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 of the following:** **12 Marks**
a)	**State any four requirements of good illumination scheme.**
Ans:	**Following requirements of good illumination scheme:** **(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)	**Write any four advantages of halogen lamps.**
Ans:	**Advantages of halogen lamps:** **(Any Four advantage's expected: 1 Mark each)** 1. Compact Size 2. No Ballast 3. Good colour rendering 4. Excellent optical control

5. Excellent lumens maintenance
6. Available in various size.
7. Higher lumens output.
8. High operating temperature
9. No blackening of lamp

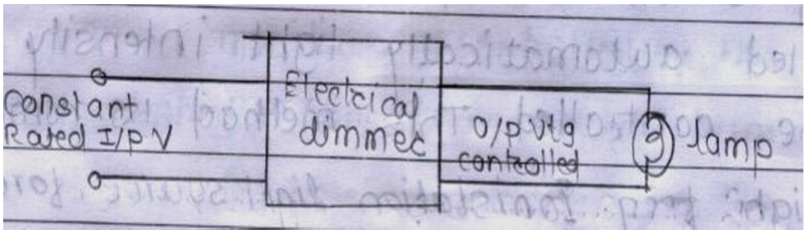
c) State the purpose of lighting control equipment.

Ans: **Purpose of Lighting Control:** **(Any Four point expected: 1/each point)**

1. Shadows: - Shadows should be minimum.
2. Glare: - Glare should be minimum.
3. Uniformity: - uniform distribution of light throughout the working plane.
4. Colour of light: - Choose fitting which produces colour like a day light e.g. Fluorescent tube
5. To turn ON or OFF the the lamps
6. For dimming, the dimming control permits the adjustment of lighting over a range.
7. For changing the lighting levels according to need or desired of the owner.
8. For energy saving.
9. To increase the life of lighting source.
10. To increase the safety of lighting system.
11. In some types of industrial or automation there is anent of lighting control.
12. To provide proper lux level on working plane the lighting control is required.
13. To provide proper lux level on working plane the lighting control is required.
14. As per Indian or international standard
15. To control the brightness of T.V monitor there is need of lighting control.

OR

Purpose of of lighting control:- **(4 Mark)**



In the electrical dimmer electrical components for e.g. rheostat, transformer etc are

commonly used. In the electrical dimmer the input voltage is always constant and output voltage across lamp is changed to control the brightness of light intensity. In the electrical dimmer there are four types.

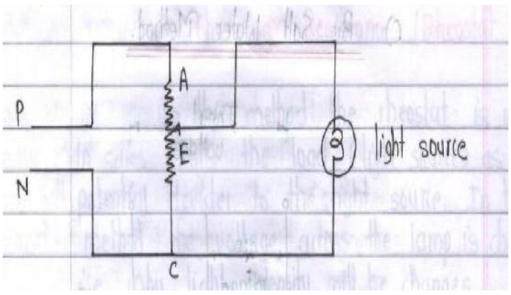
OR

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.

d) Draw a neat diagram of resistance dimmer circuit and explain in brief its working.

Ans:

Resistance dimmer circuit – **(Circuit diagram: 2 Mark & Explanation: 2 Marks)**



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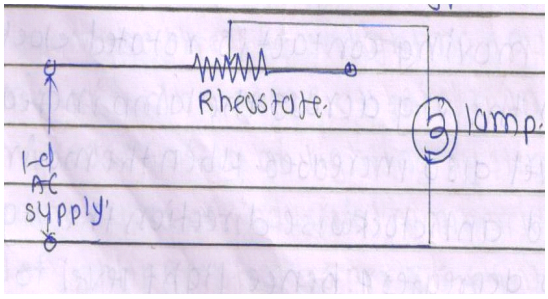


- Above figure shows the resistance or rheostat dimmer arrangement, In this method the rheostat is connected in series with lamp, by moving the sliding contacts of the rheostat.
- The voltage across the lamp can be controlled from 0 to 100 %.
- Hence accordingly the level of illuminations can be controlled.
- In this method as resistance changes output voltage across the light sources changes of that light intensity will be changes.

Q.1B) **Attempt any ONE of the following :** **06 Marks**

a) **Compare sodium vapour lamp and mercury vapour lamp on the following aspects (i) Working principle (ii) Life in Hours (iii) Starting time (iv) Lumens per watt (v) Initial cost (vi) Brightness**

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

S.No	Points	Sodium Vapour lamp	Mercury Vapour lamp
1	**Working principle**	Discharge principal	Discharge principal
2	**Life in Hours**	Life more 12000-16000 hrs.	Life less than SV lamp 12000 hrs
3	**Starting time**	More	Less
4	**Lumens per watt**	Luminous efficiency Lm/w 80-100	Luminous efficiency Lm/w 40-60
5	**Initial cost**	High	Low
6	**Brightness**	Less	More

b) **Define (i) Mean spherical candle power (ii) Luminous efficiency (iii) Space to height ratio**

Ans:

i) MSCP (Mean Spherical Candle power): **(2 Mark)**

It is the average of all candle powers in all direction in all planes. **OR**

$$MSCP = \frac{Total\ \ Lu\min ous\ lux\ in\ lumens}{4\,\Pi}$$

iv) Luminous efficiency (lamp efficiency):- **(2 Mark)**

It is defined as the ratio of the total luminous flux emitting from the source to Its electrical power input in watts.

