

# CLASS TEST

S.No. : 01 CH1\_EE\_A\_100519

Networks Theory



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**CLASS TEST  
2019-2020**

**ELECTRICAL  
ENGINEERING**

**Subject : Networks Theory**

**Date of test : 10/05/2019**

### *Answer Key*

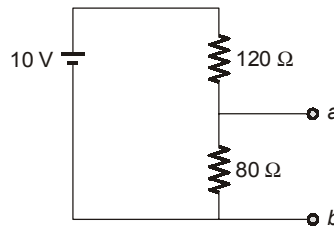
- |        |         |         |         |         |
|--------|---------|---------|---------|---------|
| 1. (a) | 7. (a)  | 13. (d) | 19. (c) | 25. (d) |
| 2. (c) | 8. (b)  | 14. (b) | 20. (b) | 26. (c) |
| 3. (c) | 9. (c)  | 15. (a) | 21. (c) | 27. (d) |
| 4. (d) | 10. (b) | 16. (b) | 22. (b) | 28. (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)



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

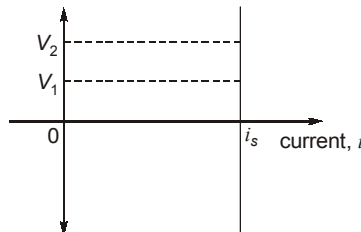
$$= \frac{10V \times 80}{200} = 4 \text{ V}$$

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

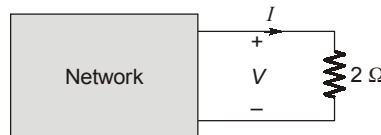
$$= \frac{80 \times 120}{200} = 48 \Omega$$

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)



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

$$V = 2I \quad \dots(ii)$$

From (i) and (ii)

$$2I = 4I - 9$$

⇒

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

5. (a)

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

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

when

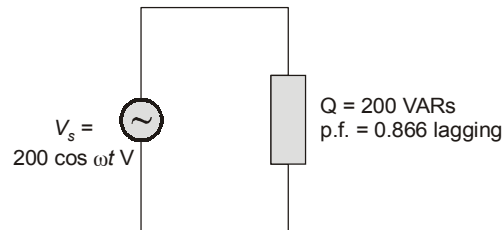
$$x(t) = t u(t) \quad (\text{ramp function})$$

$$y(t) = \int_{-\infty}^t \tau u(\tau) d\tau = \int_0^t \tau d\tau = \left( \frac{\tau^2}{2} \Big|_0^t \right)$$

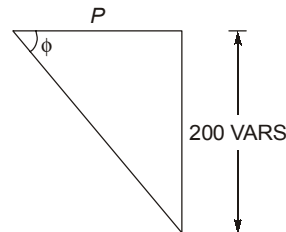
$$y(t) = \frac{t^2}{2} u(t)$$

hence the obtained answer is unit parabolic function

6. (c)



According to power triangle.



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

$$\phi = 30^\circ$$

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

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

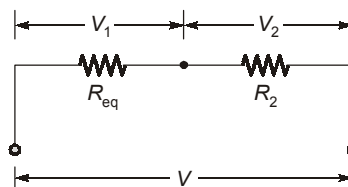
$\therefore$

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

7. (a)

When switch  $s$  is closed, the equivalent resistance

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



$$V = IR$$

for constant current,  $V \propto R$ .

So in case of  $R_{\text{eq}}$ , the resistance is decreased so voltage  $V_1$  is decreased so obviously  $V_2$  is increased.

8. (b)

Equivalent resistance

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

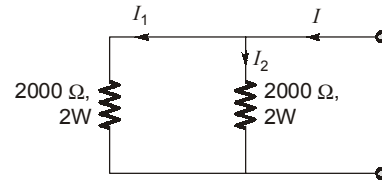
$$P_1 = 2 \text{ W} = I_1^2 \cdot 2000$$

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

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

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

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



9. (c)

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

Therefore  $\omega = 500 \text{ rad/s}$

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

$$\phi = \tan^{-1} 1 = 45^\circ$$

Hence the load is R, L the voltage will be leading by  $45^\circ$  with current.

Maximum value of voltage,

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

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

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

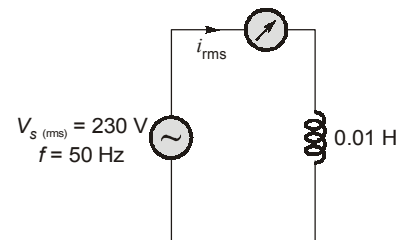
$\therefore$

$$v(t) = 28.28 \sin(500t + 45^\circ) \text{ V}$$

10. (b)

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

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



11. (c)

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

12. (b)

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

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

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

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

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

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

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

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

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

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

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

14. (b)

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

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

$$\therefore P_{\text{avg}} = I^2 R$$

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

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

15. (a)

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

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

16. (b)

