E- NOTES OF EECM (DIPLOMA 6TH SEM- EE)

Ch-1- Lighting System

Lux:- The **lux** is the SI derived unit of illuminance, measuring luminous flux per unit area. It is equal to one lumen per square metre. In photometry, this is used as a measure of the intensity, as perceived by the human eye, of light that hits or passes through a surface. It is analogous to the radiometric unit watt per square metre, but with the power at each wavelength weighted according to the luminosity function, a standardized model of human visual brightness perception.

Lumens:- The **lumen** is the SI derived unit of luminous flux, a measure of the total quantity of visible

light emitted by a source per unit of time.Lumens are related to lux in that one lux is one lumen per square meter.

The lumen is defined in relation to the candela as $1\ \text{lm} = 1\ \text{cd} \cdot \text{sr}$.

Illumination:- When light falls on a surface, it becomes visible, the phenomenon is called as **illumination**. It is defined as luminous flux falling on a surface per unit area. It is denoted by E and measured in lumen per square meter or meter- candle.

Space to height ratio:- Spacing Height Ratio is defined as the **ratio** of the distance between adjacent luminaires (centre to centre), to their **height** above the working plane.

Different types of lamps and their features:-

1. Incandescent lamps:- An incandescent light bulb, incandescent lamp or incandescent light globe is an electric light with a wire filament heated until it glows. The filament is enclosed in a bulb to protect the filament from oxidation. Current is supplied to the filament by terminals or wires embedded in the glass. A bulb socket provides mechanical support and electrical connections.

Incandescent bulbs are manufactured in a wide range of sizes, light output, and voltage ratings, from 1.5 volts to about 300 volts. They require no external regulating equipment have low manufacturing costs and work equally well on either alternating current or direct current. As a result, the incandescent bulb became widely used in household and commercial lighting, for portable lighting such as table lamps,
car headlamps, and flashlights, and for decorative and advertising lighting.
hours for lighting LEDs. Incandescent bulbs can be replaced by fluorescent lamps, high-intensity discharge lamps, and light-emitting diode lamps (LED). Some areas have implemented phasing out the use of incandescent light bulbs to reduce energy consumption.

2. Tungsten halogen lamps:-A **halogen lamp**, also known as a **tungsten halogen**, **quartz-halogen** or **quartz iodine lamp**, is an incandescent lamp consisting of a tungsten filament

sealedinto a compact transparent envelope that is filled with a mixture of an inert gas and a small amount of a halogen such as iodine or bromine. The combination of the halogen gas and
the tungsten filament produces a halogen cycle chemical reaction which redeposits evaporated tungsten to the filament, increasing its life and maintaining the clarity of the envelope. This allows the filament to operate at a higher temperature than a standard incandescent lamp of similar power and operating life, this also produces light with higher luminous efficacy and colortemperature. The small size of halogen lamps permits their use in compact optical systems for projectors and illumination. The small glass envelope may be enclosed in a much larger outer glass bulb for a bigger package, the outer jacket will be at a much lower and safer temperature, and it also protects the hot bulb from harmful contamination and makes the bulb mechanically more similar to a conventional lamp that it might replace.

3. Fluorescent lamps: A **fluorescent lamp**, or **fluorescent tube**, is a low-pressure mercury- vapor gas-discharge lamp that uses fluorescence to produce visible light. An electric current inthe gas excites mercury vapor, which produces short-wave ultraviolet light that then causes
a phosphor coating on the inside of the lamp to glow. A fluorescent lamp converts electrical energy into useful light much more efficiently than incandescent lamps. The typical luminous efficacy of fluorescent lighting systems is 50–100 lumens per watt, several times the efficacy ofincandescent bulbs with comparable light output.

Fluorescent lamp fixtures are more costly than incandescent lamps because they require a ballast to regulate the current through the lamp, but the lower energy cost typically offsets the higher initial cost. Compact fluorescent lamps are now available in the same popular sizes as incandescents and areused as an energy-saving alternative in homes.

Because they contain mercury, many fluorescent lamps are classified as hazardous waste. The United States Environmental Protection Agency recommends that fluorescent lamps be segregated from general waste for recycling or safe disposal, and some jurisdictions require recycling of them.