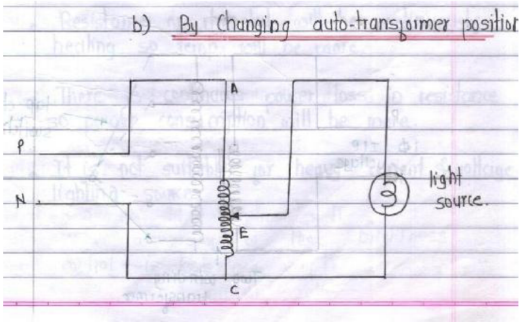
(iii) Space to height ratio: **(2 Mark)**

It is the ratio of horizontal distance between two adjacent lamps to the mounting height of the lamps.

OR

$$Space\ \ height\ ratio = \frac{Space\ \ between\ \ lamps}{Height\ \ of\ \ lamps\ \ above\ \ working\ \ \ plane}$$

Q.2	**Attempt any TWO :** **16 Marks**
a)	**Explain both the types of Dimmer transformer in detail for illumination control drawing the necessary figures.**
Ans:	**Following types of Dimmer transformer in detail for illumination control** **1) By using auto transformer –** **(Figure : 2 Mark & Explanation: 2 Mark)**

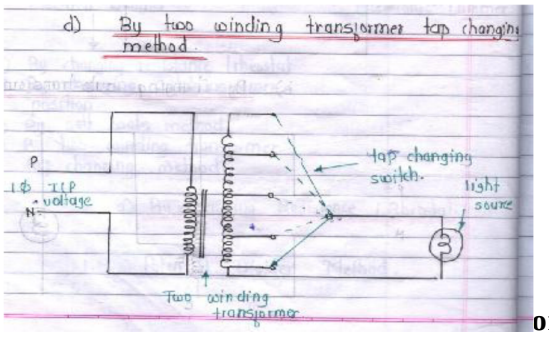


or equivalent figure

- 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.

2) By two winding transformer tap changing method –

(Figure : 2 Mark & Explanation: 2 Mark)



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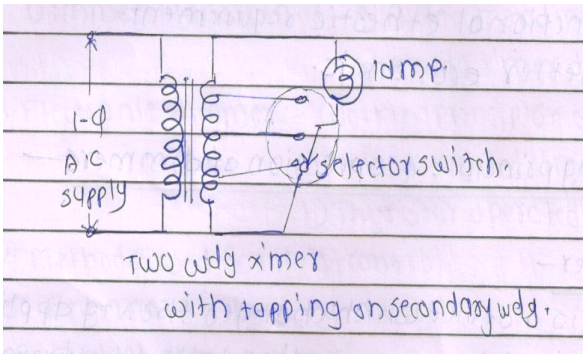


or equivalent figure

- Output voltage across the source depends upon tap position of the two winding. Transformer so that light intensity of light sources will be changes.
- In this type the voltage across the lamp is controlled according to the light level required by changing the selector switch over the tapping.
- Isolation is available

b) Estimate the number and wattage of lamps which would be required to illuminate a workshop spaced 60 x 15 m by means of lamps mounted 6 m above the working plane. The average illumination required is about 100 lux, coefficient of utilization is 0.4, luminous efficiency is 16 lumens per watt. Assume a space-height ratio of unity and a candle power depreciation of 20%.

Ans:

Given Data:

E = 100 Lux Area of working plane = 60m x 15 m = 900 m^2

U.F = 0.4 & D.F 0.8 or 1.2 height=H=6 Mts space/height=1

Efficiency of lamp = 16 lumens/watt

Candle power depreciation of 20%. So D.F = 0.8 Assumed

Determine: 1) Number of lamps if luminous efficiency of 14 lumens/watt

Solution:

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

$$Gross\ \ Lumens = \frac{900 \times 100}{0.4 \times 0.8}$$ -

$$Gross\ \ Lumens = \frac{90000}{0.4 \times 0.8}$$

$$Gross\ \ Lumens = 281250\ lumens$$ ---------- **(1 Marks)**

$$Total\ Wattage\ required = \frac{Gross\ \ Lumens}{Li\,\text{min}\,ous\ efficiency\ in\ \ lumens\ /\ watt}$$ ---------- **(1 Marks)**

$$Total\ Wattage\ required = \frac{281250}{16}$$

$$Total\ Wattage\ required = 17578.125\ \ Watts$$ ---------- **(1 Marks)**

Space/height=1 hence space=6

$$\text{No. of lamps length wise} = \frac{Lenght}{space} = \frac{60}{5} = 12\ Nos$$

$$\text{No. of lamps width wise} = \frac{width}{space} = \frac{15}{5} = 3.7 \approx 3\ \ Nos$$

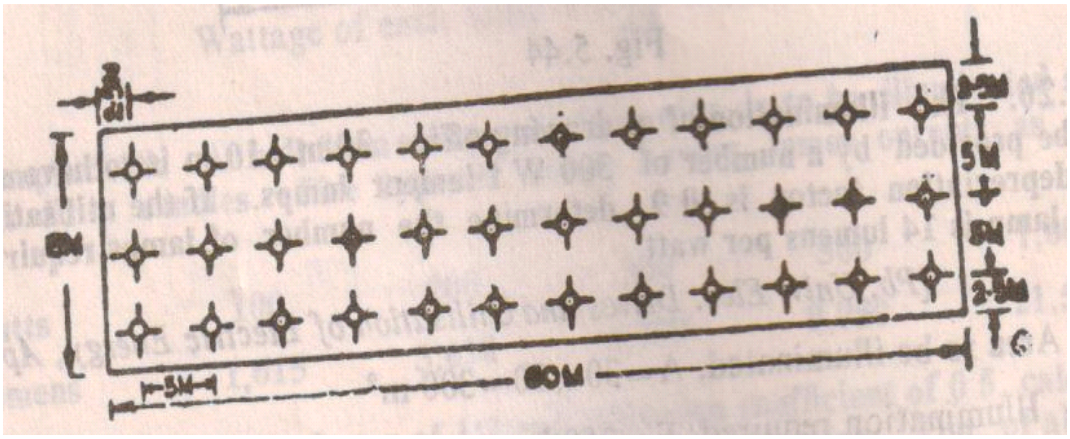
$$\text{Total No. of lamps} = Length\ wise \times width\ wise = 12 \times 3 = 36\ Nos$$ ---------- **(1 Marks)**

