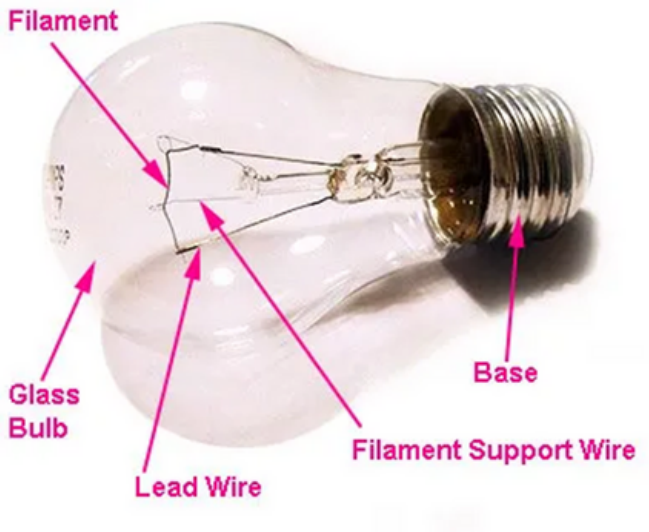
COURSE notes

Topic | Tungsten Filament Lamp (GLS)

1. What is a Tungsten Filament Lamp?

A tungsten filament lamp is a traditional incandescent light bulb where an electric current passes through a thin tungsten wire filament. The filament heats up to a very high temperature and produces light through incandescence – basically glowing from heat.



2. How Does It Work?

When electricity flows through the tungsten filament, its resistance causes it to heat up. Because tungsten has a very high melting point (around 3422 °C), the filament can get extremely hot without melting, glowing brightly and producing visible light. Inside the bulb is usually a vacuum or inert gas like argon to prevent the filament from burning out quickly.

3. Advantages

- Simple design and easy to manufacture.
- Provide warm, pleasant light (around 2700 Kelvin).
- Good color rendering – colors appear natural.
- Inexpensive upfront cost.

4. Disadvantages

- Very inefficient – most energy is wasted as heat, not light.
- Shorter lifespan compared to modern lighting like LEDs or fluorescents.
- Generates a lot of heat, which can be a safety concern or add to cooling costs.
- Being phased out in many countries due to energy efficiency regulations.

5. Common Uses

Although tungsten filament lamps are less popular now, they are still used in:

- Decorative lighting (e.g., chandeliers, vintage lamps).
- Some specialized applications requiring warm light.
- Situations where dimmable and instant-on lighting is needed.

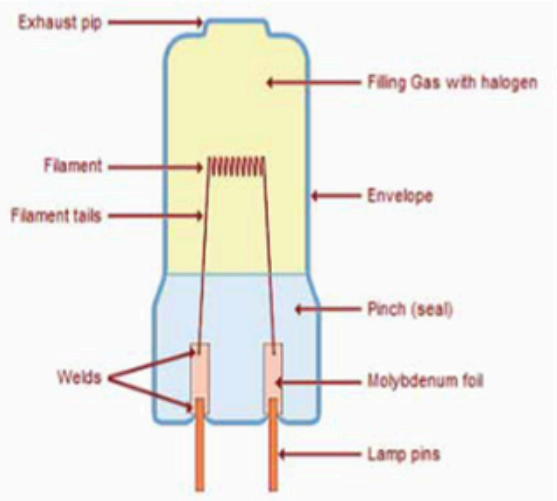
Tungsten filament lamps paved the way for modern lighting. Understanding how they work helps us appreciate advances in lighting technology. Next time, we will explore tungsten halogen lamps and how they improved upon the standard incandescent design.

COURSE notes

Topic | **Tungsten Halogen Lamp (TH)**

1. What is a Tungsten Halogen Lamp?

A tungsten halogen lamp is an improved version of the traditional tungsten filament lamp. It contains a small amount of halogen gas– usually iodine or bromine–inside the bulb.



2. How Does It Work?

Just like a regular tungsten lamp, an electric current heats the tungsten filament, making it glow and produce light. But here's the difference: The halogen gas reacts with the tungsten atoms that evaporate from the filament. Instead of settling on the glass and darkening the bulb, the halogen gas redeposits tungsten back onto the filament. This process is called the halogen cycle. This recycling keeps the filament strong for a longer time and helps the lamp last longer and stay brighter.

