

Chapter 3.8: Lighting System

Part-I: Objective type questions and answers

1.	GLS stands for_____. a) General Lamp source b) General Lamp Service c) <u>General Lighting Service</u> d) General Lighting Source
2.	A device that distributes and filters the light emitted from one or more lamps is _____. a) Control gear b) Lamp <u>c) Luminaire</u> d) Starter
3.	Ignitors are used for starting_____. a) FTL b) CFL c) <u>Sodium vapor lamps</u> d) None of the above
4.	The ratio of luminous flux emitted by a lamp to the power consumed by the lamp is _____. a) Illuminance b) Lux <u>c) Luminous Efficacy</u> d) CRI
5.	Which of the following is the best definition of illuminance? a) Time rate of flow of light energy b) <u>Luminous flux incident on an object per unit area</u> c) Flux density emitted from an object without regard for direction d) Flux density emitted from an object in a given direction
6.	Color rendering index is measured in the scale of_____. <u>a) 1 – 100</u> b) 1 – 100% c) 100 – 1000 d) None
7.	Color rendering index of Halogen lamps compared to low pressure sodium vapor lamps is _____. a) Poor <u>b) Excellent</u> c) Average d) Very poor
8.	One lux is equal to _____. a) one lumen per meter b) one lumen per m ³ <u>c) one lumen per m²</u> d) None
9.	Color rendering index of incandescent lamp is: a) fair when compared to HPSV lamp b) poor when compared to LPSV lamp c) same when compared to HPMV lamp d) <u>excellent when compared to fluorescent lamp</u>
10.	Which of the following light source has least life? a) Sodium vapor b) Mercury Vapour c) Halogen <u>d) incandescent</u>
11.	The minimum illuminance required for non working interiors as per IS 3646 is_____. a) 100 lux b) 50 lux <u>c) 20 lux</u> d) 1000 lux
12.	For the same lamp output, 250 W HPMV lamp can be replaced with_____. <u>a) 150 W HPSV</u> b) 200 W GLS c) 25 W CFL d) 150 W HPMV

13.	If voltage is reduced for gas discharge lamps, it will result in a) <u>Reduced power consumption</u> b) Increased power consumption c) Increased light levels d) No change in power consumption
14.	The percentage savings when a 300 W GLS lamp replaced with 250 W ML lamp are: a) 83% b) <u>17%</u> c) 9% d) None of the above
15.	The average rated life of CFL is ____ a) 5,000 hours b) <u>10,000 hours</u> c) 7,000 hours d) 1,000 hours
16.	Suitable lamp sources for the application of street lighting are ____ a) halogen lamps b) <u>HPSV</u> c) HPMV d) Incandescent
17.	Low bay application areas are classified for heights ____ a) Between 5 -7 m b) <u>less than 5 m</u> c) Above 10 m d) Less than 1 m
18.	Replacing a 400 W HPMV with 250 V HPSV lamp in street lighting operate for 4000 hours per annum will result in annual energy savings of: a) <u>600 kWh</u> b) 300 kWh c) 150 kWh d) 1000 kWh
19.	What is the typical frequency of operation of electronic ballast? a) 50 Hz b) 10 kHz c) 50 kHz d) <u>30 kHz</u>
20.	Which of the following options reduces the lighting consumption in the wide spread plant? a) Replacing 150 W HPSV lamps with 250 W HPMV lamps b) Maintaining 260 V for the lighting circuit with 220 V rated lamps c) <u>Installing separate lighting transformer and maintaining optimum voltage</u> d) None of the above

Part-II: Short type questions and answers

1.	What is a lamp and describe briefly the most commonly used lamps? Lamp is equipment which produces light. Lamps that are commonly used are: Incandescent, gas discharge lamps, include mercury, metal halide and high pressure sodium, low pressure sodium and fluorescent lights.
2.	What is the difference between a 'filament lamp' and a 'gas discharge lamp'? Filament lamps like incandescent lamps produce light by virtue of a filament heated to incandescence by the flow of electric current through it. The light from a gas discharge lamp is not produced by heating a filament, but by the excitation of gas contained in either a tubular or elliptical outer bulb.
3.	What is the function of Luminaire in a lighting system? Luminaire is a device that distributes filters or transforms the light emitted from one or more lamps.

