Important suggestions 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 principle components indicated in a 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 some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 A)	**Attempt any THREE :** **12 Marks**
a)	**Define following terms : (i) Lumen (ii) Luminous intensity (iii) Candle power (iv) Plane angle**
Ans:	**i) Lumen:** **(Each Definition; 1 Mark, Total 4 marks)** It is defined as the luminous flux emitted by a source of one candle power per unit solid angle in all directions **OR** It is unit of luminous flux. One lumen is defined as luminous flux emitted per unit solid angle from a point source of candle power. **ii) Luminous intensity:** The Luminous flux emitted by the light source per unit solid angle called as the luminous intensity. **OR** $I = \frac{\phi}{w}$ $(Where\ \phi = luminous\ flux, w = Solid\ Angle)$ **iii) Candle power:** It is the capacity of a light source to radiate light & is equal to the number of lumens emitted in a unit solid angle by a source of light in a direction OR It is defined as the radiation capacity of the light source in given direction.

(iv) Plane angle:

It is the angle subtended at a point in a plane by two conversing line.

OR

It is defined as the ratio of length of arc to radius.

$$Plane\ \ Angle = \frac{Arc}{Radius}$$

$$\phi = \frac{Arc}{Radius} .....radians(unit)$$

b) Compare incandescent lamp with fluorescent lamp with reference to life, starling line, luminous efficiency, C.R.I.

Ans: **(Each Point : 1 Mark)**

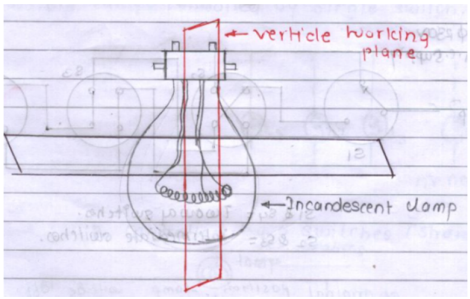
S.No.	Points of comparison	Incandescent Lamp	Fluorescent Lamp
1	Life of lamp	less	More
2	Starting Time	Less	More
3	Efficiency	Less (12 to 15 lm/w)	More (40 to 60 lm/w)
4	C.R.I	More/Very good	Less/Good or Poor

Note: Starling Line is spelling mistake so give full mark for any answer

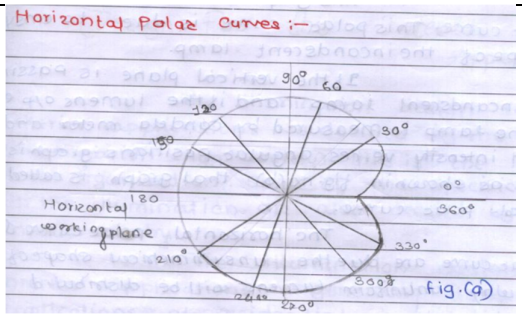
c) State the meaning of Polar curve. Also give its applications for designing lamps.

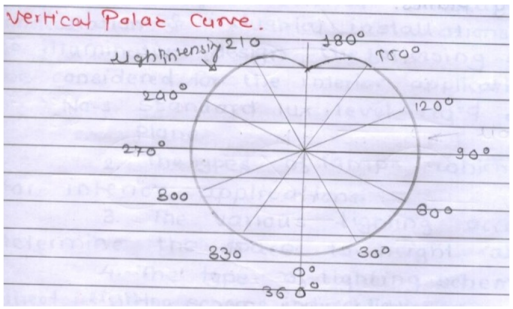
Ans: **Meaning of Polar Curves:-** **(Meaning : 2 Marks & Explanation : 2 Marks)**

Polar curves are graphical representation of light intensity with respect to angular position in horizontal or vertical plane passing through the light source.



or equivalent figure





Application of polar curves in illumination Engg:-.

The polar curves are required to determine the mean horizontal candle power (MHCP) and mean hemispherical candle power (MHSCP).The polar curves are due to limitations of unsymmetrical design shape of the incandescent lamp. The polar curves are required to calculate number of lamps in illumination design.

1. It indicates coverage of lights which helps lighting scheme.
2. To know the intensity of light emitted by the source in different direction

d) List the different methods of lighting control.

Ans: **Following Methods of lighting control :** **(Any Four Types expected : 1Mark each)**

1) Dimmer by using changing résistance (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
8) Timmer
9) Infra-red sensor
10) Ultrasonic sensor
11) Occupancy Sensor
12) Photo cell or Photo Sensor
13) On/OFF Control

OR

Following Methods of lighting control : (Any Four Types expected : 1Mark each)

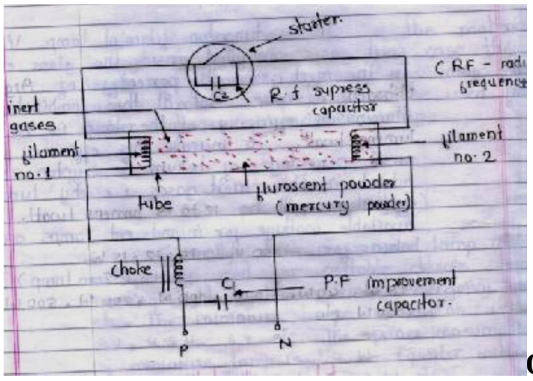
1. By changing voltage
2. By changing current
3. By changing frequency
4. By maintaining V/F ratio
5. Dimming Control
6. ON/OFF Control

Q.1B) Attempt any ONE : 06 Marks

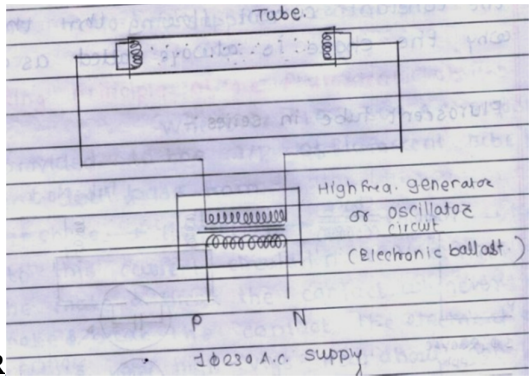
a) Explain with neat sketch construction and working of fluorescent lamp.

Ans: **(Construction-2 Mark, Working- 2 Mark & Figure-2 Mark)**

Figure of fluorescent lamp:-



OR



Construction:-

Fluorescent tube consists of tube, choke, starter & power factor improvement capacitor.

Operation:-

When switch is ON current flows through the choke-filament no1-starter-filament no. 2-to neutral, At that time choke induces high voltage which is applied to two filaments and ionized gas, Due to this there will be high voltage ionization so that light will be emitted through the tube. Choke is acting as ballast starter is used for make and break the circuit. To operate the fluorescent lamp, need a ballast (choke) to limit the current &provide the necessary starting voltage and starter for starting the tube.

