EEEE ESE JAN 2021

(Total 10 mks)

Q1. A.

1. Transformer (b)
2. Emitter and Collector both junctions are reversed biased (b)
3. Fleming's Left hand rule (d)
4. 55.2 W (a)
5. Lags behind the voltage by 90° (a)
6. 90° (c)
7. Commutator (c)
8. f (a)
9. Infinite (c)
10. 10 (a)

Q1. B

1. Neat and labelled Diagram 1mks.

   i/p and o/p waveform
   Gain Equation } 1mks

2. EMF equation of Transformer

   The sinusoidal voltage is applied to primary winding. This produces the flux ϕ, given by

   $\phi = \phi_m \sin \omega t$

According to Faraday's Law of Electromagnetic Induction, self induced emf is given by,

$$e_1 = -N_1 \frac{d\phi}{dt}$$

$$e_1 = -N_1 \frac{d}{dt}(\phi_m \sin \omega t)$$

$$\Rightarrow \quad e_1 = -N_1 \omega \cos \omega t \, \phi_m$$

$$e_1 = +N_1 \phi_m \omega \sin(\omega t - 90^\circ) \quad \text{—— 1mks}$$

$\Rightarrow$ self induced emf lags behind flux by 90°

$$\therefore \quad e = E_m \sin(\omega t \pm \phi)$$

$$E_m = N_1 \phi_m \omega$$

rms value of induced emf $\Rightarrow$ $$E_1 = \frac{E_M}{\sqrt{2}} = \frac{N_1 \phi_m \omega}{\sqrt{2}} = \frac{N_1 \phi_m 2\pi f}{\sqrt{2}}$$

$$E_1 = 4.44 f N_1 \phi_m \ V$$

$\left.\begin{array}{l} \text{Ily rms value of induced emf in secondary winding} \\ E_2 = 4.44 f N_2 \phi_m \ V \end{array}\right\}$ 1mks

(3) $V = 141.4 \sin 314t$

Sol^n^

$$\left.\begin{array}{l} \omega = 314 \\ \text{frequency} = \dfrac{314}{2\pi} = 50\,Hz \\ V_{rms} = \dfrac{V_m}{\sqrt{2}} = \dfrac{141.4}{\sqrt{2}} = 99.98\,V \end{array}\right\} \text{1mk}$$

$$\left.\begin{array}{l} V_{avg} = 0.637\,V_m = 0.637 \times 141.4 = 90.018\,V \\ \text{At } t = 3\,msec \Rightarrow v = 141.4 \sin\left(314 \times 3 \times 10^{-3} \times \dfrac{180}{\pi}\right) \\ v = 114.35\,V \end{array}\right\} \text{1mk}$$