$$Wattage\ \ of\ \ each\ lamp = \frac{Total\ \ watage\ \ required}{No.\ of\ \ lamp} \text{ -} \quad \text{---------- (1 Marks)}$$

$$Wattage\ \ of\ \ each\ lamp = \frac{17578}{36}$$

$$Wattage\ \ of\ \ each\ lamp = 488.277\ \approx\ 500\ watts \quad \text{---------- (2 Marks)}$$

Location of the lamps:



OR Student Write this way if : D.F = 1.2 :

Solution:

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

$$Gross\ \ Lumens = \frac{900 \times 100 \times 1.2}{0.4} \text{ -}$$

$$Gross\ \ Lumens = \frac{108000}{0.4}$$

$$Gross\ \ Lumens = 270000\ lumens \quad \text{---------- (1 Marks)}$$

$$Total\ Wattage\ required = \frac{Gross\ \ Lumens}{Li\min ous\ efficiency\ in\ \ lumens\ /\ watt} \quad \text{---------- (1 Marks)}$$

$$Total\ Wattage\ required = \frac{270000}{16}$$

$$Total\ Wattage\ required = 16875\ \ Watts \quad \text{---------- (1 Marks)}$$

Space/height=1, hence space=6 mts

$$\text{No. of lamps length wise} = \frac{Lenght}{space} = \frac{60}{6} = 10\ Nos$$

$$\text{No. of lamps width wise} = \frac{width}{space} = \frac{15}{6} = 2.5 \approx 3\ Nos$$

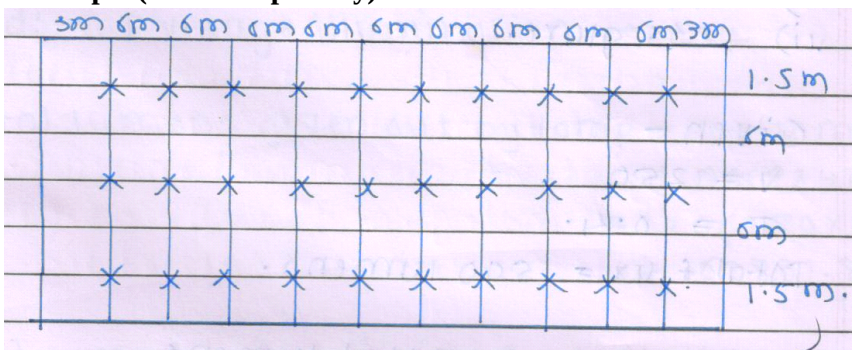
Total No. of lamps = $Length\ wise \times width\ wise = 10 \times 3 = 30\ Nos$ ---------- **(1 Marks)**

$$Wattage\ of\ each\ lamp = \frac{Total\ watage\ required}{No.\ of\ lamp} -$$ ---------- **(1 Marks)**

$$Wattage\ of\ each\ lamp = \frac{16875}{30}$$

$Wattage\ of\ each\ lamp = 562.50 \approx 600\ watts$ ---------- **(2 Marks)**

Location of the lamps: (Not Compulsory)



c) **(c) The front of a building 50 m x 16 m is illuminated by 16 nos. of 1000 watts lamps arranged so that uniform illumination on the surface is obtained. Assume :**
1. Luminous efficiency = 17.4 lumens/watt.
2. Utilization factor = 0.4
3. Depreciation factor = 1.3
4. 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)**

$$Total\ \ Luminous\ due\ to\ the\ lamps = \ lu minous\ \ effciency \times total\ \ wattage\ of\ \ the\ all\ lamps$$

$$Total\ \ Luminous\ due\ to\ the\ lamps = \ 17.4 \times 16000$$

$$Total\ \ Luminous\ due\ to\ the\ lamps = \ 278400\ lumens$$

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

But as per equation No. I :

$$Gross\ \ Lumens = \ 3120\ E$$

Putting value of equation No.II :

$$Gross\ \ Lumens = \ 3120\ E$$

$$278400 = \ 3120\ E$$

$$So,\ \ Avarage\ \ illuminations\ \ E = \frac{278400}{3120}$$

$$So,\ \ Avarage\ \ illuminations\ \ E = 89.230\ \ lux$$ ---------- **(2 Marks)**

Q.3	**Attempt any FOUR :** **16 Marks**
a)	**State any four basic requirements of street lighting.**
Ans:	**basic requirements of street lighting:** **(Any four point expected: 1 Marks each)** 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. **OR** **Main Objectives of street Lighting:** 1) To make the road clearly visible. 2) To promote safety & convenience to the traffic. 3) To make the street more attractive. 4) To increase the community value of the street.
b)	**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.

c) Find (i) MSCP (ii) Luminous intensity in lumens per watt (iii) MSCP per watt of a 250 volts lamp which takes a urrent of 0.4 amp and has a total flux of 1500 lumens.

