Assignment 2 (Answer Key)

1. (b)

$$e = -\frac{N(B_2 - B_1)A\cos\theta}{\Delta t}$$

$$= -\frac{500 \times (0 - 0.1) \times 100 \times 10^{-4} \cos 0}{0.1} = 5V$$

2.(b) Angle between normal to the plane of the coil and direction of magnetic field is θ

$\therefore$ Flux linked with coil $\phi = BA\cos\theta = \sqrt{3}.0 \times 2 \times \cos 30^{o} \Rightarrow \phi = 3$ weber

3. (d)

4. (d) $e = -\frac{d\phi}{dt} = -(10t - 4) \Rightarrow (e)_{t=2} = -(10 \times 0.2 - 4) = 2\ volt$

5. (a) Since both the loops are identical (same area and number of turns) and moving with a same speed in same magnetic field. Therefore same emf is induced in both the coils. But the induced current will be more in the copper loop as its resistance will be lesser as compared to that of the aluminium loop.

6. (b) Mutual inductance is the phenomenon according to which an opposing e.m.f. produce flux in a coil as a result of change in current or magnetic flux linked with a neighboring coil. But when two coils are inductively coupled, in addition to induced e.m.f. produced due to mutual induction, also induced e.m.f. is produced in each of the two coils due to self-induction.

7. (c) Presence of magnetic flux cannot produce current.

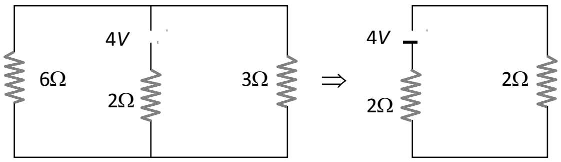
8. (d) When loop enters in field between the pole pieces, flux linked with the coil first increases (constantly) so a constant emf induces, when coil entered completely within the field, no flux change so $e = 0$. When coil exit out, flux linked with the coil decreases, hence again emf induces, but in opposite direction.

9. (b) The direction of induce current is 2 to 1 hence electron will move from 1 to 2 hence 1 is positive and 2 is negative

10. (c) Motional emf $e = Bvl \Rightarrow e = 2 \times 2 \times 1 = 4\ V$

This acts as a cell of emf $E = 4\ V$ and internal resistance $r = 2\Omega$.

This simple circuit can be drawn as follows



Current through the connector $i = \frac{4}{2+2} = 1\ A$

$\therefore$ magnetic force on connector $F_m = Bil = 2 \times 1 \times 1 = 2\ N$ (Towards left)

11. In A.C. generator uses the principle of electromagnetic induction which states that when the coil is rotated in a uniform magnetic field so that the flux through its continuous changes, an emf is induced in it.

12. As current In A is increasing in clock wise direction then current induce in b in anticlockwise direction it seems to be the current each section of both conductor is anti-parallel hence they will repel each other.

13. If a loop of conducting material is moved with a constant velocity well inside a uniform magnetic field perpendicular to the field, there will not be induced current in it because to induce a current, emf induced depends upon the rate of change of magnetic flux linked with it. In this case, flux through the loop remains constant. Hence there will be no induced current in the loop.

14. Given that, initial current, I_1=5.0A

Final current, I_2=0.0A

Change in current, $dI = I_1 - I_2$=5A

Time taken for the change, t=0.1s

Average emf, e=200V

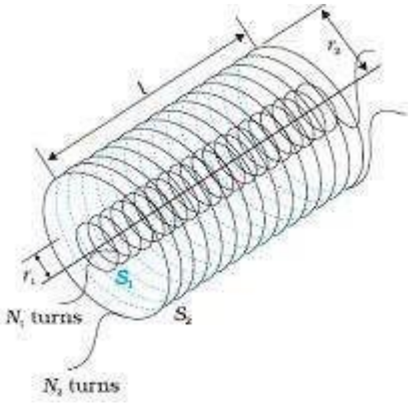
For self-inductance (L) of the coil, we have the relation for average emf as,

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

$$L = \frac{e}{dI/dt} = 200/\frac{5}{0.1}$$

Therefore, the self-induction of the coil is 4H

15 Let us consider two long co-axial solenoids each of length l, as shown in figure. Let the radius of the inner solenoid S1 be r_1 and the number of turns per unit length by n_1. Let the corresponding quantities for the outer solenoid S_2 are r_2 and n_2, respectively.



Let N_1 and N_2 be the total number of turns of coils S1 and S2, respectively. When a current I_2 isset up through S_2, it in turn sets up a magnetic flux through S_1. Let us denote it by Φ_1.

The corresponding flux linkage with solenoid S_1 is

given by, $N_1\Phi_1 = M_{12} I_2$....................(1)

M_{12} is called the mutual inductance of solenoid S_1 with respect to solenoid S_2.

It is also referred to as the coefficient of mutual induction.

The magnetic field due to the current I_2 in S_2 is $\mu_0 n_2 I_2$. The resulting flux linkage with coil S_1 is,

$N_1\Phi_1 = (n_1 l)(\pi r_1^2)(\mu_o n_2 I_2) = [\mu_o n_1 n_2 \pi r_1^2 l] I_2$............................(2)
where $(n_1 l)$ is the total number of turns in solenoid S_1. Thus, from Eq. (1) and Eq. (2), we get $M_{12} = \mu_0 n_1 n_2 \pi r_1^2 l$

We now consider the reverse case. A current I_1 is passed through the solenoid S1 and the flux linkage with coil S_2

is,

$N_2\Phi_2$

$= M_{21}$

I_1

M_{21} is called the mutual inductance of solenoid S_2 with respect to

solenoid S_1.As done in previous case, we can also get the relation for

M_{21} as

$M_{21} = \mu_0 n_1 n_2 \pi r_1^2 l$

Hence if the two solenoid coils are of equal length, then $M_{12} = M_{21} = M = \mu_0 n_1 n_2 \pi r_1^2 l$