

## AUTOMATIC LAMP DIMMING CIRCUITS

### Objective

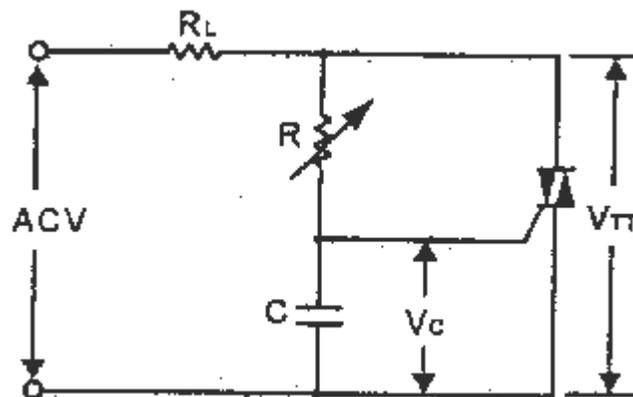
1. Understanding the operation of TRIAC and SCR phase controls.
2. Understanding the operation of DIAC-TRIAC phase control circuit.
3. Performing an automatic lamp dimming control.

### Discussion

#### TRIAC Phase Control

##### 1. RC Phase Control

The TRIAC, like SCR, is often used in an AC circuit to control the power on load. A TRIAC can operate in full-wave phase control circuits while an SCR can operate in half-wave phase control circuits. Though the power rating of TRIACs is less than that of SCRs, it is more convenient in AC applications.



**Fig. 12-1 Basic RC phase control circuit.**

Fig. 12-1 shows a basic RC phase control circuit. The capacitor voltage  $V_C$  lags behind  $V_{TT}$  an angle depending upon RC time constant and the gate trigger level required to fire the TRIAC as shown in Fig. 12-2.

On the positive half cycle of line voltage, the positive value of  $V_C$  reaches the trigger level at  $t_1$  and turns the TRIAC on. The angle  $\alpha_1$  is called the firing angle or triggering angle. This operates in I+ mode; that is, T2 positive and gate positive. On the negative half cycle, the TRIAC is triggered at  $t_3$  with a triggering angle  $\alpha_2$ . This mode is III-, or T2 negative and gate negative. Though the triggering sensitivity in mode I+ is equal to mode III-, a slight difference exists between  $\alpha_1$  and  $\alpha_2$ ,  $\alpha_1 \neq \alpha_2$ .

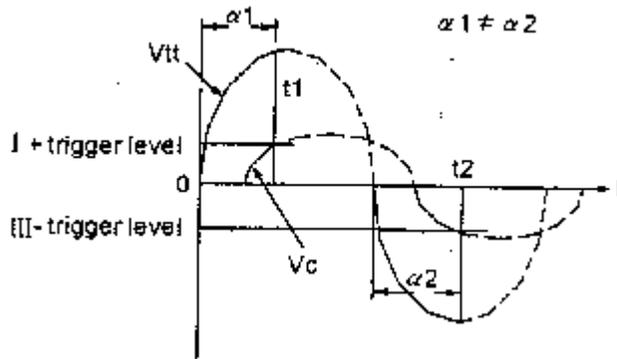


Fig. 12-2 Relationship between  $V_C$  and  $V_{TT}$  in the circuit of Fig. 12-1

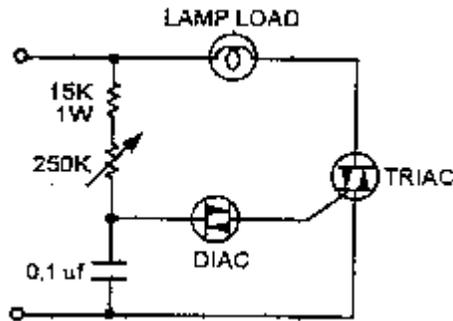


Fig. 12-3 Basic DIAC-TRIAC phase control circuit

The most elementary form of full-wave phase control is the simple DIAC-TRIAC circuit of Fig. 12-3. When the capacitor voltage reaches the bleekover voltage  $V_{BO}$ , the DIAC turns on and then turn the TRIAC on. Since the values of  $V_{BO+}$  and  $V_{BO-}$  are nearly equal, therefore the triggering angles in positive and negative half cycles are equal as shown in Fig. 12-4.