4. Mercury vapour lamp:- A **mercury-vapor lamp** is a gas discharge lamp that uses an electric arc through vaporized mercury to produce light. The arc discharge is generally confined to a
small fused quartz arc tube mounted within a larger borosilicate glass bulb. The outer bulb maybe clear or coated with a phosphor in either case, the outer bulb provides thermal insulation, protection from the ultraviolet radiation the light produces, and a convenient mounting for thefused quartz arc tube.

Mercury vapor lamps are more energy efficient than incandescent and most fluorescent lights, with luminous efficacies of 35 to 65 lumens/watt. Their other advantages are a long bulb lifetime in the range of 24,000 hours and a high intensity, clear white light output. For these reasons, they are used forlarge area overhead lighting, such as in factories, warehouses, and sports arenas as well as
for streetlights. Clear mercury lamps produce white light with a bluish-green tint due to mercury's combination of spectral lines. This is not flattering to human skin color, so such lamps are typically notused in retail stores.

They operate at an internal pressure of around one atmosphere and require special fixtures, as well asan electrical ballast. They also require a warm-up period of 4 – 7 minutes to reach full light output.

Mercury vapor lamps are becoming obsolete due to the higher efficiency and better color balanceof metal halide lamps.

5. Sodium vapour lamps:- A **sodium-vapor lamp** is a gas-discharge lamp that uses sodium in anexcited state to produce light at a characteristic wavelength near 589 nm.

Two varieties of such lamps exist: *low pressure* and *high pressure*. Low-pressure sodium lamps are highlyefficient electrical light sources, but their yellow light restricts applications to outdoor lighting, such
as street lamps, where they are widely used. High-pressure sodium lamps emit a broader spectrum oflight than the low-pressure lamps, but they still have poorer color rendering than other types of lamps. Low-pressure sodium lamps only give monochromatic yellow light and so inhibit color vision atnight.

Energy efficient practices in lighting:- Energy efficient lighting reduces the electricity demand and is a cost effective method of lighting system compared to conventional lighting methods. In trending years, the gap between power generation figures and demand figures is a matter of concern, as it implies the failure of power supply system to meet the power demand, thus a warning about lack of conservation ofenergy.

Energy efficient lighting includes the use of more illumination from less power lights by replacing highpower consumption lights like incandescent, high discharge lamps, etc. It is also replacing high power lighting accessories by low power devices such as electronic ballasts, fixtures, etc.

Replacing an ordinary bulb

In incandescent lamps, 90 percent of the electricity is wasted as heat rather than light and also 3-5 timesmore power is consumed. So replacing these bulbs with energy saving bulbs gives efficient energy lighting system. There are two main types of energy efficient devices:

1. CFL
2. LED (Light emmiting diode)

Tips for Energy saving in building:- 1. Smart Lights= A great deal of energy waste is due to carelessness.

Perhaps the most common needless energy expenditure is the failure of building users to turn off lights.Installing smart lights comes with upfront costs that are unavoidable, however, given the prevalence of light waste, they are likely to pay off in the long run.

2. Shade= Protecting your building from sunlight is a simple and relatively cheap energy saving solution. Installing shades or blinds keeps your building temperature down reducing the strainon your air conditioning system, and placing trees and landscaping in sun-facing areas can alsohelp produce shade in the right spots. Another way to help keep your building cool without running up your HVAC bill is through window tinting.

3. Understand your building energy use profile= Knowing how your energy bill is racking up is thefirst step in reversing the trend. There are a host of tools for building owners to track energy usage. Which tools you elect to incorporate into the management of your property should be based on the amount of energy it consumes.

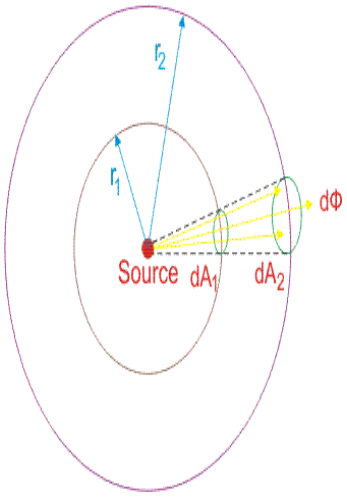
4. Stress the importance of good energy saving habits= Letting your employees and renters know the importance of efficient energy utilization can make an impact. Encouraging your renters and employees to do simple things like avoid obstructing HVAC vents with furniture or turning lights off when unused can go a long way. There's a fine line between respectfully communicating the importance of energy savings to your renters and being overbearing, but walking that line can create a better working environment for them and lower costs for you.

