ENERGY EFFICIENT MOTORS AND LIGHTING

Syllabus: Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

Energy-efficient motors, also called premium or high- efficiency motors, are 2 to 8% more efficient than standard motors. Motors qualify as "energy-efficient" if they meet or exceed the efficiency levels listed in the National Electric Manufacturers Association's (NEMA's). Energy-efficient motors owe their higher performance to key design improvements and more accurate manufacturing tolerances. Lengthening the core and using lower-electrical-loss steel, thinner stator laminations, and more copper in the windings reduce electrical losses. Improved bearings and a smaller, more aerodynamic cooling fan further increase efficiency. Energy-efficient motors generally have longer insulation and bearing lives, lower heat output, and less vibration. In addition, these motors are often more tolerant of overload conditions and phase imbalance. This results in low failure rates, which has prompted most manufacturers to offer longer warranties for their energy-efficient lines. Purchasing an energy-efficient motor can dramatically cut energy costs.

The below figure shows the difference between the standard motor and energy efficiency motors with efficiency Vs load and efficiency Vs motor rating (kw).

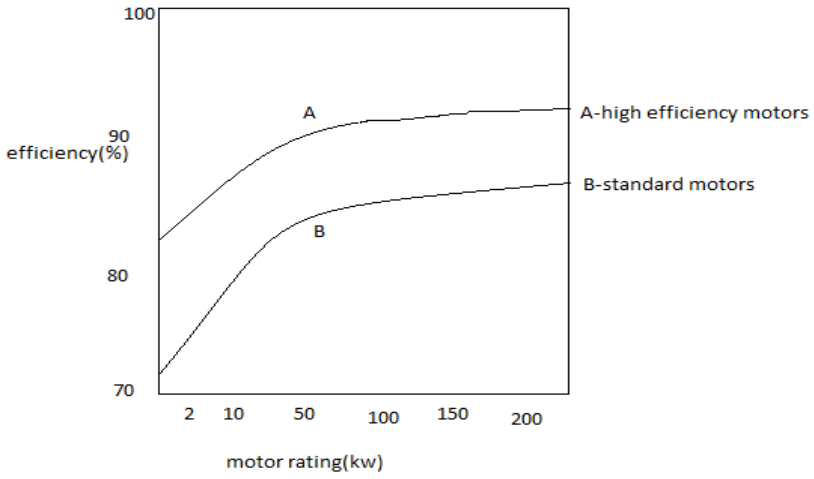


Figure: standard Vs high efficiency motors

The advantages are,

- Saves energy and money
- Near uniform efficiency from 50% to 100% of full load ensuring energy savings even at part load conditions also
- Short payback period
- Substantial savings after payback period

The applications of an energy efficient motor are specially suited for industries which are power intensive and equipments which run on constant load for long duration.

FACTORS AFFECTING EFFICIENCY AND LOSS DISTRIBUTION:-

Motor efficiency is simply of the watts output divided by the watts input. This is better expressed as the watts output minus the losses, divided by the watts input.

$$\text{Efficiecy} = \frac{746\ x\ HP\ output}{watts\ input}$$

$$= \frac{input - losses}{input}$$

The only way to improve efficiency is to reduce motor losses. The components of motor losses can be broadly defined as no-load and load losses. The typical loss distribution for an AC motor is shown in below as,

Percentage Motor Component's Loss:

Sr.No.	Motor component Loss	Total Loss %
1.	Stator I^2R loss (copper loss)	37%
2.	Rotor I^2R loss(copper loss)	18%
3.	Iron Loss	20%
4.	Friction and Windage loss	9%
5.	Stray Loss	16%

Description of Motor component's Losses:

Copper Loss:

Depends on the effective resistance of motor winding

- Caused by the current flowing through it.
- Is equal to I^2R
- Proportional to Load.
- Copper loss Is equal to I^2R + Rotor I^2R Loss.

Iron Loss:

Depending on the magnetic structure of the core and results from a combination of hysterisis and eddy current effect due to changing magnetic fields in the motor's core

- Voltage Related.
- Constant for any particular motor irrespective of load.

Friction and Windage loss:

- Occurs due to the friction in the bearing of the motor.
- The windage loss of the ventilation fan, other rotating element of the motor.
- Depend on the bearing size, speed type of bearing, lubrication used and fan blade profile.
- Constant for given speed irrespective of load.

