

Physics 122L - Faraday's Law Supplement

Hopefully this will help make sense of some of the rather vague instructions in this lab.

Determining B of a Permanent Magnet Equation (8) is just separating variables in equation (7) and integrating. We are doing the integral manually by measuring the area under the curve with a ruler. The equation you want to use to find B is

$$\mathcal{E}\Delta t = -NBA \quad (1)$$

If you end up with a wrong sign it can be fixed by the order of Φ_1 and Φ_2 . If Φ_1 is flux through the loop when it is not between the poles of the magnet, then Φ_1 is just zero, and Φ_2 is the flux when the loop is between the poles of the magnet. So looking back at the line above equation (8) in the lab book, if Φ_1 is zero and Φ_2 is positive then the negatives cancel leaving an overall positive value on the right hand side.

Putting this all together, $\mathcal{E}\Delta t$ (units volt-seconds) is the area under the curve (area of the triangle made by the strip chart recorder). N is the number of turns in the loop, A is the area of the loop. Then you can solve for B!

Measuring B of a Solenoid Equation (9) is a little confusing, because we are using AC voltage current also varies with time, however, for our purposes we are interested in the peak value of the current and therefore the peak value of B so in equation (10) use I_0 in place of i .

For the third bullet in this section (with eq 11), we ultimately want to use equation (7) to find B. Plug in equation (11) into equation (7) and take the derivative.

$$\mathcal{E}_{total} = -N \frac{d(BA)}{dt} \quad (2)$$

Now substitute equation (11)

$$\mathcal{E}_{total} = -N \frac{d(B_0 \sin[(2\pi f)t]A)}{dt} \quad (3)$$

Remember A is the area of the loop, a constant, so we can pull it out of the derivative, the same goes for B_0 . We are then left with the derivative of $\sin[(2\pi f)t]$. Remember your chain rule,

$$\frac{d \sin[x(t)]}{dt} = \cos[x(t)] \cdot \frac{dx(t)}{dt} \quad (4)$$

Then as we did for current above, look at the maximum value, so when cosine is equal to one. you should then have an equation for B_0 in terms of the voltage measured from the small solenoid (wooden dowel), the number of turns on the small solenoid, the area of the small solenoid and the frequency of the applied voltage. Solve for B_0 .

Inductance and RL Circuit This should be fairly straight forward, apply the same principles you used when finding the time constant of the RC circuit. Remember to use your actual measured values and compare measured to calculated τ_{RL} with percent error.

Questions -

Question 1 - Basically fill in the gaps between equation (3) and Equation (4)

Question 2 - Look back to the original explanation and do some careful thinking

Question 3 - This also requires some careful thinking. Remember, this lab is all about the transference of mechanical to electrical energy by way of magnetic fields.