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

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

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

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

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

$$p(t) = \begin{cases} \left(\frac{2V_m t}{T_0}\right)^2 & 0 \leq t < 0.5 T_0 \\ 0 & 0.5 T_0 \leq t < T_0 \end{cases}$$

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

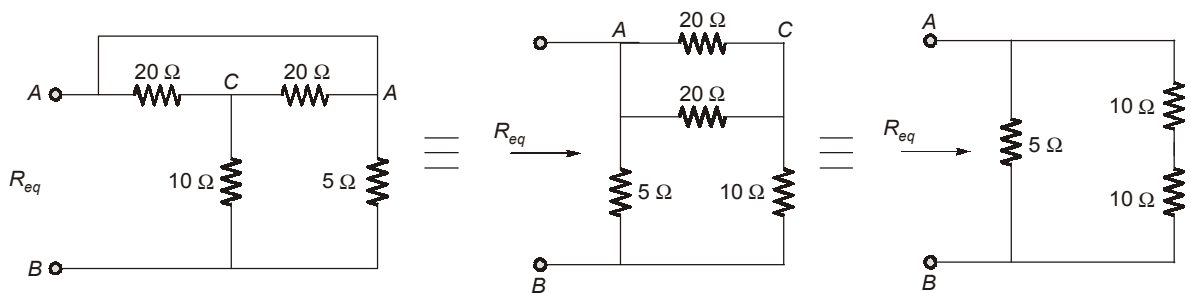
$$P_{avg} = \frac{1}{T_0} \int_0^{0.5T_0} \frac{4V_m^2}{T_0^2} t^2 dt$$

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

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

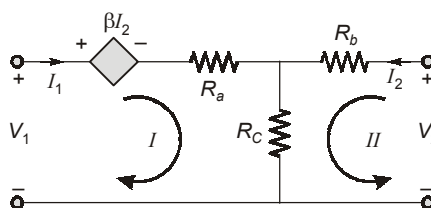
17. (c)

Redrawing the circuit



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

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

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

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

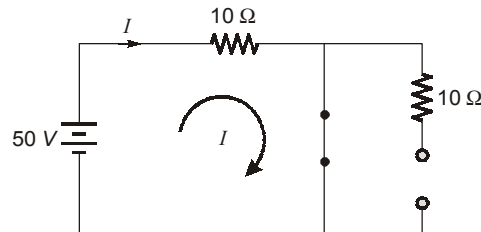
19. (c)

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

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

20. (b)  
At

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

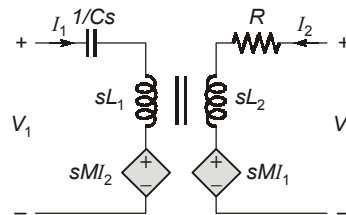


Applying KVL

$$10I = 50 \\ I = 5 \text{ A}$$

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

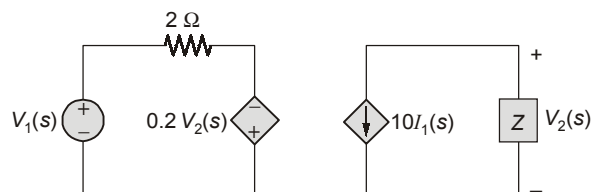
$$V_2 = sMI_1 + (R + sL_2)I_2$$

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  $I$

$$V_1(s) = 2I_1(s) - 0.2 V_2(s) \quad \dots(i)$$

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

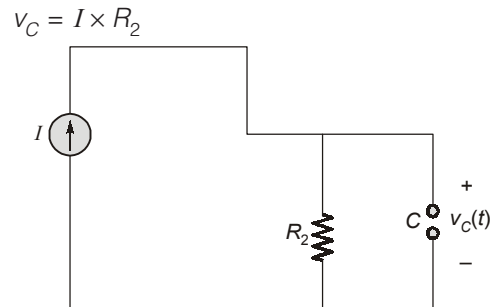
$$V_2(s) = \frac{-15sI_1(s)}{1.5s + 1} \quad \dots(ii)$$

From equations (i) and (ii)

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

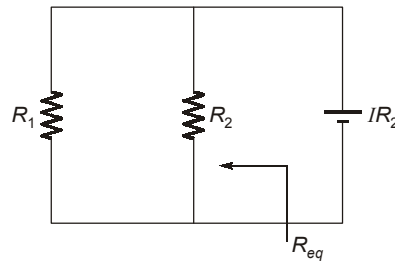
23. (b)

at  $t = 0^-$



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)

60°)

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

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

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



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)

$$R_1 + R_2 = 4.5 \quad \dots(i)$$

and

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

 $\therefore$ 

$$\begin{aligned} (R_1 - R_2)^2 &= (R_1 + R_2)^2 - 4 R_1 R_2 \\ &= (4.5)^2 - 4 \times 4.5 = \frac{9}{4} \end{aligned}$$

or,

$$R_1 - R_2 = \frac{3}{2} = 1.5 \quad \dots(ii)$$

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,

$$P_1 = P_2 = 1000 \text{ W}$$

 $\therefore$ 

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

■ ■ ■ ■