EXPERIMENT NO. 01

OBJECTIVE: TO DETERMINE THE CURIE TEMPERATURE (T_C) OF THE GIVEN FERRITE SAMPLE AND STUDY THE PERMEABILITY VARIATION IN THE VICINITY OF CURIE TEMPERATURE.

INTRODUCTION:

Curie temperature is the temperature at which the ferromagnetic materials become paramagnetic.

E.M.F. induced in secondary coils of a transformer is given, as per Faraday's Law, as

$$V_S = K\frac{dB}{dt} \qquad (1)$$

Where,
K: Constant dependent upon the geometrical factors and the turn ratio of the transformer.
B: The flux density depends on magnetizing field (H), which in turn is proportional to the primary voltage (V_p) and permeability of the core (μ).

In the ferromagnetic state, the temperature dependence of V_s thus directly gives us the temperature dependence of permeability. At Curie temperature (T_c) there would be a sudden drop in the permeability of the material and hence a corresponding drop in V_s. So, the point at which V_s starts decreasing defines the Curie temperature.

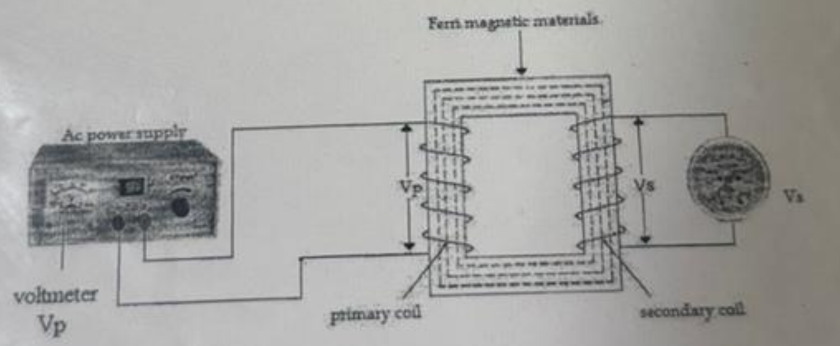

Figure 1: Schematic of the Curie Temperature setup.

At temperature exceeding T_c the materials is in the paramagnetic state where magnetic susceptibility χ_m (= μ-1) follows the Curie-Weiss Law:

$$\chi_m(T) = \frac{C}{T - T_c} \tag{2}$$

Where,
T is a temperature close to Curie temperature.

Equation (1) in the paramagnetic state can be rewritten as:

$$V_S = K\mu_0\mu_m \frac{dH}{dt}$$
$$= K\mu_0(\chi_m + 1)\frac{dH}{dt}$$

For a sinusoidal magnetising current

$$V_S = K\mu_0\omega H(1 + \chi_m) \tag{3}$$

Where ω is the angular frequency of magnetizing current.
Incorporating equation (2) in equation (3)

$$V_S = K\mu_0\omega H\left(1 + \frac{C}{T - T_c}\right) \tag{4}$$

Thus a plot of V_s vs $1/T\text{-}T_c$ should be a straight line with $\mu_0 K\omega$ H as intercept and $\mu_0 K\omega HC$ as slope.
Thus ratio of slope to intercept gives C. This fully characterizes the equation (2) which gives the temperature dependence of permeability in the paramagnetic state.

EXPERIMENTAL PROCEDURE:

1. Connect the primary turns of the coil over a ferrite core (figure 1) to an oscillator output.
2. Read the induced e.m.f in the secondary turns with the help of an ac millivoltmeter.
3. Heat up the sample in an oil bath and note secondary output as temperature increases.
4. At curie temperature the output will show a sudden drop. Once the secondary coil output starts to drop note the output for every 1^0C rise in temperature.
5. Repeat the observation of T_c during the cooling (after completing the observations of Vs vs T and shutting off the heater power).
6. To note temperature accurately locate the bulb of the thermometer in the vicinity of the sample. While reading V at varying temperature monitor current in primary turns and see that it remains constant. If needed, keep adjusting it to a constant (preset) value.

(2)

CALCULATIONS AND RESULTS:

1. Plot V_s vs. temperature and deduce T_c.
2. Plot V_s vs. 1/T-T_c plot (for T > T_c) and determine its slope, intercept and their ratio C.

TABLE:

S. NO	Temperature (◦c)	V_s (mV)