4.	<p>What does a luminaire consists of?</p> <p>Luminaire or light fixture consists of the following components:</p> <ul style="list-style-type: none"> • Lamps, • Lamp socket, • Ballasts, • Reflective material, • Lenses, refractors or louvers, • housings
5.	<p>Define Lux (lx)?</p> <p>Lux (lx) is the illuminance produced by a luminous flux of one lumen, uniformly distributed over a surface area of one square meter. It is also defined as the International System unit of illumination, equal to one lumen per square meter.</p>
6.	<p>Define luminous efficacy?</p> <p>Luminous efficacy is defined as the ratio of luminous flux emitted by a lamp to the power consumed by the lamp. Efficacy is energy efficiency of conversion from electricity to light form.</p>
7.	<p>What is “Colour Rendering Index (CRI)” in lighting technology?</p> <p>Colour Rendering Index (CRI) is a measure of the degree to which the colours of surfaces illuminated by a given light source confirm to those of the same surfaces under a reference illuminant; suitable allowance having been made for the state of Chromatic adaptation.</p>
8.	<p>What should be the criteria for selecting energy efficient lamps replacement options?</p> <p>The lamp efficacy i.e., the ratio of light output in lumens to power input to lamps in watts should form the basis for energy efficient replacement options. Over the years development in lamp technology has led to improvements in efficacy of lamps. However, the low efficacy lamps, such as incandescent bulbs, still constitute a major share of the lighting load. High efficacy gas discharge lamps suitable for different types of applications offer appreciable scope for energy conservation.</p>
9.	<p>Highlight advantages of CFL lamp (compact fluorescent lamp) over incandescent lamps?</p> <p>CFL lamps are generally used as replacement for incandescent lamps. The following are the advantages of CFL lamps over incandescent lamps:</p> <ol style="list-style-type: none"> a. Higher illumination level (55-65 lm/watt) b. Longer life (typically 10,000 hours), c. Higher energy savings and hence cost savings (nearly 80% saving), d. less heat generation
10.	<p>What are the main disadvantages of ‘filament lamps’ for panel indicator lamp application?</p> <ul style="list-style-type: none"> • Comparatively high energy consumption (15 W/lamp) than ‘LED lamps’ • Failure of lamps is high • Very sensitive to voltage fluctuations
11.	<p>What are the merits of ‘LED lamps’ over ‘filament lamps’?</p> <ul style="list-style-type: none"> • Less power consumption (less than 1Watt/lamp) • Withstand high voltage fluctuation in the power supply

	<ul style="list-style-type: none"> • Longer operating life (more than 100000 hours)
12.	<p>How 'good lighting distribution' can be achieved in a plant?</p> <p>For achieving better efficiency, luminaires that are having light distribution characteristics appropriate for the task interior should be selected. The luminaires fitted with a lamp should ensure that discomfort glare and veiling reflections are minimised. Installation of suitable luminaires depends upon the height - Low, Medium & High Bay.</p> <p>System layout and fixing of the luminaires play a major role in achieving energy efficiency. This also varies from application to application. Hence, fixing the luminaires at optimum height and usage of mirror optic luminaries leads to energy efficiency.</p>
13.	<p>Highlight various ways of how the light can be controlled efficiently in a facility?</p> <p>Various ways of light control techniques available in a facility are:</p> <ul style="list-style-type: none"> • Grouping of lighting circuits which can be controlled manually or timer based control • Installation of microprocessor based controllers with occupancy sensors, infrared sensors, movement detectors • Optimum usage of day-lighting and photovoltaic controls • Installation of exclusive transformer for lighting • Installation of servo stabilizer for lighting feeder
14.	<p>What are the advantages of installing microprocessor based controllers for lighting circuit?</p> <p>A new method of lighting circuit controls through microprocessor based controllers is becoming popular. This is achieved by infrared controlled dimming, use of movement detectors, occupancy sensors, to feed signals to control ON & OFF of lighting circuits. This method of control uses pre-programmed commands using logic circuits.</p>
15.	<p>Describe the advantages of providing transformer exclusively for lighting?</p> <p>Most of the problems faced by the lighting equipment and the gears are due to the supply voltage fluctuations. Hence, the lighting equipments have to be isolated from the power feeders. This is carried out by installing lighting voltage transformers, which regulate the voltage exclusively for lighting circuits. This reduces the voltage related problems in turn increasing the efficiency of the lighting system. This also results in energy saving during the periods when the supply voltage levels are on higher side. In addition, it increases the life and performance of the control gear units of the lamps due to better voltage regulation.</p>
16.	<p>Give a short note on utilization of 'Day lighting'?</p> <p>Whenever the orientation of a building permits, day lighting can be used in combination with electric lighting. This should not introduce glare or a severe imbalance of brightness in visual environment. Usage of day lighting (in offices / air conditioned halls) will have to be very limited, because the air conditioning load will increase on account of the increased solar heat dissipation into the area. In many cases, a switching method, to enable reduction of electric light in the window zones during certain hours has to be designed.</p>
17.	<p>What are the advantages of installing a 'servo stabilizer' for lighting circuits?</p> <p>Installation of a 'servo stabilizer' provides a stabilized voltage to the lighting circuits. The performance of the gears such as chokes, ballasts, will be improved due to the stabilized voltage. This set up also provides, the option to optimize the voltage level fed to the lighting feeder. In many plants, during the non peaking hours, the voltage levels are on the higher side. During this period, voltage can be optimized, without any significant drops in illumination but at reduced power consumption.</p>

