

# Module 3

## Illumination Systems

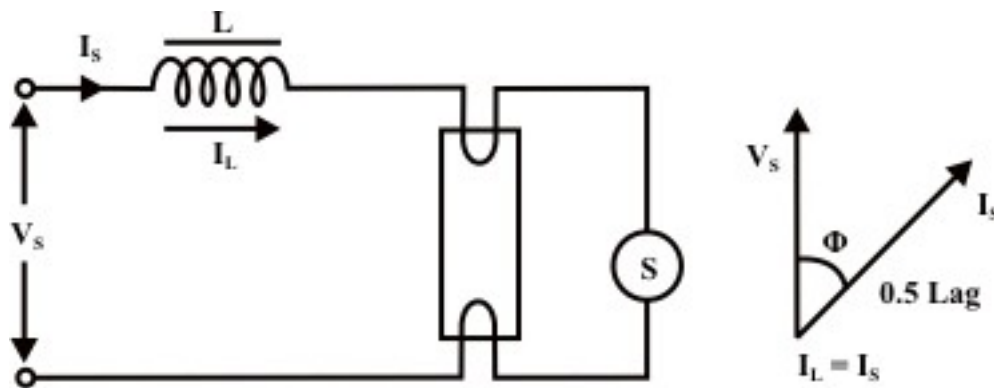
# Lesson 12

## Illumination Systems II

## Instructional Objectives

1. Understand the accessories employed in Illuminating systems.
2. What is a Ballast?
3. List various types of Ballasts.
4. List starting devices.

As already brought out the components of an Illumination system are Lamp, the Radiation Source, Luminaire that directs and controls the light flux. Control Gear is the accessory that helps in controlling the requisite amount of flux on the work plane. Now we take a look at the accessories involved. First of these is Ballast. In a discharge lamp a series impedance to limit the current is required. If the current is allowed to increase there can be explosion of the lamp. This takes the form in a.c. as Inductance-w/o undue loss of power. This is called Ballast. It should have high power factor for economic use of the supply and should generate minimum harmonics. It should offer high impedance to audio frequencies. It should suppress-Electromagnetic interference (Radio interference-TV interference). It is essentially, a reactor of a wound coil on a magnetic core often called Choke and is in series with the lamp. Typical power factor is 0.5 Lag. Power factor is improved by having a capacitor connected across input lines.



**Fig. 1: Ballast Connection Diagram**

Fig 1 shows the connection for a discharge lamp employing a ballast formed by a reactor commonly known as choke. Fig 2 shows how the capacitor may be connected to improve the power factor. As may be seen the capacitor is placed in shunt. At times a lead circuit may result by placing a capacitor in series as shown in Fig 3. However, when an illumination system employing two lamps is used power factor may be improved by having one with a lead circuit and other with a lag circuit as shown in Fig. 4. Next important accessory is a starter that initiates the discharge in a discharge lamp. Starter is marked as 'S' in the Figs.1 to 4. Starter less circuit are shown in Fig 5. They employ pre-heated filament electrodes. The preheating obtained through a small portion of voltage tapped from the input source.