Stray Loss:

It is very complex and Load related.

- Arises from harmonics and circulating current.
- Manufacturing process variations can also add to stray losses arises from harmonics and circulating current.
- Manufacturing process variations can also add to stray losses.

Power Loss Area	Efficiency Improvement
1. Iron	Use of thinner gauge, lower loss core steel reduces eddy current losses. Longer core adds more steel to the design, which reduces losses due to lower operating flux densities.
2. Stator I^2R	Use of more copper and larger conductors increases cross sectional area of stator windings. This lowers resistance (R) of the windings and reduces losses due to current flow (I).
3. Rotor I^2R	Use of larger rotor conductor bars increases size of cross section, lowering conductor resistance (R) and losses due to current flow (I).
4. Friction & Windage	Use of low loss fan design reduces losses due to air movement.
5. Stray Load Loss	Use of optimized design and strict quality control procedures minimizes stray load losses.

CONSTRUCTIONAL DETAILS:-

The efficiency of energy efficient motors is higher due to the following constructional features are,

1) By increasing the amount of copper in the motor (>60%) which reduces the resistance loss in the winding & temperature rise. Performance improves because of increased thermal mass.

2) Use of more & thinner laminations of high quality motor steel reduces core losses in the stator and rotor.

3) Narrowing of air gap between stator and rotor increases the intensity of magnetic flux, thereby improving the motor ability to deliver the same torque at reduced power. Increasing the length of the stator and rotor increases the net flux linkages in the air gap to the same effect.

4) More complex rotor bar designs enable good starting torque with efficient full speed operation.

5) Improved overall design reduces windage losses and stray load losses.

CHARACTERISTICS – VARIABLE SPEED, VARIABLE DUTY CYCLE SYSTEMS:-

The single most potent source of energy savings in induction motor system lies not in the motor, but rather in the controls that govern its operation. Adjustable speed, intelligent controls and other ways of modifying or controlling motor behavior hold great promise for improving performance and efficiency in drive systems. Controlling motor speed to correspond to load requirements provides many benefits, including increased energy efficiency and improved power factor. Adjustable speed capability can significantly improve productivity of many manufacturing processes by reducing scrap, enabling quality manufacturing during transition times and allowing more control over start up and shut down. Following are the benefits of variable speed drives (VSD):

1) Matching motor and load to the output
2) Improved power factor
3) Improved process precision
4) Faster response
5) Extend operating range
6) increased production & flexibility

RMS HORSEPOWER (RMS HP):-

The root-mean-square (RMS) value of the horsepower over one cycle can be calculated to estimate the possible heating effect on the motor. The RMS horsepower is the square root of the sums of the horsepower squared, multiplied by the time per horsepower; divided by the sums of all the time intervals. To determine the RMS load on the motor, use the following equation:

$$HP_{RMS} = \sqrt{\frac{(t_1 \times hp_1^2)+(t_2 \times hp_2^2)+ \ldots + (t_i \times hp_i^2)}{t_1 + t_2 + \ldots + t_i}}$$

Where:

hp_i = load, in horsepower, for each part of the cycle

t_i = time, in seconds, that the motor is subject to load hp_i

As long as the RMS horsepower does not exceed the full load horsepower of the motor used in the application, the motor should not overheat. This, of course, is only true as long as there is adequate ventilation during the entire cycle. To keep it simple, we have disregarded the effect of acceleration time on a self-ventilated motor.

Ex- Consider a machine with the following load profile ,and the root-mean-square (RMS) value of the horsepower

Power (HP)	5	7	1	9	1	8
Time	10	10	10	10	10	10

$$\text{RMS HP} = \sqrt{\frac{(5^2 \times 10) + (7^2 \times 10) + (1^2 \times 10) + (9^2 \times 10) + (1^2 \times 10) + (8^2 \times 10)}{60}}$$

$$\text{RMS HP} = \sqrt{\frac{(25 \times 10) + (49 \times 10) + (1 \times 10) + (81 \times 10) + (1 \times 10) + (64 \times 10)}{60}}$$

$$\text{RMS HP} = \sqrt{\frac{250 + 490 + 10 + 810 + 10 + 640}{60}}$$

$$\text{RMS HP} = \sqrt{\frac{2210}{60}} = \sqrt{36.83} \approx 6.07\,\text{HP}$$

