Somaiya Vidyavihar University

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Aatmaj Mhatre	Aatmaj

Q I]

(A) I] If two current sources I_A (7 A and internal resistance of 6 Ω) are connected then equivalent voltage between A & B is

(B) $V_{AB} = +18V$, 3.6 Ω

II] In a Op-Amp based inverting amplifier if feedback gain is 4 and input signal is 2V to peak AC, then output is

(A) 8V peak to peak and in phase with input signal

III] In a Zener diode. If breakdown voltage is high, then

(A) Both P and N are heavily doped

IV] If line voltage of 450 V is supplied to 3ϕ star type balanced network of pure resistance 15 Ω/phase, then line current will be

(d) 17.32 A

V] Which DC Motor is most suitable for elevators

(c) DC series motor

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Q1] A]

VI] A circuit with resistor inductor and capacitor in series is resonant of f_0 Hz If all the component values are now doubled, the new resonant frequency is

(C) $f_0/2$

VII] If each branch of a delta network has resistance 18Ω then each branch of the equivalent star type network has resistance

(B) 6

VIII] A parallel resonating circuit consists of Iron core coil of R Ω resistance and L H inductance in parallel with a capacitor of C μF behaves like

(B) A pure resistor of value R.

IX] In the two wattmeter method of measurement if wattmeter readings are equal and opposite then phase angle of the load is

(b) 90°

X] The inductive reactance of a 1 ϕ Transformer dependends on (D) Leakage flux

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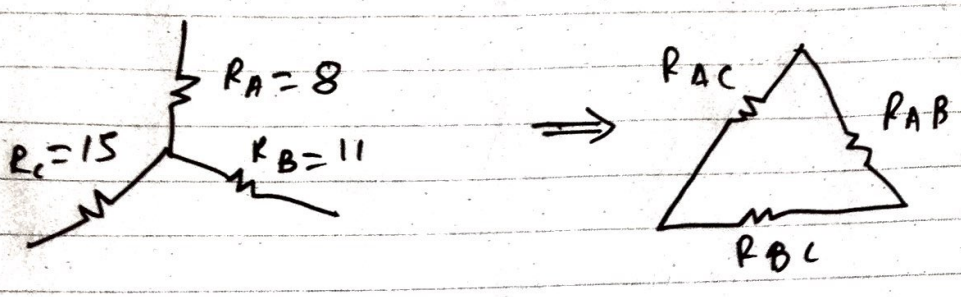
9] (B)

(1)



$$R_{AC} = R_A + R_C + \frac{R_A R_C}{R_B}$$

$$= 8 + 15 + \frac{15 \times 8}{11} = 33.90$$

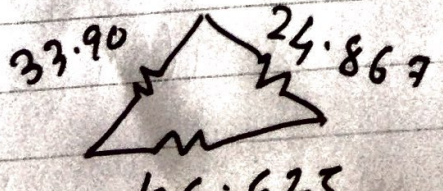
$$R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C}$$

$$= 8 + 11 + \frac{8 \times 11}{15} = 24.867$$

$$R_{BC} = R_B + R_C + \frac{R_B R_C}{R_A}$$

$$= 11 + 15 + \frac{15 \times 11}{8} = 46.625$$

Answer →



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Q1] (B) II] $I_1 = 20 \sin(\omega t + \pi/4)$ $I_2 = 14 \sin(\omega t - \pi/6)$

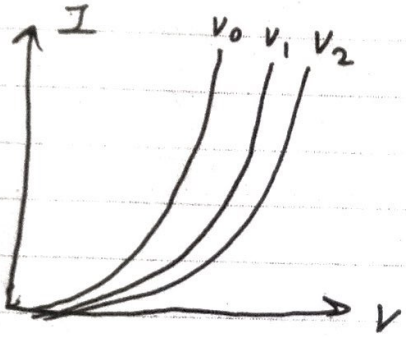
$\therefore I_1 = 14.14 \angle \pi/4$ $I_2 = 9.89 \angle -\pi/6$ (Convert to phasor)