Ans:

$$Total\ MSCP\ of\ the\ lamp = \frac{Total\ lumens\ required\ on\ working\ plane}{4\pi}$$ ---------- **(1/2 Marks)**

$$i)\ Total\ MSCP\ of\ the\ lamp = \frac{1500}{4\pi}$$

$$Total\ MSCP\ of\ the\ lamp = 119.3662$$

---------- **(1/2 Mark)**

$$Power\ of\ the\ lamp\ = V \times I = 250 \times 0.4 = 100\ watt$$

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

$$ii)\ Luminous\ intensity\ in\ Lumens\ per\ Watt\ = \frac{1500}{100} = 15$$

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

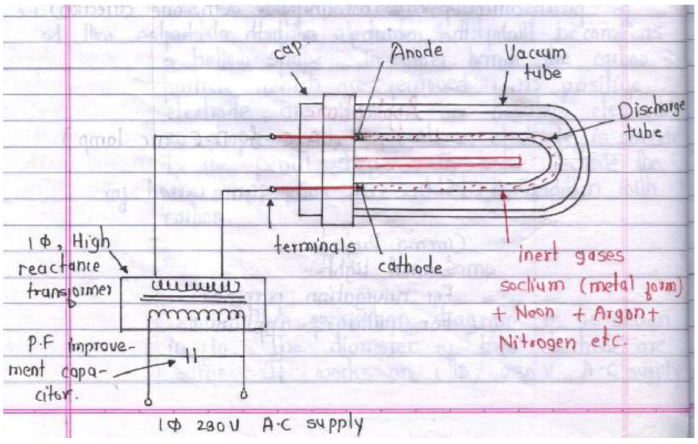
$$iii)\ MSCP\ per\ Watt\ = \frac{119.366}{100} = 1.19366$$

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

d) Explain the construction and working of sodium vapour lamp with a neat sketch.

Ans: **Diagram of sodium vapour lamp:**

(Construction-1 Marks, Working-2 Marks & Figure-1 Mark)



or equivalent figure

Construction:-

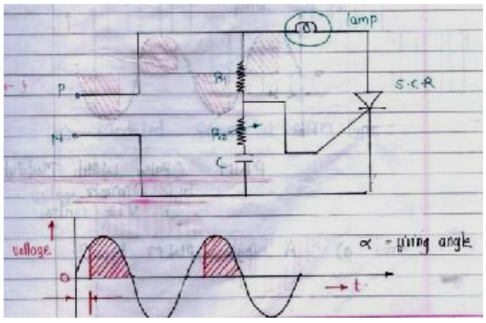
Above figure shows constructional details of sodium vapour lamp. It consists of 'U' shaped tube and at the ends of the tube two electrodes are sealed. This tube is filled with sodium and small quantity of neon gas. Since there is great effect of the change of surrounding temperature on the light output given by the lamp, hence the inner tube is enclosed in an outer double walled glass tube. Before sealing the lamp vaccum is created between the two glass tube (inner & outer).

Working:-

Before the lamp starts working, the sodium is usually in the solid form deposited on the sides of the inner tube wall. When the voltage is applied to the lamp it warms up and starts vaporizing slowly and radiates out yellow colour light and after about 10 to 20 minutes, the lamp starts giving it's full output.

e) Describe the working principle and construction of thyristor operated dimmer with diagram.

Ans: **Thyristor or SCR operated dimmer:–** **(Figure : 2 Mark & Explanation: 2 Mark)**



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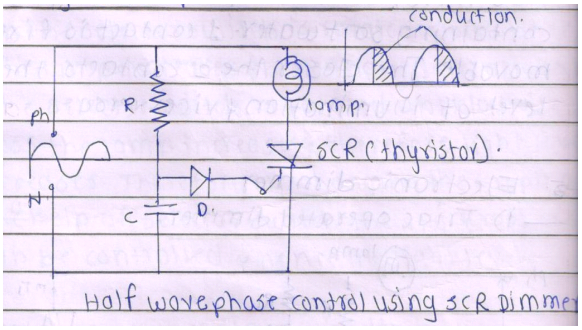


or equivalent figure

The SCR is generally used as switching component in electrical system. In the SCR when the anode terminal is +ve cathode is –ve and if the trigger pulse is applied to the gate of the SCR, then at that moment SCR will start conducting.

In the present circuit the capacitor is charged through variable resistance R2 so that Charging time constant (R2C) will be decided and after that whenever capacitor is fully charged it will discharge through the gate terminal, and SCR will be fired [ON]. The firing

period is decided by the value of R2C i.e. why conduction & firing angle will be changed. This firing angle may be vary 0 to 180° i.e. why the fired output voltage can be (variable) available across the lamp. So that light intensity will be changes, By the SCR only +ve half cycle are controlled.

Q.4 A) Attempt any THREE : 12 Marks

a) Write the recommended level of illumination in lux for the following areas of an office (i) Entrance halls and reception area (ii) Conference room (iii) Stairs (iv) Lift landing

Ans: **Recommended illumination level required for any four area of residential premises.**

(Each Point : 1 Mark)

S.No	Places of Office Purpose	illumination level in lux
i)	Entrance halls and reception area	150 to 200 Lux
ii)	Conference room	300 Lux
iii)	Stairs	70 to 100 Lux
iv)	Lift landing	70 o 100 Lux

b) A room of size 15 x 6 m is to be illuminated by twenty 200 W lamps. The MSCP of each lamp is 250. Assume a depreciation factor 1.2 and utilization factor 0.6 Find the average illumination produced on the floor.

Ans:

i) Area of room=A=15 × 6 m= 90 sq mtr. ii) MSCP of each lamp = 250

iii) Depreciation factor=D.F= 1.2 iv) Co-efficient of utilization= U.F=0.6

v) Number of lamps = 20 vi) wattage of each lamp = 200 watts

Find: Average illumination=E=?

