PHY F214 PHYSICS LAB-3 REPORT SEM-1 2017-2018

EXP No.= 5   EXP NAME=MAGNETIC INDUCTION

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ID NO. – 2016B5A30750G

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AIM:

1. Determine the voltage induced in a conducting coil as a function of the strength of the magnetic field ,the frequency of the magnetic field ,the area of cross section of thee magnetic field and the number of turns in the coil.

2. To calculate the magnetic flux passing through the magnet as it enters and leaves the stationary coil and to study the voltage impulses that are produced by the falling magnet as a function of different velocities .

Apparatus:

Forked light barrier, metal coil, permanent magnet, glass tube connecting wires, multimeter , function generator,secondary coils of various diameters and number of turns, a long primary coil.

Principle Used:

For the first part- A magnetic field of varying strength and varying frequency is produced in a long coil with the help of a function

generator and then we keep the smaller coils at the center of this long coil and measure the voltages that are induced due to the changing magnetic field of the long coil for different number of turns of the smaller coils ,different frequencies ,different cross sectional areas of smaller coils and different strengths of magnetic fields. The formula used will be

For a long coil with n' turns $|B|=(\mu_0 n' I)/l$ is the magnetic field inside the coil which is uniform.

The alternating current $I = I_0 \sin(\omega t)$

The voltage induced in the secondary coil with n turns and cross sectional area A

$V = -(\mu_0 n A n' \omega I_0 \cos(\omega t))/l$

For the second part- A permanent magnet is made to fall with different velocities and hence there is a change in the magnetic flux passing through the fixed conducting coil and thus an emf is induced in the coil given by faraday's law of induction $V= -n(d\phi/dt)$ and the magnetic flux is given by $\phi=\int B.dA$. we record the induced voltage impulse U_{ss} . As the permanent magnet moves closer to the coil the flux increases in downward direction if north pole of the permanent magnet is facing downwards . There is an induced emf in the anticlockwise direction when viewing the coil from the top and as soon as the magnet passes the coil the flux starts decreasing in the downward direction and so the emf is induced in the opposite direction.

Procedure:

For the first part- we make all the circuit connections properly and put the secondary coils inside the long coil right at the center of the primary coil as that is where the magnetic field produced by the