3. Advantages

- Higher efficiency than traditional tungsten lamps – they produce more light per watt.
- Longer lifespan due to the halogen cycle.
- Produce bright, white light with good color rendering.
- Smaller size allows for compact lamp designs.
- Can operate at higher temperatures.

4. Disadvantages

- Operate at very high temperatures, which can be a safety concern.
- More expensive upfront than standard incandescent lamps.
- Require special handling because the glass can get extremely hot.
- Contain halogen gas, which requires careful disposal.

5. Common Uses

Tungsten halogen lamps are widely used in:

- Automotive headlights
- Stage and studio lighting
- Projectors
- Task lighting (like desk lamps)
- Some household and outdoor lighting fixtures

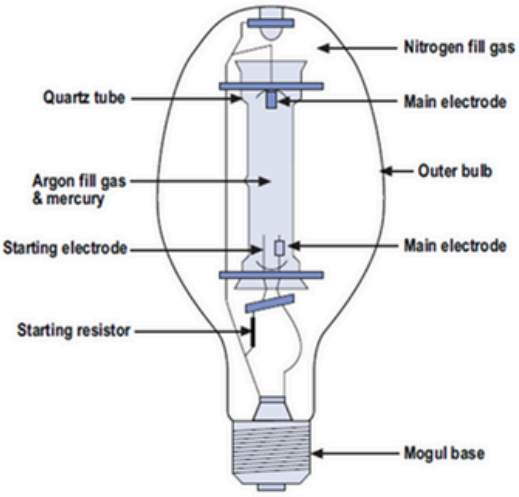
Tungsten halogen lamps are an advanced form of incandescent lamps with better efficiency and lifespan, thanks to the halogen cycle. However, they do require careful handling because they run very hot.

COURSE notes

Topic | High Pressure Mercury Vapor Lamps

1. What is a High Pressure Mercury Vapor Lamp?

A high pressure mercury vapor lamp is a type of discharge lamp that uses mercury gas at high pressure to produce light. It was one of the first types of high-intensity discharge (HID) lamps developed, and is still used in some public, industrial, and commercial settings.



2. How Does It Work?

- Inside the lamp, there's an arc tube made of quartz or ceramic.
- This arc tube contains mercury and an inert gas, such as argon.
- When electricity is applied, an arc forms between two electrodes.
- The heat from the arc vaporizes the mercury.
- As the mercury vaporizes, it emits light in the ultraviolet (UV) and visible spectrum.
- A phosphor coating (in some types) converts UV light into visible light.

Unlike incandescent bulbs, this lamp doesn't rely on a glowing filament but on a glowing plasma arc inside the tube.

3. Advantages

- Long life and low maintenance
- Higher light output than incandescent lamps
- Durable and can be used in harsh environments
- Cost-effective for lighting large outdoor spaces

4. Disadvantages

- Poor color rendering (some objects may look unnatural)
- Contains toxic mercury, so must be disposed of properly
- Slow warm-up time
- Less efficient than modern HID or LED lamps
- Produces UV radiation (needs proper shielding)

5. Common Uses

Mercury vapor lamps are commonly used in:

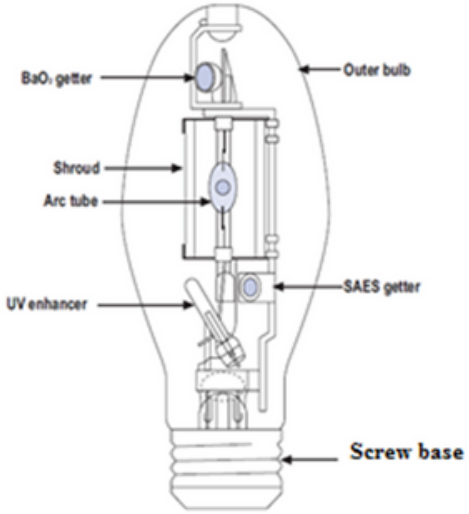
- Street lighting
- Stadiums and sports fields
- Industrial areas
- Parking lots
- Outdoor security lighting

COURSE notes

Topic | **Metal Halide Lamp**

1. What is a Metal Halide Lamp?

A metal halide lamp is a type of HID (High-Intensity Discharge) lamp. It produces light by passing an electric arc through a mixture of gases, including mercury vapor and metal halide compounds inside a quartz or ceramic arc tube.



2. How Does It Work?

- When the lamp is turned on:
- An electric arc forms between two electrodes inside the arc tube.
- The arc heats up the gases, including mercury and metal halides.
- The metal halide salts vaporize and release intense white light as the atoms get excited.
- A ballast is used to control the voltage and current.