18.	<p>What do you understand by illumination ranges given in IS 3646?</p> <p>A range of illuminances is recommended for each type of interior or activity. Each range consists of three successive steps of the recommended scale of illuminances. For working interiors the middle value (R) of each range represents the recommended service illuminance that would be used unless one or more of the factors mentioned apply.</p> <p>The higher value (H) of the range should be used at exceptional cases where low reflectance's or contrast are present in the task, errors are costly to rectify, visual work is critical, accuracy or higher productivity is of great importance and the visual capacity of the worker makes it necessary.</p> <p>Similarly, lower value (L) of the range may be used when reflectance's or contrast is unusually high, speed & accuracy is not important and the task is executed only occasionally.</p>
19.	<p>Highlight the advantages of high frequency (HF) electronic ballasts in place of conventional ballasts?</p> <ul style="list-style-type: none"> ☞ Electromagnetic chokes consume more energy compared to electronic chokes. ☞ Less heat generation, hence reduced loading on A/c (in A/C rooms). ☞ Lights instantly ☞ Improved power factor ☞ Less weight, ☞ Increased lamp life
20.	<p>Describe briefly the advantage of replacing a typical 250W HPMV with suitable HPSV lamp for street lighting purpose?</p> <p>150 watt high pressure sodium vapour lamp can be used to a 250 watt mercury vapour lamp for street lighting purpose.</p> <p>A 250 watt mercury vapour lamp produces 12700 lumens output, where as a 150 watt H.P. sodium vapour lamp produces 15000 lumens output. A HPSV lamp can produce more lumens output with 100 watt less power consumption, though colour rendering index is not as good as a mercury vapour lamp. 250W HPMW lamp has around 5000 hours of burning life while 150W HPSV has about 12000 hours of burning life.</p>

