Exp No:

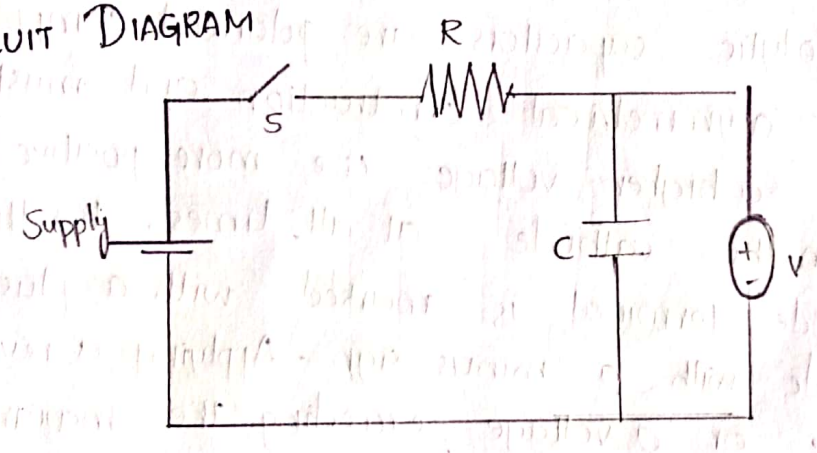
DIELECTRIC CONSTANT

Date:

Aim: Determination of dielectric constant of the dielectric material by charging and discharging of a capacitor.

Apparatus: DC regulated power supply, Electrolytic capacitor, Resistor, Digital timer, Digital voltmeter, Double plug key.

CIRCUIT DIAGRAM



Theory:

An electrolytic capacitor (e-cap) is a polarized capacitor whose anode or positive plate is made of a metal that forms an insulating oxide layer through anodization. This oxide layer acts as the dielectric of the capacitor. A solid, liquid or gel electrolyte covers the surface of this oxide layer serving as the (cathode) or the negative plate of the capacitor. Due to their very thin dielectric oxide layer and enlarged anode surface, electrolytic capacitors have a much higher - capacitance - voltage (CV) product per unit volume compared to ceramic capacitors or film capacitors, and so can have large capacitance

values. There are three families of electrolytic capacitor:

1. Aluminium electrolytic capacitors
2. Tantalum electrolytic capacitors and
3. Niobium electrolytic capacitors.

The large capacitance of electrolytic capacitors makes them particularly suitable for passing or bypassing low-frequency signals and for storing large amounts of energy. They are widely used for decoupling or noise filtering in power supplies and DC link circuits for variable frequency drives, for coupling signals between amplifier stages, and storing energy as in a flash lamp

Electrolytic capacitors are polarized components due to their asymmetrical construction and must be operated with a higher voltage (i.e. more positive) on the anode than on the cathode at all times. For this reason, the anode terminal is marked with a plus sign and the cathode with a minus sign. Applying a reverse polarity voltage or a voltage exceeding the maximum rated working voltage of as little as 1 or 1.5 volts, can destroy the dielectric and thus the capacitor. The failure of electrolytic capacitors can be hazardous, resulting in the explosion of fire. Bipolar electrolytic capacitors which may be operated with either polarity are special constructions with two anodes connected in series.

Formula:

$$k = \frac{T_{1/2} \times d}{0.693 \times R \times A \times \varepsilon_0} \times 10^{-6}$$

where $T_{1/2}$ represents the time required to charge or discharge a capacitor to 50% (intersection point of both charging and discharging curves from the graph)

d is the thickness of the dielectric medium used in the capacitor.

R is the resistance used (100 K-Ω)

A is the area of the capacitor used and

ε_0 represents permittivity of free space.