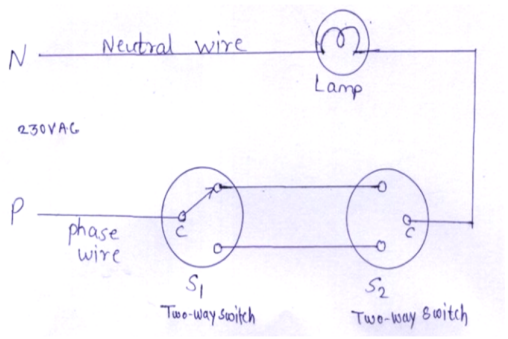
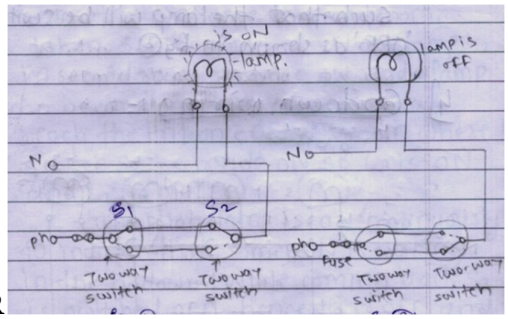
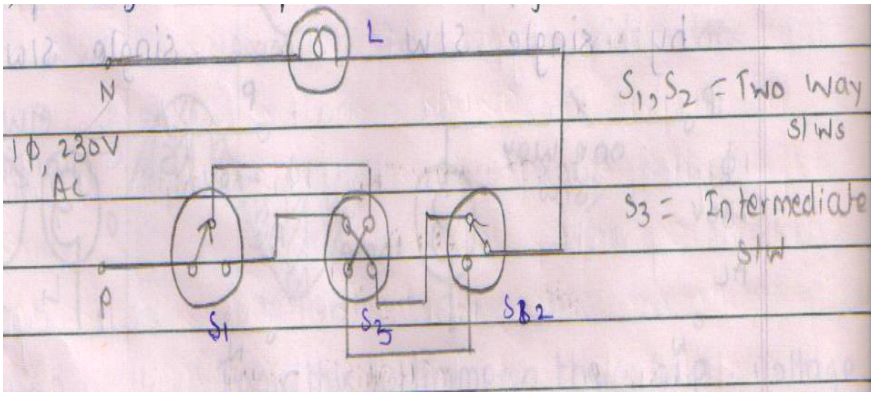
b)	**Define the following terms of illumination : (i) Space height ratio (ii) Depreciation factor (iii) Reflection factor**
Ans:	**i) Space to height ratio:** **(2 Mark)** It is the ratio of horizontal distance between two adjacent lamps to the mounting height of the lamps. **OR** $Space\ \ height\ ratio = \frac{Space\ \ between\ \ lamps}{Height\ \ of\ \ lamps\ \ above\ \ working\ \ plane}$ **ii) Depreciation factor:** **(2 Mark)** It is the ratio of illumination when everything is clean to the illumination under normal operating condition. **iii) Reflection factor:** **(2 Mark)** It is the ratio of luminous flux leaving the surface to the luminous flux incident on it.
Q.2	**Attempt any TWO :** **16 Marks**
a)	**Draw and explain single lamp control by two point, three point and four point method.**
Ans:	**1) Single lamp controlled by two point method:-** **(Figure: 2 Marks Explanation: 2 Marks: Total 4 Marks)**  **OR**  **or equivalent figure** 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.

Assume that the lamp is in between ground floor and first floor with switch S_1 is on ground floor and S_2 is on first floor. When the position of the switches S_1& S_2 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 S_2 such that the lamp will be switched 'OFF'.

2) Single lamp control by three point method:

(Figure:1 Marks & Explanation:1 Marks: Total 2 Marks)

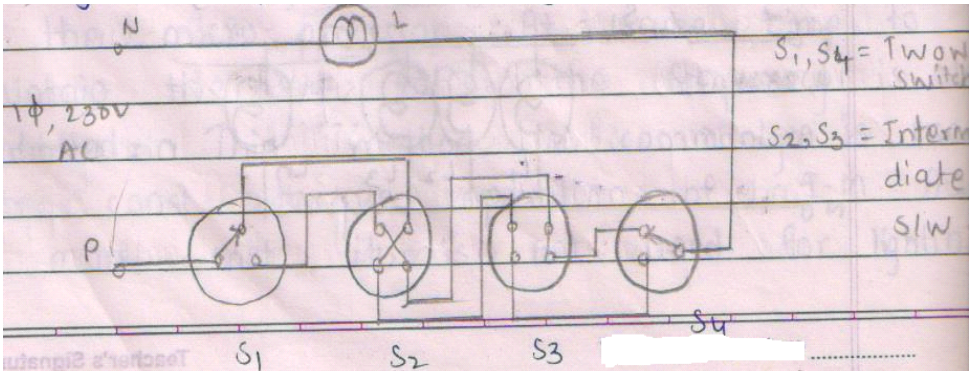


Explanation:

- It consists of two way switches & intermediate switch (the lamp is controlled by three different positions) the circuit diagram is as shown in figure above.

3) Single lamp control by Four point method:

(Figure:1 Marks & Explanation:1 Marks: Total 2 Marks)



Explanation:

- It consists of two way switches & intermediate switch (the lamp is controlled by four different positions) the circuit diagram is as shown in figure above.

b) A hall 30 meters by 15 meters with a ceiling height of 5 meters is to be provided a general illumination of 120 lumen/m^2 taking a coefficient of utilisation 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 and for 80 watt tubes.

Ans:

NOTE: Marks should 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

Given Data:

E = 120 lumens — Area of working plane = 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/80 watt tube

i) Total lumens required on working plane = $\frac{AIWD}{C}$ ----------**(1 Mark)**

$$= \frac{450 \times 120 \times 1 \times 1.4}{0.5}$$

$$= 151200 \ Lumens$$ ----------**(1 Marks)**

ii) Total No. of fluorescent tube = $\frac{Total\ lumens\ given\ out\ by\ the\ lamps}{Wattage\ of\ each\ lamp \times lu\,min\,ous\ efficiency}$

-(1 Marks)

$$= \frac{151200}{80 \times 40}$$

$$= 47.25 \cong 48 \ Nos\ of\ lamp$$ ----------**(1 Marks)**

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

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

= 48 x 80

= 3840 watts ----------**(2 Marks)**

OR

Total Wattage = Total No. of Lamps x wattage of lamp
= 47.25 x 80
= 3780 watts

➢ **Number of Lamps changed, So wattage may changes**

iv) Space & Mounting height:

$\therefore$ *Space* = 3.75 *mtr* *and* *mounting height* 5 *mtr*

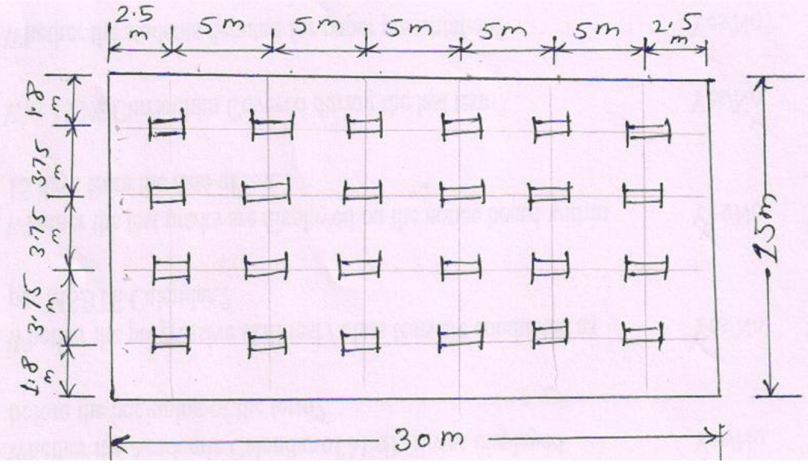
OR

$\therefore$ *Space* = 3.75 *mtr* *and* *mounting height* 5 *mtr*

$$\frac{3.75}{5} = 0.75$$ ----------**(1 Marks)**

Working plane is assumed as a ground surface

Arrangements of Fluorescent Tube : ----------**(1 Marks)**



Or equivalent layout

c) **The front of building 50 m x 16 m is illuminated by 16 Nos. of 1000 watt lamps arranged so that uniform 08 illuminations on the surface is obtained. Assume :**
(i) Luminous efficiency = 17.4 lumen/watt (ii) Utilization factor = 0.4 (iii) Depreciation factor = 1.3 (iv) Waste light factor = 1.2 . Determine the illumination on the surface.

Ans:

i) Area of room=A=50 × 16 m= 800 m^2 ii) Wattage = 1000 watt

iii) Depreciation factor=D.F= 1.3 iv) Co-efficient of utilization= U.F=0.4

v) Waste light factor = 1.2 vi) No. of lamps : 16 Nos

Find: Average illumination=E=?

Average illumination on the floor=

$= E_{AV} = \frac{No.\ of\ lamp \times U.F \times No.\ of\ Wattage \times lamp\ effeiency}{Area \times WLF \times D.L}$ -- **(2 Marks)**

$= \frac{16 \times 0.4 \times 1000 \times 17.4}{800 \times 1.2 \times 1.3}$

E_{AV}= 89.23 Lux ---------- Answer---------- (6 Mark)

OR Student May Write this way

: $Gross\ \ Lumens = \frac{A \times E \times W \times D.F}{U.F}$ ---------- **(1 Marks)**

$Gross\ \ Lumens = \frac{800 \times E \times 1.3 \times 1.2}{0.4} = 3120\ E$ - ------equation No.I---- **(1 Mark)**

$Total\ Power\ Consumption\ of\ the\ lamp = No.of\ Lamp \times Wattage\ of\ lamp$

$Total\ Power\ Consumption\ of\ the\ lamp = 16 \times 1000 = 16000\ Watt$ --------- **(2 Marks)**

$Total\ Lu\min ous\ due\ to\ the\ lamps = lu\min ous\ \ effciency \times total\ wattage\ of\ the\ all\ lamps$

$Total\ Lu\min ous\ due\ to\ the\ lamps = 17.4 \times 16000$

$Total\ Lu\min ous\ due\ to\ the\ lamps = 278400\ lumens$

$Gross\ \ Lumens = 278400\ lumens$ ----- Equation No.II---- **(2 Marks)**

But as per equation No. I :

$Gross\ \ Lumens = 3120\ E$

Putting value of equation No.II :

$Gross\ \ Lumens = 3120\ E$

$278400 = 3120\ E$

$So,\ \ Avar age\ \ illu\min ations\ \ E = \frac{278400}{3120}$

$So,\ \ Avar age\ \ illu\min ations\ \ E = 89.230\ \ lux$ ---------- **(2 Marks)**

Q.3	Attempt any FOUR : 16 Marks
a)	**State any four important terms in road lighting.**
Ans:	**Following four important terms in road lighting:** **(4 Marks)** 1. **Span:** It is the distance between two poles on a road. 2. **Spacing:** It is the distance between two adjacent poles on which lamps are fitted. **OR** It is a distance between two adjacent lines/live wires. 3. **Mounting height:** It is the distance between lamp source (height) and surface of road to be illuminated. **OR** It is a vertical distance between conductor and ground. 4. **Width of carriageway**: The area of street reserve that is provided for the movement or parking of vehicles measured from kerb to opposite kerb 5. The actual distance between first and last conductor on same pole. **OR** **Terms to determine the road lighting may be as below as which are required for the street lighting design :** **(Any Four point expected: 1 Marks each, Total 4 Marks)** 1. The street lighting should be such that the object can be seen driver of any vehicle. 2. The street lighting should be attractive. 3. It should increase the community value. 4. As per the Indian standard, the illumination level required for high traffic density should be 20:30 lux for medium traffic density it should be 8-15 lux & for low traffic density it should be minimum 4 lux. 5. It should be such that a river of any vehicle sees the object up to 30 mtr. 6. Percentage of glare should be less so there are less chances of accidents, for that angle of reflector should be well maintain. 7. It should be electrical & mechanical safe. 8. The replacement of lighting accessories should be simple 9. The maintenance & repairing should be simple future expansion should be carries out without any difficulty. 10. It should be economical. 11. For high traffic density, generally metal halide lamp, halogen lamps should be used. For medium traffic density sodium vapour lamp , mercury vapour lamp should be used & for low traffic density CFL, LED and fluorescent tube should be used.

b) **State illumination in lux for following location: Living room, Bed room, Kitchen, Hall ways.**

Ans: **illumination in lux for following location:**

(Any Four areas required- 1 Mark each, Total 4 Marks)

S.No	Areas	Recommended illumination level
1	Living Room	200 to 300 Lux
2	Bed Room	100 to 200 lux
3	Kitchen	150 to 200 Lux
4	Hall ways	60 to 100 lux

c) **Determine the MSCP of lamp emitting 1000 lumens. A surface inclined at an angle of 60° to the rays is kept 5 meters away from a 100 Cp lamp. Find the average of illumination on the surface.**

Ans:

$i)\ MSCP\ of\ Lamp = \frac{Lumens}{4\pi}$

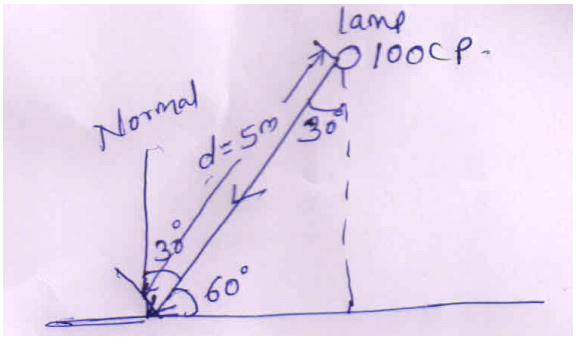
- ---------- **(1 Mark)**

$MSCP\ of\ Lamp = \frac{1000}{4\pi}$

$MSCP\ of\ Lamp = 79.5774\ Cp$

- ---------- **(1 Mark)**

ii) Average illumination:-



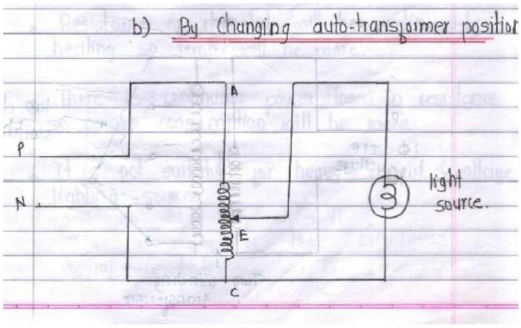
$ii)\ Average\ \ illumination = \frac{C.P\ Cos\phi}{d^2}$

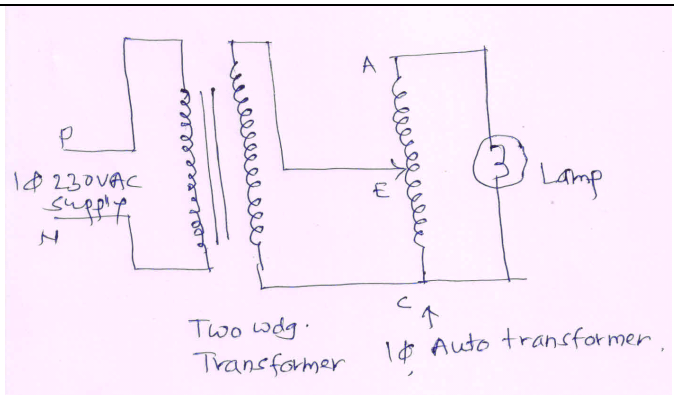
- ---------- **(1 Mark)**

$= \frac{100 \times \cos 30^0}{(5)^2}$

$= 3.4641\ \ Lux$

- ---------- **(1 Mark)**

d)	**State any four advantages of LED lamp.**
Ans:	**Advantages of LED lamp:** **(4 Marks)** 1. The LED lamps are energy saving lamps, 2. The power consumption of the single LED is very less. It is in mw. So to increase wattage series & parallel combination of LED can be used. 3. The LED lamp are manufactured for the wattages 1W, 2W 3W, 5W etc. 4. The LED lamps is available is various colors and diameter. The life of LED lamp is very high minimum 10000 working hours.
e)	**Explain separation of Auto transformer dimmer with the help of diagram.**
Ans:	**Operation of auto transformer –** **(Figure : 2 Mark & Explanation: 2 Mark)**  b) By Changing auto-transformer positio A P N B C light source. **or equivalent figure** ➢ As position of dimmer or auto transformer changes output voltages across light source will changes .So that light intensity also changes. ➢ The voltage across the lamp is varied according to the level of light required by rotating the moving contact over the winding. **OR** **Separation of Auto Transformer:-** ➢ Separation of auto transformer is only possible by using two winding transformer or any other isolation.



Q.4 A)	**Attempt any THREE :** **12 Marks**
a)	**State any four benefits of good industrial lighting.**
Ans:	**Following benefits of good industrial lighting:**

(Any Four point expected-1 Mark each)

1. Good illumination scheme encourage the personnel for better working.
2. In commercial, correctly planned scheme promote the sale.
3. In a factory lighting arrangements are planned to increase productivity & to improve the quality of production.
4. Correct & good illumination scheme avoid the accidents.
5. Adequate & glare free illumination provides pleasant atmosphere for staff.
6. Good lighting in schools & colleges helps in raising the average grades of the students.
7. In short good illumination scheme increases overall efficiency.
8. By proper illumination scheme energy saving will be effective & with cost saving also.
9. It should have sufficient light.
10. It should not strike the eyes.
11. It should not produce glare.
12. It should be installed at such a place that it gives uniform light.
13. It should be of correct type as needed.
14. It should have suitable sets, reflectors.

OR **(Any Four point expected-1 Mark each)**

1. **Comfortable:** The energy illumination scheme should be comfortable to everybody.
2. **Pleasant surrounding**: By the electrical lighting or the electrical illumination scheme the surrounding area of that location should be pleasant.

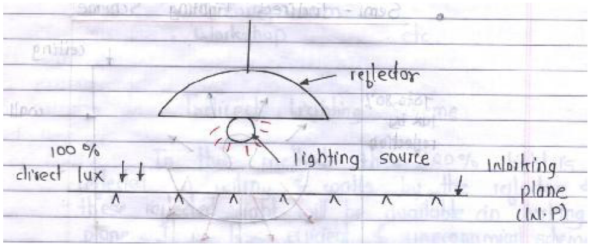
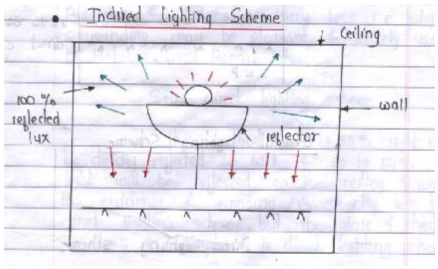
3. **Long life:** The life of the designed illumination should be large
4. **Economy:** The cost of the designed illumination scheme be low.
5. **Less Maintenance:** For only type of illumination scheme the maintenance and repairing should be less.
6. **Appearance:** The appearance of illumination scheme should be good.
7. **Less glare:** The glare is fatigue to the human eyes. The illumination scheme is designed in such away that there should be less glare to everyone i.e only electrical & mechanical accidents will be less.
8. **Less flicker:** The flicker is change in light intensity. This flicker should be always less for any type of illumination scheme. In the flicker there are changes of stroboscopic effect at the time of workshop lighting it is very imp.
9. **To avoid hard shadows:** The whole illumination scheme is designed for minimum shadows. At the time of flood light the hard shadows are avoided.
10. **Sufficient lux level:** The lux level is decided by the type of applications, type of location & their countries standard
11. **Cleanliness:** The illumination scheme should be free from any type of ash, smoke or any other air pollution it should be clean.
12. **Simple control:** The illumination scheme designed by the electrical lighting is very simple. The control, multicolor light intensity control is also possible in electrical illumination.

b) State the recommended illumination level of any four locations in a restaurant.

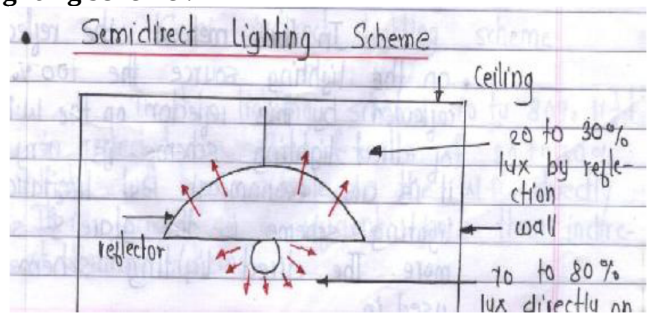
Ans: **Recommended illumination level required for any four area of restaurant :**

(Any Four Point expected : 1 Mark)

S.No	Places of Restaurant	illumination level in lux
i	Counter	150-250 Lux
ii	Dining hall	80-150 Lux
iii	Kitchen	200-300 Lux
iv	Washroom	60-80 Lux
v	passage	80-100 Lux
vi	Family Room	100-200 Lux

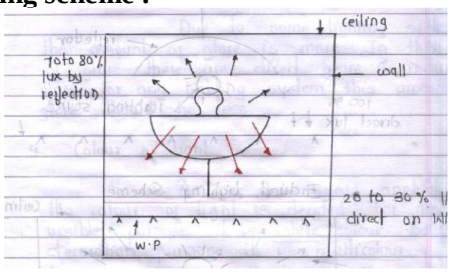
c)	**Explain the lighting schemes provided in stage lighting.**
Ans:	**Stage lighting mainly depends upon the :** **(1 Marks)** Generally Stage is required to perform various social & cultural activities. For e.g. Dance, Drama, gathering etc. The decorative lighting is commonly used for to fulfill all these activities and is very important part of this program. The lighting scheme are as bellows but type of lamps depends upon the application **(Below Any Three expected : 1 Mark each, Total: 3 Marks)** **i) Direct lighting :**  In this method, the reflector is used on the lighting source. The 100% light is reflected by this reflector on the working plane. So efficiency of direct lighting scheme is very high and it is economical also. But limitation of direct lighting scheme is that glare & shadows are more. The direct lighting scheme is widely used in drawing room, workshop etc. **Drawbacks of direct lighting system: (Any one point expected)** 1. This scheme is more efficient but it suffers from hard shadows and glare. 2. These light creates tunneling effect i.e ceiling remains dark. **ii) Indirect lighting scheme :-**  **or equivalent figure** In this method the 100% light is reflected on ceiling and walls by the reflector and this reflected light will be available on working plane. It is less efficient and uneconomical scheme but glare and shadows are very less. i.e. why surrounding may be pleasant and widely used in hotels, guest room etc.

iii) Semi direct lighting scheme :-



In this method, the 70 to 80% light will be directly reflected on the working plane and 20 to 30 % light will be reflected on the ceiling and walls. The efficiency and economy is slightly less than direct lighting scheme. But the glare and shadows are less as compare to direct lighting scheme.

iv) Semi indirect lighting scheme :-



or equivalent figure

In this lighting scheme, 70 to 80% light is reflected on ceiling & walls and 20 to 30% light will be available on the working plane directly. It is economical and efficiency as compared to indirect lighting scheme.

v) General lighting scheme:-

In this lighting scheme, the reflector is not used on the light source, so the lumens emitted by the light source will be reflected on ceiling wall and can be available directly on working plane also.

This method is commonly used in various residential, commercial and industrial installations.

OR

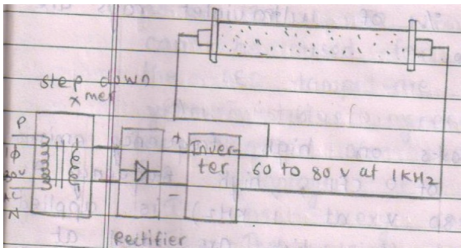
Following points lighting schemes provided in stage lighting :

(Any four Point are Expected-1 Mark each, Total 4 Marks)

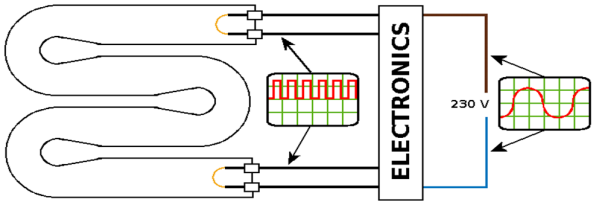
Generally Stage is required to perform various social & cultural activities. For e.g.

	Dance, Drama, gathering etc. The stage lighting is commonly used for to fulfill all these activities and is very important part of this program. **The following effects can be obtained by lighting on the stage:** 1. The activity or programme on the stage should be performed without any disturbance. 2. The lux level on the stage and light intensity is maintained and controlled as per requirement of activity. 3. The multi colour effect for particular activity of drama is also possible. 4. The smooth and simple control is also possible. 5. The replacement of lighting accessories should be simple and quick. 6. The maintenance and repairing is less. 7. The all operations in the stage lighting are smoothly and simple controlled. 8. Life of the stage lighting is more and it is more economical. 9. The Power consumption should be less. 10. The surrounding mood on the stage is maintained and improved by the stage lighting.
d)	**What type of luminaries are required for in hospital ?**
Ans:	**luminaries are required for in hospital :** 1. Lamps: **(2 Marks)** a) **Waiting room-**fluorescent tube, CFL, incandescent lamp, etc. b) **Consulting room-** fluorescent tube, CFL, incandescent lamp, torch, etc. Diagnostic Lamp c) **Operation theatre**- Ultra violet lamp, Halogen lamp, small capacity metal halide lamp, bunched filament lamp d) **Medical Store room**- fluorescent tube, CFL, incandescent lamp, etc e) **General &special ward** - fluorescent tube, CFL, incandescent lamp, Infrared lamp etc f) **ICU-** Halogen lamp, small capacity metal halide lamp, bunched filament lamp etc. **(Any Two Below point expected: 2 Marks)** 2) Voltage stabilizer 3) Ballast 4) Light intensity control device 5) various types of reflectors or name of reflector of any 6) Focus Lamps

Q. 4B)	**Attempt any ONE :** **06 Marks**
a)	**Explain with neat diagram construction and working of Compact Fluorescent Lamp. (CFL).**
Ans:	**Sketch of CFL Lamp :** **(2 Marks)**



OR



or equivalent figure

Construction:- **(2 Marks)**

- The electronic ballast circuit takes a 220 V input from external power source and sends high frequency supply is applied to that two terminals of CFL
- This ionizes the argon and mercury vapor particles.
- The ionized particles emit ultra violet radiations which strike with the fluorescent layer of material coated on the tube.
- In turn, fluorescent material spread a white light which lights up the room.

OR

Explanation of CFL:

- The compact fluorescent lamps are as shown in figure; these lamps are available in various shapes.
- The CFL is always called as a energy saving lamps.
- The illumination efficiency of CFL is between the 50-60 lumens per watt.
- The life of the CFL is more than 3000 working hours and cost also less as compare to fluorescent tubes.
- The CFL are available in various colors.

Working of CFL: **(2 Marks)**

- It works on high frequency emission for any type of CFL.
- High frequency AC Supply (60-80V at 1 KHz) is applied to the inert gases which are filled at low pressure.
- Then due to high frequency there will be ionization of mercury powder helium and other inert gases.
- And light is emitted through this fluorescent lamp.
- This high frequency is maintained constant throughout.

b)	**State advantages & disadvantages of metal Halide**
Ans:	**(Advanatges-3 Mark, disadvantages-3 Mark)** ➢ **Advantages of Metal halide lamp: (Any Three advantages are expected)** 1. high quality white light 2. Low running cost 3. High efficiency 4. Long life 5. Large range of output 6. Range of colour temperature 3000 to 6000 Kelvin 7. Several configurations single or double ended & reflector version is available ➢ **Disadvantages of metal halide lamp: (Any Thee Disadvantages are expected)** 1. High purchase cost 2. Control gear is required 3. Several minutes for start up to give out put 4. Only double ended lamp can be restarted from hot, but these needs special control gear
Q.5	**Attempt any TWO : 16 Marks**
a)	**What are the design considerations while designing illumination scheme for an industrial unit.**
Ans:	**Factors while designing industrial unit:-** **(Any Eight points expected, each point -1 Mark, Total 8 Marks)** 1) The type of industry or factory. 2) The total premises area of the whole factory in m^2. 3) The location of the factory. 4) The surrounding conditions. e.g. wind pressure, natural sun light, rainfall, etc. 5) The type of product which are manufactured in the factory. 6) The total indoor & outdoor area of the given factory.

7) The necessary lux level for the outdoor locations to increase the beauty of the factory at night, and pleasant working conditions.

8) The working plane required for the indoor application whether it is a ground surface or above ground surface.

9) The application of every room in the given factory. e.g. office, workshop, Research & development centre, testing centre, maintenance & repairing department, quality control department, sales department, commissioning department, showroom, guest room etc.

10) The required lux level for indoor premises in the given factory is decided as per application of department. e.g. In Workshop - 200 lux, e.g. In Showroom - 350 lux Above lux level is assumed.

11) As per civil construction work, the colour of ceiling walls & machines. The waste Light factor, utilization factor & depreciation factor is decided.

12) To minimize the stroboscopic effect & to minimize the glare the combination of various types of lighting source are selected.

13) The location & mounting of light source are selected in such a way that electrical & mechanical accident will be less.

14) The maintenance and repairing work for the whole illumination scheme should be less.

15) The overall cost of the illumination scheme should be less.

16) The lighting sources are selected in such a way that the overall power consumption will be less.

17) The lighting sources are selected and the illumination scheme is designed in such a way that the replacement of lighting accessories will be simple.

18) If expansion is required then it should be possible in present illumination scheme.

OR

(Any Eight points expected, each point -1 Mark, Total 8 Marks)

1. **Comfortable:** The energy illumination scheme should be comfortable to everybody.
2. **Pleasant surrounding**: By the electrical lighting or the electrical illumination scheme the surrounding area of that location should be pleasant.

3. **Long life:** The life of the designed illumination should be large
4. **Economy:** The cost of the designed illumination scheme be low.
5. **Less Maintenance:** For only type of illumination scheme the maintenance and repairing should be less.
6. **Appearance:** The appearance of illumination scheme should be good.
7. **Less glare:** The glare is fatigue to the human eyes. The illumination scheme is designed in such away that there should be less glare to everyone i.e only electrical & mechanical accidents will be less.
8. **Less flicker:** The flicker is change in light intensity. This flicker should be always less for any type of illumination scheme. In the flicker there are changes of stroboscopic effect at the time of workshop lighting it is very imp.
9. **To avoid hard shadows:** The whole illumination scheme is designed for minimum shadows. At the time of flood light the hard shadows are avoided.
10. **Sufficient lux level:** The lux level is decided by the type of applications, type of location & their countries standard
11. **Cleanliness:** The illumination scheme should be free from any type of ash, smoke or any other air pollution it should be clean.
12. **Simple control:** The illumination scheme designed by the electrical lighting is very simple. The control, multicolor light intensity control is also possible in electrical illumination.

OR

1) Level of illumination or degree of illumination: It depends on nature of work to be carry out. The degree of level of illumination also depends on following factors.

i) The size of object & its distance from observer.

ii) If object is moving higher level of illumination is required than stationary object.

iii) If the objects are required to be seen for long duration of time, higher level of illumination is necessary & for stair cases, corridors less illumination is required.

2) Glare: The glare causes unnecessary eye fatigue so it must be avoided, it can be prevented by using diffusing glass screen, suitable reflectors & proper mounting height. Reflected glare from the polished surfaces within the line of vision should be avoided.

3) Shadows: The formation of long and hard shadows must be avoided. The long and hard shadows cause accident. Such shadows can be avoided by

i) Using proper mounting height of the lamps. ii) Using more number of lamps & providing indirect lighting.iii) Employing wide surface sources of light.

Complete absence of shadows is again not recommended as soft shadows are required to identify three dimensional objects.

4) color rendering: This refers to the ability of the light source to reproduce the original colour of the objects when the object is illuminated by that source.

5) Lamp fittings: The lamp fittings serve the following functions in good illumination scheme.

i) To diffuse the light ii) To cut off the light at certain angle to avoid glare iii) To give mechanical protection to light source. iv) To increase the aesthetical requirement of the premises. V) To control the level of light (control gear)

6) Maintenance: Regular cleaning of lamps & light fittings is necessary to maintain their efficiency. The maintenance is necessary against dust, water leakage, dangerous gases which may cause corrosion of light fittings. Hence light fittings should be simple & easy from maintenance point of view.

7) Following factors are consider while designing interior illumination: utilization factor, deprecation factor, Maintenance factor and space to height ratio

OR

The stepwise factors while designing the illumination for industrial unit:

(Any Eight points expected, each point -1 Mark, Total 8 Marks)

1. Visit to corresponding site and make the proper survey of every room and its interior applications. Measure the dimensions of every room (length, width, height). Make the proper plan layout with proper isometric view.
2. Find out application and working plane of every room.
3. As per the illumination standard decide proper lux level on that particular working plane.
4. As per quality of civil work and surrounding conditions and colour of walls and ceiling decide waste light factor, utilization factor, depreciation factor etc.
5. Find out total lumens required on working plane.

$$\text{Total lumens required on working plane} = \frac{AIW}{CD}$$

6. Decide the type and wattage of lamp which is to be used for that particular application
7. Assume the proper illumination efficiency of those specific lamps which are to be used on that working plane

8. Find out total no. of lamps and tubes for that particular working plane and after that find out total no. of lamps & tubes or any other lamps for interior application of commercial installation. By assuming proper space to height ratio make the proper illumination scheme. This procedure is repeated for every working plane in every room.
9. Find out total no. of lamps or tubes for that particular working plane

$$Number\ of\ Lamps\ \ required = \frac{Total\ \ Lumens\ \ \text{Re}quired}{Wattage\ of\ \ each\ \ lamp\ \ \%\,\eta\ of\ each\ \ lamp}$$

10. Find out total power consumption of all interior applications for calculated lamps and tubes.
11. Find out the rated current for all applications.

If 1Ph, 230V supply is provided, $P = VI\cos\phi$

If 3ph, 400V supply is provided, $P = \sqrt{3}\ VI\cos\phi$

12. Determine size of wire or cable required for whole residential or commercial installation. The size of wire is decided by the starting current, which is 1.5 times rated current, for momentary overload S.C. future expansion and starting surge

b) State the functions of luminaries used in flood lighting.

Ans: **The functions of luminaries used in flood lighting:**

(Any Eight points expected, each point -1 Mark, Total 8 Marks)

1. It perform triple function, photometric, mechanical & Electrical
2. To direct to appropriate location without causing glare or discomfort
3. To protect the lamp from mechanical damage.
4. Controlling & distributing of light emitted by the lamp.
5. It controls proper reflection factor
6. Lux level on working plane is well maintained.
7. Smooth and auto control is also possible.
8. Minimum and easy replacement is possible by proper luminaries.
9. Chances of fire Hazard will be less.
10. Percentage of glare will be very less.
11. Over lamping of light and avoidance of shadows is possible.

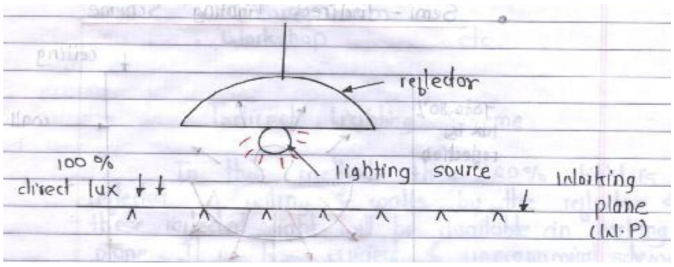
c) Explain lighting schemes for Hospital.

Ans: **lighting scheme adopted for hospitals:** **(2 Marks)**

1. Direct lighting scheme
2. Indirect lighting Scheme
3. Semi indirect scheme
4. General lighting scheme

Explanation : **(Any Three Expected: 2 Mark each, Total 6 Marks)**

i) Direct lighting :

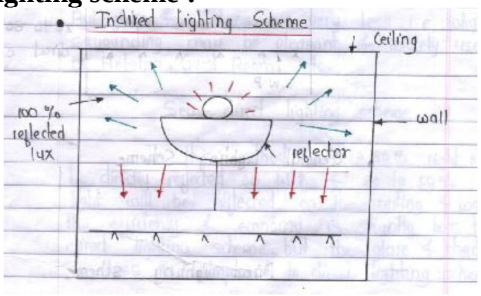


In this method, the reflector is used on the lighting source. The 100% light is reflected by this reflector on the working plane. So efficiency of direct lighting scheme is very high and it is economical also. But limitation of direct lighting scheme is that glare & shadows are more. The direct lighting scheme is widely used in drawing room, workshop etc.

Drawbacks of direct lighting system: (Any one point expected)

1. This scheme is more efficient but it suffers from hard shadows and glare.
2. These light creates tunneling effect i.e ceiling remains dark.

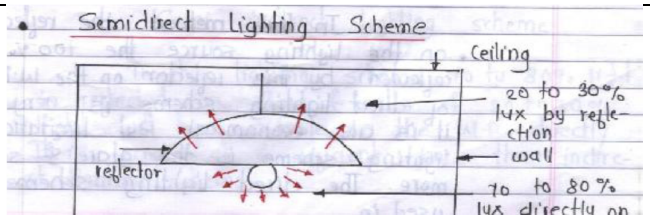
ii) Indirect lighting scheme :-



or equivalent figure

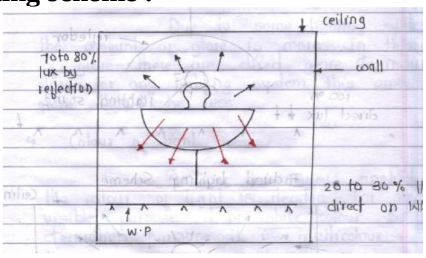
In this method the 100% light is reflected on ceiling and walls by the reflector and this reflected light will be available on working plane. It is less efficient and uneconomical scheme but glare and shadows are very less. i.e. why surrounding may be pleasant and widely used in hotels, guest room etc.

iii) Semi direct lighting scheme :-



In this method, the 70 to 80% light will be directly reflected on the working plane and 20 to 30 % light will be reflected on the ceiling and walls. The efficiency and economy is slightly less than direct lighting scheme. But the glare and shadows are less as compare to direct lighting scheme.

iv) Semi indirect lighting scheme :-



or equivalent figure

In this lighting scheme, 70 to 80% light is reflected on ceiling & walls and 20 to 30% light will be available on the working plane directly. It is economical and efficiency as compared to indirect lighting scheme.

v) General lighting scheme:-

In this lighting scheme, the reflector is not used on the light source, so the lumens emitted by the light source will be reflected on ceiling wall and can be available directly on working plane also.

This method is commonly used in various residential, commercial and industrial installations.

OR

In the lighting scheme lighting calculation and lighting methods are considered.

For Lighting calculation is done according to: **(2 Marks)**

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

Following illumination Scheme for hospitals are also considered : **(6 Marks)**

(Any Six Point expected: 1 Mark each Total: 6 Mark)

1. **Comfortable: -** The energy illumination scheme should be comfortable to everybody.
2. **Pleasant surrounding**: By the electrical lighting or the electrical illumination scheme the surrounding area of that location should be pleasant.
3. **Long Life: -** The life of the designed illumination should be larger.
4. **Economy: -** The cost of the designed illumination scheme should be low.
5. **Less maintenance: -** For any type of illumination scheme the maintenance & repairing should be less.
6. **Appearance: -** The appearance of illumination scheme should be good.
7. **Fewer glares: -** The glare is fatigue to the human eyes. The illumination scheme is designed is such a way that there should be less glare to everyone i.e. Only electrical & mechanical accidents will be less.
8. **Fewer Flickers: -** The flicker is change in light intensity. This flicker should be always less for any type of illumination scheme. In the flicker there are change of stroboscopic effect at the time of workshop lighting in it is very important.
9. **To avoid hard Shadows: -** The whole illumination scheme is designing for minimum shadows. At the time of flood light the hard shadows are avoided.
10. **Sufficient lux Level: -** The lux level is decided by the type of application, type of location.
11. **Cleanliness: -** The illumination scheme should be free from any type of ash, smoke or any other air pollution it should be clean.
12. **Simple Control: -** The illumination scheme designed by the electrical lighting is very simple. The control, multicolour light intensity control is also possible in electrical illumination.

OR

Following illumination Scheme for hospitals are also considered:

In Operation Theater:- **(Any Four Point expected: 1 Mark each Total: 4 Mark)**

1. In operation theater of hospital the direct lighting scheme is normally used.
2. On operation table bunched filament lamps or focus lamps can be used.

3. On operation table sometimes metal halide lamps of lower wattages with multiple sources are also used.
4. Normally high illumination efficiency white colour emitted light source are preferred.
5. In operation theaters some ultraviolet lamps or tubes are also used as a anti-bacteria source.
6. Lux level on the working plane is high. (400 to 600 lux)

In General ward of the hospital:-

(Any Four Point expected: 1 Mark each Total: 4 Mark)

1. General lighting scheme is preferred.
2. Reflectors are not used.
3. Fluorescent tubes, CFL or incandescent lamps are used as a lighting source.
4. Lux level on the working plane is less. (100 to 150 lux)
5. Area of working Plane.
6. $Calculate\ \ Total\ \ Lumens = \frac{A \times I \times W}{C. \times M.F}$
7. Assume wattage and efficiency of the lamp
8. Find out number of lamps =

$$Number\ of\ Lamps\ \ required = \frac{Total\ \ Lumens}{Wattage\ of\ \ each\ lamp \times Illumination\ of\ \ lamp}$$

9. Mark the number of Lamps on given plane layout.
10. Calculate total power.

Q.6	**Attempt any FOUR :**	**16 Marks**
a)	**Explain any four important terms in road lighting.**	
Ans:	**Following four important terms in road lighting:**	**(4 Marks)**

1. **Span:** It is the distance between two poles on a road.
2. **Spacing:** It is the distance between two adjacent poles on which lamps are fitted. **OR** It is a distance between two adjacent lines/live wires.
3. **Mounting height:** It is the distance between lamp source (height) and surface of road to be illuminated. **OR** It is a vertical distance between conductor and ground.
4. **Width of carriageway**: The area of street reserve that is provided for the movement or

parking of vehicles measured from kerb to opposite kerb **OR**

The actual distance between first and last conductor on same pole.

OR

Terms to determine the road lighting may be as below as which are required for the street lighting design :

(Any Four point expected: 1 Marks each, Total 4 Marks)

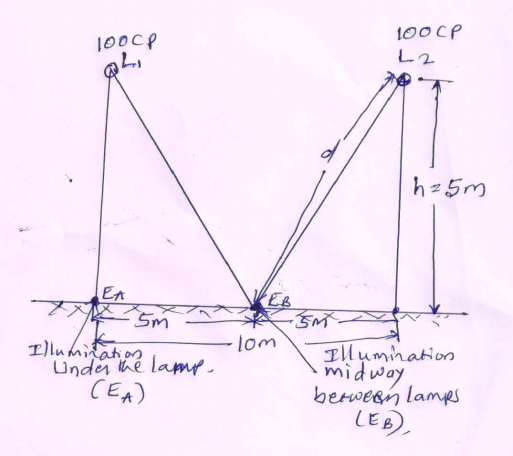
1. The street lighting should be such that the object can be seen driver of any vehicle.
2. The street lighting should be attractive.
3. It should increase the community value.
4. As per the Indian standard, the illumination level required for high traffic density should be 20:30 lux for medium traffic density it should be 8-15 lux & for low traffic density it should be minimum 4 lux.
5. It should be such that a river of any vehicle sees the object up to 30 mtr.
6. Percentage of glare should be less so there are less chances of accidents, for that angle of reflector should be well maintain.
7. It should be electrical & mechanical safe.
8. The replacement of lighting accessories should be simple
9. The maintenance & repairing should be simple future expansion should be carries out without any difficulty.
10. It should be economical.

For high traffic density, generally metal halide lamp, halogen lamps should be used.

For medium traffic density sodium vapour lamp , mercury vapour lamp should be used & for low traffic density CFL, LED and fluorescent tube should be used.

b) Two lamp posts are 10 meters apart and fitted with 100 Cp per amp each at the height of 5 meters of above ground. Calculate illumination (i) under each lamp, (i) midway between the lamps.

Ans:



i) illumination under each lamp:

$$illumination\ under\ each\ lamp = \frac{CP}{h^2} = \frac{100}{(5)^2}$$

$$illumination\ under\ each\ lamp = 4\ Lux$$ ----------**(2 Marks)**

ii) Illumination midway between the lamps:

$$illumination\ midway\ between\ the\ lamp = \frac{2CPCos\phi}{d^2}$$

$$d = \sqrt{(5)^2 + (5)^2}$$

$$d = 7.07106$$

$$Cos\phi = \frac{5}{7.07106}$$

$$Cos\phi = 0.7071$$

$$illumination\ midway\ between\ the\ lamp = \frac{2 \times 100 \times 0.7071}{(7.07106)^2}$$

$$illumination\ midway\ between\ the\ lamp = \frac{141.42}{50}$$

$$illumination\ midway\ between\ the\ lamp = 2.8284\ Lux$$ ---------- **(2 Marks)**

OR

ii) Illumination midway between by the lamps No.1: **(2 Marks)**

$$illumination\ midway\ between\ the\ lamp = \frac{CPCos\phi}{d^2}$$

$$d = \sqrt{(5)^2 + (5)^2}$$

$$d = 7.07106$$

$$Cos\phi = \frac{5}{7.07106} \qquad Cos\phi = 0.7071$$

$illumination\ midway\ between\ the\ lamp = \frac{100 \times 0.7071}{(7.071)^2}$

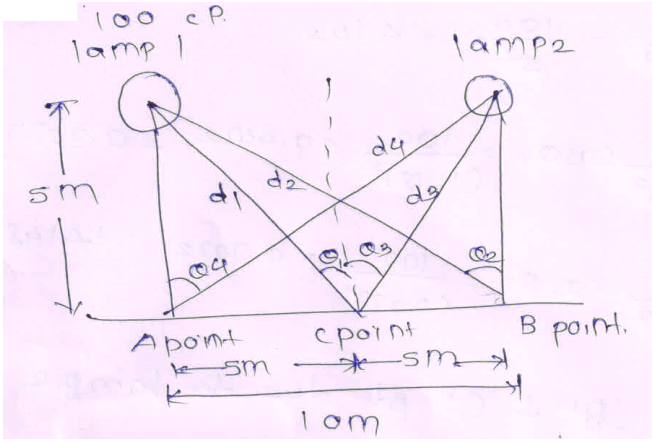
$illumination\ midway\ between\ the\ lamp = 1.4144\ lumens$

$Similary\ by\ lampTwo = 1.4144\ lumens$

So, Total lumens at midway = 1.4144 + 1.4144 = 2.8288 Lumens

Total lumens at midway = 2.8288 Lumens

OR Student may solve this way



(1 Mark)

1)

$$d_1 = \sqrt{(5)^2 + (5)^2} = 7.07$$

$$d_2 = \sqrt{(5)^2 + (10)^2} = 11.18$$

$$d_3 = \sqrt{(5)^2 + (5)^2} = 7.07$$

$$d_4 = \sqrt{(5)^2 + (10)^2} = 11.18$$

2)

$$\cos\phi_1 = \frac{h}{d_1} = \frac{5}{7.07} = 0.7072$$

$$\cos\phi_2 = \frac{h}{d_2} = \frac{5}{11.18} = 0.4472$$

$$\cos\phi_3 = \frac{h}{d_3} = \frac{5}{7.07} = 0.7072$$

$$\cos\phi_4 = \frac{h}{d_4} = \frac{5}{11.18} = 0.4472$$

3) illumination at 'A', 'B', 'C' point due to lamp -1 : **(1 Mark)**

$$at\ point\ 'A' = \frac{I}{h^2} = \frac{100}{(5)^2} = 4\ Lux$$

$$at\ point\ 'B' = \frac{I}{d_2^{\,2}}\cos\phi_2 = \frac{100}{(11.18)^2} \times 0.4472 = 0.3577\ Lux$$

$$at\ point\ 'C' = \frac{I}{d_1^{\,2}}\cos\phi_1 = \frac{100}{(7.07)^2} \times 0.7072 = 1.4148\ Lux$$

