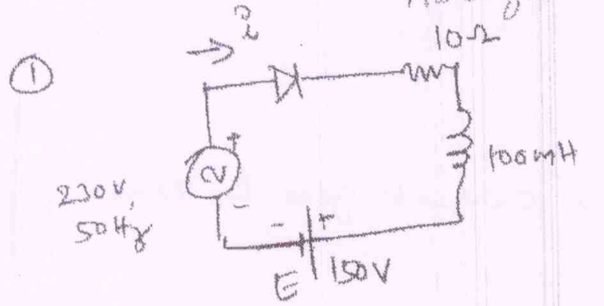
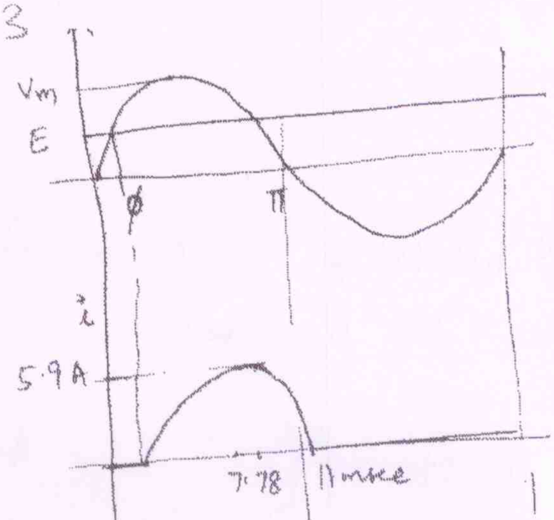
Assignment – 3

①





Assume that the diode starts conducting at $\omega t = \phi$ & conducts till the current falls to zero.

$$\phi = \sin^{-1}\left\{\frac{E}{V_m}\right\} = \left\{\sin^{-1}\left\{\frac{150}{325.26}\right\}\right\} = 27.46^\circ = 0.4793\,\text{rad}$$

$$V_m \sin\omega t - E = iR + L\frac{di}{dt}$$

Solving the differential equation

$$i = \frac{V_m}{Z}\sin(\omega t - \theta) - \frac{E}{R} + Ae^{-R/L\,t} \quad \text{——①}$$

$$Z = \sqrt{R^2 + (\omega L)^2} = 32.969\,\Omega \qquad \theta = \tan^{-1}\left\{\frac{\omega L}{R}\right\} = 72.343^\circ$$

$$= 1.263\,\text{rad}$$

Substituting $\omega t = \phi$, $i = 0$, and $t = \frac{\phi}{\omega} = 1.525$ msec in ①

$$A = \frac{21.96}{e^{-R/L\,t_0}} = 25.578 \text{ ampere}$$

So $i = 9.866\sin(\omega t - 1.2626) - 15 + 25.578\,e^{-100t}$ ——②

differentiating ② and equating to zero

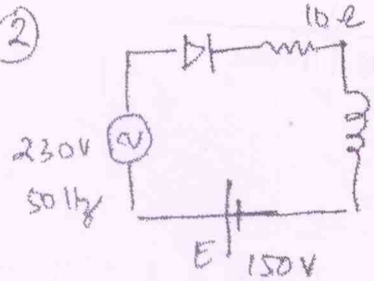
$$\frac{di}{dt} = 3099\cos(314t - 1.2626) - 2557.8\,e^{-100t} = 0$$

Solving for t, I_{max} occurs at $t = 7.78$ msec

$$I_{max} = i\big|_{t = 7.78\text{ msec}} = 5.9\text{A}$$

Substituting $i = 0$ in (2), the current goes to zero at $t = 11$ msec.

