Lab 4. Magnetic Measurements and Faraday's Law

Name:______________________________ Date:______________________________

1 Introduction

Faraday's law states that a voltage e(t) is induced at the terminals of a coil that "sees" a time-varying magnetic flux $\Phi(t)$

$$e(t) = -\frac{d\Phi(t)}{dt} \tag{1}$$

For an N turn coil, each turn having an area A, the magnetic flux is $\Phi(t) = B(t)NA$, where B is the magnetic flux density. If the coil voltage e(t) is electronically integrated through an integrator as shown in Figure 2, then

$$V_{out}(t) = -\frac{1}{RC}\int_0^t e(t')dt' \tag{2}$$

where RC is the time constant of the integrator. Combining (1) and (2), we obtain

$$V_{out}(t) = -\frac{1}{RC}NA[B(t) - B(0)] \tag{3}$$

If B(0)=0, then

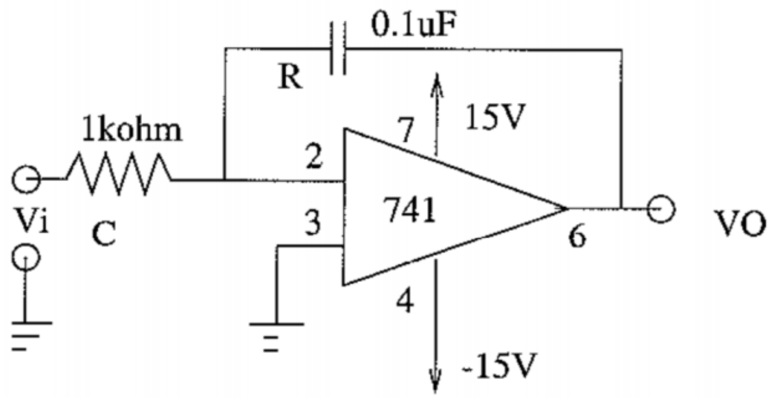
$$B(t) = -\frac{RCV_{out}(t)}{NA} \tag{4}$$

In this demonstration you will insert a coil into the static magnetic field of a solenoid (or turn on the magnetic field with the coil in place) and use (4) to determine the magnetic induction B(t) along the solenoid axis. You will compare to measurements made using a Bell Gaussmeter.

2 Procedure

1. Connect the coil to the Tektronix 7854 storage oscilloscope. The observing procedures are:
   - Triggering Setting: A trigger mode = auto, coupling=AC, source = line. Horizontal display: Time base A at 50ms/div, vertical display: 10mV/div.
   - Push the *stored* button.
   - Push the *aqr* button and swing the coil fast through the magnet right after the push. Observe the waveform on the oscilloscope.

Figure 1:



- Repeat the above step until you can get the same waveform everytime.
- Record the waveform here. Mark the vertical and horizontal scales.

2. Calculate the estimated average voltage by

$$V = -2 * \frac{d\Phi(t)}{dt} = -2 * \frac{\Delta\Phi}{\Delta t} = -\frac{2BNA}{\Delta t}$$

The radius of the coil is __________
B at the gap measured by the Gauss Meter is __________ T
number of turns of the coil is __________
Δt read from the waveform is __________
The calculated V from measured B is __________ T