VOLTAGE VARIATION-VOLTAGE UNBALANCE:-

Voltage variation:-

National Electrical Manufacturers Association (NEMA) standard recognizes the effect of voltage and frequency variation on electric motor performance. The standard recommends that the voltage deviation from the motor rated voltage not exceed 10% at the rated frequency. The rated motor voltage has been selected to match the utilization voltage available at the motor terminals. This voltage allows for the voltage drop in the power distribution system and for voltage variation as the system load changes.

The basis of the NEMA standard rated motor voltages for three phase 60 Hz induction motors is as follows:

System voltage	Rated motor voltage
208	200
240	230
480	460
600	575

Voltage unbalance:-

Voltage unbalance can be more detrimental than voltage variation to motor performance and motor life. When the line voltages applied to a polyphase induction motor are not equal in magnitude and phase angle, unbalanced currents in the stator windings will result. A small percentage voltage unbalance will produce a much larger percentage current unbalance.

Some of the causes of voltage unbalance are the following:

1) An open circuit in the primary distribution system.

2) A combination of single phase and three phase loads on the same distribution system, with the single phase loads unequally distributed.

Percentage Voltage Unbalance is defined by NEMA as 100 times the deviation of the line Voltage from the average voltage divided by the average voltage. If the measured voltages are 420, 430 and 440V, the average is 430V and the deviation is 10V. The Percentage Unbalance is given by,

$$= \frac{10\ \text{V} \times 100}{430\ \text{V}} = 2.3\%$$

(or)

Voltage unbalance is defined as the NEMA as 100 times the absolute value of the maximum deviation of the line voltage from the average voltage on a three phase system divided by the average voltage.

$$\%\ voltage\ unbalance = \frac{\text{max. voltage deviation from average voltage}}{\text{average voltage}} \text{ x } 100$$

1% voltage unbalance will increase the motor losses by 5%. Fig shows the increase in motor losses due to voltage unbalance.

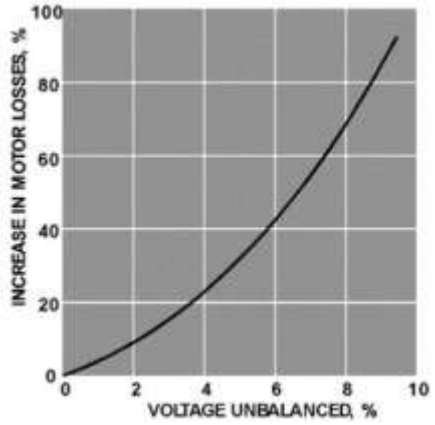


Figure: Effect of voltage unbalance on motor losses

OVER MOTORING:-

In many instances, the practice has been to over motor an application, i.e., to select a higher horsepower motor than necessary. The disadvantages of this practice are,

- Lower efficiency
- Lower power factor
- Higher motor cost
- Higher controller cost
- Higher installation costs

Over-motoring, or **motor oversizing**, occurs when a motor is selected with a higher power rating than necessary for the intended application. While this approach is often adopted to ensure reliability and accommodate potential future demands, it can lead to several inefficiencies and increased costs.

Drawbacks of Over-Motoring:

1. **Reduced Energy Efficiency**: Motors are typically most efficient when operating at 70–80% of their rated capacity. Running an oversized motor at low loads can result in decreased efficiency, leading to higher energy consumption and increased operational costs.
2. **Increased Capital and Operating Costs**: Oversized motors are more expensive to purchase and install. Additionally, they may require larger associated components, such as drives and transformers, further escalating costs.

3. **Lower Power Factor**: Operating oversized motors can lead to a lower power factor, meaning the motor draws more current than necessary for the work performed. This inefficiency can result in higher electricity bills and potential penalties from utility providers.
4. **Increased Mechanical Stress**: Oversized motors can exert higher starting torques, potentially causing excessive wear on mechanical components and leading to more frequent maintenance needs.
5. **Overheating Risks**: At low loads, oversized motors may not generate sufficient heat to activate built-in cooling mechanisms, increasing the risk of overheating and potential motor damage.