primary coil will be uniform . We connect the secondary coil to the multimeter to measure it's induced voltage the voltage generated will be an A.C voltage. Then first we measured the relation between the induced voltage as a function of the frequency in the primary coil with n=300 turns and d=41mm
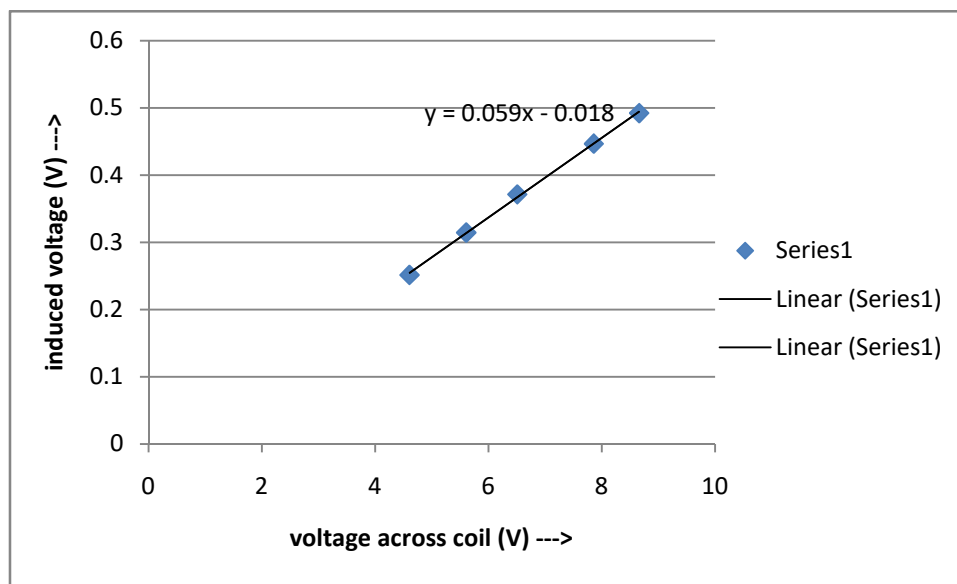
Frequency(kHz)	Induced voltage(V)
3.758	0.2844
5.268	0.3727
6.249	0.4206
7.227	0.4616
9.130	0.5255
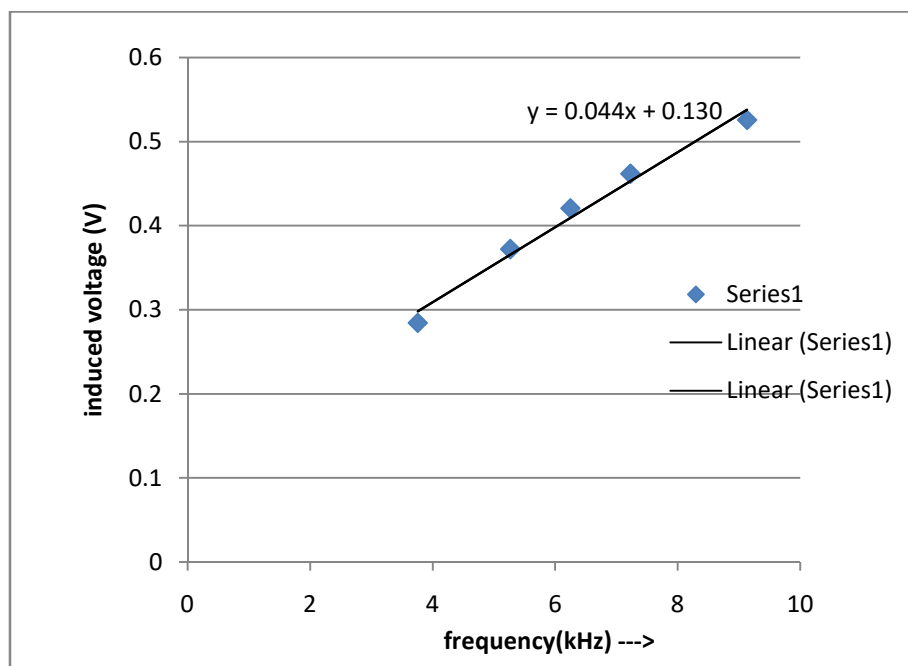
Graph of induced voltage vs frequency

Second we took another secondary coil of number of turns =200 and the diameter of the secondary coil=41mm keeping the frequency=5.469kHz

Voltage across the primary coil(V)	Induced voltage(mV)
5.60	162.61
6.05	177.01
6.70	196.66
7.45	218.40
8.63	234.90

Graph of voltage across coil vs induced voltage

Third we measured the relationship between the change in the diameter of the secondary coil and the induced voltage by keeping all other quatities like current,number of turns ,and frequency constant.

Diameter (mm)	Induced voltage(mV)
26	223.2
33	365.1
41	562.3
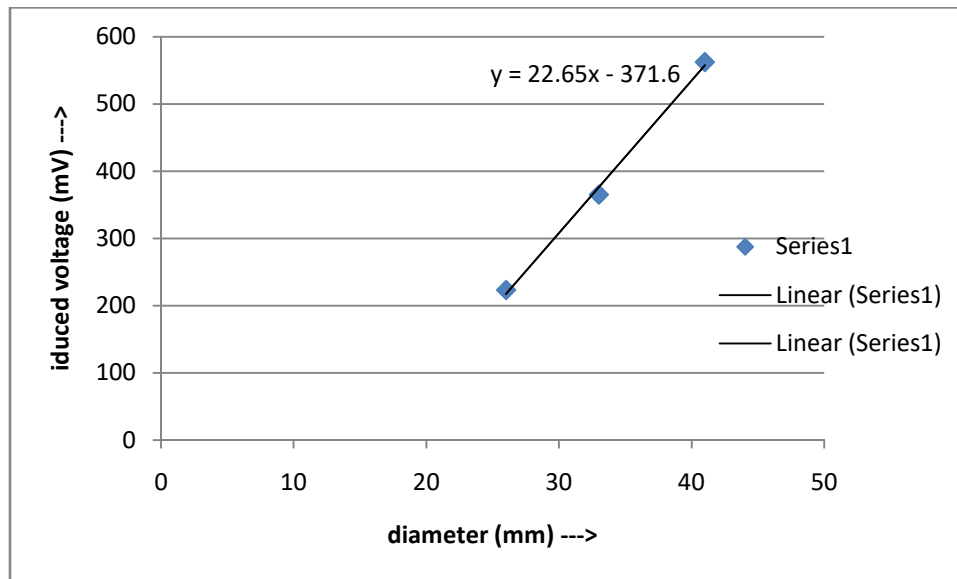
Graph of induced voltage vs diameter of the secondary coil

