Worksheet - 15

A.1 $B = 0.02\ T,\ r = 2 \times 10^{-2}\ m$

$\frac{dr}{dt} = 10^{-3}\ m/s$

$\phi = B.A$

$\phi = B.\pi r^2$

$\frac{d\phi}{dt} = B\pi 2r\frac{dr}{dt}$

$\frac{d\phi}{dt} = 2.5\ \mu wb$

$e = \frac{-d\phi}{dt} = -2.5\mu V$

A.2 $B = B_0 \sin \omega t$

$= 0.2 \sin 300t$

(a) $\phi = (B_0 \sin \omega t).A\cos\theta$

$\phi = (0.2\ \sin 300t).A\cos 60$

$\phi = (0.2\ \sin 300t) \times 5\ \times 10^{-4} \times \frac{1}{2}$

$\frac{d\phi}{dt} = 5\ \times 10^{-5} \times 300 \times \cos 300t$

For max. emf $\cos 300t = 1$

$e = 150\ \times 10^{-4}\ V$

(b) $\phi = BA\cos 60^o$

$= \frac{1}{2}\ BA$

$\phi = \frac{1}{2}\ (B_o \sin \omega t)\ A$

$e = \frac{-d\phi}{dt} = \frac{1}{2}\ B_o\ A\ \omega \cos \omega t$

$= \frac{1}{2} \times 0.2\ \times 5\ \times 10^{-4}\ \times 300\ \times$

$\cos 300\ \times \frac{\pi}{900}$

$e = 7.5\ \times 10^{-3}\ V$

(c) $\phi = \frac{1}{2}\ (B_o\ \sin \omega t)A$

$e = \frac{-d\phi}{dt} = \frac{1}{2}\ B_o\ A\ \omega \cos \omega t$

$= \frac{1}{2} \times 0.2\ \times 5\ \times 10^{-4}\ \times 300 \cos 300\ \times$

$\frac{\pi}{600} = 0$

A.3. $\phi = (5t^3 + 4t^2 + 2t - 5)wb$

$t = 2S, R = 5\Omega,\ I = ?$

$e = \frac{-d\phi}{dt}$

$e = 15t^2 + 8t + 2$

$At\ t = 2S$

$e = 15 \times 4 + 8\ \times 2 + 2$

$e = 78\ V$

$e = RI$

$I = \frac{e}{R} = \frac{78}{5} = 15.6\ A$

A.4. For Rectangular loop

$\phi_i = B.A\cos 0 = 0 \cdot 8 \times 15\ \times 5 \times 10^{-4}$

$=\ 60\ \times 10^{-4} = .6 \times 10^{-2}\ Wb$

For Square Loop

$\phi_f = B.A = 1 \cdot 4\ \times 10^{-2} Wb$

$\therefore\ |e| = \frac{\phi_f - \phi_i}{\Delta t}$

$= \frac{10^{-2}(1.4-.6)}{0\cdot 5} = 0 \cdot 016\ V$

A.5. $l = 88\ cm = 88\ \times 10^{-2}\ m$

$B_1 = 2 \cdot 5\ wb/m^2$

$2\pi r = l$

$r\ = \frac{88 \times 10^{-2}}{2\pi}\ m = \frac{44 \times 10^{-2}}{\pi}\ m$

$B_2 = 3\frac{wb}{m^2},\ \ A = 22\ \times 10^{-2}\ m$

$\Delta t = 0.5\ sec$

$\Phi_i = B_1.\pi r^2$

$= 2 \cdot 5\ \times\ \pi\ \times \frac{(44\ \times 10^{-2})^2}{\pi^2}$

$= 0.154\ Wb$

$\phi_f = B_2.A = 3\ \times (22\ \times 10^{-2})^2$

$= 0.145\ Wb$

$|e| = \frac{\phi_i - \phi_f}{\Delta t}$

$= \frac{.154-.145}{.5} = 0.018V$

A.6. $R = 10\Omega, N = 1000$

$\phi_i = 5.5 \times 10^{-4}$ wb

$\phi_f = 0 \cdot 5 \times 10^{-4}$ wb

$|e| = \frac{\phi_i - \phi_f}{\Delta t} \times N$

$e = \frac{1000 \times 10^{-4} \times 50}{0 \cdot 1}$

$e = 5$ V

$e = RI$

$I = 0 \cdot 5$ A

$I = \frac{q}{t}$

$q = 0.05$ C

A.7 $e = Bv_{avg}\, l$

$= B\left(\frac{0+v}{2}\right) l$

$= \frac{1}{2} B(\omega l) l$

$= \frac{1}{2} Bl^2 (2\pi\nu)$

$= \frac{1}{2} \times (.4 \times 10^{-4}) \times (.5)^2 \times 2 \times 3.14 \times \frac{120}{60}$

$e = 6 \cdot 28 \times 10^{-5}$ V

A.8. $\phi = N \vec{B} . \vec{A}$

$= N\, BA \cos\theta$

$e = -\frac{d\phi}{dt} = NBA\ \omega \sin \omega t$

A.9. Max emf, $e_o = NBA\ \omega$

$e_o = 20 \times 3 \times 10^{-2} \times \pi(\cdot 08)^2 \times 50$

$= \cdot 603$ V

Amg emf $= 0$ (over a cycle)