Best Practices for Motor Sizing to avoid Over Motoring:

- **Accurate Load Assessment**: Evaluate the actual load requirements, including torque, speed, and duty cycle, to determine the appropriate motor size.
- **Consider Future Demands**: While sizing for current needs, also account for potential future increases in load to ensure the motor can handle future demands without being oversized.
- **Utilize Motor Sizing Tools**: Employ manufacturer-provided sizing software or consult with experts to select a motor that aligns with the specific application requirements.
- **Regular Maintenance**: Implement a proactive maintenance schedule to ensure the motor operates efficiently and to extend its lifespan.

MOTOR ENERGY AUDIT:-

The Electrical Motor Energy Audit is the collection of actual electrical motor load data including: voltage, current, active power, total power, reactive power, and power factor under normal operating conditions.

Average Energy Conservation ranges from 3 -35% depending on motor load conditions and will always be dependent upon the load. Motor applications that are under loaded or oversized have more electrical losses and therefore more potential for Energy Conservation and dollar savings. If necessary an additional Electrical Motor Energy Audit can be conducted following Implementation to verify the actual Energy Conservation and dollar savings. The verification process simply entails the collection of an average baseline motor load sample (before process) followed by another comparable average motor load sample with the ECI method (after process), and the evaluation of the difference. Energy Conservation is realized immediately upon Implementation.

The process of electric motor management as,

- Save energy
- Reduce operating costs
- Minimize downtime
- Increase productivity.

LIGHTING INTRODUCTION:

In today's energy-conscious world, **lighting renovations** are an effective way to reduce costs and environmental impact while delivering strong returns on investment. Good lighting goes beyond just meeting brightness standards—it ensures visual comfort, enhances task performance, and improves occupant satisfaction. Although standards typically measure light on horizontal surfaces for convenience, people actually judge lighting quality by the brightness of vertical surfaces.

Lighting significantly affects mood, behavior, and productivity. For example, cool, bright lighting in fast-food restaurants encourages quick visits, whereas warm, dim lighting in fine dining promotes relaxation. Lighting design should be tailored to suit the function of each space.

While lighting energy costs ($0.50–$1.00 per ft² per year) are notable, they are minor compared to labor costs ($100–$300 per ft² per year). High-quality lighting can boost productivity, but poor lighting renovations may reduce comfort and negate energy savings. Ultimately, lighting design should prioritize supporting people, not just saving energy.

The luminance is the amount of light that leaves a surface, either by transmission through the material or, more commonly, reflection from the surface. (Figure 2) In simple terms, the luminance is the product of the illuminance and the reflectance of the surface divided by π. The eye sees luminance rather than illuminance. Therefore with the same illumination, by changing the surface reflectance, the luminance of the surface changes proportionally.

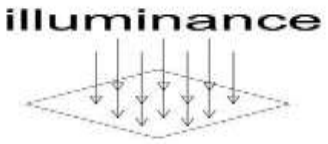


Figure 1. Illuminance: a measure of the light falling on a surface



Figure 2. Luminance is a measure of the light leaving a surface

LIGHTING SYSTEM DESIGN:-

"Design" is the science and art of making things useful to human kind and lighting design is the application of lighting—including daylight when it is specifically used as source of lighting to human spaces. Like architecture, engineering and other design professions, lighting design relies on a combination of specific scientific principles, established standards and conventions, and a number of aesthetic, cultural and human factors applied in an artful manner.

The two objectives of the lighting designer are,

(1) To provide the right quantity of light,

(2) Provide the right quality of light.

Lighting Quantity:-

Lighting quantity is the amount of light provided to a room. Unlike light quality, light quantity is easy to measure and describe.

Units:- Lighting quantity is primarily expressed in three types of units: watts, lumens and foot-candles (fc).

Watts measure the electrical input (power consumed) by a lighting system. Lumens measure the light output from a lamp or fixture. Foot-candles indicate how much light actually reaches the work surface (e.g., a desk) and are measured with a light meter. While watts show energy used and lumens show light produced, foot-candles reflect the usable light at the task level. The Illuminating Engineering Society (IES) recommends lighting levels based on foot-candles, as they represent the actual effectiveness of the lighting system.