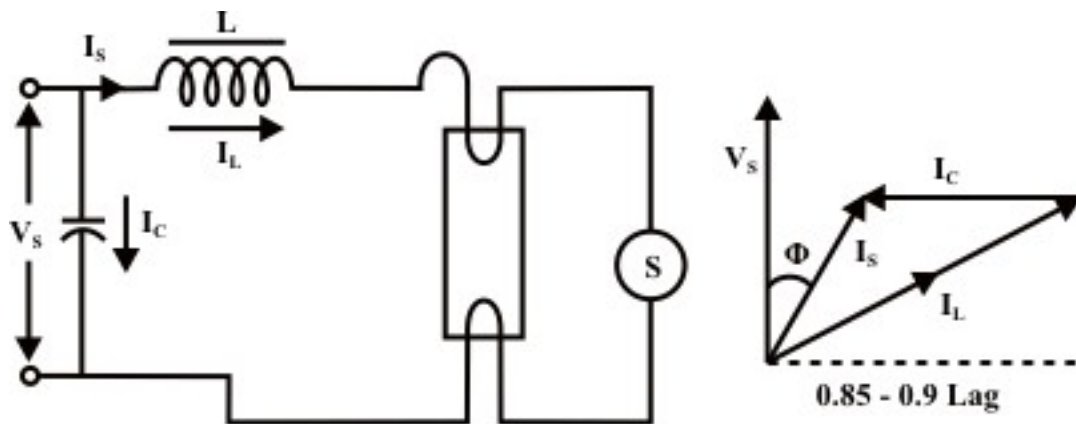


Fig. 2: Power Factor Improved by placing a Capacitor

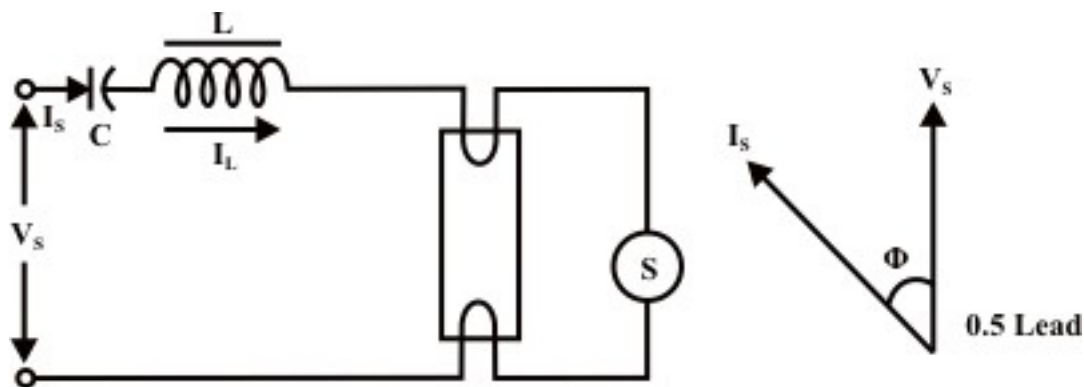


Fig. 3: Lead circuit

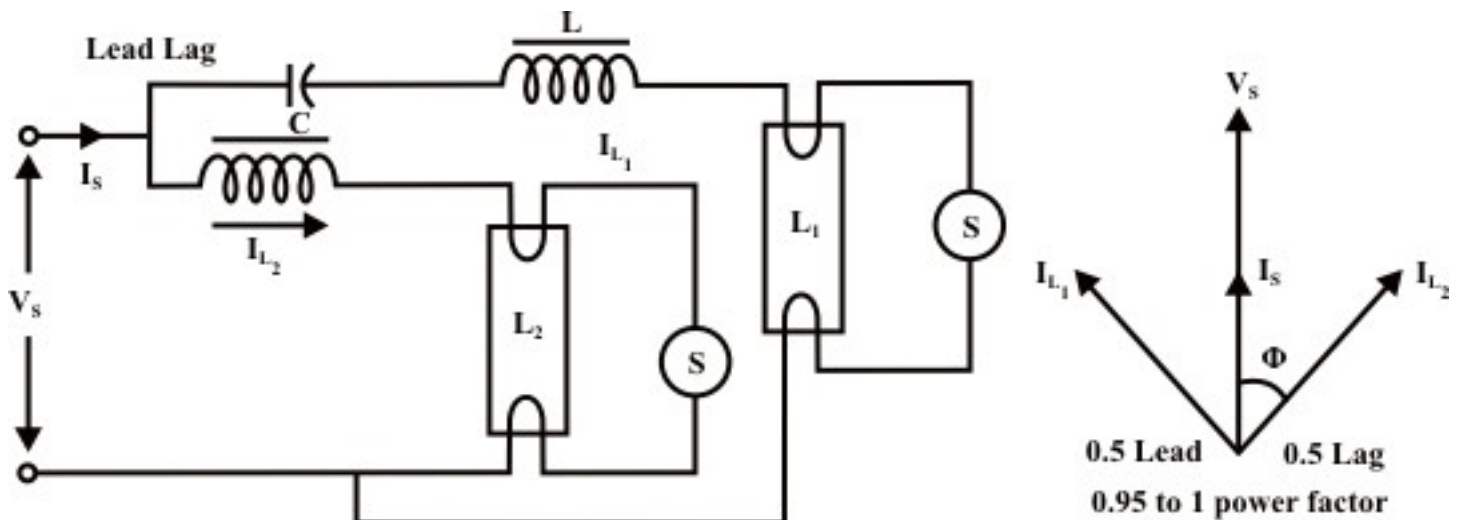
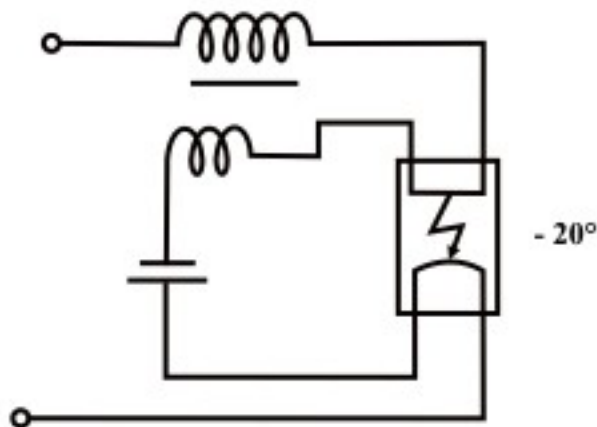
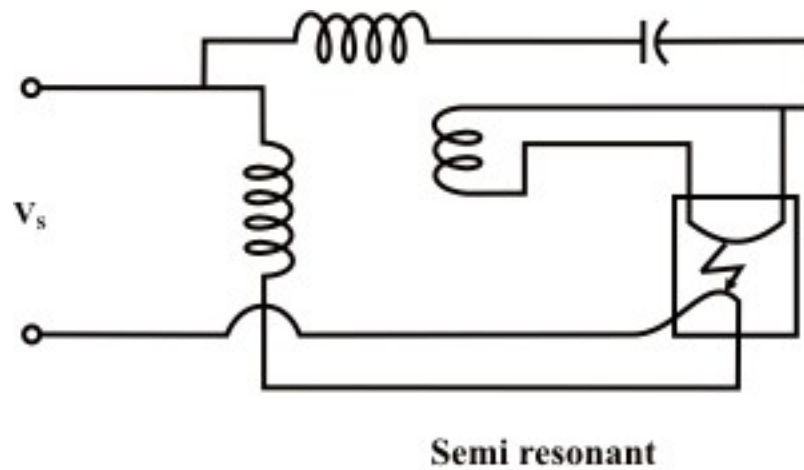


Fig. 4: Lead Lag Circuit

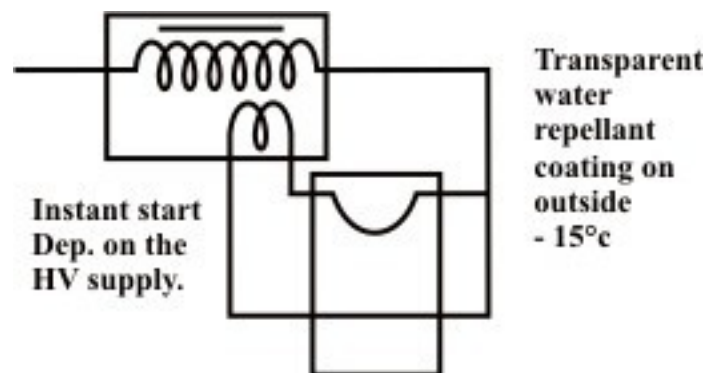
When discharge lamps are used on dc the ballast takes the form of a resistor together with associated power loss. These days they take the form of an electronic ballast which converts dc to high frequency ac of around 20 kHz.