(2)



Assuming that the diode starts conducting at $\omega t = \phi$, where

$$\phi = \sin^{-1}\left\{\frac{E}{V_m}\right\}$$

$$= -0.4793 \text{ radians}$$

$$i = \frac{V_m}{Z}\sin(\omega t - \theta) + \frac{E}{R} + Ae^{-R/L\, t} \quad \text{— (1)}$$

At $\omega t = \phi$, $i = 0$ and $t = \frac{\phi}{\omega} = -1.525$ msec. Subs these values in (1),

$$A = -4.538 \text{ A}.$$

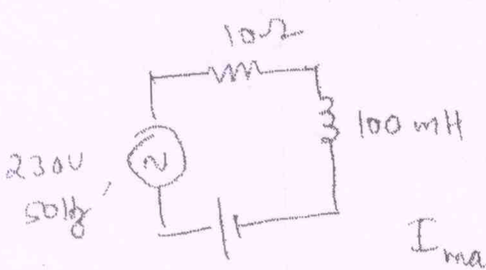
So

$$i = 9.866 \sin(\omega t - 1.2626) + 15 - 4.533 e^{-100t} \quad \text{— (2)}$$

For discontinuous conduction mode, the current should go to zero before it reaches $(2\pi + \phi) = 5.804$ rad

But $i\big|_{(2\pi+\phi)=\omega t} = 4.56 \text{ A} > 0$.

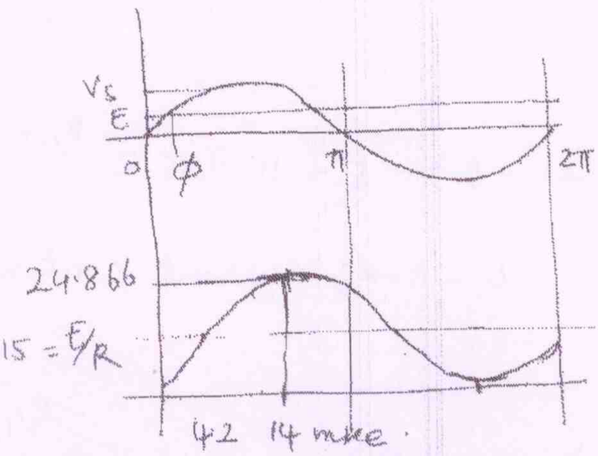
So continuous conduction mode, and the diode can be removed. In steady state



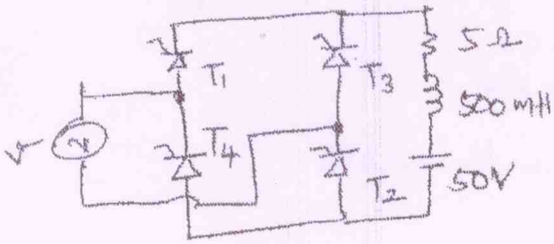
$$i = \frac{V_m}{Z}\sin(\omega t - \phi) + \frac{E}{R}$$

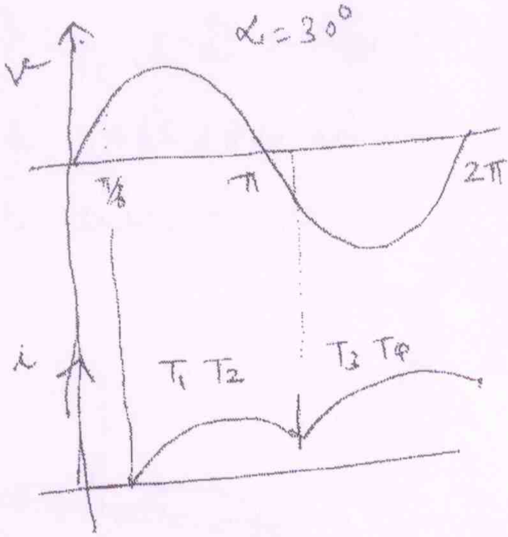
$$\phi = 1.2626 \text{ rad}$$

$$I_{max} = \frac{V_m}{Z} + \frac{E}{R} = 24.866 \text{ A at } \omega t = 4.404 \text{ radians}$$



(3)





$$V_m \sin \omega t = L\frac{di}{dt} + iR + E$$

$$i = \frac{V_m \sin \omega t - E}{L(D + R/L)}$$

Solving the differential eqtn,

$$i = \frac{\sqrt{2}\,V_s}{Z}\sin(\omega t - \theta) - \frac{E}{R} + A e^{-R/L\,t}$$

