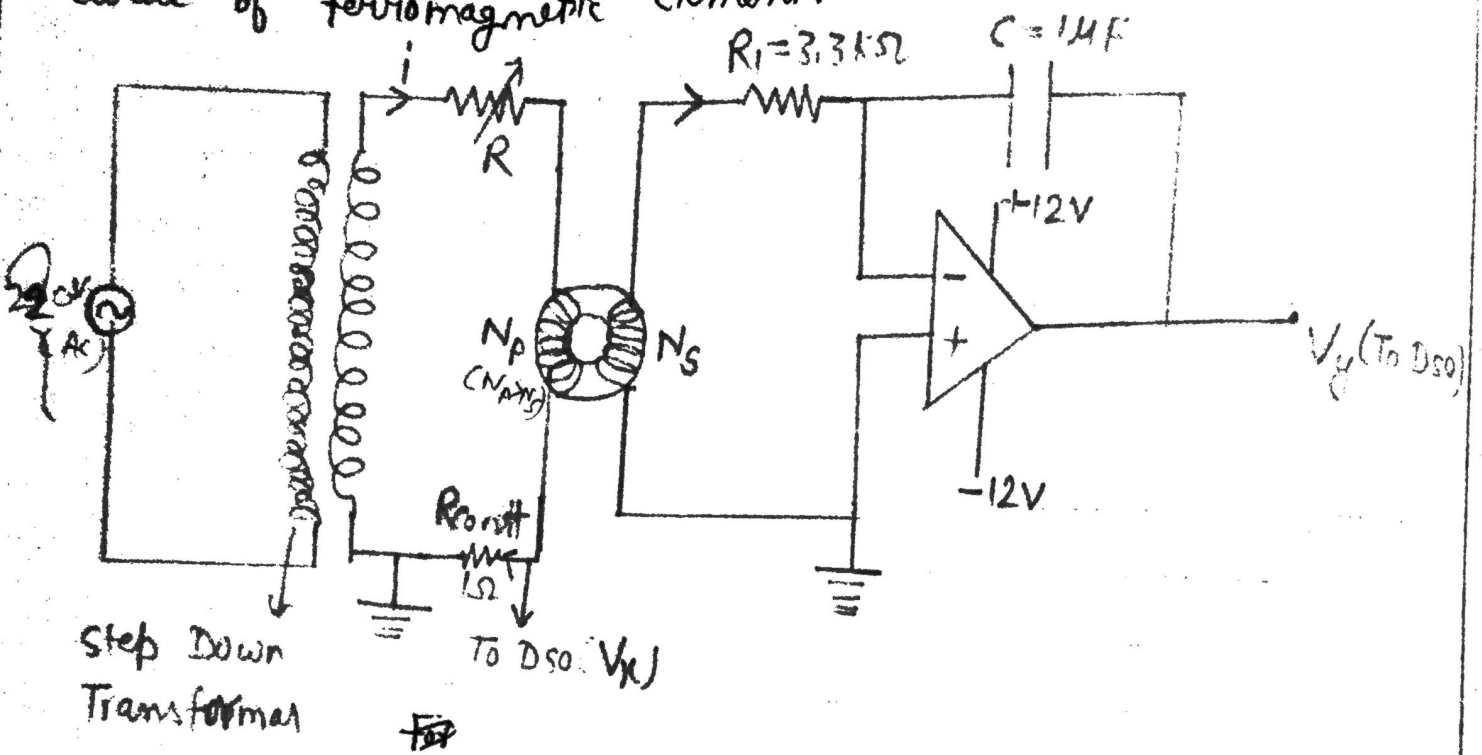
Circuit Diagram: of ckt for the determination of BH curve of Ferromagnetic Element.



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Experiment -01

Aim - To determine B-H curve of ferromagnetic element and find energy loss from Hysteresis curve.