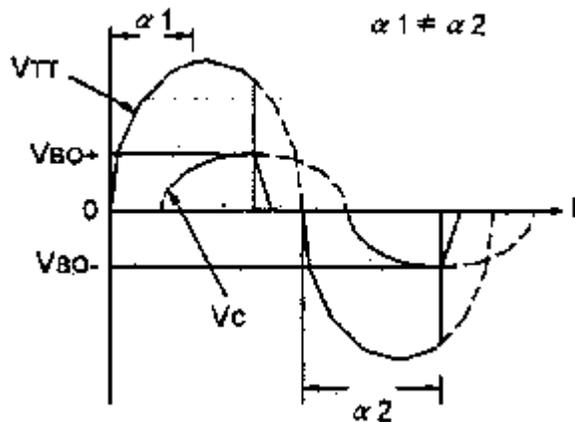
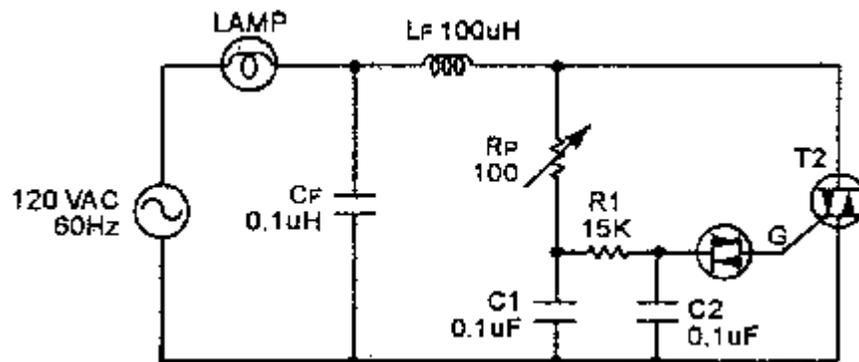


Fig. 12-4 Relationship between  $V_C$  and  $V_{TT}$  in the circuit of Fig. 12-3

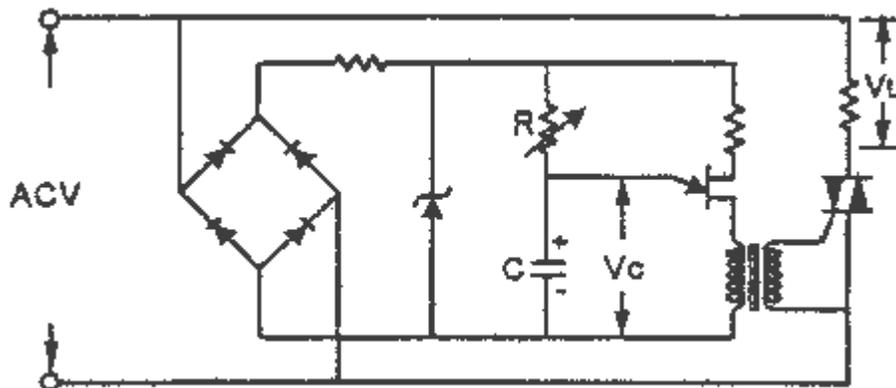
The circuit of Fig. 12-3 is widely used in lamp dimming control and fan speed control circuit. The disadvantage of this circuit is the range as firing angle less than 180 degrees.



**Fig. 12-5 Extended range phase control circuit**

To extend the range of firing angle, it is a good solution to connect two sections of RC phase shifting network in series as shown in Fig. 12-5. The capacitor  $C_F$  is used to limit the value of  $dv/dt$ , and the inductor  $L_F$  is to limit value of  $di/dt$ .