(4) Output Charecteristics of npn transistor in CE mode

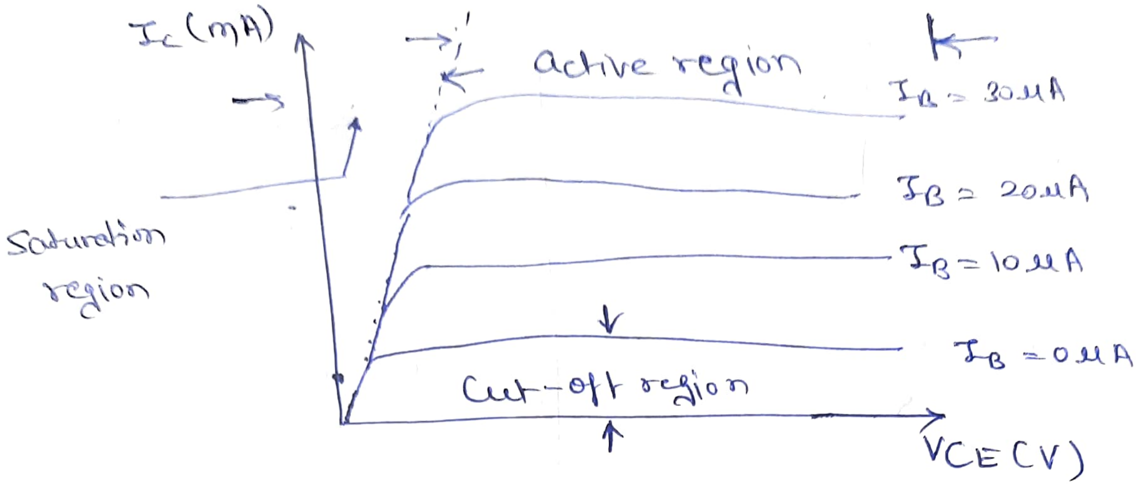
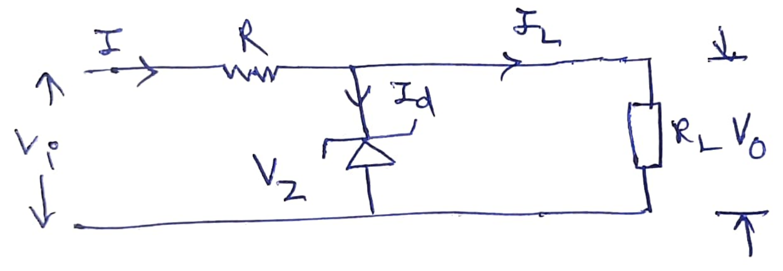


Diagram — 1mk

Explaination — 1mk

(5)



— 1mk

Zener diode as a voltage regulator

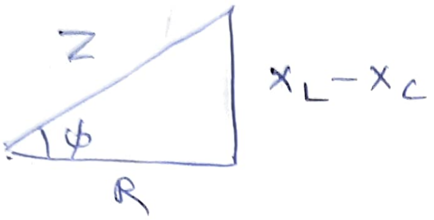
→ Explaination — 1mk

(6) Any four advantages of three phase over single phase AC — 2mks

(7)

(7) Impedance Triangle of a series RLC circuit

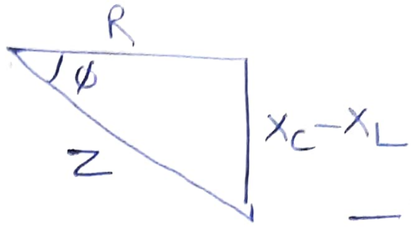
if $X_L > X_C$ & $Z = R + jX$



$$\cos\phi = \frac{R}{Z}$$

$$\bar{Z} = Z \angle \phi$$

if $X_L < X_C$ & $Z = R - jX$



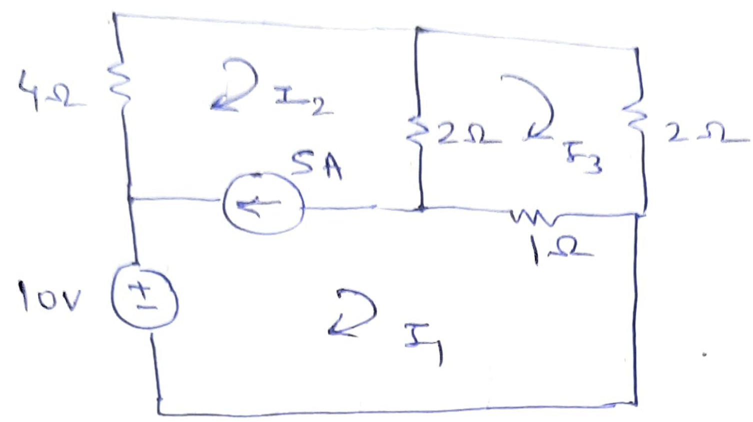
— 1mk

$$\cos\phi = \frac{R}{Z}$$

$$\bar{Z} = Z \angle -\phi$$

1mks

Q. 2 Find I_1, I_2 and I_3 in given electrical n/w.



$I_2 - I_1 = 5$ —— (1) —— 02 mk

Writing supermesh eq^n ;

