECTRICAL ENGINEERING

Date of Test : 19/07/2019

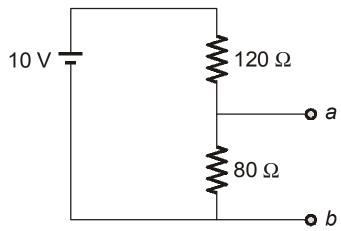
ANSWER KEY ➤ Network Theory

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

DETAILED EXPLANATIONS

1. (a)
As DC and cosine components are absent, therefore it is an odd signal.
As even harmonics are absent, therefore it has half wave symmetry.

2. (c)



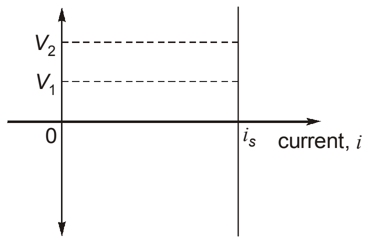
$$V_{Th} = V_{AB} = \text{open circuit voltage across ab}$$

$$= \frac{10V \times 80}{200} = 4 \text{ V}$$

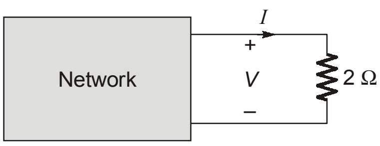
$$R_{Th} = 80\ \Omega \parallel 120\ \Omega$$

$$= \frac{80 \times 120}{200} = 48\ \Omega$$

3. (c)
The ideal independent current source is a two terminal element which supplies its specified current to the circuit in which it is placed independently of the value and direction of the voltage appearing across its terminals.



4. (d)



$$V = 4I - 9 \text{ (given)} \quad \text{...(i)}$$

$$V = 2I \quad \text{...(ii)}$$

From (i) and (ii)

$$2I = 4I - 9$$

$$\Rightarrow \quad I = 4.5 \text{ A}$$

5. (a)
If $y(t)$ is the output and $x(t)$ is input then

$$y(t) = \int_{-\infty}^{t} x(\tau)\,d\tau$$

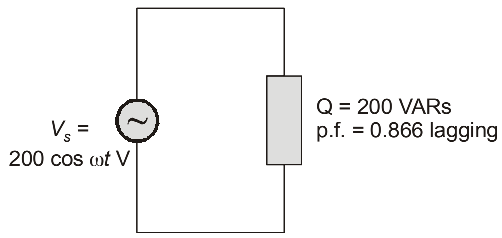
when $x(t) = t\,u(t)$ (ramp function)

$$y(t) = \int_{-\infty}^{t} \tau u(\tau)\,d\tau = \int_{0}^{t} \tau\,d\tau = \left(\frac{\tau^2}{2}\bigg|_0^t\right)$$

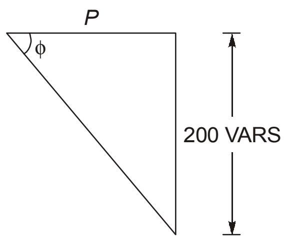
$$y(t) = \frac{t^2}{2}u(t)$$

hence the obtained answer is unit parabolic function

6. (c)



According to power triangle.



$$\phi = \cos^{-1}(0.866)$$

$$\phi = 30^\circ$$

The $P_{(avg)}$ drawn from the source,

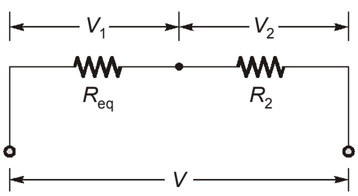
$$Q = \text{Reactive power} = P_{(avg)} \times \tan\phi$$

$$\therefore \quad P_{(avg)} = \frac{Q}{\tan\phi} = \frac{200}{\tan 30^\circ} = \frac{200}{(1/\sqrt{3})} \simeq 346\text{ W}$$

7. (a)

When switch s is closed, the equivalent resistance

$$R_{eq} = \left(\frac{R_1 \times R_3}{R_1 + R_3}\right) \text{ is less than } R_1 \text{ or } R_3 \text{ individually}$$



$$V = IR$$

for constant current, $V \propto R$.

So incase of R_{eq}, the resistance is decreased so voltage V_1 is decreased so obviously V_2 is increased.