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right) = \tan^{-1}\left(\frac{2\pi\, 50 \times 0.5}{5}\right) = 88.176^\circ$$

$$= 1.538$$

for $\omega t = \alpha$, $i = 0$ (initial condition)

$$A_1 = \frac{E}{R} - \frac{\sqrt{2}\,V_s}{Z}\sin(\alpha - \theta)\, e^{R/L\,\alpha/\omega}$$

case (i) $\alpha = 30^\circ$

$A_1 = 11.9556$

for case (ii), $\alpha = 80$, $A_1 = 10.75$

for case(i), $i = \frac{\sqrt{2}\,V_s}{Z}\sin(\omega t - \theta) - \frac{E}{R} + 11.955\,e^{-R/L\,t}$

put $\omega t = \pi + \pi/6 = 7\pi/6$, $i = +ve$, current continuous

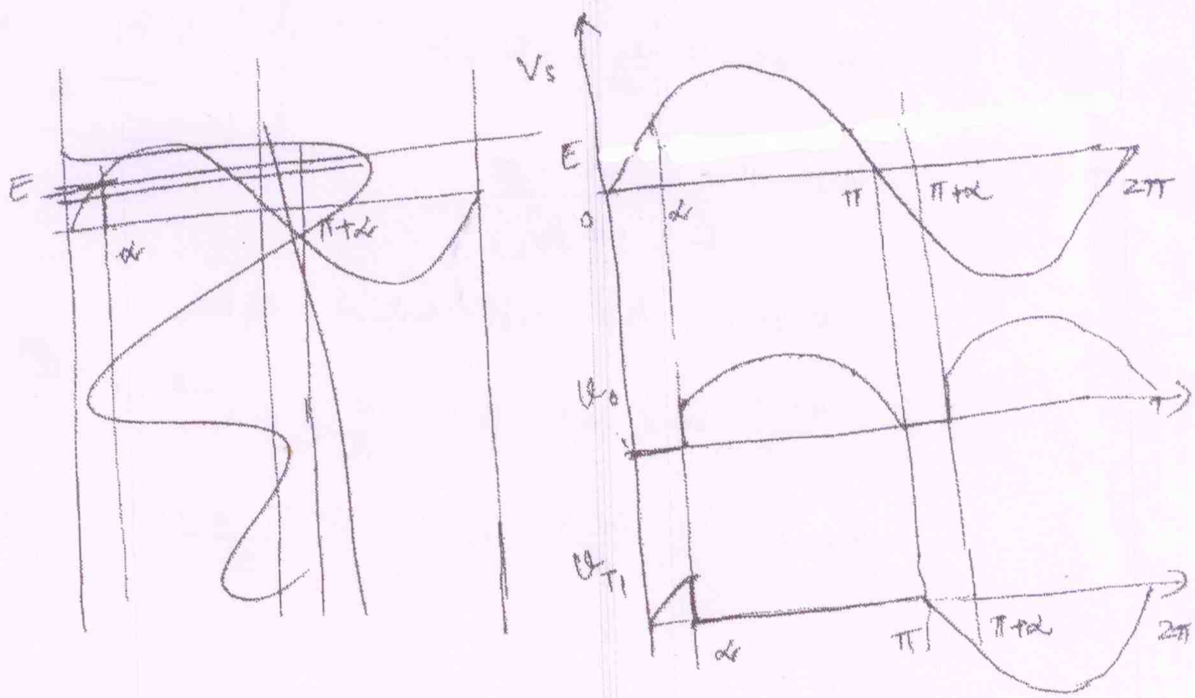
$i = 2.39$ (+ve).

for case (ii), $i = \frac{\sqrt{2}\,V_s}{Z}\sin(\omega t - \theta) - \frac{E}{R} + 10.75\,e^{-R/L\,t}$

for $\omega t = 260°$, $i = -ve$.

So current discontinuous.

(4)



Conducting devices

0 to α	α to π	π to π+α	π+α to 2π
D_1, D_2	T_1, D_2	D_1, D_2	$T_2\ D_1$

85.

$$I_{av} = \frac{1000}{100} = 10A$$

Average voltage drop across the inductor, L is zero.

$$\therefore \frac{2V_m}{\pi}\cos\alpha = 5\times10 + 100 = 150$$

$$\therefore \cos\alpha = \frac{150\times\pi}{2\times240\times\sqrt{2}} = 0.694$$

$$\therefore \alpha = 46.05^\circ$$