## 2. Phase Control with Pulse triggering



**Fig. 12-6 UJT relaxation oscillator in TRIAC phase control**

Fig. 12-6 shows a pulse triggering circuit for the TRIAC. The trigger pulse is generated by a UJT relaxation oscillator and coupled by the transformer to the gate of the TRIAC.

## Description of Experiment Circuit

The circuit of Fig. 12-7 is a lamp dimming control circuit used in this experiment. A brief description is made as follows:

The DIAC is a useful trigger device for TRIAC power control applications. If the applied voltage across two terminals reaches the breakover voltage of DIAC, the DIAC is thus turned on. In the circuit of Fig. 12-7, when line voltage is applied, the capacitor C1 charges through R<sub>1</sub> and V<sub>R1</sub> and builds a sufficient voltage to trigger SCR or TRIAC to switch on. By adjusting V<sub>R1</sub>, the conduction angle of SCR or TRIAC can be changed to achieve the function of lamp dimming control.

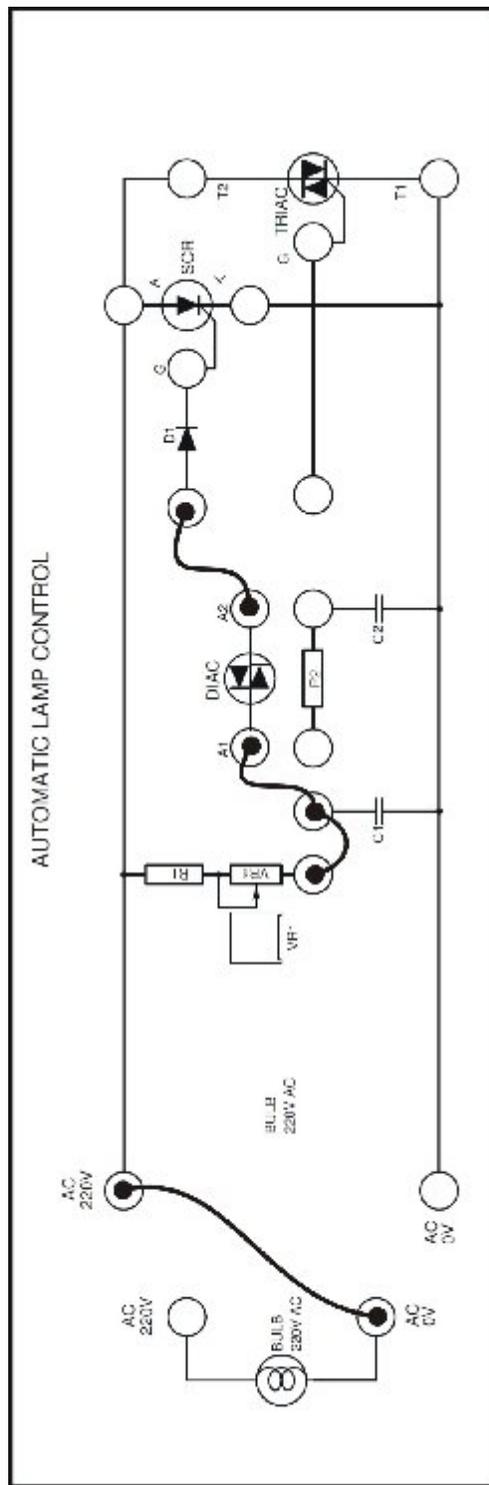


Fig 12.7

Similarly, if DIAC is used and  $C_1$  changes to reach the breakover voltage of DIAC, DIAC turns on and triggers SCR or TRIAC to conduct.  $R_2C_2$  network is used to extend the range of firing angles. Diode D1 is to protect the SCR gate from the negative triggering pulse.

The CDS is used to perform the function of automatic lamp dimming control. In normal light level, the trigger potential is set at a low level that can not trigger DIAC to turn on. Thus SCR or TRIAC and LP are off. When the light source is blocked, an increase in CDS resistance causes a sufficient trigger potential to turn the DIAC on SCR or TRIAC is then turn on and LP is on.