Next we measured the relationship between the number of turns and the induced voltage by keeping secondary coils of different number of turns but same diameter keeping all other quatities as constant such as current,frequency.

Number of turns	Induced voltage(mV)
75	58.56
150	116.11
300	222.80
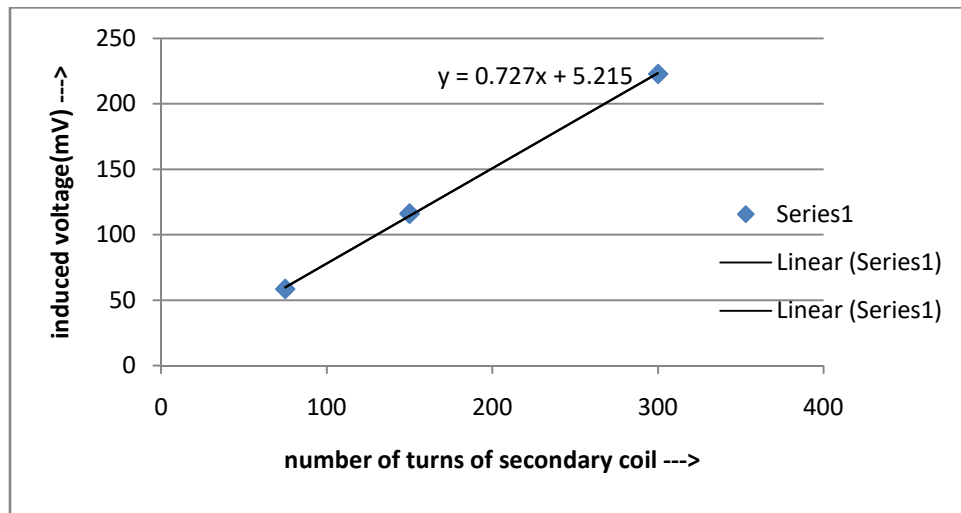
Induced voltage vs number of turns in secondary coil

For the second part:

We did all the connections of the circuit properly the light barrier was supplied 5 V and the glass tube was properly aligned with the light barrier so that the light from it is blocked properly and then we put the magnet in the tube and let it fall with 3 different heights and measured the readings of the induced voltage and then with the help of the graphs calculated the velocity of the magnet as it passes through the coil.

In all the following cases t1(time at which the magnet enters coil)