$I_o = \frac{e_o}{R} = \frac{\cdot 603}{10} = \cdot 0603$ A

Power loss $P = \frac{I_o e_o}{2}$

$= \cdot 018$ W

Source – external agent

A.10. (i) $\phi = BA = \cdot 4 \times 5 \times 10^{-2}$

$= 2 \times 10^{-2}$ Wb

(ii) $t = \frac{60-20}{10} = 4$ sec

(iii) $e = Blv$

$= \cdot 4 \times \cdot 25 \times \cdot 1 = \cdot 01$ V

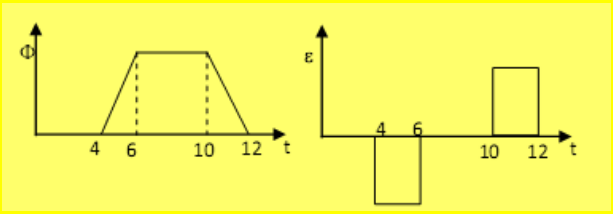
emf is induced when loop enters & leaves the magnetic field

$\therefore t = \frac{20}{10} = 2$ sec in both cases

(iv) $I = \frac{e}{R} = \frac{\cdot 01}{\cdot 1} = \cdot 1$A

- Anticlockwise

(v)



A. 11. $R_{AB} = 2\Omega$

$R_{net} = 2 + 1 = 3\Omega$

Induced emf in loop $e = I\, R_{net}$

$e = 2 \times 10^{-3} \times 3 = 6 \times 10^{-3}$V

$e = Bvl$

$6 \times 10^{-3} = 2\, v \times 15 \times 10^{-2}$

$v = \cdot 02$ m/s

A.12. $e = L\frac{dt}{dt}$

$= \cdot 4 \times 10^{-3}\left(\frac{250 \times 10^{-3}}{\cdot 1}\right) = 10^{-3}V$

A.13. $L = \mu_o n^2 A.l$

$L = 4\pi \times 10^{-7}\left(\frac{400}{\cdot 2}\right)^2 (2 \cdot 5 \times 10^{-4})(\cdot 2)$

$= 2.5 \times 10^{-4}$ H

$$e = L\frac{dI}{dt}$$

$\frac{dI}{dt} = \frac{e}{L} = \frac{100\times10^{-6}}{2.5\times10^{-4}}$ =0.4A/s

A.14. $e = L\frac{dI}{dt}$

$$250 \times 10^{-6} = L\left(\frac{10-6}{\cdot 4}\right)$$

$$L = 25\mu H$$

A.15. Total flux $\phi = LI$

$= 20 \times 10^{-3} \times 4 \times 10^{-3}$

$= 80\ \mu Wb$

Mag. Flux through area of cross section

$\phi = \frac{80\times10^{-6}}{100} = 0.80\ \mu Wb$

A.16. $L = \mu_o n^2 A l$

$\frac{L_1}{L_2} = \frac{n_1^2}{n_2^2}$

$\frac{100}{L_2} = \frac{600^2}{500^2}$

$L_2 = 75$ mH

A.17. Discussed in class

A.18. Due to symmetry ϕ linked with bigger loop due to 2A is equal to the ϕ linked with smaller loop due to 2A

Mag field due to current in bigger loop at the centre of smaller loop

$$B = \frac{\mu_o}{4\pi}\frac{2\pi IR^2}{(R^2+x^2)^{3/2}}$$

$$= \frac{10^{-7} \times 2 \times 3\cdot14 \times 2 \times (\cdot 2)^2}{((\cdot 2)^2 + (\cdot 15)^2)^{3/2}}$$

$$= \frac{5.02\times10^{-8}}{.0156}$$

$$= 3\cdot23 \times 10^{-6}\ T$$

(a) Mag. Flux linked with smaller loop

$\phi = BA$

$= (3\cdot23 \times 10^{-6})\ (\pi \times (.3 \times 10^{-2})^2)$

$= 9 \times 10^{-11}$ Wb

(b) $\phi = MI$

$M = \frac{\phi}{I} = \frac{9\times10^{-11}}{2}$

$= 4\cdot5 \times 10^{-11}$ H

A.19. $M = \mu_o n_1 n_2 A l$

$= 4\pi \times 10^{-7} \times \left(\frac{4000}{\cdot 2}\right)\left(\frac{2000}{\cdot 1}\right) 4 \times 10^{-4} \times \cdot 01$ = 0.02H

A.20. (a) $n = \frac{1200}{2\pi r} = \frac{1200}{2\pi r} = \frac{4000}{\pi}$

Mag. Field produced along the axis of solenoid

$B = \mu_o n I$

$B = 4\pi \times 10^{-7} \times \frac{4000}{\pi} I$

Mag. Flux linked with solenoid

$\phi = BA \times$ total no of turns

$\phi = \left(4\pi \times 10^{-7} \times \frac{4000}{\pi} I\right) 12 \times 10^{-4} \times 1200$

Now, $\phi = LI$; or $L = \frac{\phi}{I}$

$$= \frac{\left(4\pi \times 10^{-7} \times \frac{4000}{\pi} I\right) 12 \times 10^{-4} \times 1200}{I}$$

$L = 2.3 \times 10^{-3}$H

(b) Mutual induction of two coils

$$M = \mu_o n_1 n_2 A l$$

$$M = 4\pi \times 10^{-7} \times \left(\frac{1200}{2\pi r}\right)\left(\frac{300}{2\pi r}\right) \times 12 \times 10^{-4} \times 2\pi r$$

Given r = 0.15cm

$M = 5.76 \times 10^{-4}$ H

$$|e| = M\frac{dI}{dt} = 5.76 \times 10^{-4}\left(\frac{2}{.05}\right)$$

= 0.023V