### Equipment Required

- 1 – Power Supply Unit IT-9000
- 1 – Module IT-9006
- 1 – Oscilloscope

### Procedure

1. Connect 110VAC power supply from Power Supply Unit IT-9000 to Module IT-9006. Install the lamp in the socket on module.
2. Make connection as shown in fig 12-7. Now locate these components on the Module and complete the circuit diagram by connecting the components using the leads with
3. 2mm male pins. Repeat steps 2 and 3. Record the results in Table 12-1.

Table 12-1

SCR A	$V_{ct}$

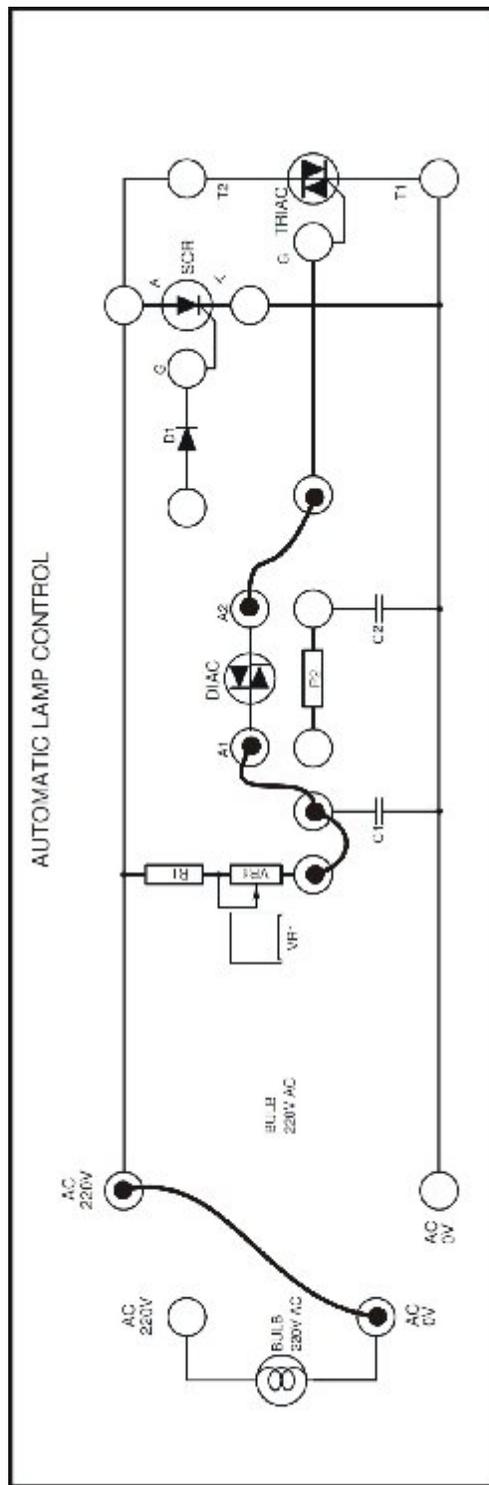
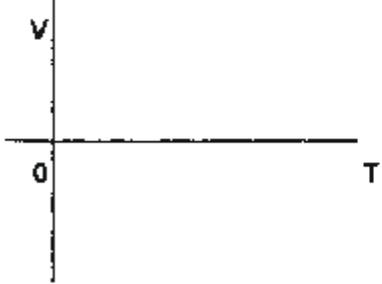
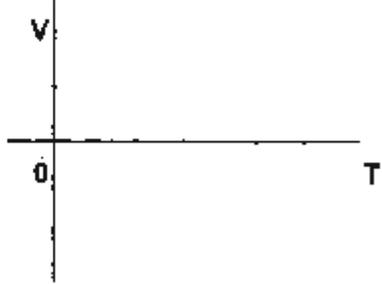