$10 - 4I_2 - 2(I_2 - I_3) - 1(I_1 - I_3) = 0$

$-I_1 - 6I_2 + 3I_3 = -10$ —— (2) —— 02 mk

KVL in loop (3)

$-2(I_3 - I_2) - 2I_3 - 1(I_3 - I_1) = 0$

$I_1 + 2I_2 - 5I_3 = 0$ —— (3) —— 02 mk

$$\begin{bmatrix} -1 & 1 & 0 \\ -1 & -6 & 3 \\ 1 & 2 & -5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 5 \\ -10 \\ 0 \end{bmatrix}$$ —— 01 mk

$\Rightarrow$ $I_1 = -2.69\ A = -\frac{35}{13}\ A$

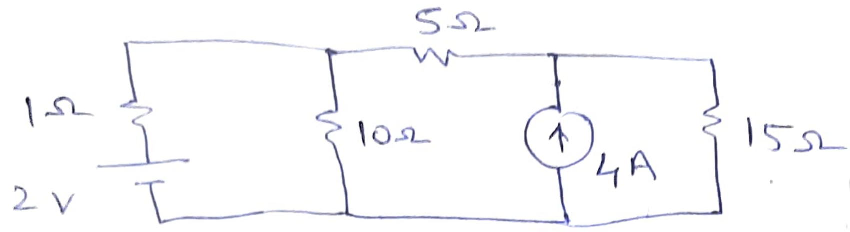
$I_2 = 2.307\ A = \frac{30}{13}\ A$ —— 03 mk

$I_3 = 0.384\ A = \frac{5}{13}\ A$

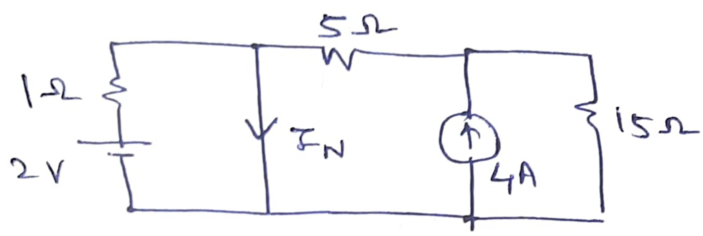
OR

Q2 a

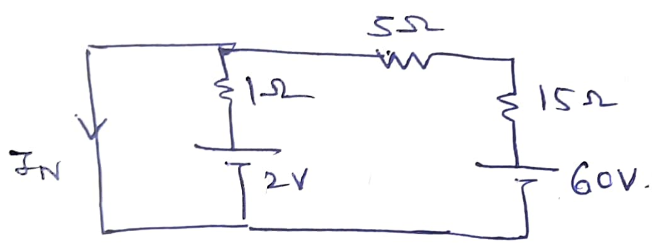
Calculate power dissipated in 10Ω using Norton's Theorem.

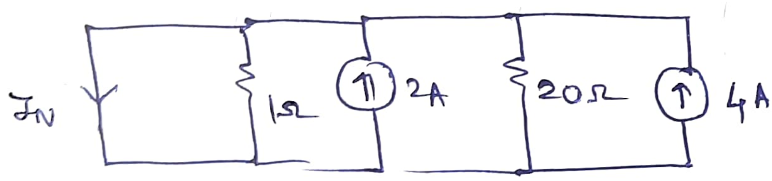


Step ① find Norton's Current ; short circuit 10Ω.