$\therefore I_1 = 10 + j10$ $I_2 = 8.57 + j(-4.949)$

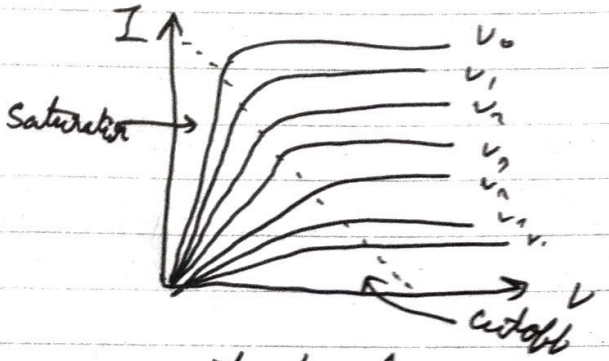
$\therefore I_1 + I_2 = 18.57 + 5.051j = 19.244 \angle 15.21$

$I_N = 24.52 \sin(\omega t + 15.21^\circ)$

III]



Input of CE



output of CE

IV] Advantages of zener diode → (i) Small size can fit in mobile phones

(ii) less heat produced
(iii) Energy efficiant
(iv) Acts as voltage regulator
(v) Prevents over-voltage and protects devices from damage
(vi) low cost alternative

V] When two voltage sources are connected in a circuit, each source produces current independant of the other sources and the net resultant current is the vector sum of all independent currents produced. This is called superposition theorem.

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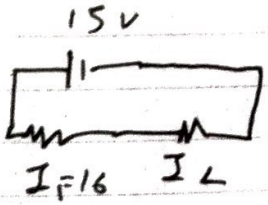
D i) (B) vi]

$V = 15\,V$ DC

$I_1 = 1\,A$

$I_L = ?$



By Maximum power transfer theorem, we know that the maximum power is when $I_1 = I_L$ and is given by

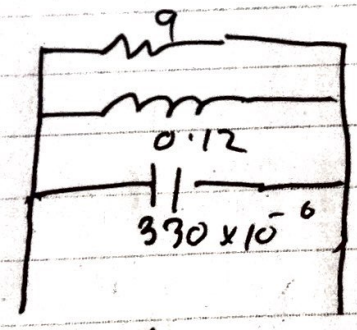
$$P_{max} = \frac{V^2}{2R} = \frac{15 \times 15}{2 \times 16} = 7.031\,W$$

Answer → Maximum power absorbed by load resistance is 7.031 W

vii] $R = 9\,\Omega$

$L = 0.12\,H$

$C = 330\,\mu F$



$$q_F = \frac{\text{Voltage through capacitor}}{\text{Total voltage}} = \frac{330}{9} = 36.66$$

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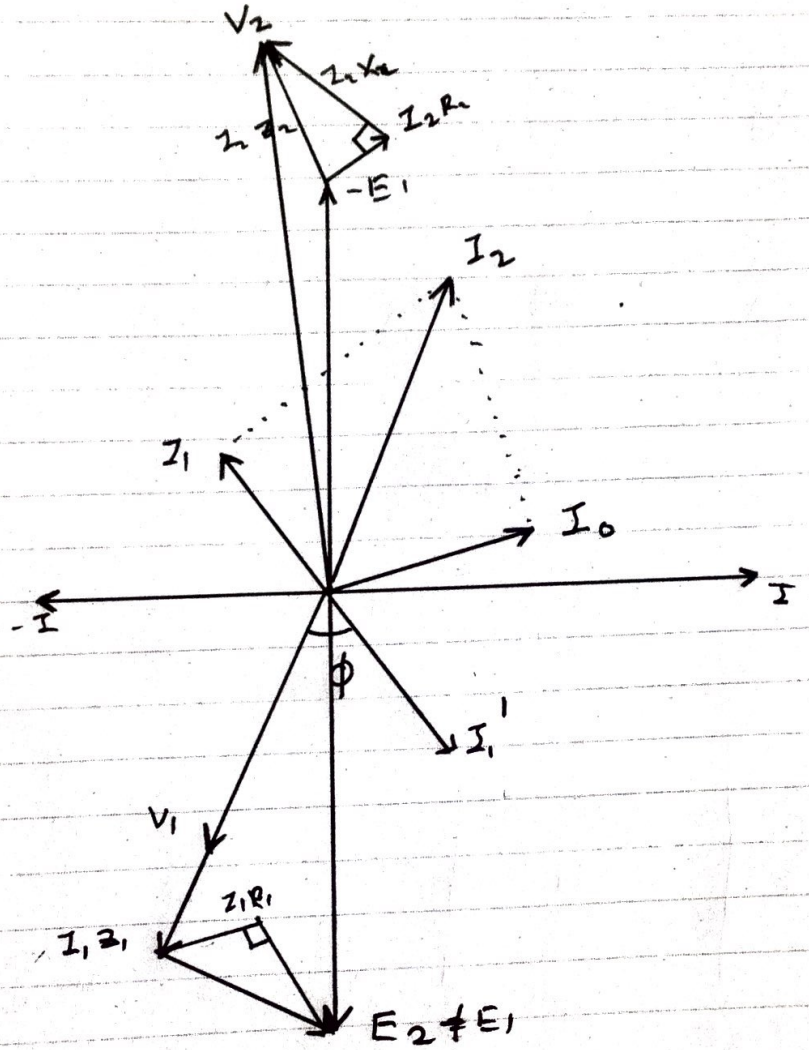
Q2]