Part-III: Long type questions and answers

1.	<p>List all the possible energy conservation measures possible in lighting system?</p> <p>Following are the possible energy conservation measures possible in lighting system:</p> <ol style="list-style-type: none"> a. Use of natural day lighting, b. Use of electronic chokes instead of conventional electromagnetic ballasts, c. Use of 36 watt slim tubes instead of 40 watt standard fluorescent tube lamps, d. Use of CFL lamps instead of GLS lamps with e-chokes, e. Use of 250w, 150w, 70w sodium vapour / metal halide lamps to replace 400w, 250w, 125w mercury vapour lamps, f. Use of electronic chokes for HPSV, HPMV and metal halide lamps, g. Use of lighting voltage transformers for lighting circuits. h. Use of timer control or photo-sensors for lighting circuit control for occupancy control and street lighting purposes, i. Use of dimming controls,
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	<ul style="list-style-type: none"> j. Use of high reflectivity light fittings, k. Use of task lamps instead of cluster of lamps, l. Individual lamp controls instead of group switching, etc. 																							
2.	<p>Describe the step by step methodology of lighting system audit in a plant?</p> <p>Improvement option in lighting at any facility would involve following step by step approach:</p> <ul style="list-style-type: none"> a. Step-1: Inventorise the lighting system elements with respect to device rating, population & use profile. b. Step-2: Measure and document lux levels at various plan locations at working place, at day time and night times w.r.t lamps ON or OFF during the said period. c. Step-3: Use a portable load analyzer to measure and document the voltage and power consumption profile at various lighting load distribution panels d. Step-4: Compare the measured lux values with standard values and identify locations of under-lit and over-lit areas e. Step-5: Analysis of failure rates of lamps, ballasts and actual life expectancy levels from the past data. f. Step-6: Based on above careful assessment has to be carried out along with energy saving potential, investment required and payback calculations. 																							
3.	<p>Compare the techno-economics of replacing 400 W HPMV lamps with 250 W HPSV, 250 W HPMV with 150 W HPSV and 125 W HPMV with 70 W HPSV lamps for same light output for 4500 hours of annual operation and consider Rs. 4.5 as per unit cost?</p> <p>A 400 watt HPMV lamp can be replaced by a 250 watt HPSV or metal halide lamp without any change in light output (though color rendering effect may be different). Similarly 250 watt & 125 watt HPMV lamps can be replaced by 150 watt & 70 watt HPSV / metal halide lamps. Savings due to these replacements are worked out below considering 4500 hrs of operation at Rs.4.50 per unit of energy.</p> <table border="1" data-bbox="240 1621 1386 1935"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Replacement of HPMV with HPSV / MH lamp</th> </tr> <tr> <th>400 W to 250 W</th> <th>250 W to 150 W</th> <th>125 W to 70 W</th> </tr> </thead> <tbody> <tr> <td>Power savings per lamp</td> <td>150W</td> <td>100W</td> <td>55W</td> </tr> <tr> <td>Energy savings per lamp per annum (excluding ballast loss savings)</td> <td>675 kWh</td> <td>450 kWh</td> <td>247.5 kWh</td> </tr> <tr> <td>Energy cost saving per lamp per annum</td> <td>Rs.3,037.50</td> <td>Rs.2,025.00</td> <td>Rs.1,113.75</td> </tr> <tr> <td>Simple pay back period</td> <td colspan="3">Less than 1 to 2 years, though MH lamps are costlier compared to HPSV lamps</td> </tr> </tbody> </table>		Replacement of HPMV with HPSV / MH lamp			400 W to 250 W	250 W to 150 W	125 W to 70 W	Power savings per lamp	150W	100W	55W	Energy savings per lamp per annum (excluding ballast loss savings)	675 kWh	450 kWh	247.5 kWh	Energy cost saving per lamp per annum	Rs.3,037.50	Rs.2,025.00	Rs.1,113.75	Simple pay back period	Less than 1 to 2 years, though MH lamps are costlier compared to HPSV lamps		
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4.	<p>Compare the efficacy, colour rendering index and life of generally used lamps in the industry. Also state the typical applications of the same.</p>																							

Type of Lamp	Lux / Watt		Color Rendering Index	Typical Application	Life (Hours)
	8-18 Range	Avg.			
Incandescent	8-18 Range	Avg.	Excellent	Homes, restaurants, general lighting, emergency lighting	1000
Fluorescent Lamps	46-60	50	Good w.r.t. coating	Offices, shops, hospitals, homes	5000
Compact fluorescent lamps (CFL)	40-70	60	Very good	Hotels, shops, homes, offices	8000-10000
High pressure mercury (HPMV)	44-57	50	Fair	General lighting in factories, garages, car parking, flood lighting	5000
Halogen lamps	18-24	20	Excellent	Display, flood lighting, stadium exhibition grounds, construction areas	2000-4000
High pressure sodium (HPSV) SON	67-121	90	Fair	General lighting in factories, ware houses, street lighting	6000-12000
Low pressure sodium (LPSV) SOX	101-175	150	Poor	Roadways, tunnels, canals, street lighting	6000-12000

5. Tabulate the types of luminaries with their gear and controls used in different industrial locations?

Location	Source	Luminaire	Gear	Controls
Plant	HID/FTL	Industrial rail reflector: High bay Medium bay Low bay	Conventional/low loss electronic ballast	Manual/electronic
Office	FTL/CFL	FTL/CFL	Electronic/low loss	Manual/auto
Yard	HID	Flood light	Suitable	Manual
Road peripheral	HID/PL	Street light luminaire	Suitable	Manual