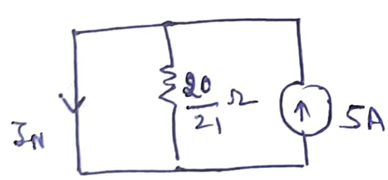


using source transformation



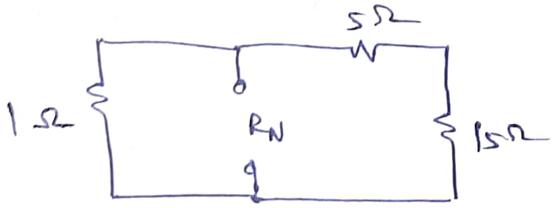


⇒



⇒ $\boxed{I_N = 5A}$ —— 2 mks

Step ② find R_N

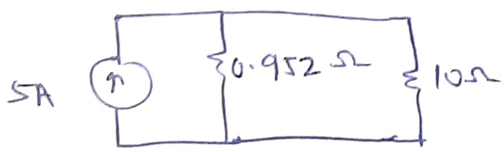


$$\Rightarrow R_N = \frac{20 \times 1}{21}$$

$$= \frac{20}{21} = 0.952\,\Omega$$

—— 1 mks

Step ③ Power in 10Ω resistance

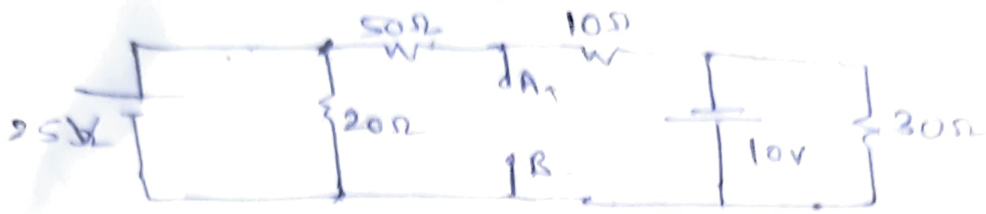


$$I_{10\Omega} = \frac{5 \times 0.952}{5 + 10} = 0.434\,A$$

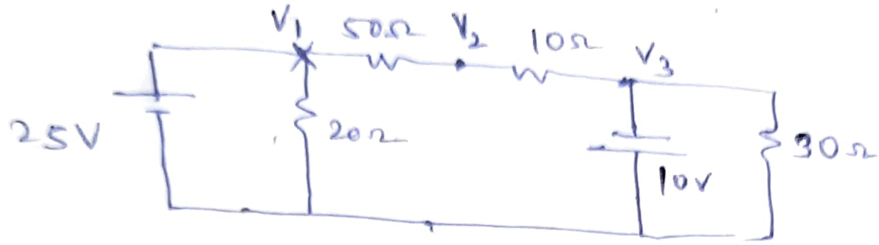
$$P_{10\Omega} = I_{10\Omega}^2 R = (0.434)^2 \times 10$$

$$\boxed{P_{10\Omega} = 1.88\,W}$$ —— 2 mks

2(b) find Thevinin's Equivalent across AB.



Step ① find V_{th}



~~Apply KCL at V_1~~ from ckt

$V_1 = 25V$ and $V_3 = -10V$ —— ①

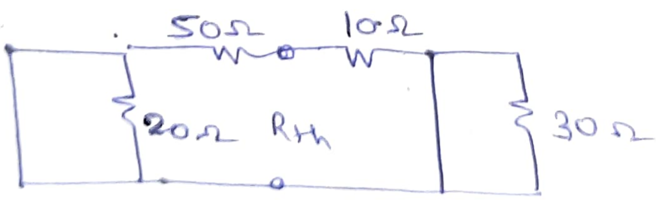
Apply KCL at V_2

$$\frac{V_2 - V_1}{50} + \frac{V_2 - V_3}{10} = 0$$

$$-\frac{1}{50}V_1 + \left(\frac{1}{50}+\frac{1}{10}\right)V_2 - \frac{1}{10}V_3 = 0 \quad \text{using ①}$$