Apparatus required - Breadboard, 12 V step down transformer, Power supply, connecting wires, Capacitor, Resistances, 1Ω resistance, 741 OP-AMP IC, multimeter, wire cutter, DSO, Function generator, Toroid coil, Vernier calliper, Resistance box

Formula Used -

$$H = \frac{N_p V_R}{L_p R_{const.}}$$

where N_p - No. of turns in Primary coil
L_p → Length of Primary coil
N_s - No. of turns in Secondary coil

$$B = \frac{V_y R_1 C}{N_s A_s}$$

A_s - Area of cross section of secondary coil
R_1 - Resistor used in integrator
C → Capacitor used in integrator

$$W = \frac{V_x V_y N_p R_1 C}{N_s A_s L_p R_{const}}$$

V_R - Voltage across $R_{const.}$ resistor
V_y - Output of integrator
$V_x V_y$ - Area of the curve

$$A_s = \pi \left(\frac{R_{ext} - R_{int}}{2} \right)^2$$

R_{ext} - External radius of coil
R_{int} - Internal radius of coil

$$L_p = 2\pi \left(\frac{R_{int} + R_{ext}}{2} \right)$$

Precautions: (i) The value of resistors and capacitors should be checked carefully.
(ii) All apparatus should be working properly.
(iii) Ideal integrator should work properly.
(iv) All connections should be tight enough.
(v) LR Resistance shouldn't get too heated
(vi) Area of BH curve should increase on increasing current.
(vii) Take the maximum area of DSO screen to trace BH curve.
(viii) Take multiple set of observations for the diameter of toroid in different positions.
(ix) Take maximum are of DSO screen while tracing BH curve.

Observations:

External and Internal Diameter of Toroid:

LC of main scale = 0.001 inch.

MSR (inch)	VSD	VSR (inch)	Total reading (inch)
4.775	8	0.008	4.783
4.775	0	0	4.775
4.925	0	0	4.925
4.825	10	0.01	4.835.

Average internal Diameter = 4.830 inch ≈ 122.682 mm.
Internal Radius (Rint) ≈ 61.34 mm

Note: Thickness of Toroid was measured since the range of vernier callipes was small.

OBSERVATIONS:

S.No.	R(Ω)	V(V)	I(A)	Area (cm^2)	mV per division		$V_x V_y (V^2)$	Energy Loss (J/m)
					x-axis	y-axis		
1.	1Ω	1.9	1.9	20.23	1000	1000	20.23	599.89
2.	3Ω	4.7	1.56	43.59	500	500	10.90	323.15
3.	5Ω	6.5	1.30	25.88	500	500	6.47	191.86
4.	10Ω	10.7	1.07	15.57	200	200	0.63	18.46
5.	15Ω	10.8	0.72	29.69	100	200	0.59	17.60
6.	20Ω	10.9	0.54	26.27	100	200	0.53	15.58
7.	25Ω	11.3	0.45	18.29	100	200	0.37	10.84
8.	30Ω	11.8	0.39	28.09	50	100	0.14	4.15
9.	35Ω	11.9	0.34	24.4	50	100	0.12	3.62
10.	40Ω	12	0.30	24.47	50	100	0.14	4.07
11.	45Ω	12.1	0.27	20.13	50	100	0.10	2.98
12.	50Ω	12.2	0.24	17.93	50	100	0.089	2.66
13.	55Ω	12.3	0.22	12.22	50	100	0.06	1.81
14.	60Ω	12.3	0.20	19.54	50	50	0.0481	1.45
15.	65Ω	12.4	0.19	15.08	50	50	0.037	1.12