4) illumination at 'A', 'B', 'C' point due to lamp -2 : **(1 Mark)**

$$at\ point\ 'B' = \frac{I}{h^2} = \frac{100}{(5)^2} = 4\ Lux$$

$$at\ point\ 'A' = \frac{I}{d_4^{\,2}}\cos\phi_4 = \frac{100}{(11.18)^2} \times 0.4472 = 0.3577\ Lux$$

$$at\ point\ 'C' = \frac{I}{d_3^{\,2}}\cos\phi_3 = \frac{100}{(7.07)^2} \times 0.7072 = 1.4148\ Lux$$

5) illumination at point 'A' :

$$illumination\ at\ point\ 'A' = 4 + 0.3577 = 4.3577\ Lux$$

6) illumination at point 'B' :

$$illumination\ at\ point\ 'B' = 0.3577 + 4 = 4.3577\ Lux$$

illumination Midway between Lamps : **(1 Mark)**

$$illumination\ midway\ between\ lamps = 1.4148 + 1.4148$$

$$illumination\ midway\ between\ lamps = 2.8296\ \ lux$$

c)	Which are three different methods of lighting calculation methods? Explain any one.
Ans:	**Following methods of lighting calculation methods:** **(2 Mark)**

4. Lumens or Light flux method
5. Point to point or Inverse Square law method
6. Watts per Square meter method

Explanation: **(Explanation of Any one method expected : 2 Mark)**

i) Lumens or Light flux method:

This method is applied where an average illumination is required also when inform illumination is required. Total lumens output is calculated from the efficiency of each lamp and the number of lamp is used in the circuit. To calculate lumens received on the working plane, The total lumens already calculated 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 appoint 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 accordingly to the illumination desired on an average value considering overall efficiency of the lighting system.

d) State the importance of light house in the shipyards and state different types of lights are provided by light house.

Ans:

The importance of light house: **(2 Marks)**

A **lighthouse** is a tower, building, or other type of structure designed to emit light from a system of lamps and lenses and to serve as a navigational aid for maritime pilots at sea or on inland waterways.

Lighthouses mark dangerous coastlines, hazardous shoals, reefs, and safe entries to harbors; they also assist in aerial navigation. Once widely used, the number of operational lighthouses has declined due to the expense of maintenance and use of electronic navigational systems.

The following types of lights are provided by light house. **(2 Marks)**

1. Arc lamp
2. Metal halide Lamp
3. Focus Lamp
4. High wattages neon lamps
5. Flashers

e) Explain the different lighting schemes used for agricultural and horticultural applications.

Ans:

In lighting scheme lighting calculation is very important point which depends upon type of applications for agricultural and horticultural purpose.

List the various indoor lighting:

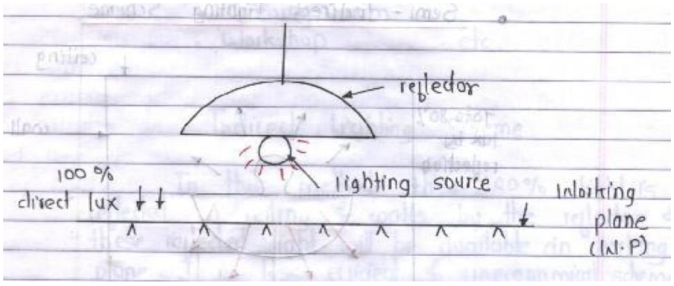
(Any Two Schemes expected: 1/2 Mark each, Total 1 Mark)

1. Direct Lighting Scheme
2. Indirect lighting scheme
3. Semi direct Lighting Scheme
4. Semi indirect lighting Scheme
5. General Lighting Scheme

Explanation :

(Any one explanation Expected: Figure; 1 Mark & Explanation: 2 Mark)

i) Direct lighting :

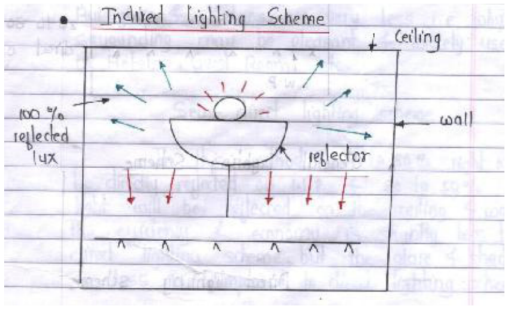


In this method, the reflector is used on the lighting source. The 100% light is reflected by this reflector on the working plane. So efficiency of direct lighting scheme is very high and it is economical also. But limitation of direct lighting scheme is that glare & shadows are more. The direct lighting scheme is widely used in drawing room, workshop etc.

Drawbacks of direct lighting system: (Any one point expected)

1. This scheme is more efficient but it suffers from hard shadows and glare.
2. These light creates tunneling effect i.e ceiling remains dark.

ii) Indirect lighting scheme :-

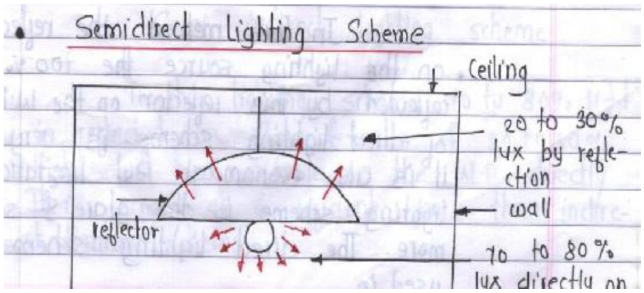


or equivalent figure

In this method the 100% light is reflected on ceiling and walls by the reflector and this reflected light will be available on working plane. It is less efficient and uneconomical

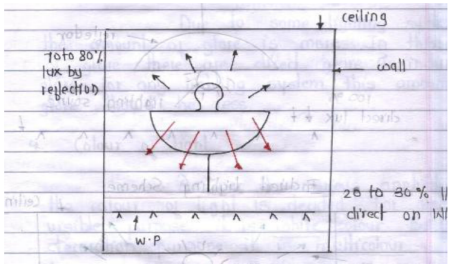
scheme but glare and shadows are very less. i.e. why surrounding may be pleasant and widely used in hotels, guest room etc.

iii) Semi direct lighting scheme :-



In this method, the 70 to 80% light will be directly reflected on the working plane and 20 to 30 % light will be reflected on the ceiling and walls. The efficiency and economy is slightly less than direct lighting scheme. But the glare and shadows are less as compare to direct lighting scheme.

iv) Semi indirect lighting scheme :-



or equivalent figure

In this lighting scheme, 70 to 80% light is reflected on ceiling & walls and 20 to 30% light will be available on the working plane directly. It is economical and efficiency as compared to indirect lighting scheme.

v) General lighting scheme:-

In this lighting scheme, the reflector is not used on the light source, so the lumens emitted by the light source will be reflected on ceiling wall and can be available directly on working plane also.

This method is commonly used in various residential, commercial and industrial installations.

OR Student may write this way

In the lighting scheme lighting calculation and lighting methods are considered.

For Lighting calculation is done according to: **(2 Marks)**

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

Lighting schemes used for agricultural and horticultural applications:

(Any Two point expected : 1 Marks each, Total 2 Marks)

- Direct Lighting Scheme is preferred for agricultural and horticultural applications.
- Because for the growth of plants, flowers etc the rays of light from the source (Lamps) should reach them directly.
- The warm and light effect is provided as a natural sun light whenever it required.
- The wind pressure is also provided by maintaining the exhaust fan/ regular fan.
- Room temperature and humidity is also controlled.

----------**END**----------