Metal halide lamps need a warm-up period, usually 2-5 minutes, to reach full brightness.

3. Advantages

- High luminous efficiency (more lumens per watt)
- Bright, intense light suitable for large spaces
- Good color rendering index (CRI) – colors appear natural
- Longer lifespan compared to incandescent or halogen lamps (6,000–20,000 hours)

4. Disadvantages

- Longer warm-up and re-strike time
- Sensitive to position and temperature
- Contain mercury and require careful disposal
- Not as energy-efficient as LEDs
- Can degrade over time (color shift and reduced output)

5. Common Uses

Metal halide lamps require powerful and consistent lighting, such as:

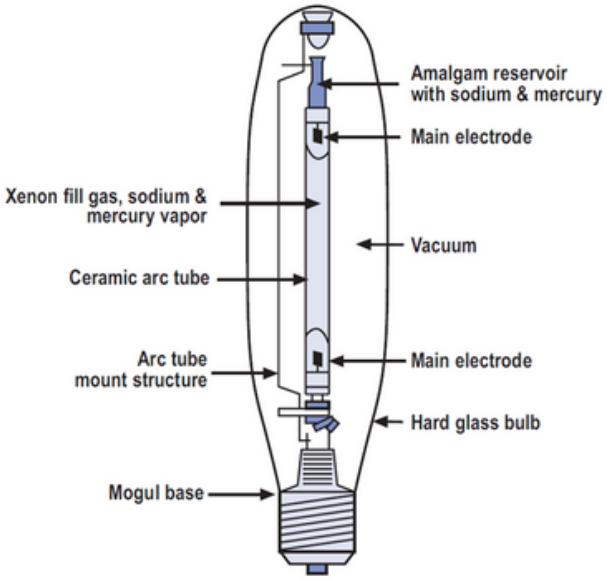
- Sports stadiums and arenas
- Factories and warehouses
- Car parks and street lighting
- High-ceiling commercial areas
- Outdoor floodlights

COURSE notes

Topic | High Pressure Sodium Lamp

1. What is a High Pressure Sodium Lamp?

A High Pressure Sodium lamp is a type of HID (High-Intensity Discharge) lamp. It is known for its very high efficiency and distinctive yellow-orange light. SON lamps are often used for street lighting, parking lots, and industrial areas.



2. How Does It Work?

- Inside the lamp is an arc tube made of ceramic or alumina.
- The arc tube contains a small amount of sodium, mercury, and xenon gas.
- When voltage is applied, the xenon gas helps start the arc between the electrodes.
- As the arc heats up, it vaporizes the sodium and mercury.
- These vapors emit a bright yellow-orange light as electrons excite the sodium atoms.

3. Advantages

- Very high luminous efficiency (up to 150 lumens per watt)
- Long lifespan (typically 12,000 to 24,000 hours)
- Low maintenance cost
- Operate well in outdoor and rough environments
- More efficient than mercury vapor and metal halide lamps

4. Disadvantages

- Poor color rendering - objects may appear dull or unnatural
- Takes time to warm up to full brightness
- Contains toxic materials, like sodium and mercury
- Color shift occurs over time
- Require ballasts and ignitors, which can add cost and complexity

5. Common Uses

SON lamps are best used in situations where high brightness and energy efficiency are more important than color accuracy, such as:

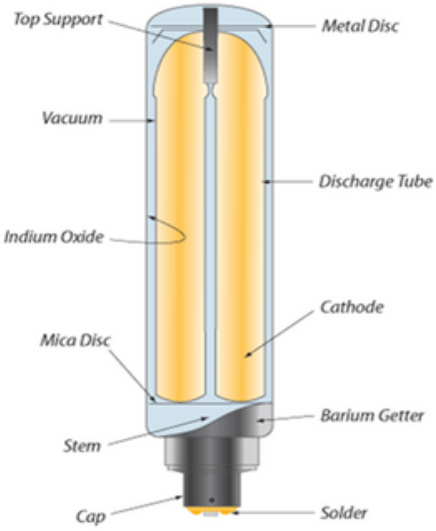
- Street lighting
- Tunnel lighting
- Parking garages
- Stadiums and industrial sites
- Outdoor security lighting

COURSE notes

Topic | **Low Pressure Sodium Lamp**

1. What is a Low Pressure Sodium Lamp?

A Low Pressure Sodium Lamp is a type of gas-discharge lamp that uses sodium in a low-pressure vapor state to produce light. It emits a very distinct yellow-orange glow and is known for its high efficiency in converting electricity into visible light.