Except high pressure mercury lamp where  $V > V_s$  (starting) all lamps need a starting device. At times, it is integral part of a lamp. Switch start employs bimetallic strip that opens upon

heating. Starterless, rapid start or instant starts are useful for outdoor applications. Other forms of starters employed are three electrode devices called ignitors.



**Fig. 5: Starter Less Circuits**

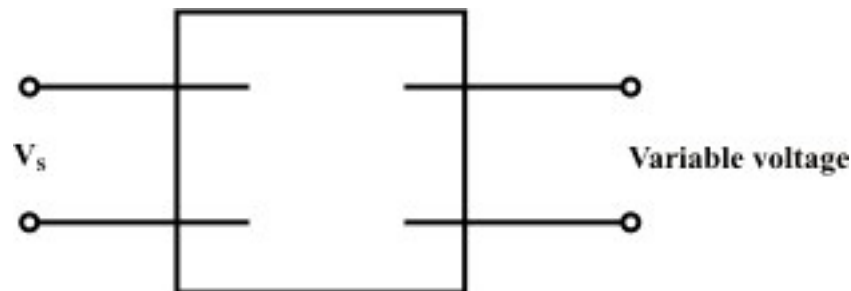


**Fig. 6: Rapid Start Discharge Lamp**

Ignitors are small 3 electrode devices, which are ignited by control pulses from small electronic circuit. Typically Metal Halide lamps require 600 – 700V and Low Pressure Sodium Vapor lamps require 400- 600V. Ignition is through a Thyristor that generate a set of HV pulses, which

are stopped after Lamp glows or ignited. High Pressure Sodium Vapor Lamp needs about 3000V.

Different Light Flux Levels are required at different times. This consists Local and General Lighting taken care by having dimmers and lamps of different wattages. Fig. 7 shows a typical Dimmer stat.