PROCEDURE:

1. The circuit connections are made as shown in figure
2. Move the switch S to discharge mode and check if capacitor voltage in the voltmeter is zero or not
3. Then the switch S is changed to charging mode and the stop watch is switched on simultaneously.
4. Note down the voltage across the capacitor at every 20 seconds interval till the voltage readings become practically constant.
5. At this situation, capacitor is fully charged. Note down the voltage value for discharge mode at time "0" secs. Now turn the switch S to discharge mode and note the voltage for 20 seconds interval till the capacitor value is practically zero.
6. Plot a graph between the time (t) taken along x-axis and capacitor voltage (V) along y-axis for both charging and discharging modes.
7. The two graphs intersect at a point P whose x-intercept gives the value T1/2
8. Determine the value of dielectric constant 'k' of the medium in the capacitor by using the above formula.

OBSERVATIONS :

Resistance R = 100 kΩ

Length (L) = 20.24 mm

Breadth (b) = 10.28 mm

Thickness (d) = 5.37 μm

Area (A) = L x b = 20.24 x 10.28 mm²

= 208.0672 mm²

Table 1

Time (s)	Voltage during charging (V)	Voltage during discharging (V)
0	0	4.47
20	1.45	3.11
40	2.39	2.11
60	3.07	1.44
80	3.52	1.00
100	3.83	0.69
120	4.05	0.48
140	4.19	0.33
160	4.30	0.23
180	4.36	0.16
200	4.41	0.11
220	4.45	0.08
240	4.47	0.05

Calculations :

$$k = \frac{T_{1/2} \times d}{0.693 \times R \times A \times \varepsilon_0} \times 10^{-6}$$

$T_{1/2} = 33$, $d = 5.37$ μm , $R = 100$ kΩ , $L = 20.24$ $b = 10.28$ mm

$$K = \frac{36 \times 5.37 \times 10^{-6} \times 10^{-6} \times 10}{0.693 \times 10^{5} \times 20.82 \times 8.85 \times 10^{-12} \times 10^{-6}}$$

$K = 1.51$

~~Table 2~~: Model Graph

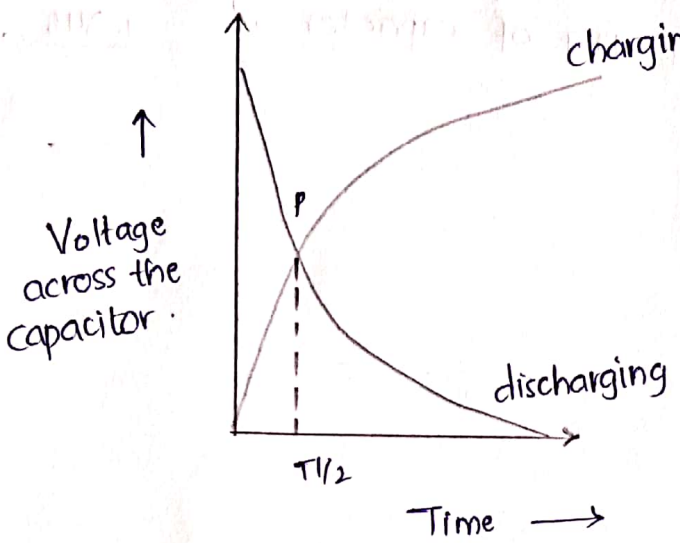


Table 2:

Voltage (y) (charging)	Time (x)	Voltage (y) (discharging)
0	0	4.47
1.54	20	3.11
2.39	40	2.11
3.07	60	1.44
3.52	80	1.00
3.83	100	0.69
4.05	120	0.48
4.19	140	0.33
4.30	160	0.23
4.36	180	0.16
4.41	200	0.11
4.45	220	0.08
4.47	240	0.05

dielectric constant

Precautions :

All connections must be perfect and there should not be loose contacts.