8. (b)

Equivalent resistance

$$= 2000 \parallel 2000 = 1000\ \Omega$$

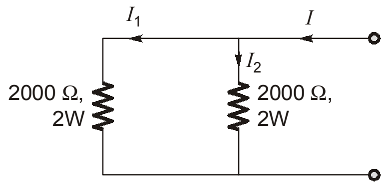
$$P_1 = 2\text{ W} = I_1^2 \,.\, 2000$$

$$I_1^2 = \frac{1}{1000}$$

$$I_1 = \frac{1}{\sqrt{1000}} = I_2$$

$$I = I_1 + I_2 = \frac{2}{\sqrt{1000}}$$

$$P = I^2 .\, R_{eq} = \frac{4}{1000} \times 1000 = 4\text{W}.$$



9. (c)

Given, current in the circuit as $i(t) = 2 \sin 500t$ A.

Therefore $\omega = 500$ rad/s

The phase angle, $\phi = \tan^{-1}\frac{\omega L}{R} = \tan^{-1}\frac{500 \times 20 \times 10^{-3}}{10}$

$$\phi = \tan^{-1} 1 = 45°$$

Hence the load is R, L the voltage will be leading by 45° with current.

Maximum value of voltage,

$$V_m = I_m \times |Z|$$

$$= 2 \times \sqrt{10^2 + (500 \times 20 \times 10^{-3})^2} = 2 \times \sqrt{10^2 + 10^2}$$

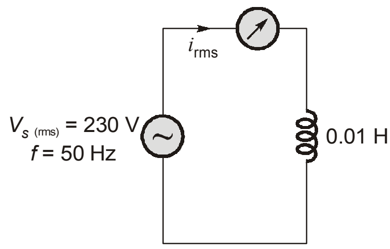
$$= 20\sqrt{2} = 28.28 \text{ V}$$

$\therefore$ $v(t) = 28.28 \sin(500t + 45°)$ V

10. (b)

$$I_{rms} = \frac{V_{rms}}{|Z|} = \frac{230}{2\pi \times 50 \times 0.01}$$

$$= \frac{230}{\pi} \simeq 73.2\text{ A}$$



11. (c)

$$f(t) = u(t-a) = \left(\frac{1}{s}e^{-as}\right)$$

12. (b)

$$i(t) = \frac{v(t)}{2} = 25\left(1 - \frac{(\omega t)^2}{2!} + \frac{(\omega t)^4}{4!} - \ldots\right) = (25\cos\omega t)$$

13. (d)

In the given circuit, the resistors DE and EF are in series. Hence their equivalent resistance = 2 + 4 = 6 ohms. This 6 ohm resistance is in parallel with resistance DG. The equivalent resistance of these two resistors is given by

$$R_{eq} = \frac{12 \times 6}{12 + 6} = 4\,\Omega$$

This 4 ohm resistor is in series with resistance CD giving equivalent resistance = 4 + 2 = 6 ohms. This 6-ohm resistor is in parallel with resistance CG giving equivalent resistance

$$R_{eq} = \frac{6 \times 6}{6+6} = 3\Omega$$

This 3 ohm resistance is in parallel with resistance CH giving equivalent resistance.

$$R_{eq} = \frac{6 \times 3}{6+3} = 2\Omega$$

This 2 ohm resistance is in parallel with resistance CA giving equivalent resistance.

$$R_{eq} = \frac{2 \times 2}{2+2} = 1$$

This 1 ohm resistance is in series with 3 ohm resistance giving total resistance of the circuit = 3 + 1 = 4 Ω

Hence current, $$\frac{V}{R} = \frac{100}{4} = 25 \text{ A}$$

14. (b)

$$V = \frac{V_m}{\sqrt{2}} = \frac{100}{\sqrt{2}} \text{ volt}$$

$$I = \frac{I_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} \text{ A}$$

∴ $$P_{avg} = I^2 R$$

Now, $$R = \frac{V}{I} = Z = \frac{100}{10} = 10\ \Omega$$ (since v and i in phase)

∴ $$P_{avg} = \left(\frac{10}{\sqrt{2}}\right)^2 \times 10 = 500 \text{ watt}$$

15. (a)

When two inductors are connected in series, the effective inductance is

In this case,
$$L_{eff} = L_1 + L_2 - 2M$$
$$= 2 + 4 - 2 \times 0.15$$
$$= 5.7 \text{ mH}$$

16. (b)