Solution:

Total lumens given out by all lamps= $(MSCP \times 4\pi) \times 20$ ---------- **(1/2 Mark)**

$= (250 \times 4\pi) \times 20$

= 62831.853 Lumens. ---------- **(1 Mark)**

Total lumens received on the floor = Total lumens given out by all lamps x $\frac{U.F}{D.F}$ ------ **(1/2 Mark)**

Total lumens received on the floor = $62831.853 \times \frac{0.6}{1.2}$

= 31415.9265 Lumens. ---------- **(1 Mark)**

Average illumination on the floor = $E_{AV} = \frac{Total\ lumens\ recieved\ on\ the\ floor}{Area}$

$= \frac{31415.9265}{90}$

E_{AV}= 349.065 Lumens per square mtr--- Answer---------- (1 Mark)

OR

E_{AV}= 349.065 Lux --- Answer

c) Which type of lamp is used for fresh water aquarium and why?

Ans: **lamp is used for fresh water aquarium:** **(Type of Lamps : 2 Mark)**

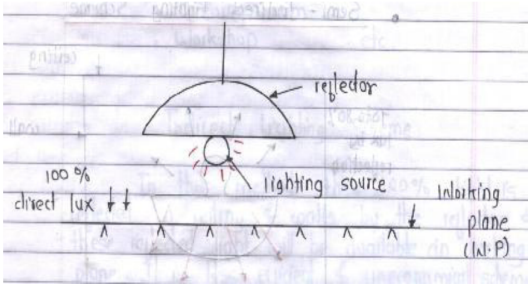
1. Ultraviolet Lamp
2. CFL Lamp
3. LED Lamp
4. Small wattage Halogen Lamp
5. Decorative Lamp

Reason: **(2 Mark)**

1. Due to ultraviolet lamps / tubes the bacteria in the water will kill that is why life of fish (Aquatic animals) will increased.
2. Beauty of aquarium will increase.
3. The surrounding condition will be fruitful to plants and fishes to increase their life.

d) Explain direct and semi-direct lighting with the required sketches.

Ans: **i) Direct lighting :** **(2 Mark)**

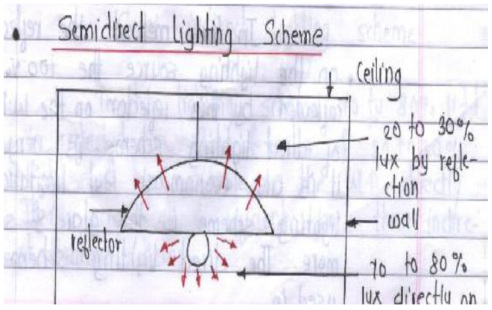


In this method, the reflector is used on the lighting source. The 100% light is reflected by this reflector on the working plane. So efficiency of direct lighting scheme is very high and it is economical also. But limitation of direct lighting scheme is that glare & shadows are more. The direct lighting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

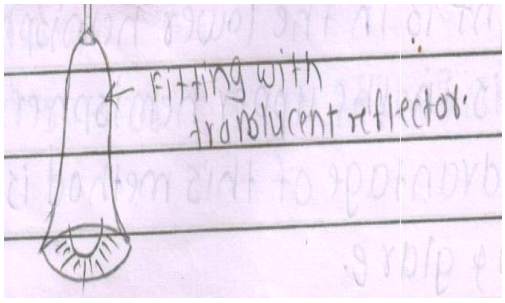
Drawbacks of direct lighting system: (Any one point expected)

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) Semi direct lighting scheme :- **(2 Mark)**



OR



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.

Q. 4B)	**Attempt any ONE :** **06 Marks**
a)	**An illumination on the working plane of 75 Lux is required in a room 72 m x 15 m in size. The lamps are required to be hung 4 m above the work bench. Assume a suitable space-height ratio, a utilization factor of 0.5, a lamp efficiency of 14 lumens per watt and a candle power depreciation of 20%, estimate the number, rating and disposition of lamps.**

Ans:

NOTE: 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.

Given Data:

E = 75 Lux — Area of working plane = 72 m x 15 m = 1080 m^2

U.F = 0.5 & D.F = 0.8 or 1.2 — Assume Wattage of each lamp = 200 watt

Efficiency of lamp = 14 lumens/watt — Height=H=4 Mts

Determine: 1) Number of lamps if luminous efficiency of 14 lumens/watt

If Student get D.F = 0.8 :

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

$$Gross\ \ Lumens = \frac{1080 \times 75}{0.5 \times 0.8}$$

$$Gross\ \ Lumens = \frac{81000}{0.5 \times 0.8}$$

$Gross\ \ Lumens = 202500$ ---------- **(1 Marks)**

$Number\ of\ \ Lamps\ \ \ required = \dfrac{Gross\ \ Lumens}{Wattage\ of\ \ each\ lamp \times efficiency\ of\ \ each\ lamp}$ --**(1 Marks)**

$$Number\ of\ \ Lamps\ \ \ required = \frac{202500}{200 \times 14}$$

$Number\ of\ \ Lamps\ required = 72.32 \approx 72\ Lamps$ ---------- **(2 Marks)**

Their disposition: **(1 Mark)**

- Assume space to height ratio = 3:4 = 0.75
- Number of lamps lengthwise (No of rows) = $\dfrac{Length\ (L)}{Space\ (S)} = \dfrac{75}{3} = 25$
- Number of lamps widthwise (No of columns) = $\dfrac{Width\ (W)}{Space\ (S)} = \dfrac{15}{5} = 3$

---------- L= 72 Meters ----------

5M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M	3M
5M																							
5M																							

Fig: Dispositions of lamps (at each cross or Junction of 3 lines there is one lamp except 1st columns)

Total number of lamps as per illumination design = 24 x 3 = 72 Nos

If Student write this way D.F = 1.2 :