Fig 12.8

4. Make connection as shown in fig 12-8. Repeat steps 2 and 3. Record the results in Table 12-2.

Table 12-2

TRIAC T2	$V_{G1}$
	

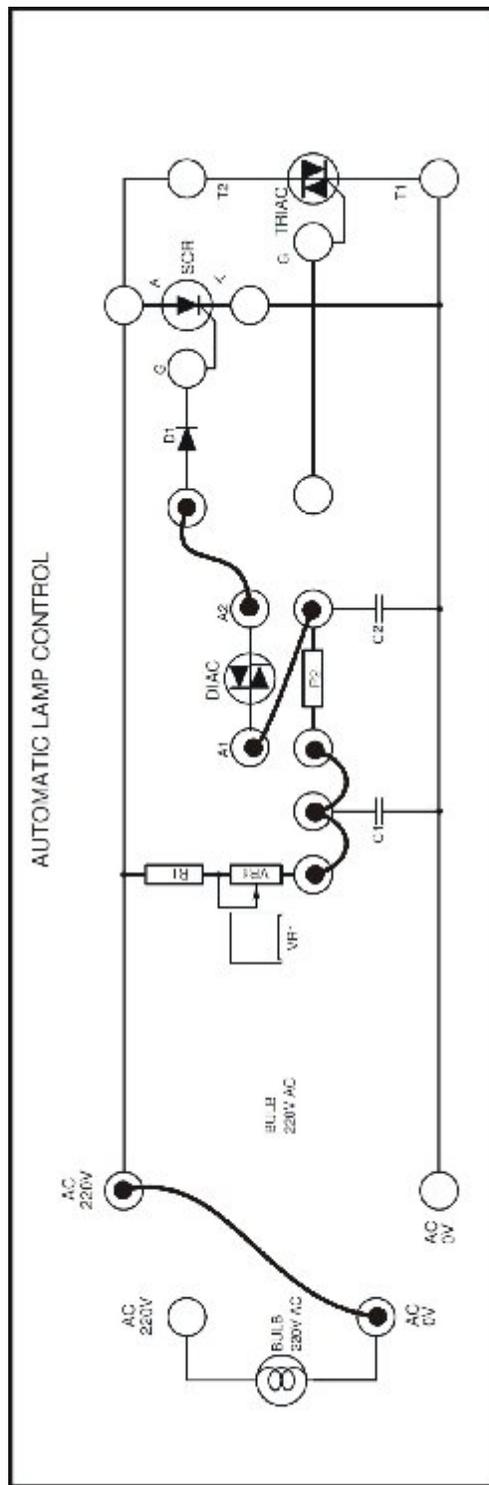
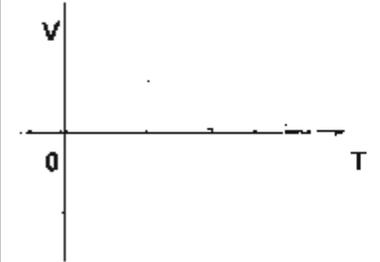
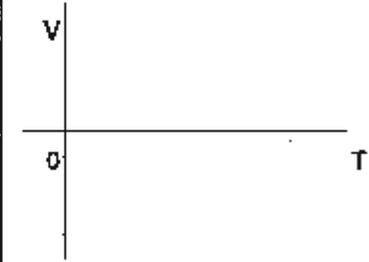
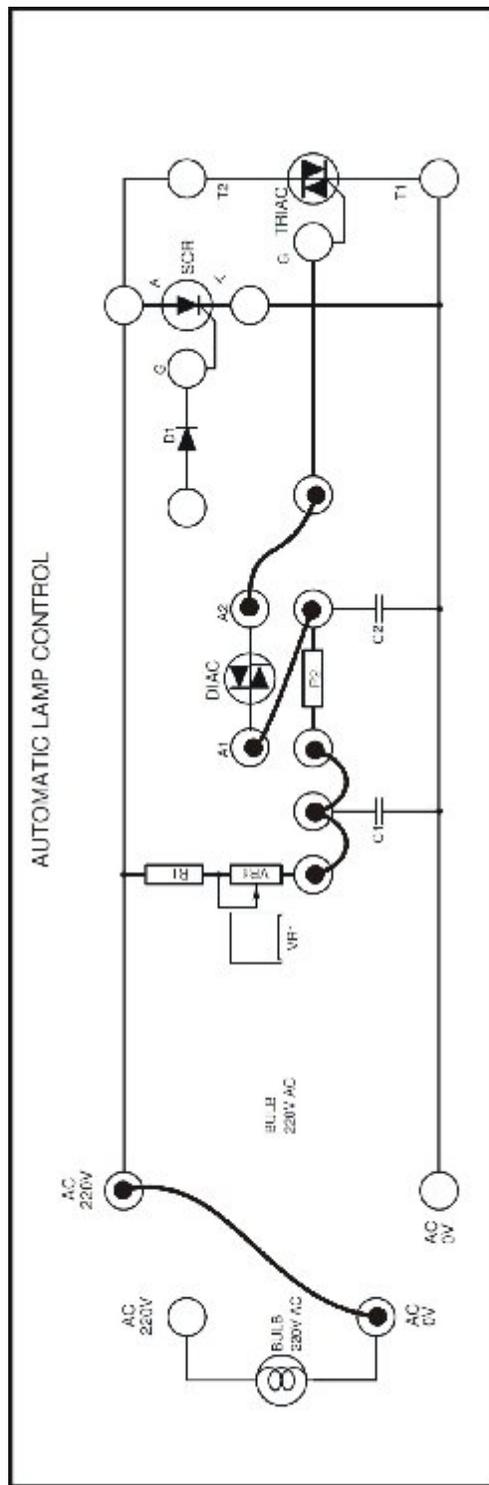