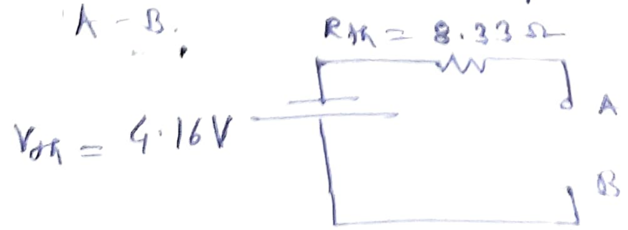
$\Rightarrow$ ~~Vth~~ $V_2 = V_{th} = -4.16\ V$ —— 02 m

Step ②



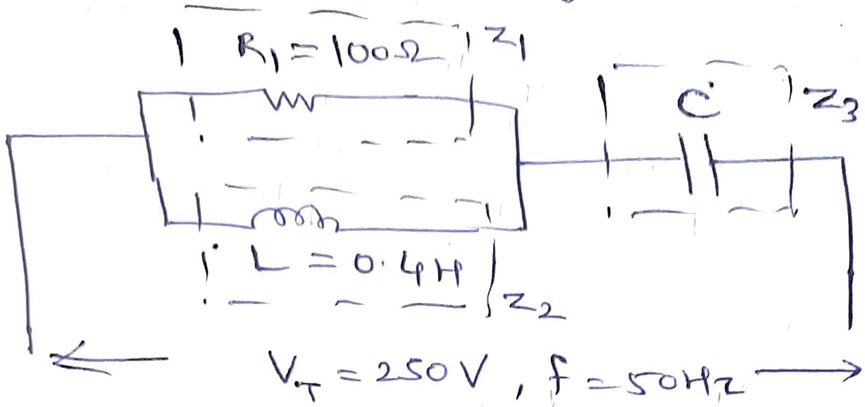
$R_{th} = 50 \| 10 = \frac{50 \times 10}{60} = 8.33\ \Omega$ —— 02 M

step ③ Thevinin's Eqt ckt across terminal A - B.



—— 01 m

Q.3a. find C for unity power factor.



