EXPERIMENT 4
MUTUAL INDUCTANCE

OBJECTIVE

Investigation of mutual inductance between coils for various arrangements

EQUIPMENT

Oscilloscope, Function Generator, 15 mH and 29 mH inductors

PRELIMINARY WORK

P1 Find the total inductance L in terms of L_1, L_2 and M if two coils having inductances L_1, L_2 and a mutual inductance M between them are connected as shown in Figure 1. **Do not use time domain calculations.** Use the frequency domain.

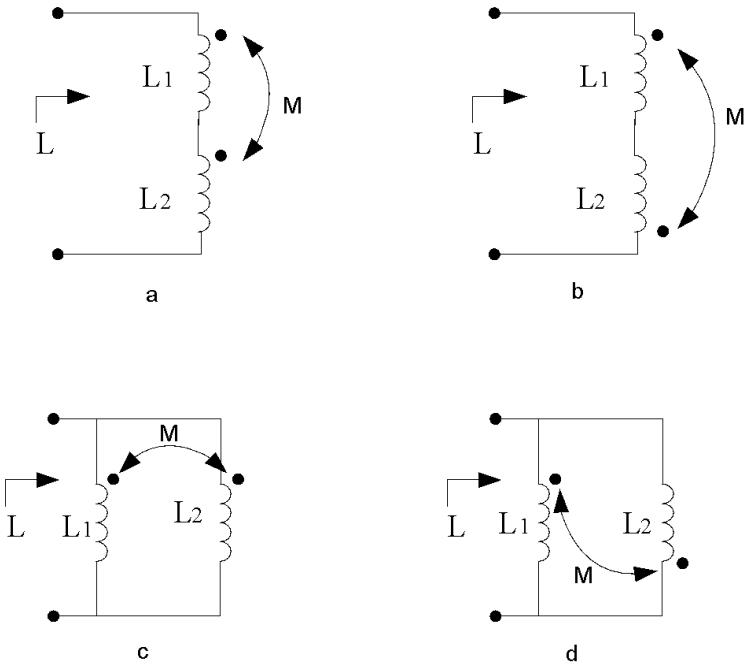

Figure 1: Different connections of two coils

P2 For the connection of coils shown in Figure 1, if the inductances are given as L_1=15mH, L_2= 29 mH, and L=75 mH, calculate M. What is the coefficient of coupling between L_1 and L_2?

P3 Consider the circuit in Figure 2

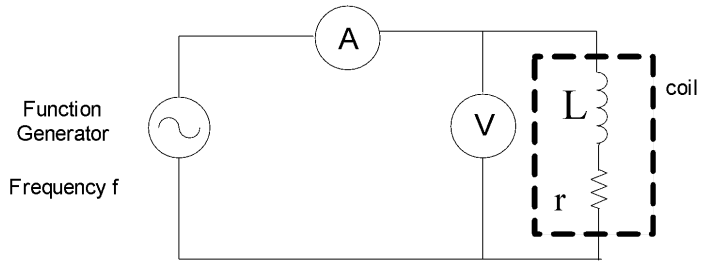

Figure 2 Measurement of the inductance of a coil

If the frequency f of the signal generator is high enough so that the Q factor of the coil $Q = \omega L / r \geq 10$, then show that the value of the inductance can be evaluated from the formula

$$L = V / 2\pi fI$$

with an error less than 0.5% irrespective of the value of r

P4 Propose a method to determine the mutual inductance M between two coils using the readings of the meters as shown in Figure 3. Voltage is measured by an oscilloscope, and current is measured by an AVO8.

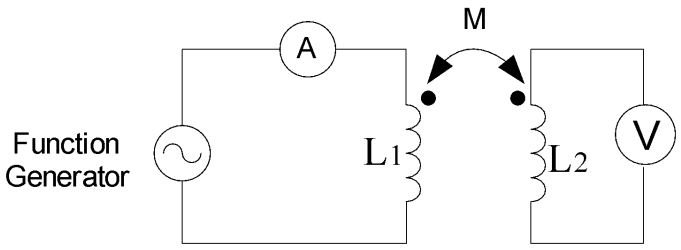

Figure 3 Measurement of the mutual inductance between two coils

EXPERIMENTAL WORK

E1 Measure the self-inductances L_1, L_2 and mutual inductance M between them by using the circuits shown in Figure 2 and Figure 3, respectively. L_1, L_2 are wound on the same wheel.

E2 Measure the total inductance of each of the connections of the coils shown in Figure 1 by using the circuit of Figure 2. Compare the measured values of L with those which you will find by substituting the measured values of L_1, L_2 and M in the expressions of preliminary work P1.

E3 Measure and plot the mutual inductance between two coils shown in Figure 4a while changing the distance between them from d=0 to 12 cm in 2 cm steps by using the circuit of Figure 3.

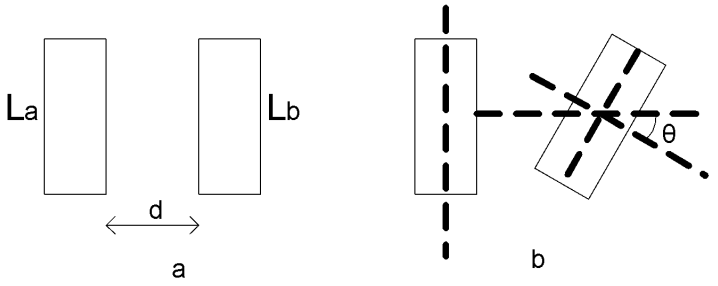

Figure 4: Figures for E3 and E4

E4 Measure and plot mutual inductance between two coils shown in figure 4 b) while keeping the center of the coil L_b stationary and turning it around its center. The angle θ should be set 0, 30, 45, 60, 90, 120, 135, 150, 180

CONCLUSION

C1 Is it possible to have a coupling coefficient of unity using the coils available in the laboratory? Why?

C2 Can you suggest another method by which the mutual inductance between two coils can be measured? Answer this question in the light of the results obtained in P1