Fig 12.9

5. Make connection as shown in fig 12-9. Repeat steps 7 and 8 and record the results in Table 12-3.

Table 12-3

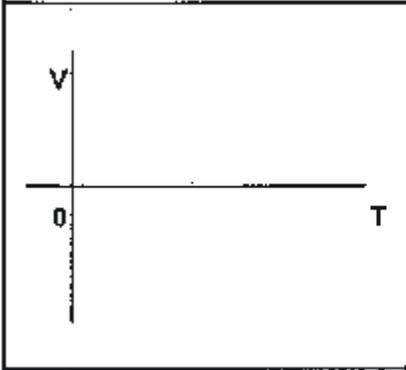
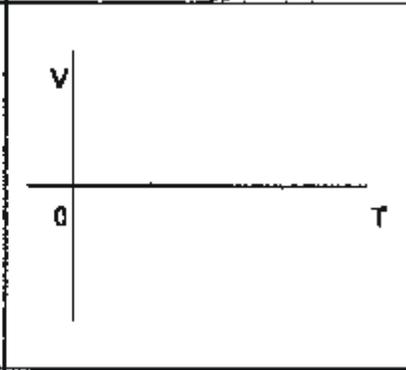
SCR A	$V_{C2}$
	



**Fig 12.10**

6. Make connection as shown in fig 12-10. Repeat steps 7 and 8. Record the results in Table 12-4.

Table 12-4

TRIAC T2	$V_{C2}$
	

7. Which of the trigger circuits is the best?

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Which of the power control circuits has maximum power output?