Soln

$L = 0.4H \qquad X_L = j2\pi f L = j125.66\Omega = j40\pi\ \Omega$

$\bar{Z}_1 = 100\Omega$

$\bar{Z}_2 = 40\pi\ \Omega$

$\bar{Z}_3 = -jX_c$

$\bar{Z}_T = (\bar{Z}_1 \parallel \bar{Z}_2) + \bar{Z}_3$

$$\bar{Z}_T = \frac{(100)(j125.66)}{100 + j125.66} + (-jX_c)$$

$$= 61.22 + j48.72 - jX_c$$

$\bar{Z}_T = 61.22 + j(48.72 - X_c)$

$\bar{Z}_T = Z_T \angle \phi_T$

$Z_T = \sqrt{(61.22)^2 + (48.72 - X_c)^2}$

$$\phi_T = \tan^{-1}\left(\frac{48.72 - X_c}{61.22}\right)$$

Now, for unity power factor i.e $\cos\phi_T = 1$

$\phi_T = 0°$

$$\Rightarrow 0 = \tan^{-1}\left(\frac{48.72 - X_c}{61.22}\right)$$

$$\Rightarrow \tan 0 = \frac{48.72 - X_c}{61.22}$$

$\Rightarrow \boxed{X_c = 48.72\Omega}$

Now, $X_C = \frac{1}{2\pi f C}$

$$C = \frac{1}{2\pi \times 50 \times 48.72}$$

$$\boxed{C = 6.53 \times 10^{-5} F}$$

OR

Q.3 (a) A series RLC ckt

$R = 10\Omega$ $L = 0.014H$ $C = 100\mu F$

(1) Resonant frequency $\omega_r = \frac{1}{\sqrt{LC}} = 845.15$ rad/sec — 1mk

(2) Q factor $= \frac{1}{R}\sqrt{\frac{L}{C}} = 1.183$ — 1mk

(3) Bandwidth (BW) $= \frac{R}{L} = 714.28$ rad/sec — 1mk

(4) Lower and upper frequency points of BW

$\omega_H = \omega_r + \frac{BW}{2} = 1202.9$ rad/sec

$\omega_L = \omega_r - \frac{BW}{2} = 488.01$ rad/sec — 1mk

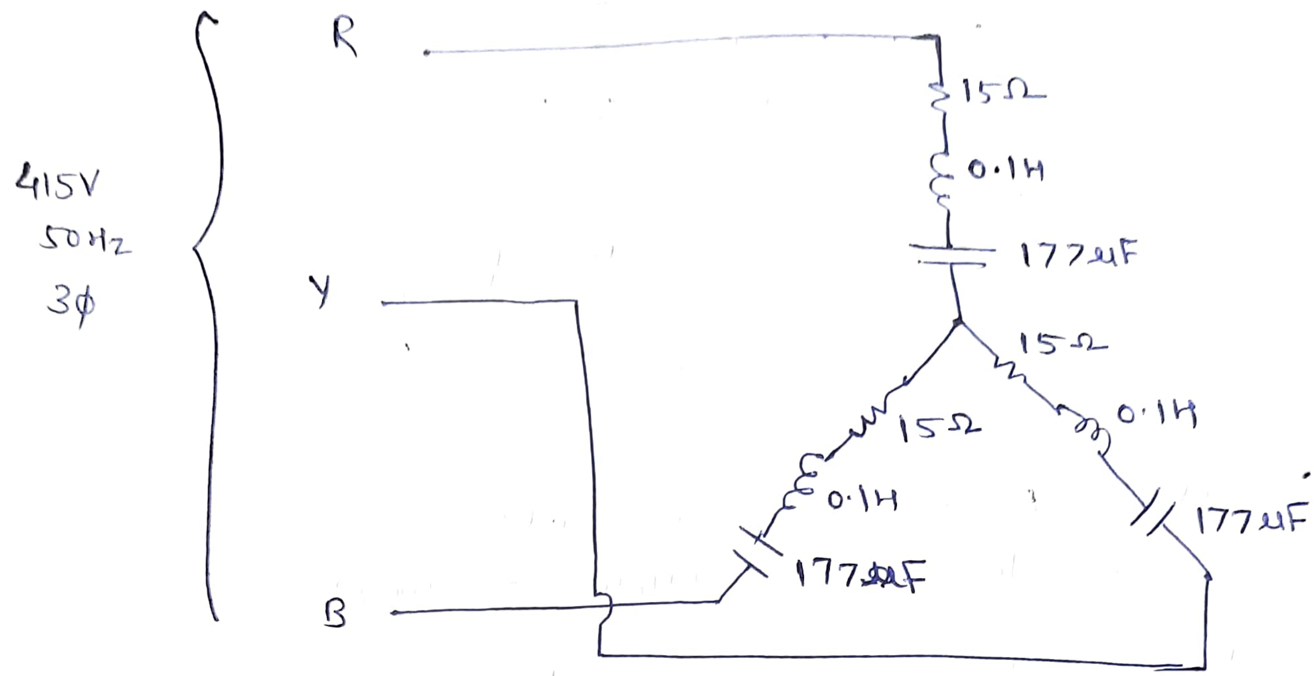
(5) if $V(t) = 1 \sin(1000t)$

$\Rightarrow$ $V_T = \frac{1}{\sqrt{2}} = 0.707$ V

$$V_C = \frac{V_T}{R}\sqrt{\frac{L}{C}}$$

$$= 0.836 \text{ V}$$ — 1mk

Q. 2 (b)



Soln —

$X_L = 2\pi f L = 2\pi \times 50 \times 0.1 = 31.41\Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 177 \times 10^{-6}} = 17.97\Omega$