5. New commercial HVAC units= There is a good chance that your building is not equipped with an efficient HVAC system. Your HVAC system is likely accounts for over half of your building's net energy consumption. While getting a new HVAC system has upfront costs, in the long run, the amount you'll save will trump the cost of the system.

Laws of Illumination:- 1. Inverse square law of illuminance= This law states that the Illuminance (E) at any point on a plane perpendicular to the line joining the point and source is inversely proportional to the square of the distance between the source and plane.

$$E = \frac{I}{d^2}$$

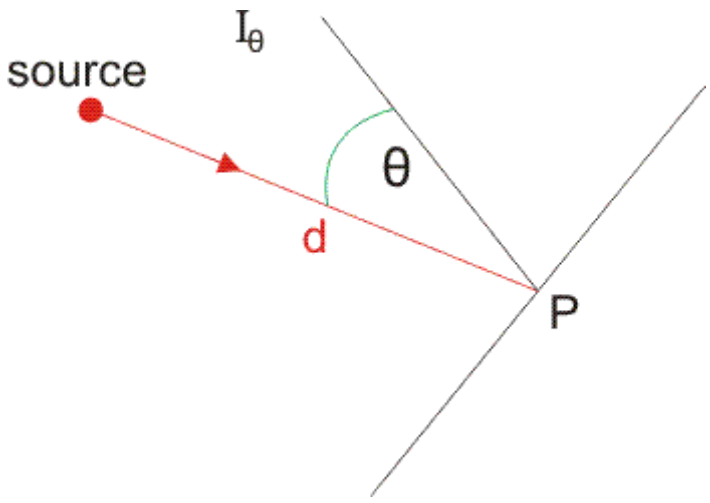
Where, I is the luminous intensity in a given direction.



2 Lamberts cosine law= The law states that Illuminance at a point on a plane is proportional to the cosine of the angle of light incident (the angle between the direction of the incident light and the normal to the plane).

$$E = \frac{I_\theta}{d^2}\cos\theta$$

It is the point source Illuminance equation. Where, Iθ is the luminous intensity of the source in the direction of the illuminated point, Θ is the angle between the normal to the plane containing the illuminated point and the line joining the source to the illuminated point, and d is the distance to theilluminated point.



Reqirements of proper lighting:- 1. Sufficiency

2. Distribution
3. Absence of glare
4. Absence of sharp shadows
5. Colour of light
6. Steadiness
7. Surroundings
8. Angle of light

Macro level approach at design stage:- The specific Energy Consumption is the measure of Energy Conservation activities in majority of Industries. The macro level approach for Energy Conservation is to

minimize the specific energy consumption. A three-pronged approach is suggested for Energy Conservation to minimize the specific energy consumption. High capacity utilization of equipment is very important in achieving low specific energy consumption. This brings down the fixed energy consumption and loss components such as lighting, Transformer loss etc. At-least 90% capacity utilization is to be ensured for achieving lower specific energy consumption. Achieving high capacity utilization is under the control of plant personnel. The Energy Efficient Plants are operating at 90 to 100
% of Capacity Utilization.

In industrial complexes, many induction motors may often run at no load or low partial load. Irrespective of the load conditions, these motors are, however, always connected to mains. Due to applied rated voltage at stator terminals, rated iron losses have to be supplied constantly to the motors. Summed up over years, these losses mean a waste of primary energy, whose availability on our planet is limited. If it were possible means of an additional switching device to reduce the terminal voltage of induction motors at no-load and low partial loads, some electrical energy might be saved.

CH-2-ENERGY CONSERVATION AND EC ACT 2001

Energy management:- Energy management includes planning and operation of energy production and energy consumption units. Objectives are resource conservation, climate protection and cost savings, while the users have permanent access to the energy they need. It isconnected closely to environmental management, production management, logistics and other established business functions.

Energy management is the proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy to meet the requirements, taking into accountenvironmental and economic objectives.