The equation of line passing through origin is $y = mx$

$$V = \left(\frac{y_2 - y_1}{x_2 - x_1}\right)t$$

$$V = \frac{V_m}{\frac{T_0}{2}}t$$

$$V = \left(\frac{2V_m}{T_0}\right)t$$

the instantaneous power for $0 \le t \le T_0$ is

$$p(t) = \begin{cases} \dfrac{\left(\dfrac{2V_m t}{T_0}\right)^2}{R} & 0 \le t < 0.5\,T_0 \\ 0 & 0.5\,T_0 \le t < T_0 \end{cases}$$

P_{avg}, observing that the fundamental period is T_0, we have

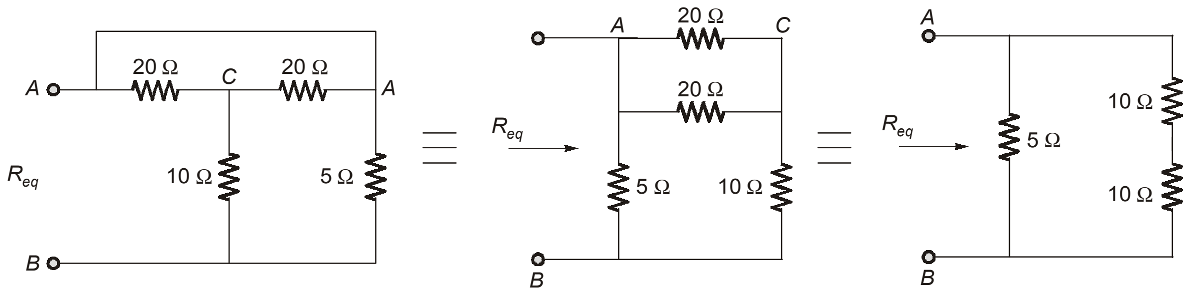
$$P_{avg} = \frac{1}{T_0}\int_0^{0.5T_0} \frac{4V_m^2}{T_0^2\,R} t^2\, dt$$

$$= \frac{4V_m^2}{T_0^3\,R}\left[\frac{t^3}{3}\right]_0^{0.5\,T_0}$$

$$P_{avg} = \frac{V_m^2}{6R}$$

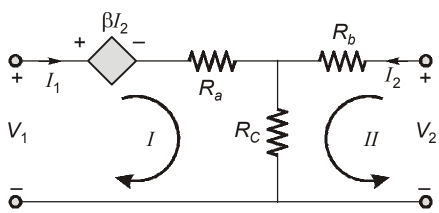
17. (c)

Redrawing the circuit



$$R_{eq} = 5\|(10+10) = \frac{5\times 20}{5+20} = 4\ \Omega$$

18. (c)



Applying KVL

in loop 1

$$\beta I_2 + (R_a + R_c)I_1 + R_c I_2 = V_1$$

$$V_1 = (R_a + R_c)I_1 + (\beta + R_c)I_2$$

Comparing this with standard equation

$$V_1 = Z_{11}I_1 + Z_{12}I_2$$

$\Rightarrow$ $$Z_{12} = \beta + R_c$$

19. (c)

$$i(0^+) = \lim_{s\to\infty} sI(s) = \lim_{s\to\infty} s\cdot sC\cdot V(s)$$

$$= \lim_{s \to \infty} s^2 \times \frac{1}{2} \times \frac{s+1}{s^3 + s^2 + s + 1} = \frac{1}{2} \text{ A}$$

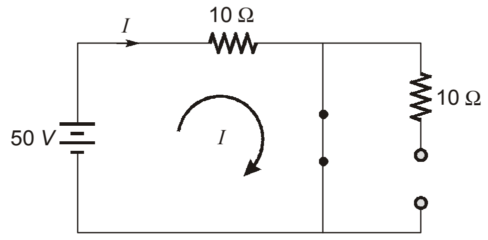
20. (b)

At

$$t = 0^+$$

$$v_c(0^-) = v_c(0^+) = 0 \quad \Rightarrow \quad \text{short circuited}$$

$$i_L(0^-) = i_L(0^+) = 0 \quad \Rightarrow \quad \text{open circuited}$$



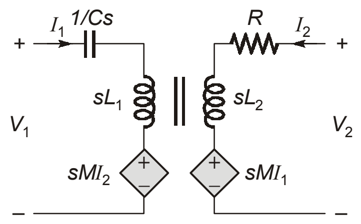
Applying KVL

$$10I = 50$$

$$I = 5 \text{ A}$$

21. (c)