2. How Does It Work?

It operates by passing an electric current through a mixture of gases, primarily neon and argon, which heats up and eventually vaporizes the sodium. The sodium atoms become excited and then emit light at a specific wavelength, producing that characteristic yellow-orange light.

- Warm-up Period: It requires a few minutes to reach full brightness as the sodium vaporizes.
- Light Emission: Almost all the light is emitted in a narrow band of the yellow-orange spectrum.

3. Advantages

- High Luminous Efficacy: They produce a large amount of light per unit of electricity (up to 200 lumens per watt).
- Energy Efficiency: Very low energy consumption compared to other lamp types.
- Long Life Span: Can last over 18,000 hours with proper maintenance.
- Good Performance in Cold Weather: Operates effectively in lower temperatures.

4. Disadvantages

- Poor Color Rendering: Everything appears yellowish or gray, making it difficult to distinguish colors.
- Bulky Fixtures: It requires larger and more complex fixtures compared to LED or other modern lighting.
- Warm-up Time: They need time to reach full brightness after being switched on.
- Contains Sodium: Requires careful handling and disposal due to chemical hazards.

5. Common Uses

Because of their high efficiency, they are used mainly in:

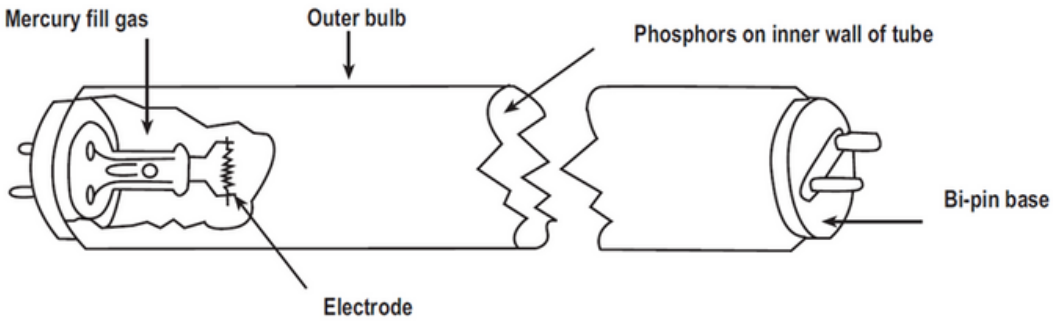
- Street Lighting: Excellent for illuminating roads and highways.
- Security Lighting: Used in parking lots and industrial areas.
- Tunnel Lighting: Suitable for providing consistent light in long tunnels.

COURSE notes

Topic | **Tubular Fluorescent Lamp (MCF)**

1. What is a Tubular Fluorescent Lamp (MCF)?

These lamps are long, tube-shaped lights that are widely used in schools, offices, and commercial buildings. Unlike incandescent bulbs, they use a different method to produce light–one that is more energy-efficient.



2. How Does It Work?

- Inside the tube is a low-pressure gas–mainly mercury vapor and an inert gas like argon. The inside surface of the tube is coated with phosphor powder.
- When electricity flows through the lamp, it excites the mercury atoms, which emit ultraviolet (UV) light. This UV light then hits the phosphor coating, which glows and produces visible white light.
- That's why it's called a fluorescent lamp–it uses fluorescence to convert UV into visible light.

3. Advantages

- High energy efficiency
- Long lifespan
- Produces less heat
- Good light distribution
- Lower operating cost over time

4. Disadvantages

- Contains small amounts of mercury (needs safe disposal)
- Needs a ballast (can fail over time)
- Flickering may occur if faulty
- Color rendering is moderate, not as sharp as LED

5. Common Uses

These lamps are used in many places, such as:

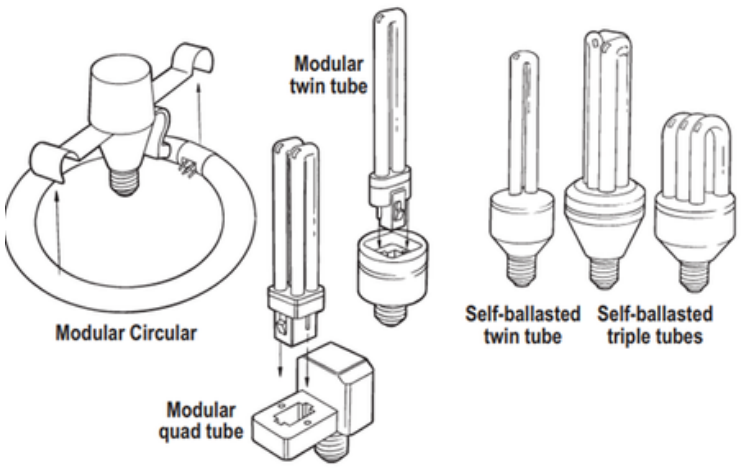
- Schools and universities
- Offices and libraries
- Hospitals and clinics
- Supermarkets and factories
- Parking garages and workshops