Solution: $Gross\ \ Lumens\ (lumens\ recived) = \dfrac{A \times E \times D.F}{U.F}$ ---------- **(1 Marks)**

$$Gross\ \ Lumens = \frac{1080 \times 75 \times 1.2}{0.5}$$

$$Gross\ \ Lumens = \frac{97200}{0.5}$$

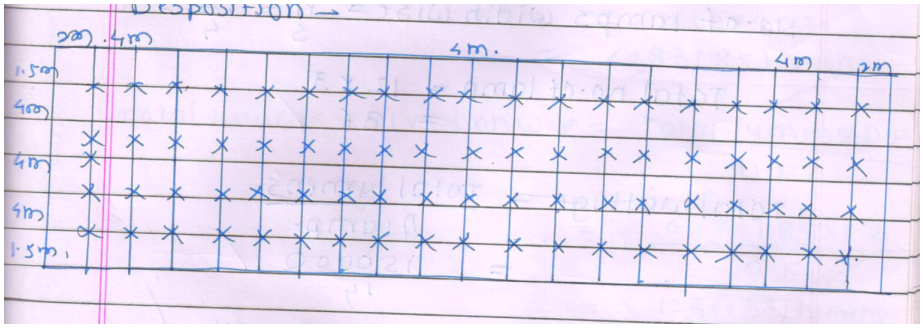
$$Gross\ \ Lumens = 194400$$ ---------- **(1 Marks)**

Their disposition S.H.R: 1 Space : 4 Mtr **(1 Mark)**

- Assume space to height ratio = 1
- Number of lamps lengthwise (No of rows) = $\dfrac{Length\ (L)}{Space\ (S)} = \dfrac{72}{4} = 18$
- Number of lamps widthwise (No of columns) = $\dfrac{Width\ (W)}{Space\ (S)} = \dfrac{15}{4} = 3.75 \approx 4$

Total number of lamps as per illumination design = 18 x 4 = 72 Nos

Dispositions:



$$Total\ \ Wattage = \frac{Total\ \ lumens\ \ revcived}{luminous\ \ efficency}$$ ----------**(1 Marks)**

$$Total\ \ Wattage = \frac{194400}{14}$$

$$Total\ \ Wattage = 13885.71\ \ watts$$ ----------**(1 Marks)**

$$Wattage\ \ of\ \ each\ \ lamp = \frac{Total\ \ wattage}{No.\ of\ \ Lamp} = \frac{13885.71}{72}$$

$$Wattage\ \ of\ \ each\ \ lamp = 192.85 \approx 200\ Watts$$ ----------**(1 Marks)**

b) **Which type of light source is used for following application :**
(i) Advertisement (ii) Flood lighting (iii) Street lighting (iv) Decorative lighting (v) Hospital (vi) Railway platform lighting

Ans: **Recommended illumination level required for any four area of residential premises.**

(Each Point : 1 Mark)

S.No	Application	Light source
i)	Advertisement	Metal halide Lamp, Neon Lamp, Halogen lamp, LED lamp, Neon Tube
ii)	Flood lighting	Mercury vapour Lamp, Halogen Lamp, LED lamp, Metal Halide etc
iii)	Street lighting	Mercury vapour Lamp, sodium vapour lamp, Fluorescent lamp, LED Lamp, Metal Halide lamp etc
iv)	Decorative lighting	Metal halde Lamp, Neon Lamp, Multi colour LED Lamp, Small capacity projector lamp, Neon Tube
v)	Hospital	Fluorescent lamp, LED lamp, Halogen Lamp. Ultraviolet lamp, infrared lamp, CFL, Bunched filament projector lamp, Focus lamp
vi)	Railway platform lighting	Metal halde Lamp, Mercury vapour Lamp, sodium vapour lamp, Fluorescent lamp, LED Lamp, incandescent lamp

Q.5 **Attempt any TWO** **16 Marks**

a) **A minimum illumination of 80 lumens/m2 is required in the factory shade of 50 in x 12 m. Calculate the number, location and wattage of the units used. Assume that depreciation factor 0.8, coefficient of utilization is 0.4 and efficiency of lamp units is 14 lumens/watt.**

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 = 80 lumen/sqm
U.F = 0.4 & D.F = 0.8
Efficiency = 14 lumens/watt
Area of working plane = 50 m x 12m = 600 sq m
Wattage of Lamps Assumed = 100 watt /200/500 Watt assumed: Waste light factor = 1

i) Total Lumens utilized = E x A or ---------- **(1/2 Marks)**

= 80 x 600 = 48000 Lumens----------**(1 Marks)**

ii) Total Lumens given out by the lamp $= \frac{Total\ lumens\ utilised}{U.F \times D.F}$ --------- **(1/2 marks)**

$= \frac{48000}{0.6 \times 0.8}$

$= 150000\ Lumens$ ---------- **(1 Marks)**

iii) Total Wattage $= \frac{Total\ lumens\ given\ out\ by\ the\ lamps}{lu\,min\,ous\ efficiency}$ ---------- **(1/2 Marks)**

$= \frac{150000}{14}$

$= 10714.285\ \ Watts$ ---------- **(1 Marks)**

The wattage of lamps is assumed – 100 watt

iv) Number of Lamps $= \frac{Total\ Wattage}{Wattage\ of\ each\ lamp}$ ---------- **(1/2 Marks)**

$= \frac{10714.285}{100}$

$= 107.142 \cong 107\ \ Nos$ ---------- **(2 Marks)**

$\therefore Numbers\ of\ lmaps = 107\ Nos$

OR Student May Write this way

Total lumens required on working plane $= \frac{AIW}{C \times D}$ ---------- **(1/2 Mark)**