EFFICACY:

Efficacy refers to the ratio of light output (lumens) to power input (watts), measured in lumens per watt (lm/W). It indicates how efficiently a light source converts electrical energy into visible light. Unlike the common misconception that higher wattage means more light, lamps with higher efficacy produce more light using the same or less power. High-efficacy lighting is more energy-efficient and cost-effective.

IES Recommended Light Levels:-

The Illuminating Engineering Society (IES) is the largest organized group of lighting professionals in the United States. Since 1915, IES has prescribed the appropriate light levels for many kinds of visual tasks.

Lamp Efficacies for Various Lamp Types	
Lamp Type	**Efficacy (Lumens per Watt)**
Incandescent Lamp	10 – 17 lm/W
Halogen Lamp	15 – 25 lm/W
Compact Fluorescent (CFL)	35 – 60 lm/W
Linear Fluorescent (T8/T5)	60 – 100 lm/W
Metal Halide	75 – 100 lm/W
High-Pressure Sodium (HPS)	80 – 140 lm/W
Light Emitting Diode (LED)	90 – 150+ lm/W

Lighting Quality:

Lighting quality significantly affects occupant mood, behavior, and performance. For example, bright white lighting in fast-food restaurants encourages quick visits, while warm, dim lighting in fine dining promotes relaxation. Light color and quality shape how people perceive and respond to spaces—stores use

cool white lighting to feel clean and efficient, while warm tones would feel inappropriate in such settings.

UNIFORMITY

Uniformity of illuminance refers to how evenly light is distributed across a space. Proper fixture spacing is key to avoiding bright or dark spots that can cause visual discomfort. While uniform lighting offers flexibility and reduces lighting issues, applying it across large areas can waste energy. For instance, in a manufacturing facility, only 20% may need high light levels (100 foot-candles), while the rest needs much less (40 fc). Lighting the entire space uniformly at 100 fc wastes energy. Instead, uniform lighting should be targeted at task areas, such as a workbench for assembling small parts, ensuring visual comfort and efficiency without unnecessary energy use.

GLARE:

Glare is visual discomfort caused by bright objects within a darker background—it's the **relative brightness** that matters. For example, car headlights cause glare at night but not during the day. **Contrast**, the difference in brightness between an object and its background, usually improves visibility. However, excessive contrast or brightness can lead to glare, making tasks harder and reducing comfort and productivity. In work environments, managing glare is crucial to maintain visual comfort and employee performance.

VISUAL COMFORT PROBABILITY (VCP):-

Visual Comfort Probability (VCP) measures the percentage of people comfortable with glare from a lighting fixture. For example, a VCP of 80 means 80% of occupants find the glare acceptable. A minimum VCP of 70 is recommended for general interiors, while areas like computer workstations and executive offices should have VCPs above 80.

To reduce glare, lighting designers can:

- Hide bare lamps from view
- Relocate or replace fixtures with higher VCP models
- Use indirect lighting, deep cell parabolic troffers, or special lenses

These methods often lower fixture efficiency because some light is trapped. Alternatively, reducing ambient light and adding task lighting can also minimize glare.

COLOR:-

Color considerations have an incredible influence on lighting quality. Light sources are specified based on two color-related parameters: the Color Rendering Index (CRI) and the Coordinated Color Temperature (CCT).

COLOR RENDERING INDEX (CRI):- CRI (Color Rendering Index) shows how well a light source reveals colors compared to natural light. It ranges from 0 to 100—higher numbers mean colors look clearer and more natural. A CRI above 75 is good for most tasks, while below 55 is poor.For **example,**

typical office lights (T12 Cool White) have a CRI of about 62. High CRI lights are important where accurate color recognition matters, like in printing rooms. For places like outdoor security lighting, a high CRI is less important than having plenty of light.

COORDINATED COLOR TEMPERATURE (CCT):-

Coordinated Colour Temperature means matching the color temperatures of different light sources in a space to create consistent, balanced lighting. This avoids mixing warm and cool tones that can feel awkward or unnatural, improving comfort, mood, and color appearance.

fFor example, using all warm lights (~2700K) in a restaurant creates a cozy atmosphere, while mixing warm and cool lights can look mismatched and uncomfortable.