COURSE notes

Topic | **Compact Fluorescent Lamp (CFL)**

1. What is a Compact Fluorescent Lamp (CFL)?

A Compact Fluorescent Lamp (CFL) is a smaller version of a traditional fluorescent lamp. It was designed to fit in the same socket as an incandescent bulb, but uses much less electricity. CFLs are part of the gas discharge lamp family. Like tubular fluorescent lamps, they contain a gas (argon and a small amount of mercury vapor), and they emit ultraviolet light that is converted into visible light by a phosphor coating inside the tube.



2. How Does It Work?

- When the lamp is switched on, electric current flows through the gas inside the tube.
- This current excites the mercury atoms, which emit ultraviolet (UV) light.
- The UV light hits the phosphor coating inside the glass, which then glows and produces visible light.
- CFLs usually include a built-in electronic ballast at the base to control the current and help the lamp start quickly.

3. Advantages

- Uses less electricity than incandescent lamps
- Longer lifespan–fewer replacements needed
- Lower heat output makes them safer in enclosed spaces
- Available in various shapes and colors to suit different lighting needs

4. Disadvantages

- Contains mercury, so it must be disposed of properly
- Sensitive to frequent switching on and off
- Takes a few seconds to reach full brightness
- Not ideal for dimmer switches unless marked as dimmable

5. Common Uses

These lamps are used in many places, such as:

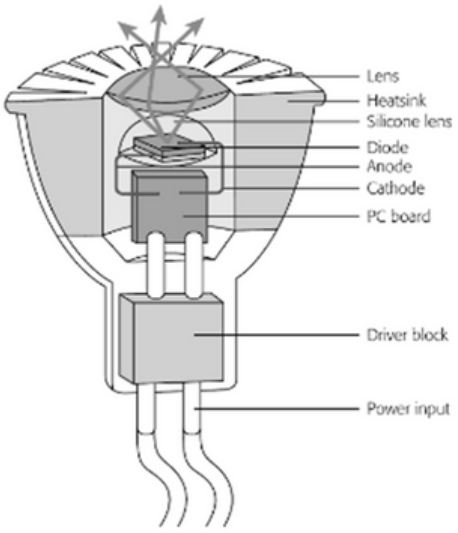
- Residential homes (bedrooms, living rooms, kitchens)
- Offices and retail spaces
- Hotel rooms
- Lamps, ceiling fixtures, and downlights

COURSE notes

Topic | **Light Emitting Diode (LED)**

1. What is a Light Emitting Diode (LED)?

An LED lamp is a type of solid-state lighting that uses a semiconductor to produce light. Unlike incandescent or fluorescent lamps, LEDs do not use gas or filaments. Instead, they use a chip made of materials like gallium nitride to emit light when electricity passes through it. Because of this mechanism, LEDs are highly efficient, durable and environmentally friendly.



2. How Does It Work?

- When voltage is applied to the LED chip, electrons and holes in the semiconductor recombine.
- This recombination process releases energy in the form of light–a process known as electroluminescence.
- The color of the light depends on the material used in the LED chip.

Most white LEDs are made by using a blue LED chip coated with a yellow phosphor layer, which blends into white light.

3. Advantages

- Extremely energy efficient
- Very long life span
- Cool operation (low heat emission)
- Environmentally safe (no mercury)
- Suitable for smart and dimmable lighting systems

4. Disadvantages

- Higher initial cost (but cheaper in the long run)
- Sensitive to high temperature and voltage fluctuations
- Light quality may vary in cheap or low-grade LEDs
- Directional light (may require diffuser for wide coverage)

5. Common Uses

These lamps are used in many places, such as:

- Residential homes (bedrooms, living rooms, kitchens)
- Commercial and office buildings
- Street lighting and traffic signals
- Automotive lighting (headlights, brake lights)
- Decorative and architectural lighting