$= \frac{600 \times 80 \times 1}{0.4 \times 0.8}$

$= 150000\ Lumens$ ----------**(1 Marks)**

iii) Total Wattage $= \frac{Total\ lumens\ given\ out\ by\ the\ lamps}{lu\,min\,ous\ efficiency}$ ----------**(1/2 Marks)**

$= \frac{150000}{14}$

$= 10714.285\ \ Watts$ ---------- **(1 Marks)**

iv) Number of Lamps $= \frac{Total\ Wattage}{Wattage\ of\ each\ lamp}$ ----------**(1 /2 Marks)**

$$= \frac{10714.285}{100}$$

$$= 107.14 \cong 107 \ Nos \ of \ lamp$$ ----------**(1 Marks)**

$$\therefore Numbers \ of \ lamps = 107 \ Nos \ of \ 100 \ watt$$

OR Student Assume Wattage of Lamp = 200 watt

iv) Number of Lamps $= \frac{Total \ Wattage}{Wattage \ of \ each \ lamp}$ ----------**(1/2 Marks)**

$$= \frac{10714.285}{200}$$

$$= 53.571 \cong 54 \ Nos \ of \ lamp$$ ----------**(2 Marks)**

$$= 54 \ Nos \ of \ lamp$$

OR Student Assume Space to height ratio = 1 , H = 4 Mtr , Space = 4 mtr

Total lumens required on working plane = $\frac{AIW}{C \times D}$ ---------- **(1/2 Mark)**

$$= \frac{600 \times 80 \times 1}{0.4 \times 0.8}$$

$$= 150000 \ Lumens$$ ----------**(1 Marks)**

No. of lamps length wise = $\frac{Lenght}{space} = \frac{50}{4} = 12.5 \approx 12 \ Nos$

No. of lamps width wise = $\frac{width}{space} = \frac{12}{4} = 3 \ Nos$

Total No. of lamps = $Length \ wise \times width \ wise = 12 \times 3 = 36 \ Nos$ ----------**(1 Mark)**

iii) Total Wattage = $\frac{Total \ lumens \ given \ out \ by \ the \ lamps}{lu\,min\,ous \ efficiency}$ ----------**(1/2 Marks)**

$$= \frac{150000}{14}$$

$= 10714.285 \ \ Watts$ ---------- **(1 Marks)**

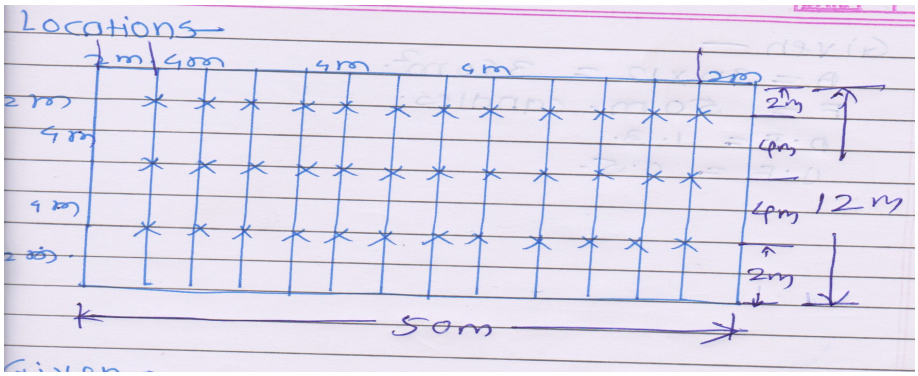
iv) Wattage of each Lamps $= \frac{Total\ Wattage}{No.\ of\ lamps}$ ----------**(1 Marks)**

$= \frac{10714.285}{36}$

$= 297.61 \cong 300\ Watts$ ----------**(2 Marks)**

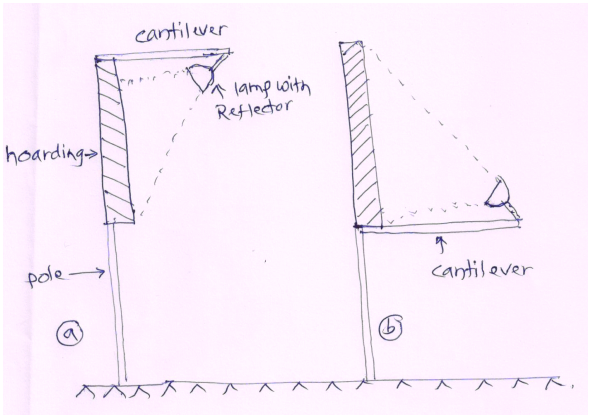
$\therefore Lamps \ \ wattage = 300\ watt$

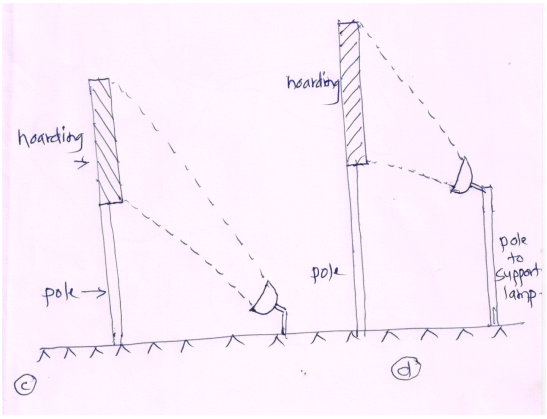
Location of lamps: **(1 Mark)**



b) What are the various arrangements of locating lamps for lighting for advertisements hoarding? Draw the basic circuitry and explain in detail.