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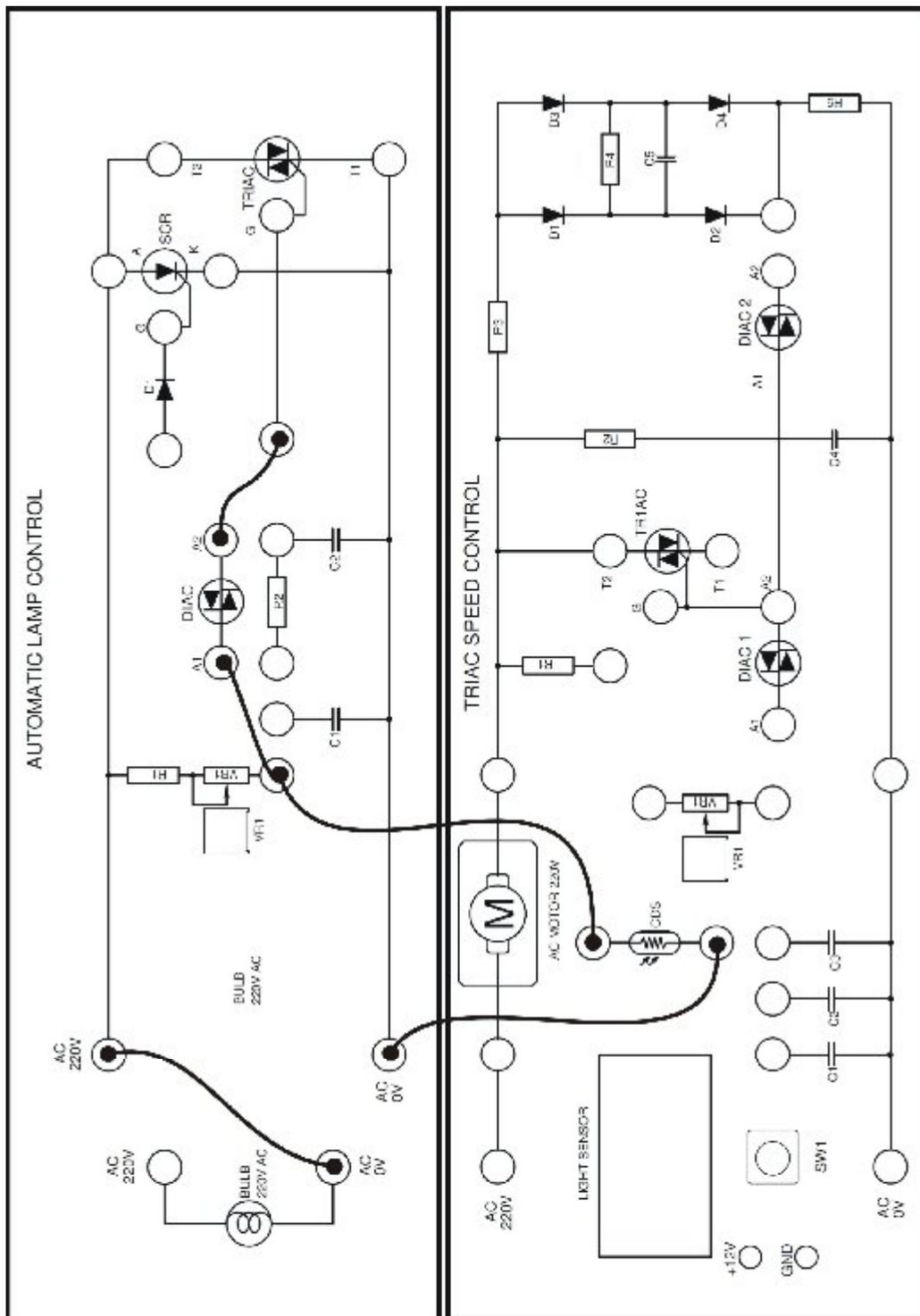


Fig 12.11

8. Make connection as shown in fig 12-11. Expose CDS to normal light level. Adjust VR1 to keep TRIAC in off state before conducting.
9. Observe and record the states of lamp, DIAC, and TRIAC.

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10. Press and hold SW1. Observe and record the states of lamp, DIAC, and TRIAC.

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### **Conclusion**

You have experimented the automatic lamp dimming control. Single section of RC phase shifting control may cause a hysteresis phenomenon. This effect can be eliminated by adding a RC network in series.

Since SCR conducts only during the positive half cycle of line voltage, the power delivered to the load is smaller than the TRIAC control circuit. This effect has been demonstrated by measuring the load voltages and observing the brightness of the lamp. By the way, the CDS light control circuit can be used as a streetlight control circuit.

SIGNATURE OF SUBJECT TEACHER: