Winter – 2019 Examinations

Model Answers

Subject & Code: Illumination and Electrification of Buildings (22530)

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

1 Attempt any TEN of the following: 20

1 a) Define Enhance lighting.

Ans:

Enhance lighting:

- Enhance lighting is the lighting with various colour effect and controlled light intensity, used for decoration and effective visualization of gold, silver, diamond and watches showroom purpose.

2 Marks for correct definition

1 b) Compare the salient features of LED and CFL based on:
i] Lamp Efficiency
ii] Life span

Ans:

Parameter	LED	CFL
Lamp Efficiency	High (more than 70 lumen per watt)	Comparatively less (50-60 lumen per watt)
Life span (in working hours)	10000	3000

1 Mark for each parameter

1 c) Define the terms incandescent and incandescent lamp.

Ans:

Incandescent is the phenomenon in which the object emits or creates light when it is heated.

An incandescent lamp is a lamp in which the filament is heated by electrical current & light is created.

1 Mark for each definition

1 d) State two types of Electronic dimmer.

Ans:

Two types of electronic dimmers are**:**
1) S.C.R. operated dimmer
2) Triac operated dimmer

1 Mark for each

1 e) State the first law of illumination.

Ans:

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**.**

1 Mark for statement

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

1 Mark for equation and terms

where, I - Luminous intensity in a given direction.
d - Distance between the source and plane
E - Illuminance

1 f) State the Lux level recommended for (1) Class Room (2) College Auditorium

Ans:

1] Class Room – 300 lux 2] College Auditorium - 500 lux

1 Mark for each

1 g) State any two type of lamps used in Horticulture.

Ans:

i] High pressure sodium lamps
ii] Metal halide lamps
iii] Any of the standard high pressure lamp of 250W, 500W, 1000W

1 Mark for each of any two = 2 Marks

2 Attempt any THREE of the following: 12

2 a) Explain the features of Aquarium lighting.

Ans:

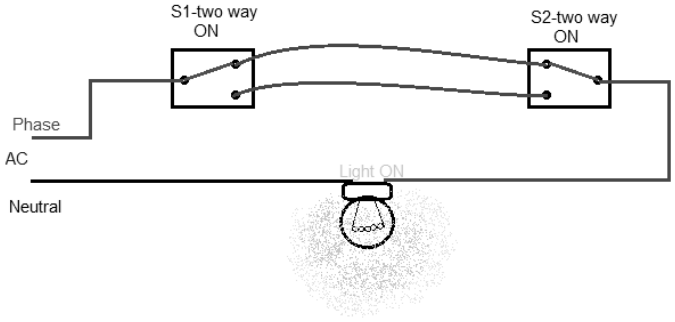
1) The aquarium light depends upon the size of the aquarium tank (Length, width and depth)
2) The aquarium lighting depends upon the all surrounding condition e.g. colour and size of the given hall in which the aquarium is placed.
3) The aquarium lighting depend upon the maintenance schedule of the tank water and other aquarium accessories.
4) The aquarium lighting depends upon the surrounding temperature and required temperature of water in the tank.
5) In some type of aquarium the ultraviolet lamps are provided for the bacteria killing purpose.
6) The aquarium lighting also depends upon the various aquarium accessories used in the tank.
7) The aquarium lighting should be electrically and mechanically safe to all the type of fishes and operator also.
8) The aquarium lighting should be economical.
9) The life of the aquarium lighting should be long.

1 Mark for each of any four features = 4 Marks

2 b) Illustrate with neat wiring diagram a single lamp control by two point method.

Ans:

Single lamp control by two point method:



2 Marks

This system is commonly used for stair case wiring. It consists of two way switches (the switch operates always in one of the two possible positions) the circuit diagram is as shown in figure above.

2 Marks

Assume that the lamp is in between ground floor and first floor with switch S1 is on ground floor and S2 is on first floor. When the position of the switches S1 & S2 is as shown in figure then the lamps is 'ON'. When a person reaches on first floor the lamp is required to be switched 'OFF' so the person will change the position of switch S2, so that the lamp will be switched 'OFF'.

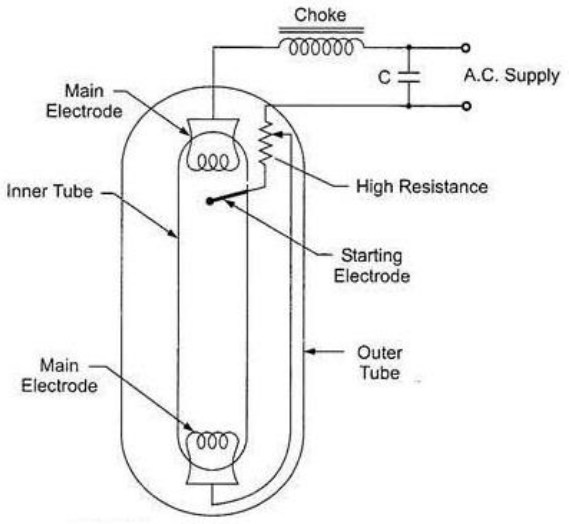
2 c) Explain the working of HPMV Lamp with neat diagram.

Ans:

High-pressure Mercury-Vapour Lamp (HPMVL):

Working:

- Whenever 1-ph, 230V, AC Supply is provided to the discharge tube of MVL, initially the current flows from Phase to the choke to the starting electrode to neutral.
- The starting electrode or resistance is made of tungsten filament having more resistance (5 to 10 kΩ), so that whenever current flows through the tungsten filament, as per the thermal emission, the light is emitted through the filament. The initial colour of light is therefore blue.



High pressure mercury vapour lamp (HPMV).

2 Marks for diagram

- At the same time the rated voltages is applied in between the main electrode No.1 & main electrode no. 2. Due to this voltage, there will be collision of neon gas particles & current will start to flow through the discharge tube,
- Whenever temperature surrounding the inner tube increases up to 600° C the mercury powder will start vaporizing & the continuous collision process of all inert gases takes place so that full light is emitted through the discharge tube.
- The colour of light is bluish white. The full light is emitted after 10-15 min.

2 Marks for explanation

OR Student may write

The construction & connection diagram is as shown in figure. As per this construction there are following components.

Choke: The choke is acting as the ballast. At the time of supply voltage variation, the current flowing through the inner tube is maintained constant to keep uniform light intensity. Sometimes choke can be designed to get the higher voltages, to apply to the inner tube of mercury vapour lamp.

Starting resistance/limiting resistance: Whenever current flows through the starting resistance, there is a I^2R loss which is converted into heat. If the temperature of this heat goes near about 600° C then inert gases ionization starts.

Auxiliary electrode & Main electrode: It is made by high resistive element. The ionization is takes place through the inert gases whenever current flows from auxiliary electrode to main electrode.

Inner Tube: The various inert gases e.g. Argon, Nitrogen etc with mercury powder are filled in the inner tube at 5 to 7 times of the atmospheric pressure.

Outer Tube: The function of outer tube is to make the vacuum surrounding the inner tube to avoid thermal dissipation or to maintain 600°C surrounding the inner tube.

Power factor improvement Capacitor: The function of power factor improvement capacitor is to improve the power factor from 0.5 to 0.95.

2 d) Compare the AC and DC Arc lamps.

Ans:

AC Arc Lamp	DC Arc Lamp
Cross section area of electrode is same	Cross section area of electrode is positive rod is twice that of negative rod
Series inductor is used for stability	Series resistance used for stability
Voltage required is (39 +2.8 L)V Where L is length of arc in mm	Voltage is required 40V to 60V
AC supply is used for AC arc lamp	DC supply is used for DC arc lamp
Luminous efficiency is less	Luminous efficiency is high

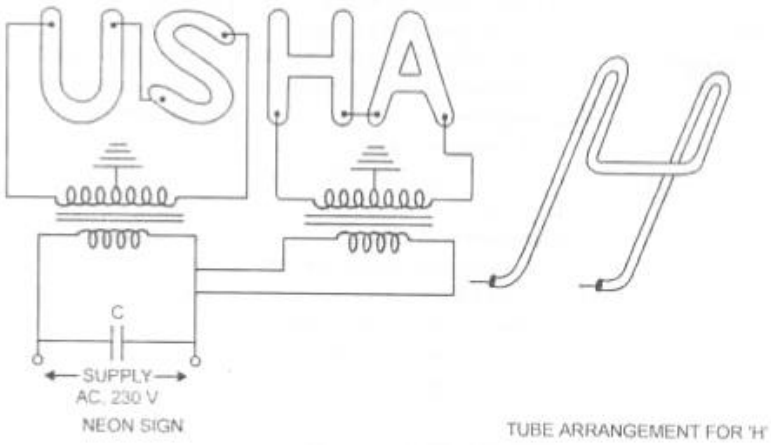
1 Mark for each of any four points = 4 Marks

3 Attempt any THREE of the following: 12

3 a) Explain the working of Neon sign tube with diagram.

Ans:

Neon sign tube:



2 Marks for diagram

The construction & circuit diagram for neon tube is as shown in fig. Basically neon tube is used for advertisement or decoration purpose. The maximum length of tube is 8m. The available diameter for neon tubes are 5mm,10mm,15mm, 20mm, 30mm, etc. When the supply is switched on at primary, high voltage is induced in secondary winding of HT transformer. This voltage is applied across electrodes. At this high voltage, a discharge occurs in neon gas. In the neon tube, we can achieve various colours by changing the constituents of the gases and mercury filled in the tube.

The choke is used for ballast & power factor improvement capacitor is also used. For the neon tube, continuous high voltage is required, so that following precautions should be taken.

- The neon tube should be installed by government authorized supervisor.
- The metal body of the HT transformer must be earthed separately.
- Caution notice of danger board is required.

2 Marks for explanation

3 b) State the selection criterion of the lamp for various purposes.

Ans:

Selection criterion of the lamp for various purposes:

While selecting a lamp for a particular purpose, the available lamps are compared on the basis of following criteria:

- Light output
- Input wattage
- Efficacy (lumens per watt)
- Rated service life
- Size
- Surface brightness
- Color characteristics
- Electrical operating characteristics
- Requirement of additional equipment such as ballasts
- Compatibility with the electrical system
- Suitability for the operating environment

½ Mark for each of any eight criteria = 4 Marks

3 c) State any four design considerations for illumination scheme of commercial complex.

Ans:

Design considerations for illumination scheme of commercial complex:

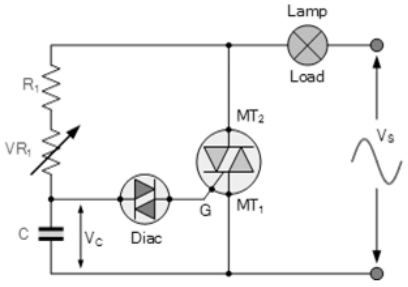
- Tasks to be performed in the space
- Desired light levels based on the tasks performed in the space
- Room size and dimensions
- Structural obstructions such as beams
- Layout of furniture and obstructions such as partitions
- Room and object surface colors and reflectances
- Special concerns such as safety and security
- Hours of operation
- Assessment of normal operating conditions
- Possibility or known existence of abnormal operating conditions
- Cleanliness of the area during operation
- Maintenance schedule
- Availability of daylight

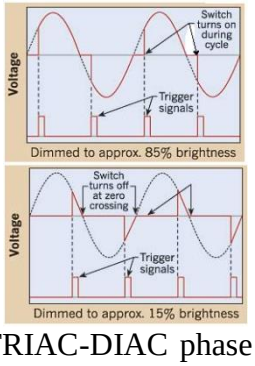
1 Mark for Each of any four design consideration = 4 Marks

3 d) Describe the working principle of Thyristor operated dimmer with the help of circuit diagram.

Ans:

Thyristor operated dimmer:





2 Marks for circuit diagram

A popular thyristor operated dimmer circuit employ TRIAC-DIAC phase control for

low AC power control. During each half-cycle, the capacitor charges through (R_1+VR_1). When the capacitor voltage becomes equal to a breakover voltage of diac, the diac conducts. The capacitor then discharges through diac and gate-MT_1 junction of triac. The discharge current provides gate current to triac to turn it on. After turn-on of triac, it acts like short-circuit and supply voltage appears across lamp. For rest of the half-cycle, the supply voltage appears across the lamp. If the triac is fired early in the half-cycle, the supply voltage appears across lamp for longer period and lamp glows brighter. However, if the triac is fired later in the half-cycle, the supply voltage appears across lamp for lesser period and lamp glows dim. The firing instant is decided by the capacitor charging to breakover voltage of diac. i.e charging time constant {C (R_1+VR_1)}. Thus by reducing VR_1 the lamp brightness can be increased. — 2 Marks explanation

OR

(Any other equivalent circuit diagram using SCR and its explanation)

4 Attempt any THREE of the following: 12

4 a) Select the illumination level required as per ISI for following working plane in residential building.
(i) Kitchen sink
(ii) Staircase
(iii) Dining room
(iv) Study room

Ans:

Sr.No	Area	Recommended illumination level
1	Kitchen sink	200 Lux
2	Staircase	60 to 100 Lux
3	Living Room	200 to 300 Lux
4	Dining Room	150 Lux

1 Mark for each = 4 Marks

4 b) Explain the lighting scheme to be designed for each of the following:
i) Special ward in hospitals
ii) Dentist's Cabin

Ans:

i) Special ward in hospital:

For the patients in the wards, lighting should create a cozy and pleasant atmosphere. Lighting in the wards should be planned in such a way that it meets the specific requirements of the patients in a ward, for example, some of the patients may like to sleep before the scheduled time of 'lights out ' so a high level of illumination will be a nuisance to those patients. Considering all these requirements, the level of illumination of 100 lux is acceptable for general lighting of wards which will also meet the needs of the nursing staff. — 2 Marks

Apart from general lighting, individual patients can be provided with additional lights in the form of bed head lights which can be switched 'on' or 'off' by patients themselves. These lights also contribute to the general appearance of the wards by breaking the monotonous uniformity that will result from general lighting.

ii) Dentist's Cabin:

The right dental lighting should strike a balance between providing enough high

intensity illumination to enhance work precision, especially when it comes to procedures such as colour matching for restorations and cosmetic work**,** as well as reducing eye strain and improving energy levels as light can affect how tired you feel at the end of the day. 2 Marks

That blue light is a dental curing light. It's basically a piece of dental equipment that we use to harden or cure our resin or basically, tooth-colored filling materials, as well as some other materials that we use such as cements and bonding agents that we use to restore your teeth back to health.

4 c) Analyze the effect of supply voltage on performance of LED as regards current, Lumen output, efficacy and life.

Ans:

1) **Effect on Current:-** In LED current depends upon supply voltage, if voltage get changes then current also change but this change in current will be control by resistors which are connected in series.
2) **Effect on Lumen output:-** If voltage is increased then brightness of LED get increased. 1 Mark each
3) **Effect on Efficacy:-** With fluctuation in supply voltage of LED, the efficacy gets decreased.
4) **Effect on Life:-** If supply voltage is not stable then life of LED get reduced.

4 d) State the purpose of lighting control. List the different types of dimmer.

Ans:

Purpose of Lighting Control:-

1. To turn ON or OFF the lamps
2. For dimming: The dimming control permits the adjustment of lighting over a range.
3. For changing the lighting levels according to need or desired of the owner.
4. For energy saving.
5. To increase the life of lighting source.
6. To increase the safety of lighting system.
7. In some types of industrial or automation, there is need of lighting control.
8. To provide proper lux level on working plane, the lighting control is required.
9. To fulfillment light intensity as per Indian or international standard
10. To control the brightness of T.V monitor, there is need of lighting control

½ Mark for each of any four purposes = 2 Marks

Types of Dimmer :

1) Dimmer by using changing resistance (Rheostatic)
2) By using auto transformer
3) By salt water method
4) By two winding transformer tap changing method
5) Thyristor or SCR operated dimmer
6) Triac operated Dimmer
7) PWM (Pulse width modulation) Controlled technique.

½ Mark for each of any four dimmers = 2 Marks

4 e) State the different types of outdoor flood lighting and where are they used.

Ans:

There are three types of projectors used for flood lighting :

a) Narrow beam Projector

b) Medium angle Projector
c) Wide angle Projector

1 Mark for each type = 3 Marks

a) Narrow beam Projectors: -

Light beam with such a projectors spreads between 12° and 25°. They can be employed for a distance of 70 meter.

b) Medium angle Projectors: -

Projectors with beam spread between 25° and 40°. These are employed for a distance of 30-70 meter.

c) Wide angle Projectors: -

A projector with beam spreads between 40° and 90°. They can be employed for a distance of 30 meter or below.

USE:

1 Mark for any two uses

1) It is used to illuminate buildings at night, ancient building and monuments, churches & gardens etc
2) It is used for illuminating railway yards, stadiums, car parking area etc.
3) It is used for illuminating advertisements, boarding's etc.

5 Attempt any TWO of the following: 12

5 a) State the various lighting calculations methods and Describe any one of them.

Ans:

Lighting calculation methods:

2 Marks for methods

1. Lumens or Light flux method
2. Point to point or Inverse Square law method
3. Watts per Square meter method

i) Lumens or Light flux method:

4 Marks for explanation of any one method

This method is applied where an average illumination is required. Total lumens output is calculated from the efficiency of each lamp and the number of lamps used in the circuit. To calculate lumens received on the working plane, the total lumens already calculated is multiplied by the co-efficient of utilization. When the lamps & the surroundings are not perfectly clean, then while calculating the lumens received on the working plane, the depreciation factor or maintenance factor is taken into consideration,

Thus lumens received on working plane =(Number of lamps× wattage of each lamp × efficiency of each lamp × coefficient of utilization) / (depreciation factor)

OR

= number of lamps × wattage of each lamp× efficiency of each lamp × utilization factor ×maintenance factor

OR

$$Calculate\ Total\ Lumens = \frac{A \times I \times W}{C \times M.F.}$$

ii) Point to point or Inverse Square law method:-

This method is applied where the illumination is required at a point due to one or more

sources of light. The illumination at any point within the range of lamp can be calculated from the inverse square Law, if a polar curve of lamp and candle power of lamp reflected by its reflector in different directions is known. If two or more lamps are illuminating the same working plane, illumination due to each can be calculated and added. This method is not commonly used due to more complications involved in its calculations. However, It is used in flood lighting & the yard lighting calculations.

iii) Watts per Square meter method:-

Basically it is a thumb rule method. It is very handy for rough calculation or checking. While applying this method, we allow watts/square meter of area to be illuminated is taken according to the illumination desired on an average value considering overall efficiency of the lighting system.

5 b) A workshop measures 10m ×25m. The shop is illuminated by 24 lamps of 200 watts each. The lumen efficiency of each lamp is 15 lumens per watt. Depreciation factor is assumed to be 0.8 and a co-efficient of utilization of 0.5. Determine the illumination on the working plane.

Ans:

Data Given:

Area of workshop =10m ×25m= 250m^2 — 1 Mark for area

Total lumen by all lamps = No. of lamps × watt of each lamp × efficiency of each lamp
= 24×200×15
=72000 lumens — 2 Marks for total lumens

$\therefore$ Lumens utilized $= \frac{Lumens\ produced \times Utilization\ factor}{Depreciation\ factor} = \frac{72000 \times 0.5}{0.8} = 45000\ lumens$ — 2 Marks for lumens utilized

$\therefore$ Illumination on the working plane = lumens per area = 45000/250
= 180 lumens/m^2 or lux. — 1 Mark for illumination

5 c) State the requirements of illumination scheme of shipyard.

Ans:

Requirements of illumination scheme of shipyard:

1) The shipyard lighting always depends upon the surrounding conditions. e.g. wind pressure, rain fall, location of shipyard from the sea-share etc.
2) The shipyard lighting always depends upon the type & capacity of alternator which is held in ship for interior applications and the capacity of alternator which is installed in the ship-yard and any other non-conventional sources installed in that particulars area for all outdoor application.
3) In the every shipyard there may be limitation on the conventional sources. To over-come these limitations, sometimes non-conventional sources, e.g. solar, tidal etc are to be used. At the time of illumination design we have to consider this factor.
4) We have to consider control room, emergency–control, emergency medical centre, loading and unloading areas etc. in the ship-yard for its standard lux level.
5) In every ship-yard, the electrical & mechanical safety is the prime-moto. At the time of illumination design, the all safety precautions are to be taken.
6) The life of the shipyard lighting should be always more.

1 Mark for each of any six points = 6 Marks

7) The cost of the ship-yard lighting should be always economical.
8) The every ship-yard station should be free from any type of pollution, e.g. water pollution, sound pollution or noise pollution to the commercial communication signals.
9) At the time of ship-yard lighting for the outdoor applications, we have consider total area of water, which is covered by the illumination.
10) The ship-yard lighting is always at the remote place slightly away from the sea-shore, so the ship-yard lighting wiring should be easy for replacement.
11) The maintenance and the repairing of the shipyard lighting system should be simple & less. The ship-yard lighting should allow the navigation signals and lights to control the various ships.
12) In ship-yard lighting the various lamp are used to get the proper lux level and for energy saving purpose. Some of the lamps are forge, Bollards, foot lamps, solar grass lamps, LED-Solar energy lawn lamps, various focus lamps, metal halide lamps etc.

3 Mark for ladder diagram

6 Attempt any TWO of the following: 12

6 a) Enlist the luminaries used in factory lighting and lux level required in various areas.
Ans:

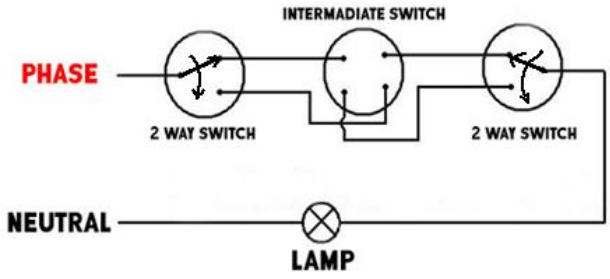
Sr. No	Area	Luminaries	Lux level
1	Office building	Fluorescent tube, LED, CFL	500 lux
2	Testing centre	Fluorescent tube, LED, CFL	400 to 500 lux
3	Workshop/work place	Halogen lamp, mercury vapour lamp, sodium vapour lamp	Above 5000 lux
4	Research and development center	Fluorescent tube, LED, CFL	500 to 600 lux
5	Outdoor area/parking area	Mercury or sodium vapour lamp	1000 to 2000 lux
6	Quality control department	Fluorescent tube, LED, CFL	600 to 700 lux
7	Sales department	Fluorescent tube, LED, CFL	300 to 400 lux
8	Commissioning department	Fluorescent tube, LED, CFL	400 to 500 lux
9	Small Store Room Without sunlight	Fluorescent tube, LED, CFL, Projector lamp, filament lamp, Halogen Lamp, Metal Halide lamp etc	200-300 Lux
10	Highbay area	Fluorescent tube, LED, CFL, Projector lamp, filament lamp, Halogen Lamp, Metal Halide lamp etc	Above 600 Lux

1 Mark for each of any six areas = 6 Marks

6 b) Describe control of a single lamp from three places. Draw the relevant circuit diagram.
Ans:
Single lamp control from three places-

It consists of two way switches & intermediate switch, the circuit diagram is as shown in figure. We require two 2-way switches and one intermediate switch and a lamp. Connect all these as shown as in the diagram below. For shown positions of two-way switches, the lamp will glow only if the intermediate switch is in position 2. With these positions of the switches, if position of any one switch is changed, then the lamp will be turned off.

2 Marks for explanation



4 marks for diagram

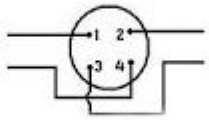


FIG 1
INTERMEDIATE SWITCH

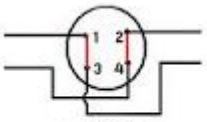


FIG 1[A]
POSITION 1
KNOB OF SWITCH IS UP

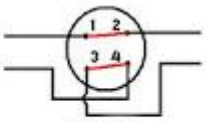


FIG 2[A]
POSITION 2
KNOB OF SWITCH IS DOWN

6 c) A drawing hall 30 metres by 15 metres with a ceiling height of 5 metres is to be provided with a general illumination of 120 lumens per m^2; taking a coefficient of utilization of 0.5 and depreciation factor of 1.4, Determine the number of fluorescent tubes required, their spacing, mounting height and total wattage. Take luminous efficiency of fluorescent tube as 40 lumens per watt for 80 watt tubes.

Ans:

(**NOTE: Marks should be given step wise for numerical solution of problems.)**

Data Given:

I = 120 lumens/m^2 Area of working plane A = 30 m x 15 m = 450 m^2

C = 0.5 D.F = 1.4 Wattage of each lamp = 200 watt

Efficiency of lamp = 40 lumens/watt for 80 watt tube.

i) Total lumens required on working plane $= \frac{AIWD}{C} = \frac{450 \times 120 \times 1 \times 1.4}{0.5}$ 1 Mark

$=151200$ *lumens*

ii) Total No. of fluorescent tube

$= \frac{Total\ lumens\ given\ out\ by\ lamps}{Wattage\ of\ each\ lamp \times luminous\ efficiency} = \frac{151200}{80 \times 40}$ 1 Mark

$= 47.25 \cong 48$ *Nos of lamp*

The number of lamps can be increased or decreased (46 Lamps or 50 Lamps) for better illumination design.

iii) Total Wattage = Total No. of Lamps x wattage of lamp

= 48 x 80
= 3840 watts 1 Mark

iv) Space & Mounting height:

∴ *Space*= 3.75*m and mounting height* 5m (Widthwise)
Space-height ratio = 3.75/5 = 0.75 1 Mark
And *Space*= 5*m and mounting height* 5m (Lengthwise)
Space-height ratio = 5/5 = 1
Working plane is assumed as a ground surface

Arrangements of Fluorescent Tube : 2 Marks