t2(time at which it leaves the coil),y1(positive peak value of induced voltage),y2 (negative peak value of induced voltage), a1(positive area),a2(the negative area), v1(velocity at which the magnet passes), U (the difference between the peak values),L(length of the magnet=6cm).
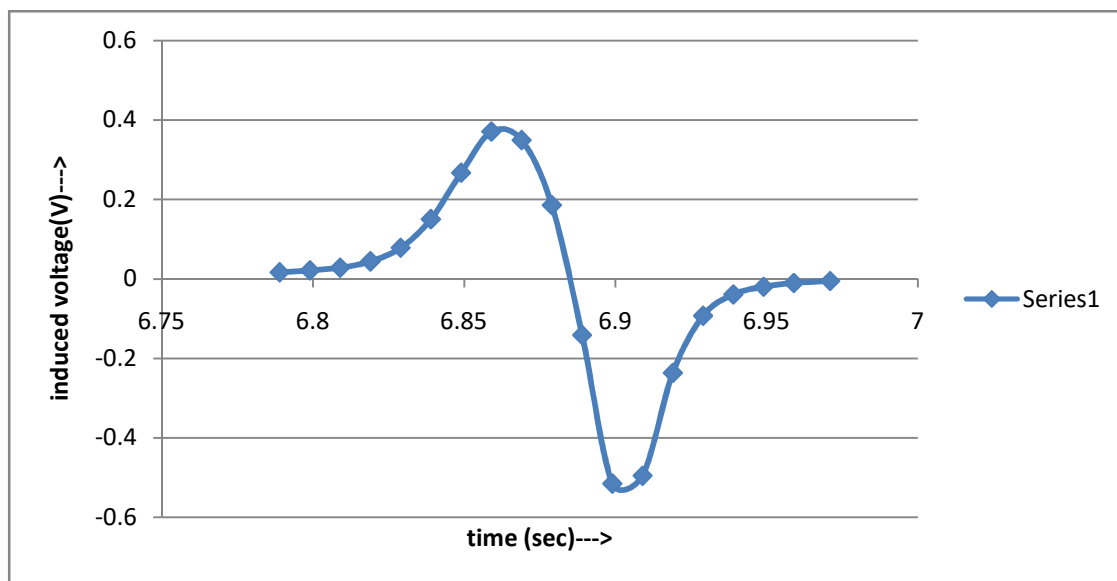

Data 1

time(s)	induced voltage(V)	photogate data				
6.789	0.01634392	4.296285				
6.799	0.02108832	4.291424				
6.809	0.02799215	4.273401				
6.819	0.04394019	4.291118				
6.829	0.07795759	4.301453				
6.839	0.149981	0.00736276				
6.849	0.2667554	0.02278853				
6.859	0.370243	0.007235485				
6.869	0.3488964	0.02520676				
6.879	0.1850781	0.007184575				
6.889	-0.1414661	4.3013				
6.899	-0.5152383	4.288802				
6.909	-0.4954351	4.282667				
6.919	-0.2366843	4.283838				
6.929	-0.09310752	4.314129				
6.939	-0.03942023	4.296209				
6.949	-0.020080566	4.301351				
6.959	-0.010541	4.293969				
6.971	-0.005548906	4.293689				

the v1=L/(t2-t1) = .006/(6.8816-6.8394)= 1.4218 m/s

y1=.370243V   y2=-.515238 V

U=y2-y1=0.88548 V

a1=.014106   a2=.014925   total area=φ=.029031 V.s

Graph of induced voltage vs time for data 1

Data 2

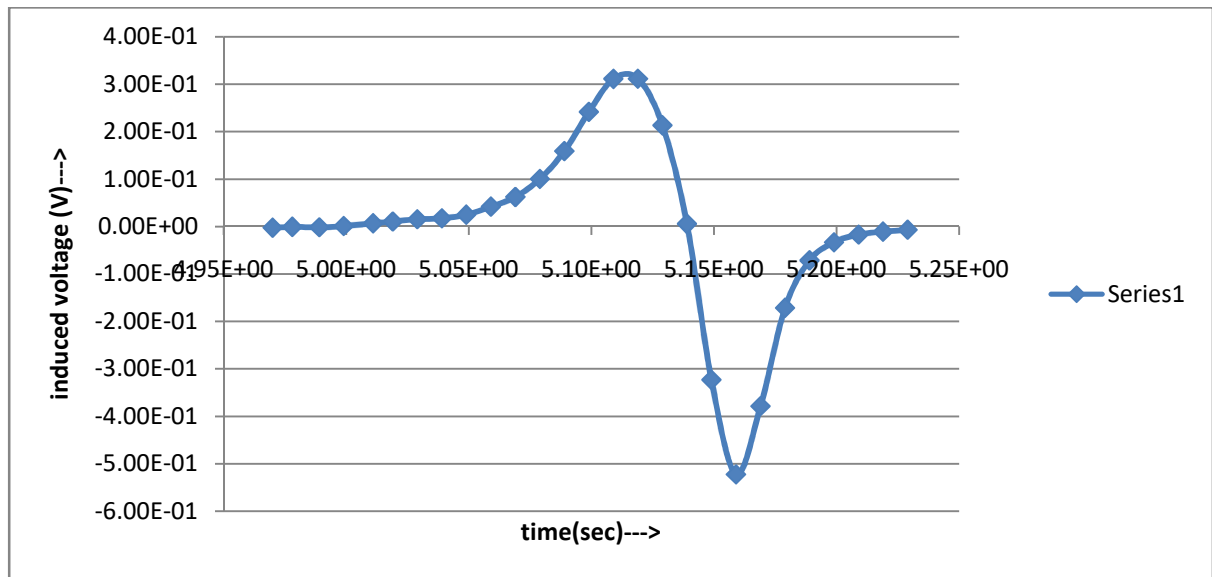| time(sec)	induced volatge(V)	photogate data				
4.97E+00	-2.48E-03	4.17E+00				
4.98E+00	-7.16E-04	4.19E+00				
4.99E+00	-1.60E-03	4.17E+00				
5.00E+00	1.16E-03	4.19E+00				
5.01E+00	6.87E-03	4.17E+00				
5.02E+00	1.05E-02	4.18E+00				
5.03E+00	1.54E-02	4.17E+00				
5.04E+00	1.74E-02	4.19E+00				
5.05E+00	2.49E-02	4.17E+00				
5.06E+00	4.19E-02	4.16E+00				
5.07E+00	6.23E-02	4.17E+00				
5.08E+00	1.00E-01	4.16E-02				
5.09E+00	1.59E-01	2.51E-02				
5.10E+00	2.42E-01	2.29E-02				
5.11E+00	3.11E-01	2.48E-02				
5.12E+00	3.11E-01	2.29E-02				
5.13E+00	2.13E-01	2.44E-02				
5.14E+00	5.64E-03	4.15E-02				
5.15E+00	-3.23E-01	4.18E+00				
5.16E+00	-5.22E-01	4.21E+00				
5.17E+00	-3.79E-01	4.19E+00				
5.18E+00	-1.71E-01	4.19E+00				
5.19E+00	-7.15E-02	4.18E+00				
5.20E+00	-3.32E-02	4.20E+00				
5.21E+00	-1.70E-02	4.19E+00				
5.22E+00	-1.09E-02	4.20E+00				
5.23E+00	-6.84E-03	4.18E+00				

$T_1=5.0786$ $t_2=5.1389$

$V_1=L/(t_2-t_1)=0.06/(5.1389-5.0786)=0.99502$ m/s

$Y_1=0.31137$ V $y_2=-0.52243$ V

$U=y_2-y_1=0.83380$ V

$a_1=0.015158$ $a_2=0.013754$ total area$=\phi=0.028912$ V.s

Graph of induced voltage vs time for data 2

Data 3

| time(sec)	induced voltage(V)	photogate data				
8.97E+00	3.11E-02	4.13E+00				
8.98E+00	5.87E-02	4.14E+00				
8.99E+00	1.30E-01	4.12E+00				
9.00E+00	2.81E-01	2.23E-02				
9.01E+00	4.77E-01	-2.99E-04				
9.02E+00	4.33E-01	2.46E-02				
9.03E+00	1.07E-01	4.11E-02				
9.04E+00	-4.67E-01	4.12E+00				
9.05E+00	-6.34E-01	4.13E+00				
9.06E+00	-2.85E-01	4.14E+00				
9.07E+00	-9.64E-02	4.15E+00				
9.08E+00	-3.73E-02	4.13E+00				
9.09E+00	-1.55E-02	4.14E+00				
9.10E+00	-5.00E-03	4.12E+00				
9.11E+00	-2.35E-03	4.15E+00				