Impedance of each phase,

$\overline{Z_{ph}} = R + jX_L - jX_C = 15 + j31.41 - j17.98$

$\overline{Z_{ph}} = 15 + j13.43 = 20.13 \angle 41.83^\circ$ — 1 mks

for star connected

$I_L = I_{ph}$ and $V_L = \sqrt{3} V_{ph}$

$V_L = 415V \Rightarrow V_{ph} = 239.6V$

$I_L = I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{239.6}{20.13} = 11.9A$ — 1 mk

$pf = \cos\phi_{ph} = 0.745$ (lag) — 1 mk

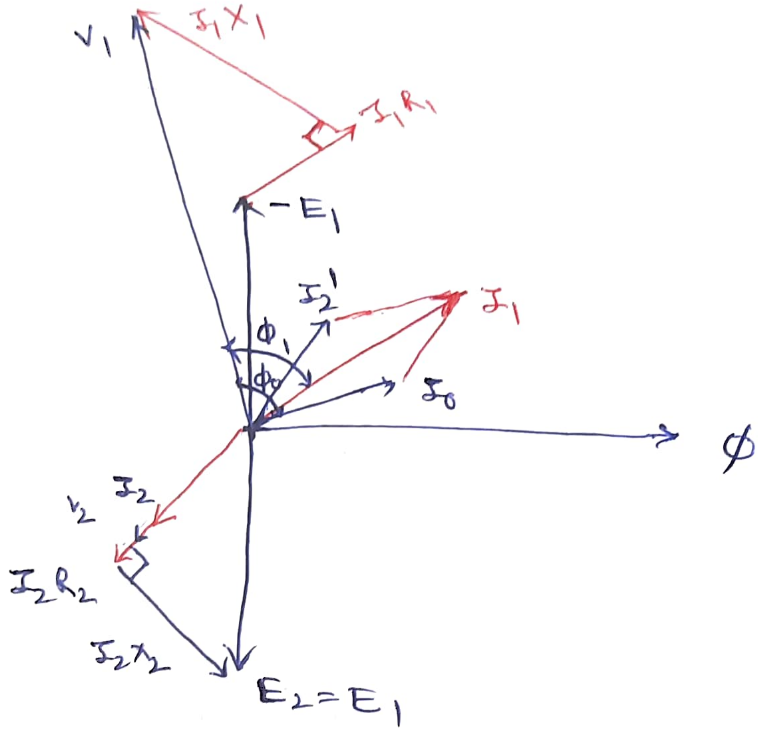
Active Power $P_{3\phi} = \sqrt{3} V_L I_L \cos\phi_{ph}$

$P_{3\phi} = 6373.61 W$ — 1 mk

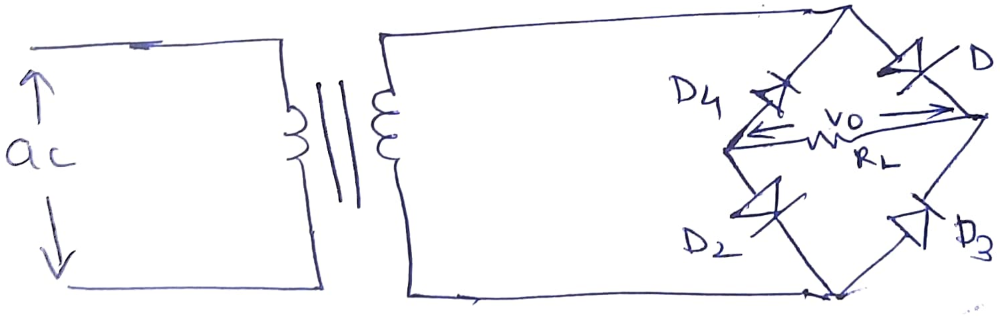
Reactive Power $Q_{3\phi} = \sqrt{3} V_L I_L \sin\phi_{ph}$

$= 5704.67$ VAR — 1 mk

Q.4(a) Phasor diagram considering winding resistance and magnetic leakage when load is resistive.



Q.4 b full wave bridge rectifier.



— 1mk

Step wise explanation — 4mks