Drawing equivalent in s-domain



Applying KVL

in loop I

$$V_1 = \left(\frac{1}{sC} + sL_1\right) I_1 + sMI_2$$

in loop II

$$V_2 = sMI_1 + (R + sL_2)I_2$$

comparing with standard equations

$$Z_{11} = \frac{1}{sC} + sL_1$$

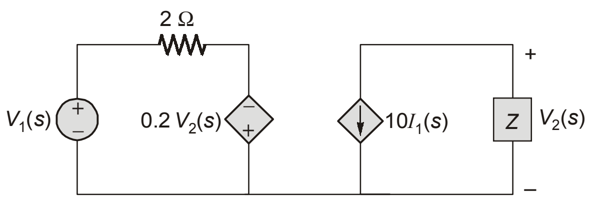
$$Z_{12} = sM$$

$$Z_{21} = sM$$

$$Z_{22} = R + sL_2$$

22. (b)

Redrawing the circuit



$$Z = 1.5s \parallel 1 = \frac{1.5s \times 1}{1.5s+1} = \frac{1.5s}{1.5s+1}$$

Applying KVL in loop I

$$V_1(s) = 2I_1(s) - 0.2\, V_2(s) \quad \text{...}(i)$$

$$V_2(s) = -10 I_1(s) \times \frac{1.5s}{1.5\,s+1}$$

$$V_2(s) = \frac{-15 s I_1(s)}{1.5\,s+1} \quad \text{...}(ii)$$

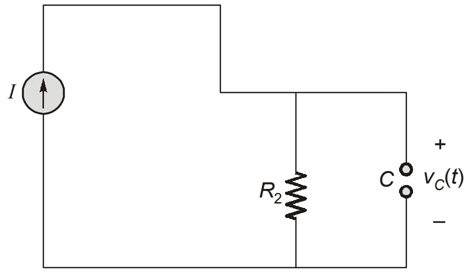
From equations (i) and (ii)

$$\text{Input admittance} = \frac{I_1(s)}{V_1(s)} = \frac{1.5s+1}{6s+2}$$

23. (b)

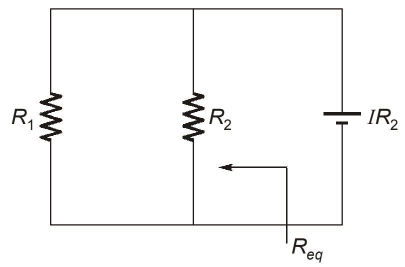
at $t = 0^-$

$$v_C = I \times R_2$$



at $t = 0^+$

$$v_C(0^-) = v_C(0^+) = IR_2$$



$$v_C(\infty) = 0$$

($\because$ capacitor will discharge fully)

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

$$v_C(t) = [v_C(0) - v_C(\infty)]e^{-\frac{t}{\tau}} + v_C(\infty)$$

$$v_C(t) = IR_2 \cdot e^{\frac{-t(R_1+R_2)}{R_1 R_2 \cdot C}} \text{ Volts}$$

24. (a)

$$S = VI^* = (10\angle 15^\circ)\,(2\angle -45^\circ)^* = 20\angle 15 + 45^\circ = 20\angle 60^\circ = 20\,(\cos 60^\circ + j \sin 60^\circ)$$

$$= 20\left(\frac{1}{2} + j\frac{\sqrt{3}}{2}\right)$$

$$= (10 + j10\sqrt{3}) = (10 + j17.32) = P + jQ$$

25. (d)

Given, power consumed is

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

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

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

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

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

26. (c)

27. (d)

Carbon resistor and semiconductors have non-linear relationship between V and I. Hence, Ohm's law is not applicable. Also, these are not bilateral.

28. (b)

If 'l' refers to the length then,

$$I \propto \frac{1}{R} \propto \frac{A}{\rho l} \propto \frac{A}{l}$$

When l is reduced. I will increase and vice-versa.

29. (d)

$$R_1 + R_2 = 4.5 \quad \text{...(i)}$$

and $$\frac{R_1 R_2}{R_1 + R_2} = 1 \text{ or } R_1 R_2 = 4.5$$

$\therefore$ $$(R_1 - R_2)^2 = (R_1 + R_2)^2 - 4 R_1 R_2$$

$$= (4.5)^2 - 4 \times 4.5 = \frac{9}{4}$$

or, $$R_1 - R_2 = \frac{3}{2} = 1.5 \quad \text{...(ii)}$$

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

$$R_1 = 3\ \Omega \text{ and } R_2 = 1.5\ \Omega$$

or, $$R_1 = 1.5\ \Omega \text{ and } R_2 = 3\ \Omega$$

30. (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

$\therefore$ $P_{eq} = 500$ Watt

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