t1=8.9965 s   t2=9.0285 s

v1=L/(t2-t1)=0.06/(9.0285-8.9965)=1.8750 m/s

y1=0.47701 V   y2=-0.63424 V

U=1.1113 V

a1=0.012262 V.s   a2=0.015169V.s   total area=ϕ=a1+a2=0.027431
V.s
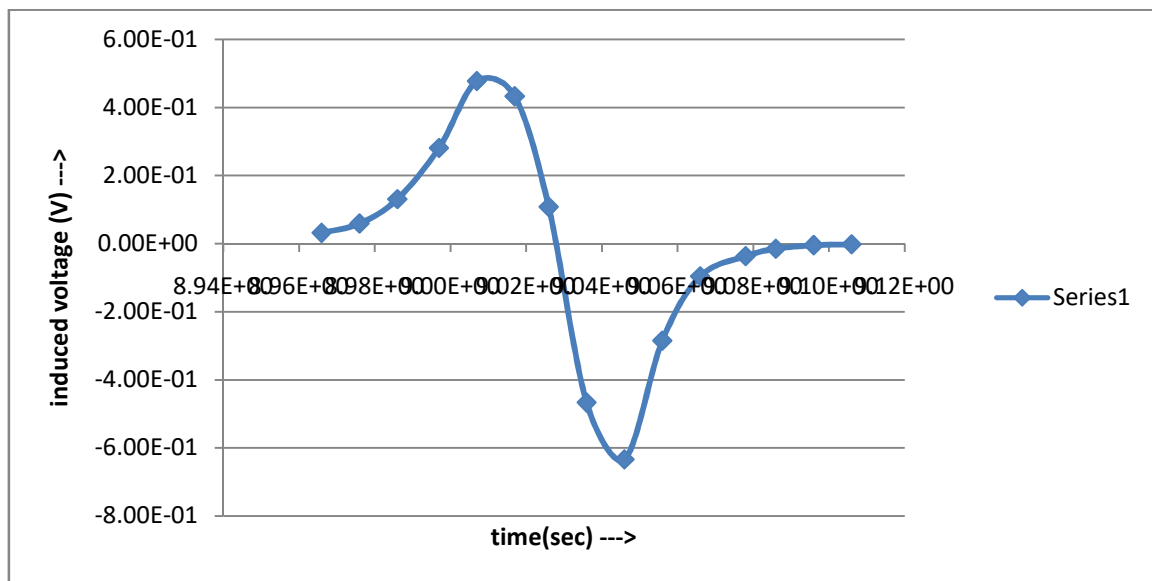
Graph of induced voltage vs time for data 3

now that we have got the velocities and U for 3 velocities we plot the
graph for U vs velocity
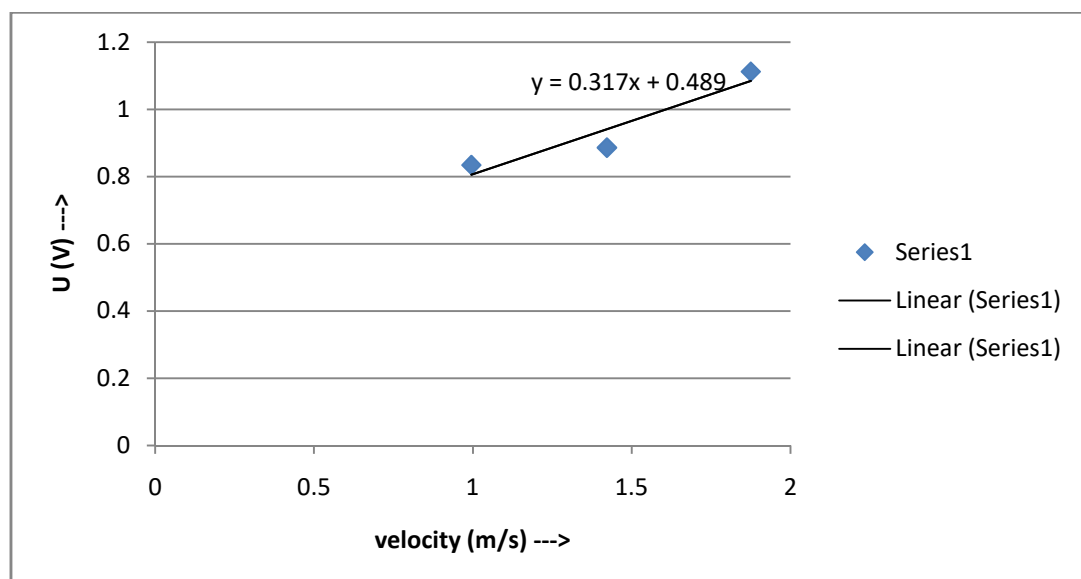
Graph of U vs velocity