Energy conservation:- **Energy conservation** is the effort made to reduce the consumption of energy byusing less of an energy service. This can be achieved either by using energy more efficiently (using lessenergy for a constant service) or by reducing the amount of service used (for example, by driving less).Energy conservation is a part of the concept of Eco-sufficiency. Energy conservation reduces the need for energy services and can result in increased environmental quality, national security, personal financial security and higher savings. It is at the top of the sustainable energy hierarchy. It also lowers energy costs by preventing future resource depletion.

Energy can be conserved by reducing wastage and losses, improving efficiency through technological upgrades and improved operation and maintenance. On a global level energy use can also be reduced bythe stabilization of population growth.

Energy efficiency:-

Energy efficiency simply means using less energy to perform the same task – that is, eliminating energy waste. Energy efficiency brings a variety of benefits: reducing greenhouse gas emissions, reducing demand for energy imports, and lowering our costs on a household and economy- wide level. While renewable energy technologies also help accomplish these objectives, improving energy efficiency is the cheapest – and often the most immediate – way to reduce the use of fossil fuels. There are enormous opportunities for efficiency improvements in every sector of the economy, whetherit is buildings, transportation, industry, or energy generation.

Need of energy efficiency:- 1. Reducing green house gas emmissions.2 Reducing demand for energy imports.

3 Lowering our cost on a household and economy-wide level.4 To increase the output.

5 To minimise the loses.

Energy conservation act 2001:- The Act empowers the Central Government and, in some instances, State Governments to: 1. specify energy consumption standards for notified equipment and appliances.

2.direct mandatory display of label on notified equipment and appliances.

3. prohibit manufacture, sale, purchase and import of notified equipment and appliances notconforming to energy consumption standards.

4. notify energy intensive industries, other establishments, and commercial buildings as designatedconsumers.

5.establish and prescribe energy consumption norms and standards for designated consumers.

6.prescribe energy conservation building codes for efficient use of energy and its conservation in newcommercial buildings having a connected load of 500 kW or a contract demand of 600 kVA and above.

7. amend the energy conservation building codes prepared by the Central Government to suit regionaland local climatic conditions.

8.direct every owners or occupier of a new commercial building or building complex being a designatedconsumer to comply with the provisions of energy conservation building codes.

9.direct, if considered necessary for efficient use of energy and its conservation, any designated consumer to get energy audit conducted by an accredited energy auditor in such manner and at suchintervals of time as may be specified.

Energy conservation act 2010:- The new Energy Conservation (Amendment) Bill 2010, passed in this yearBudget and Monsoon season under the Energy Conservation Act 2001, makes a stringent penalty for violating energy consumption norms. provided for setting up of an Appellate Tribunal for Energy Conservation, which would hear appeals against orders of the adjudicating officer, central or state government orders. The Amendment Act instead provides that the Appellate Tribunal for electricity established under the Electricity Act shall be the Appellate Tribunal for the purposes of Energy Conservation Act 2001.Greener buildings, a smarter electric grid, more efficient home appliances and more advanced industrial and manufacturing processes have the potential to significantly reduce India's electricity shortage, reduce pollution and decrease its emissions of greenhouse gases, while boosting
the country's economic output over the next eight years.

Star Rating:- Star ratings are provided to all the major kind of appliances in the form of labels. These star ratings are given out of 5 and they provide a basic sense of how energy efficient each product is, just in a single glance. The manufacturers are officially required to put these labels as per **the Standards and Labelling Program introduced in 2006**.

The prime importance of these Star Ratings is to educate and inform consumers about how energy efficient each product is. This also makes the manufacturer responsible for creating products which are highly energy efficient as consumers may eventually prefer better rated products.

There are two variants of these labels, a big one and a smaller version:

Big label: The big energy rating label is aimed at appliances which have a constant usage and consume more electricity. These labels show additional information such as the yearly energy consumption of the product, brand name, product category and much more. For consumers, this big label is helpful as it allows you to calculate the actual money you would spend in electricity bills for that particular product.

Small label:- Small labels can be found in appliances which usually don't consume more energy. These labels just give you a visual representation of the energy consumption levels by showing star ratings.

Types of products available for star rating:-

1. Geysers
2. Washing machines
3. Air
4. Condition
5. TV
6. Freez
7. Computers
8. Ceiling fans
9. Tubelights, etc