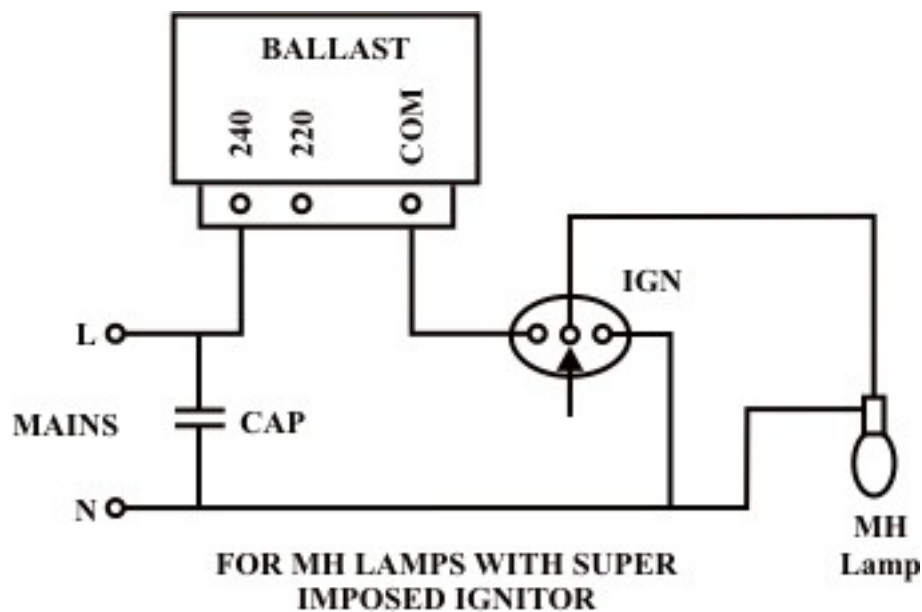


**Fig. 7: Dimmer stat**

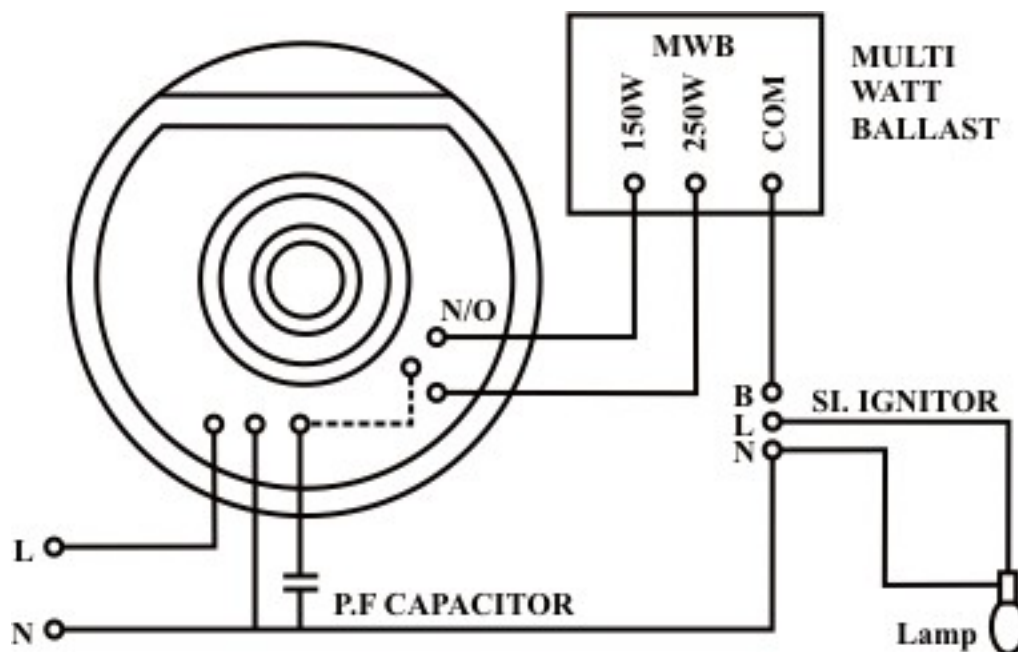
A dimmer stat is an autotransformer that can give a variable output voltage. Fig. 8 shows a typical metal halide lamp employing ignitor as a starting device.

Fig. 9 shows a typical scheme for a multi watt circuit. Typically street lighting requires such multi watt lamps. High wattage lighting is employed during heavy traffic and low wattage during the rest of the night.

This lecture thus covered the accessories necessary in an Illumination system.



**Fig. 8: Typical MH Lamp employing Ignitor**



Power saving of HPSV lamp from 250W to 150W (Use multi Watt ballast)

**Fig. 9: circuit employing Multi Watt ballast**

## Lecture Summary

- Control gears are the accessories that help in controlling the requisite amount of light flux on the work plane
- Gas discharge lamps are constant current devices. Constant current is achieved by use of ballasts.

Requirements for good ballasts:

- less undue power loss
- should offer high impedance to audio frequency
- should suppress EMI / RFI / TVI
- should provide proper starting conditions
- should have as high power factor as possible

To improve power factor capacitors are used in series.

- Excepting HP Hg-vapor lamps, all lamps have starting voltage > spark over voltage. Hence starters & igniters are used as starting devices.
- Igniters are small three electrode devices which are fired by controlled pulses from small electronic circuits.
- Apart from local & general lighting dimmers / timers are used for two – stage lighting

## Tutorial Questions

- Why are inductors preferred for use as ballasts?

They provide high starting voltages without undue loss of power.

- What is the disadvantage of using inductance as ballasts? How can it be rectified?  
Inductance have low power factor which is undesirable. Hence series capacitor or lead-lag circuits are used for improving the power factor
- How can we stabilize current when a DC source is used? What are its disadvantages?  
Resistance are used to stabilize current but they have a constant power loss
- What is the principle of operation of starterless circuits? What is its usefulness?  
They work on the principle of semi-resonant circuits. They employ preheated filament electrodes which draw small amount of voltage. They are useful in smooth operation of discharge lamps at extreme cold conditions
- What are switch type starters?  
They are bimetallic switches which remain close while starting & opens upon heating when lamp glows