I]



Phasor diagram for single phase transformer considering its winding resistance and magnetic leakages when capacitive load is connected

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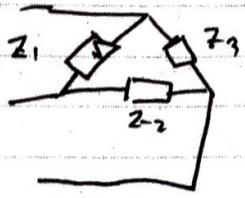
Q2]

II] $Z = 15 + j10$

$V_s = 400\,V$



for a delta network,

$$V_L = V_{ph} = 400$$

$$I_{ph} = \frac{V_{ph}}{Z} = \frac{400}{15+j10} = \frac{400\ \angle -33.69}{18.027}$$

$$I_{ph} = 22.188\angle -33.69$$

$$I_L = \sqrt{3}\, I_{ph}$$

$$= 38.432\angle -33.69$$

$$W_1 = I_L V_L \cos(30+\phi)$$

$$W_1 = 15372 \cos(-3.69)$$

$$W_1 = 15340.13 \text{ Watt}$$

$$W_2 = I_L V_L \cos(30-\phi)$$

$$W_2 = 15372 \cos(63.69)$$

$$W_2 = 6813.29 \text{ watt}$$

Answer $W_1 = 15.340\ kW$

$W_2 = 6.813\ kW$

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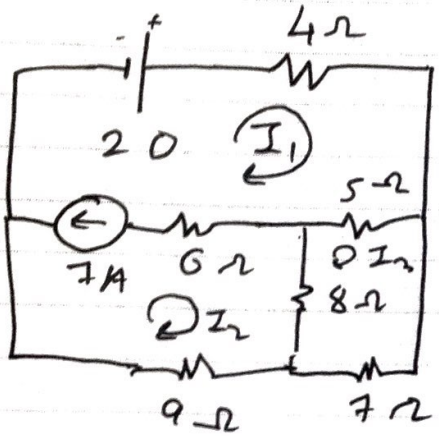
Q3



Let I_1 be current in loop 1
I_2 in loop 2
I_3 in loop 3

Let direction of I_1, I_2, I_3 be clockwise ↻

In loop 3, Apply KVL

$$-5I_3 + 5I_1 - 7I_3 - 8I_3 + 8I_2 = 0$$

$$\therefore 5I_1 + 8I_2 - 20I_3 = 0 \quad - (1)$$

In loop 1 & 2, apply supermesh analysis

$$I_1 - I_2 = 7 \quad - (2) \text{ (7A constant current source)}$$

and

$$-4I_1 - 5I_1 + 5I_3 - 8I_2 + 8I_3 - 9I_2 + 20 = 0$$

$$\therefore -9I_1 + 17I_2 + 13I_3 = -20 \quad - (3)$$

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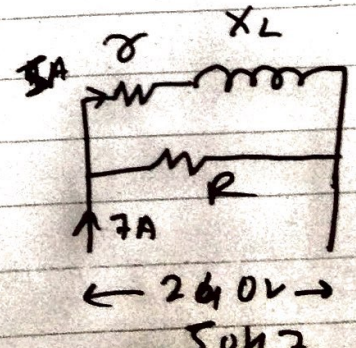
$$\therefore 5I_1 + 8I_2 + -20I_3 = 0$$
$$\therefore 1I_1 + -1I_2 + 0I_3 = 7$$
$$\therefore -9I_1 + -17I_2 + 13I_3 = -20$$

$$\therefore \begin{bmatrix} 5 & 8 & -20 \\ 1 & -1 & 0 \\ -9 & -17 & 13 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 7 \\ -20 \end{bmatrix}$$

$I_1 = 5.846$
$I_2 = -1.153$
$I_3 = 1$

Power absorbed in 9Ω $= I^2R$
$= (1.153)^2 \times 9$
$= 11.964$

(Q4) $R = 80\Omega$, $f = 50$
$V = 240\ 1\phi$
$\omega = 2\pi f = 2 \times \pi \times 50 = 314$
$I_C = 5$
$I_T = 7$



To find → γ, P, X_L

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Current through pure resistance is

$$I = \frac{V}{R} = \frac{240}{80} = 3A$$

Impedance of the coil is

$$|Z| = \frac{V}{I} = \frac{240}{5} = 48\,\Omega$$

Total Impedance $= |Z_T| = \frac{V}{I} = \frac{240}{7} = 34.28\,\Omega$

~~From above we know that~~

$$R^2 + X_L^2 = 48^2$$

Let current through coil be $5\angle A = a+ib$
Let Total current be $7\angle B = c+id$

$$\therefore 5\angle A + 3\angle 0 = 7\angle B \quad \text{(Vector sum)}$$

$$\therefore a+ib + 3 + 0j = c+id$$

$$\therefore a+3 = c$$
$$b = d$$

But we know $a^2+b^2 = 5^2$
$c^2+d^2 = 7^2$

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Hence we have

$$a^2 + b^2 = 5^2$$
$$(a+3)^2 + b^2 = 7^2$$

$$\therefore a^2 + b^2 + 6a + 9 = 7^2$$
$$\therefore a^2 + b^2 + 6a + 9 = 49$$
$$\therefore 25 + 6a = 40$$
$$\therefore 6a = 15$$
$$\therefore a = 2.5$$
$$\therefore b = \pm 4.33$$

$$\therefore c = 5.5$$
$$d = 4.33$$

$$\therefore A = \tan^{-1}\left(\pm \frac{b}{a}\right) = \pm 60^\circ$$

$$B = \tan^{-1}\left(\frac{d}{c}\right) = \pm 38.21^\circ$$

$$\therefore \phi = B = 38.21^\circ$$

Power factor = $\cos\phi = \cos(38.21) = 0.7857$

Power = $V \times I \cdot \cos\phi$
$= 7 \times 240 \times 0.7857 = 1320.058$ W

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~~Power~~ for coil, $\phi = A = 60^\circ$ (consider $\phi = -60$ and not $\phi = +60$)

$\therefore$ Power factor = $\cos(\phi) = \cos 60 = 0.5$

$\therefore$ Power absorbed by coil = $VI \cdot \cos\phi$

$= 240 \times 5 \times 0.5$

$= 600$ W.

Current through coil = $5 \angle -60$

$$Z = \frac{V}{I} = \frac{240}{5\angle -60} = 48 \angle +60$$

$\therefore Z = 24 + 41.57i$

$\therefore r = 24$

$X_L = 41.57$

$\therefore \omega L = 41.57$

$\therefore L = \frac{41.57}{314} = 0.132$

Answer → $L = 0.132$ H

$r = 24\ \Omega$

$P_{coil} = 600$ W

$P_{tot} = 1320$ W

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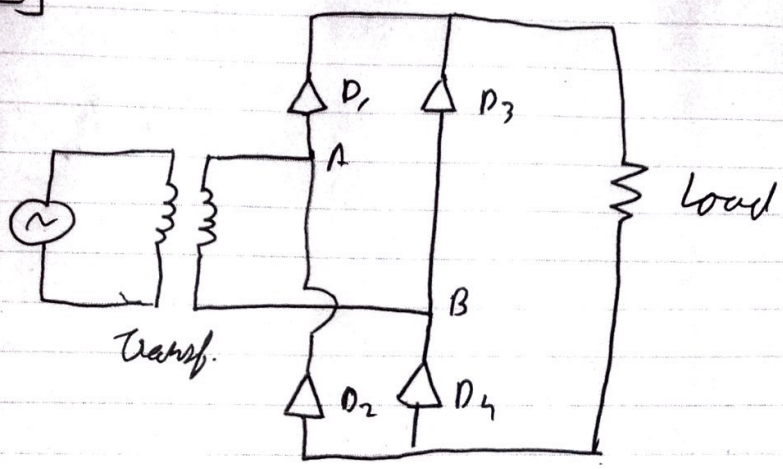
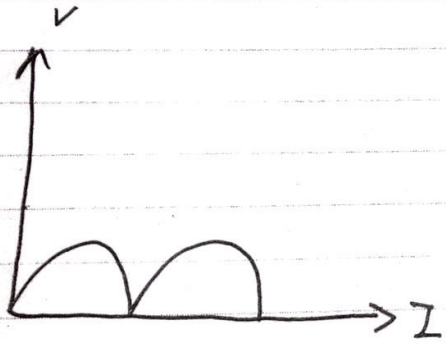
Q2

III



Single phase bridge rectifier



output

$D_1 D_2 D_3 D_4$ → Diodes

Both cycles are utilized By this type of transformer

When current is in +ve cycle, it passes through A – D1 – D_4 – B

When current is in –ve cycle it passes through B – D_3 – D_2 – A

So load experiences only linear current throughout both cycles.

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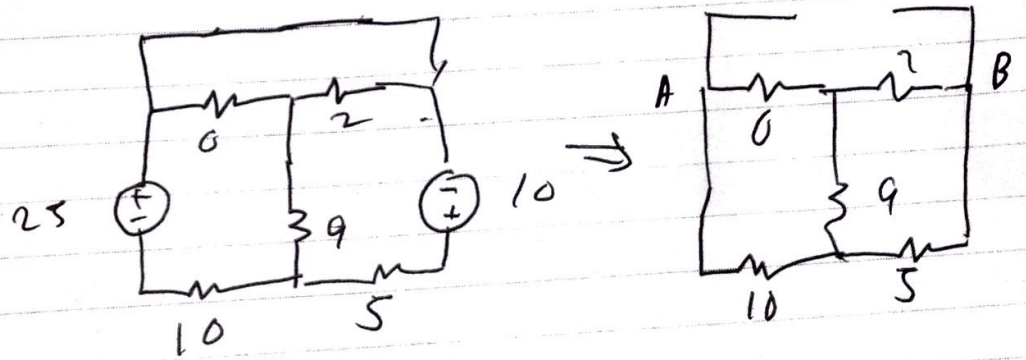
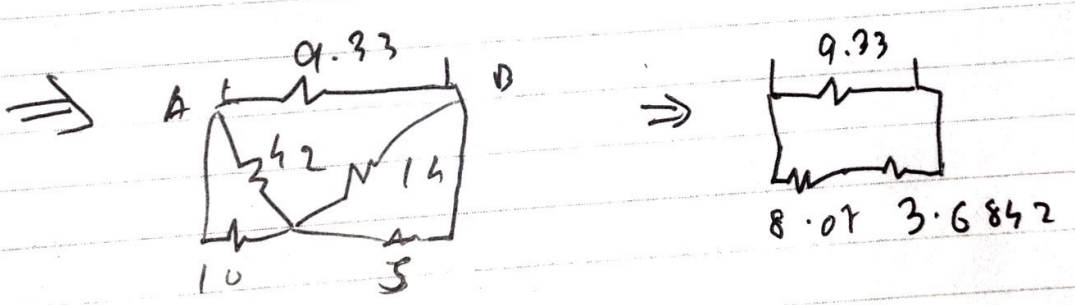
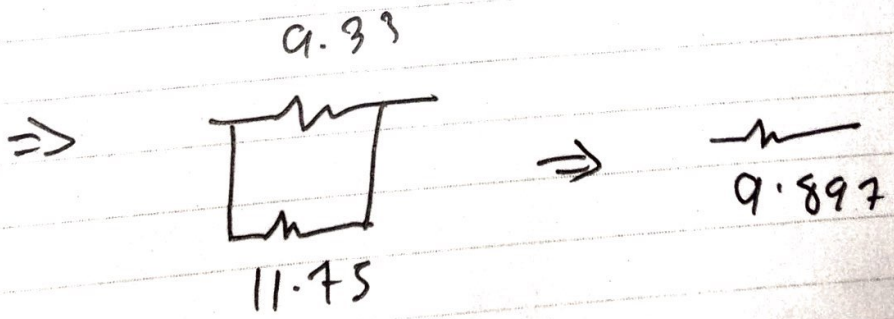
Q3] Norton →

R_{eq} =







$\therefore R_{eq} = 9.897$