as we can see the area for the different velocities is almost coming
same if we round it to 4 decimal places then a1=0.0290 a2=0.0289
a3=0.0274   for velocities v1=1.4218 m/s v2=0.99502m/s v3=1.8750

m/s. So it shows that the flux through the coil is independent of the velocity with which the magnet falls.

Velocity of magnet(m/s)	Magnetic flux(V.s)
0.99502	0.028912
1.4218	0.029031
1.875	0.027431
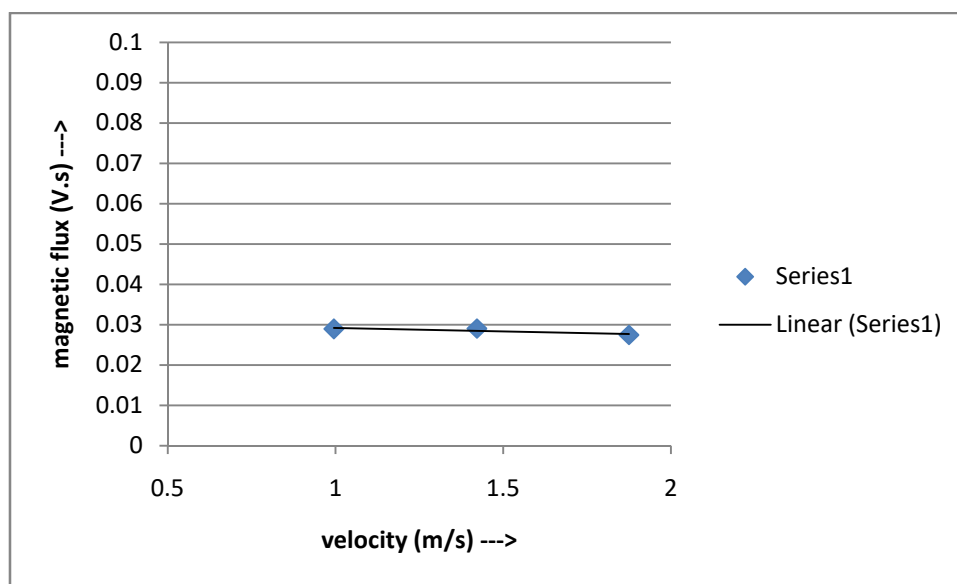
Graph of magnetic flux vs velocity of magnet

OBSERVATIONS:

For part 1- 1.we can see from the graphs that induced voltage in the secondary coil increases linearly with the increasing frequency.

2. we can also see that the induced voltage in the secondary coil increases with increasing current in the primary coil.

3. the induced voltage in the secondary coil increases with increasing diameter of the secondary coil keeping other quantities as constant .

4. the induced voltage in the secondary coil increases linearly with increasing number of turns in the secondary coil.

For part 2- 1. We can see from the gaphs of the voltage impulse vs velocity that the impulse increases with increasing velocity as the rate of change of flux is greater for greater velocity.

2.we can see from the graph that the voltage reverses it's direction as soon as the magnet crosses the coil. As when it is entering the coil the flux is increasing in downward direction and when it is moving out the flux decreases in downward direction and as the coil tries to oppose this change the current flows anticlockwise when viewed from top when entering and while leaving it flows in clockwise direction .

3. the negative voltage is higher in magnitude as the speed of the magnet is greater as it moves out hence the rate of change of flux is greater as so is the induced voltage.