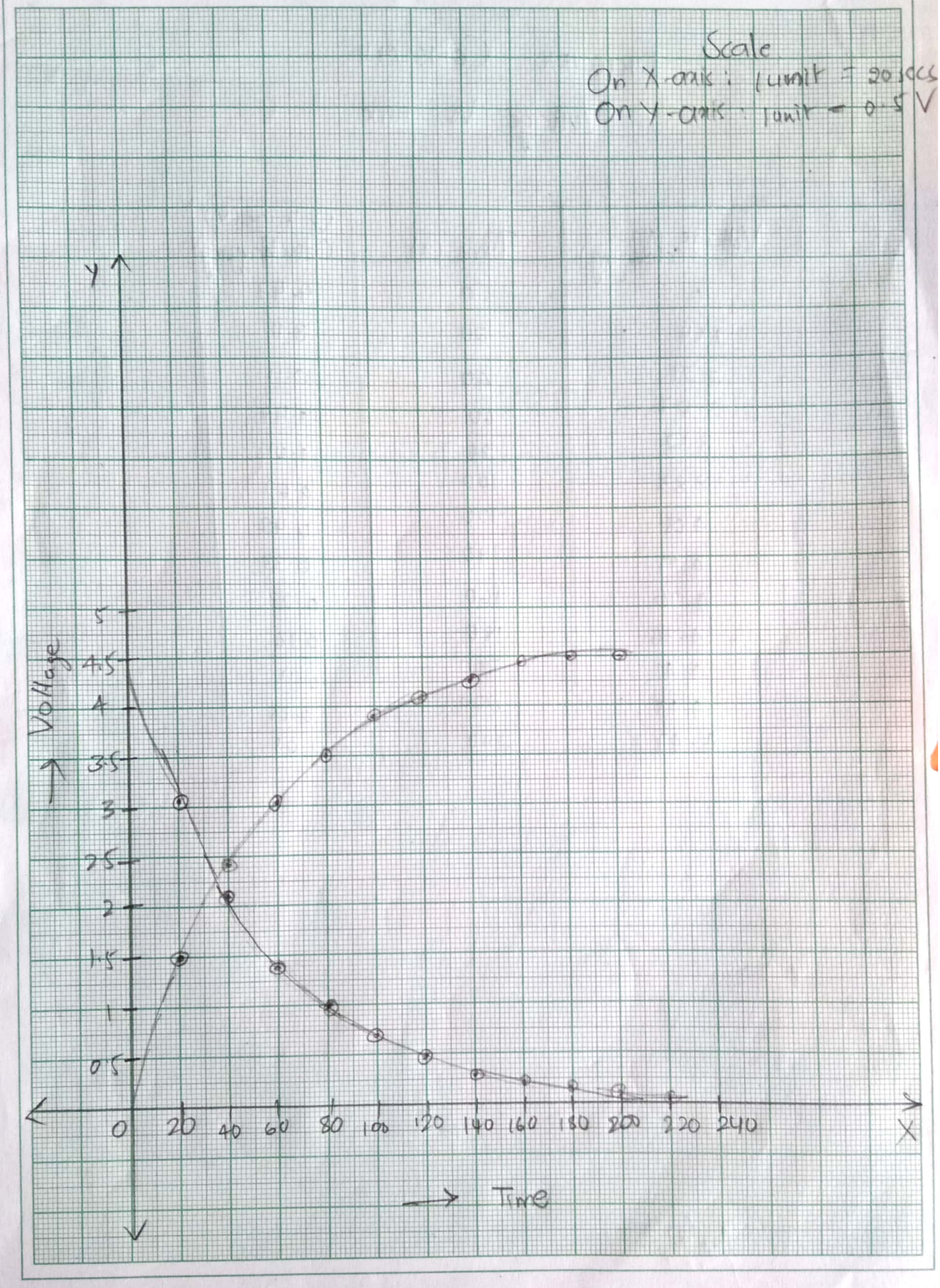
Result :

The dielectric constant of the dielectric medium by charging and discharging of capacitor is 1.346.

Date :

DIELECTRIC CONSTANT

Page No.:



DIELECTRIC CONSTANT

Voltage Vs Time

Voltage (Y) (Charging)	Time (x)	Voltage (Y) (discharging)
0	0	4.47
1.54	20	3.11
2.39	40	2.11
3.07	60	1.44
3.52	80	1.00
3.83	100	0.69
4.05	120	0.48
4.19	140	0.33
4.30	160	0.23
4.36	180	0.16
4.41	200	0.11
4.45	220	0.08
4.47	240	0.05