CORRELATED COLOR TEMPERATURE (CCT):-

Correlated Color Temperature (CCT) describes the color appearance of a light source, measured in Kelvin (K). It's based on the color a heated object (like a wire) glows at different temperatures:

- 2000K = warm red light
- 5000K = neutral white light
- 8000K = cool blue light

CCT affects a room's atmosphere but is different from CRI (color accuracy). For example:

- Hospitals and labs use cool (blue-white) light
- Restaurants often prefer warm (yellow-red) light for coziness
- Offices traditionally use cool white (~4100K), but neutral white (~3500K) lamps are becoming popular for a balanced feel.

Key Aspects of Good Lighting System Design:

- **Identify Requirements:**

  Determine the specific lighting needs for each area, considering factors like task requirements, desired ambiance, and any unique characteristics of the space.

- **Layered Lighting:**
- Utilize a combination of ambient, task, and accent lighting to create depth and versatility.
- **Brightness and Uniformity:**

  Ensure proper illumination levels and even distribution of light across the space to avoid glare and dark spots.

- **Color Temperature:**

  Select appropriate color temperatures for different areas, with cooler tones for task areas and warmer tones for relaxation spaces.

- **Control Systems:**

  Implement dimmers, occupancy sensors, or smart controls to adjust light levels and save energy.

- **Energy Efficiency:**

  Choose energy-efficient lighting fixtures and consider daylight integration to minimize energy consumption.

- **Glare Control:**

  Minimize glare from light sources by using appropriate fixtures, diffusers, and light placement.

- **Consider Appearance:**

  Pay attention to the appearance of the space and how the lighting fixtures complement the overall design.

- **Cost of Implementation:**

  Factor in the cost of equipment, installation, and ongoing energy consumption.

Good Lighting System Practices:

- **Use LED lighting:**

  LED bulbs are energy-efficient and long-lasting, making them a good choice for various lighting applications.

- **Maximize daylight:**

  Utilize natural light as much as possible to reduce reliance on artificial lighting.

- **Consult with a lighting designer:**

  If needed, seek professional help to create a tailored lighting plan that meets your specific needs.

- **Regularly maintain and clean fixtures:**

  Ensure optimal performance and longevity by keeping fixtures clean and replacing bulbs when needed.

- **Test and adjust:**

  Evaluate the lighting system after installation and make adjustments as needed to achieve the desired results.

By following these design principles and practices, you can create a lighting system that is both functional and aesthetically pleasing, enhancing the comfort, productivity, and overall experience of any space.

Lighting System Practice:-

1. Basics of Lighting Systems

- **Purpose:** Provide adequate illumination for visibility, safety, comfort, and aesthetics.
- **Types of Lighting:**
  - **Ambient (General) Lighting:** Overall illumination of a space.
  - **Task Lighting:** Focused light for specific activities (reading, cooking).
  - **Accent Lighting:** Highlights objects or architectural features.
  - **Decorative Lighting:** Adds to the aesthetic appeal.

2. Types of Light Sources

- **Incandescent bulbs:** Traditional, warm light, less energy-efficient.
- **Fluorescent lamps:** More efficient, cooler light, often used in offices.
- **LEDs:** Highly efficient, long lifespan, versatile in color and intensity.
- **Halogen:** Brighter than incandescent, more heat.
- **Smart bulbs:** Connected and controllable remotely.

3. Lighting Components

- **Lamps/Bulbs:** Source of light.
- **Fixtures/Luminaires:** Hold and protect bulbs; direct or diffuse light.
- **Ballasts/Drivers:** Control current to bulbs (fluorescent, LED).
- **Switches and Controls:** Manual or automated control systems.
- **Dimmers:** Adjust brightness.
- **Sensors:** Motion, daylight sensors for energy saving.

4. Lighting Design Considerations

- **Illuminance (lux):** Amount of light per unit area.
- **Color Temperature:** Measured in Kelvin (K). Lower K = warm/yellow; higher K = cool/blue.
- **Color Rendering Index (CRI):** Ability of light source to show true colors.
- **Energy Efficiency:** Use of LED, sensors, timers to save energy.
- **Glare Control:** Avoid excessive brightness causing discomfort.
- **Uniformity:** Even distribution of light.