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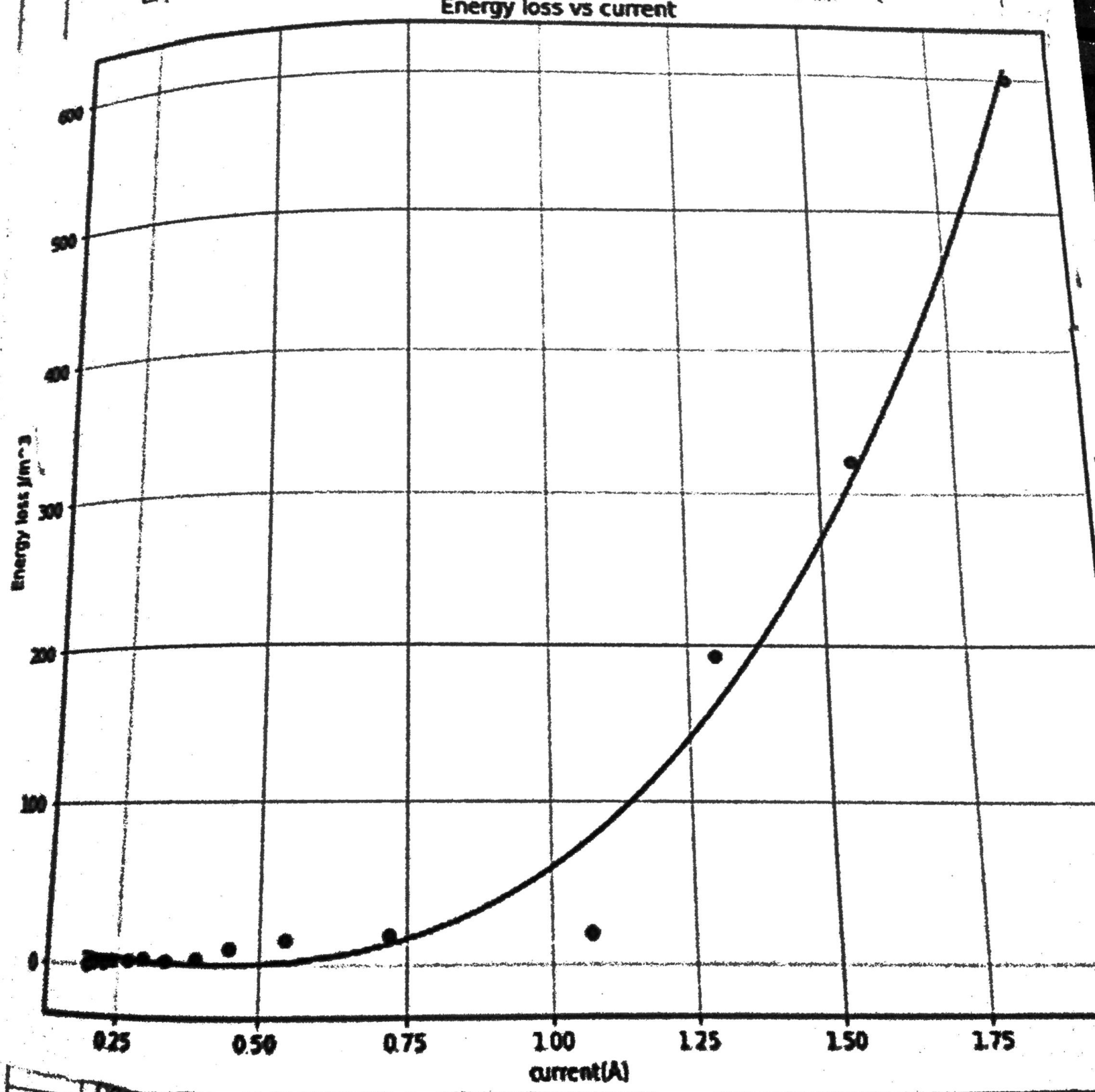

Power loss with the current through R branch of circuit

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LC of Screw gauge = 0.01 mm.

MSR (mm)	CSD	Zero error(-)	CSR (mm)	TR (mm)
22mm	37	10	0.27	22.27
22	49	10	0.39	22.39
22	63	10	0.53	22.53
22	19	10	0.09	22.09

average thickness = 22.32 mm.

∴ External Diameter = Dinternal + 2 x thickness = 167.322mm

R_{ext} = 83.66 mm

Area Calculation: $N_p = 560$, $N_s = 350$, $R = 3.3 K\Omega$, $C = 1 \mu F$

$$L_p = 2\pi\left(\frac{R_{ext} + R_{int}}{2}\right) = 45.53 \text{ cm} = 4.55 \times 10^{-1} \text{ m}.$$

$$A_s = \pi\left(\frac{R_{ext} - R_{int}}{2}\right)^2 = 3.9107 \text{cm}^2 = 3.9 \times 10^{-4} \text{ m}^2$$

Energy loss $W = V_x V_y \times \frac{N_p R_1 C}{N_s A_s L_p R_{const}}$

$= V_x V_y \times 29.75 \text{ J/m}^3$.

($V_x V_y$ is area of BH curve x volts per division along x axis x volts per division along y-axis)

Result - The BH curve for the given ferromagnetic material have been plotted & studied to see the trend of energy loss with the current through R branch of circuit which is an increasing trend that is initially having smaller increment than what has been observed at the later stages.

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Sources of ERROR:

(i) Due to heating of 1Ω resistor its resistance value can change significantly and also it can damage breadboards and other components.

(ii) Ideal integrator may not be working properly.

(iii) Error while calculating the area under the curve.

(iv) Error in the measurement of diameter & thickness.

Discussion: Area of BH curve was calculated using software sketch and calc by taking unit length equal to the One Division of DSO.

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