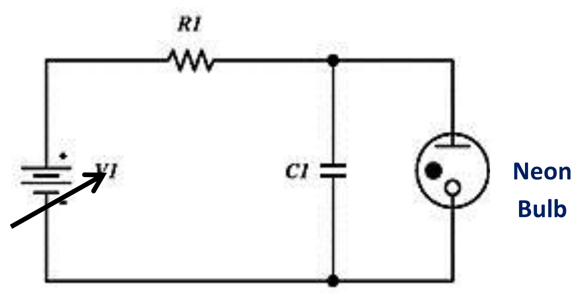
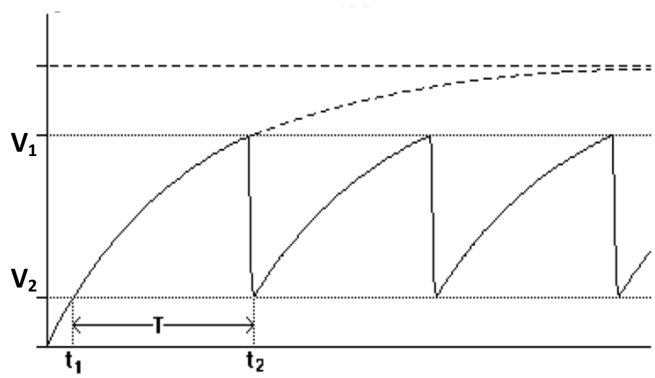
Experiment No: 04

Aim of the experiment: To find the capacitance of unknown Capacitor using flashing quenching method.

Apparatus Required: Capacitor of unknown capacity, three capacitors of known capacity, resistance of the order of few MΩ, neon bulb, stabilized D.C. of 220 V, connecting wires.

Theory: When a neon bulb is placed in parallel with a capacitor and connected to D.C. supply which can be continuously increased from 0 to 150 volt through a high resistance of about 1MΩ, the voltage across capacitor and the bulb will always be same as both are in parallel. The external voltage is slowly increased to a value say V_1 when the lamp begins to glow. As soon as the neon lamp flashes, it becomes conducting and the capacitor begins to discharge through it. It continues to do so until the extinction (or quenching) potential V_2 is reached when the neon lamp ceases to glow and stops conducting. The capacitor then again beings to charge till the flashing potential V_1 is reached when again the lamp flashes and begins to glow. The process is repeated.





During charging of capacitor, neon lamp does not glow. In other words, the total time t between two consecutive flashes is equal to the time taken by the voltage first to fall from the flashing potential V_1 to quenching potential V_2 (discharge) and then to rise from V_2 to V_1 (charging). This flashing and quenching time can be determined by noting the time taken by the lamp to produce say 20 consecutive flashes and quenches. If t_1 is the time taken by the capacitor voltage to fall from V_1 to V_2 and t_2 is the time taken by the voltage to rise from V_2 to V_1, then:

$$V_2 = V_1 e^{-t_1/CR}$$

Or
$$t_1 = -CR\log_e \frac{V_2}{V_1}$$

And
$$V_2 = V_1\left(1 - e^{-t_2/CR}\right)$$

Or
$$t_2 = -CR\log_e\left(1 - \frac{V_2}{V_1}\right)$$

$\therefore$
$$t = t_1 + t_2 = C\left[-R\log_e \frac{V_2}{V_1} - R\log_e\left(1 - \frac{V_2}{V_1}\right)\right]$$

As R, V_2 and V_1 have constant fixed values, the function within brackets is a constant, let it be k such that $t = k\,C$.