5. Electrical Aspects

- **Wiring:** Proper gauge and insulation; follow safety codes.
- **Load Calculation:** Total wattage and amperage for circuit protection.
- **Grounding:** Safety requirement.
- **Circuit Types:** Series (rare in lighting), parallel (common).

6. Common Practices in Installation

- Plan layout with lighting levels and fixture placement.
- Use of ceiling height and room dimensions to calculate fixture types and numbers.
- Use lighting simulation software for complex systems.
- Test wiring and connections for continuity and safety.
- Label circuits and switches clearly.

7. Maintenance and Troubleshooting

- Regular cleaning of fixtures and bulbs.
- Replace bulbs with matching specs.
- Check for flickering or dim lights indicating wiring issues.
- Inspect switches and controls for proper function.
- Ensure ballast/driver health in fluorescent/LED systems.

LIGHTING CONTROLS:-

A lighting control system is a smart network that manages lighting by connecting sensors, switches, and lights through a central controller. It automatically adjusts lighting to save energy and improve comfort in homes, offices, factories, and public spaces. Often called Smart Lighting, these systems help meet energy codes and green building standards.

Lighting controls range from simple manual switches to advanced devices like occupancy sensors, photocells, and time clocks. Traditional lighting controls manage fixed light groups independently and are adjusted locally. In contrast, a lighting control system integrates various devices (relays, sensors, switches) and can be controlled both locally and centrally via software, sometimes interfacing with other building systems like HVAC or fire alarms for coordinated operation.

Switches:-

The standard manual single-pole switch is the simplest energy-saving device but offers limited control. A common issue is people forgetting to turn lights off, especially if switches are hard to find or far from exits. Proper placement of switches—near entrances/exits and with multiple control points—makes it easier for occupants to turn off lights. When switches are convenient, users are more likely to switch off lights, reducing the need for more complex controls.

Time Clocks:-

Time clocks can be used to control lights when their operation is based on a fixed operating schedule. Time clocks are available in electronic or mechanical styles. However, regular check-ups are needed to ensure that the time clock is controlling the system properly. After a power loss, electronic timers without battery backups can get off schedule—cycling ON and OFF at the wrong times. It requires a great deal of maintenance time to reset isolated time clocks if many are installed.

LIGHTING ENERGY AUDIT:-

Assess opportunities for increasing lighting energy:-

a) **Turn off lights in unoccupied areas.**

1) Post reminder stickers to turn off lights when leaving the area.
2) Install time switches or occupancy sensors in areas of brief occupancy and remote areas (warehouses, storage areas, etc.).
3) Rewire switches so that one switch does not control all fixtures for multiple work areas.
4) Ensure wall-switch timers function properly.

b) Determine if existing lighting levels are higher than recommended levels.

Use a light meter to measure light levels and consult the Illuminating Engineering Society of North America (IESNA) illumination standards.

1) Reduce lighting levels where appropriate.
2) Reduce lighting hours.
3) Employ uniform or task delamping to reduce power and lighting.

c) Review outside lighting needs.

1) Eliminate outdoor lighting where possible and where safety and security are not compromised.
2) Replace exterior incandescent lights with more efficiency lights such as high pressure sodium (HPS) or metal halide (MH).
3) Replace burned out lamps with lower wattage lamps.

d) Remove unneeded lamps (delamp).

e) Install more efficient lighting.

f) Employ more effective lighting settings.

g) Follow a regular a maintenance schedule.

h) Upgrade exit signs with the help of an expert.

i) Use day lighting effectively.

j) Remove unnecessary lighting in beverage machines.

k) Train staff, especially housekeeping staff, on lighting policies/efficiency.

Top reasons to audit your lighting system:-

1) To save energy and money with existing equipment by using new light control strategies.
2) To improve your facility's image — go green.
3) To enhance your facility's atmosphere for occupants with added comfort, safety, and productivity.
4) Because lighting uses 39% of electricity in office buildings (EIA Commercial Buildings Energy Consumption Survey, 2003 data, released in 2008).
5) Because you know that older equipment needs to be replaced with more energy efficient Products.
6) Because, sometimes, simple operational changes can impact energy savings dramatically.
7) To re-optimize system operation after facility changes.