Circuit Diagram:

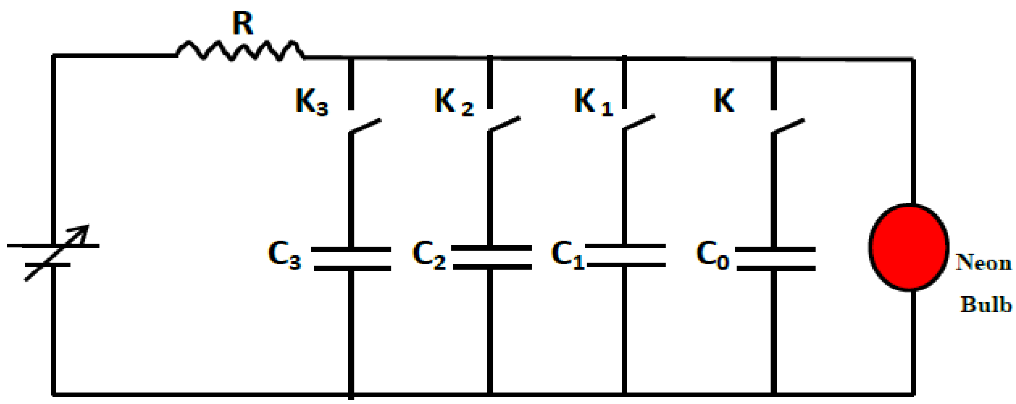


Figure: Circuit diagram for determination of Capacitance of unknown capacitor C_0.

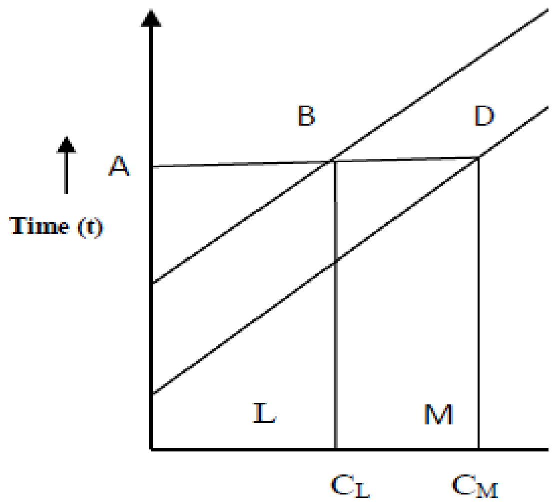
Procedure:

1. Draw the diagram showing the connections as on the trainer board make the connection with all the capacitors in the parallel with a separate key to operate and high resistance are in series with the circuit containing power supply with stabilized output of 220 V DC.
2. Connect the condenser C_1 in the circuit by inserting K_1 also connect the key to power supply and increase the voltage till neon lamp just begin to flash.

The bulb starts flashing and quenching as it is connected in parallel with the condenser.

3. Note the flashing and quenching time for 20 flashes. The power supply disconnected.
4. Connect the unknown capacity C_0 so the C_0 and lamp are in parallel their capacities get added and total capacity parallel with the lamp is $(C_1 + C_0)$. Again adjust the power supply voltage again to the sum value as in previous case note the time for 20 flashes. Remove the key K_1.
5. Repeat the experiment with the capacity C_2 alone $(C_2 + C_0)$ and C_3 alone $(C_3 + C_0)$ then repeat the experiment with known capacities C_1, C_2, $C_1+C_2+C_3$ and each time taking time for 20 Flashes.

S. No.	Known Capacity (µF)	Time for 20 flashes	
		without C_0	**with C_0**
1.	C1		
2.	C2		
3.	C3		
4.	$C4 = C_1+C_2$		
5.	$C_5 = C_2+C_3$		
6.	$C_6 = C_1+C_2+C_3$		



Calculations:

Draw two graphs on the same scale and on the graph paper, one between *C* and *t* and other between *C* and *t*. They will be parallel lines as shown. Now draw a line ABD parallel to *X*-axis as shown, where they cut the graphs, draw BL, DM parallel to Y-axis is shown. Now the unknown capacity is given by:

$$C_0 = C_L - C_M = \ldots.. \ \mu F$$

Result: The Capacitance of unknown capacitor is $C_0 = \ldots\ldots.. \ \mu F$

Precautions:

1. Count the number of flashes very carefully.
2. Connections should be tight.
3. Capacitors should always be connected parallel to lamp.