Ans: **Various arrangements of locating lamps for lighting for advertisements hoarding;**
(Figure : 2 Marks & Explanation: 2 Marks)





Explanation:

- Arrangement for locating lamps for advertisement hoarding are depends upon following factors :

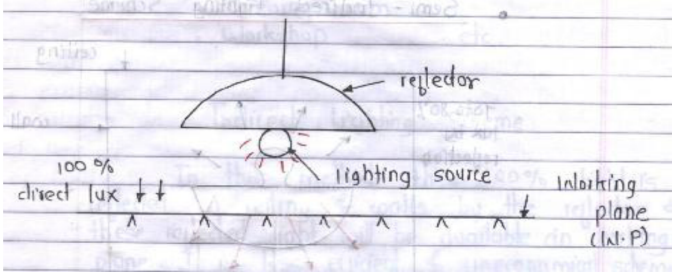
a) Total area of the hoarding
b) Height of the hoarding from the ground surface
c) Location of the hoarding
d) Lux level on the hoarding
e) Colour combination of advertisement

- The main arrangements for lighting as per above figures this is as per projection of focus lamp
  a) Focus lamps projection on cantilever from top of the hoarding
  b) Focus lamps projection on cantilever from bottom of the hoarding
  c) Focus lamps projection from ground surface apart from the hoarding
  d) Focus lamps projection from additional pole on ground surface apart from the hoarding
  e) Focus lamps can be projected from top, bottom, side and in front of the hoarding.
- For the advertisement we can use focus lamps of spread angles
  a) Narrow beam Projector
  b) Medium angle Projector
  c) Wide angle Projector
- Total number of lamps in the projector may differ it depends on illumination design, if the number of lamps are more then series/parallel wiring can be selected.

c) Describe in detail the lighting schemes used for aquariums and shipyards.

Ans: **The following lighting schemes can be used for aquariums and shipyards as per need of all design considerations of aquariums and shipyards:**

i) Direct lighting : **(Figure : 2 Mark & Explanation: 2 Mark)**



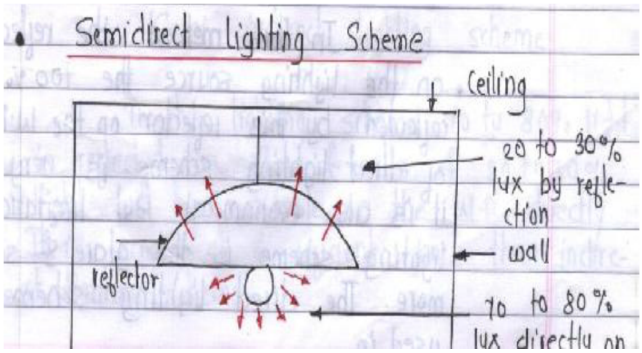
In this method, the reflector is used on the lighting source. The 100% light is reflected by this reflector on the working plane. So efficiency of direct lighting scheme is very

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.

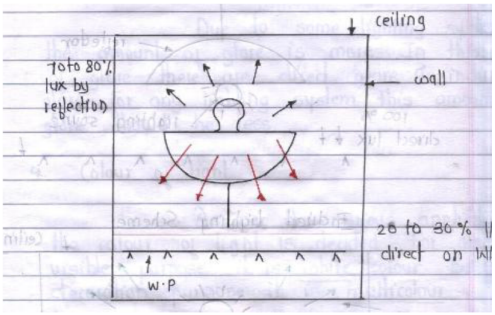
iii) Semi direct lighting scheme :- **(Figure : 2 Mark & Explanation: 2 Mark)**



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.

OR

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.

Q.6	**Attempt any FOUR :** **16 Marks**
a)	**A room of size 20 m x 5 m is illuminated by 20 number of 200 watt lamps. The MSCP of each lamp = 250. Assume utilization factor = 0.6 and depreciation factor = 1.2. Find average illumination produced on the floor. State and explain the features of railway platform lighting.**
Ans:	i) Area of room=A=20 × 5 m= 100 sq mtr. ii) MSCP of each lamp = 250 iii) Depreciation factor=D.F= 1.2 iv) Co-efficient of utilization= U.F=0.6 v) Number of lamps = 20 vi) wattage of each lamp = 200 watts Find: Average illumination=E=? **Solution:** Total lumens given out by all lamps= $(MSCP \times 4\pi) \times 20$ $= (250 \times 4\pi) \times 20$ = 62831.853 Lumens. ---------- **(1/2 Mark)** Total lumens received on the floor = Total lumens given out by all lamps x $\frac{U.F}{D.F}$ Total lumens received on the floor = 62831.853 x $\frac{0.6}{1.2}$ = 31415.926 Lumens. ---------- **(1/2 Mark)** Average illumination on the floor = E_{AV} = $\frac{Total\ lumens\ recieved\ on\ the\ floor}{Area}$ $= \frac{31415.926}{100}$ **E_{AV}= 314.159 Lumens per square mtr--- Answer---------- (1 Mark)** **Following the features for railway platform lighting: (2 Mark)** Good platform lighting on all stations is essential for the safety and comfort of passengers and railway staff. The recommended value of illumination is 100-150 lux. T-5 fluorescent lamps are used as source of light. The luminaries should be arranged in such a way that the light strikes the platform 'H' straight down and without shadows provided reasonable uniform light across the width of the

platform. For non-covered portion of the railway station, street light fitting of T-5 fluorescent lamps with width angle distribution reflectors are suitable modern LED street light fitting of 36/40 w are also used.

OR Student may be write (Any Four point expected : 1/2 Mark each)

1. The general requirements & objectives for the railway lighting is similar to shipyard lighting or factory lighting.
2. The total area covered by the railway department.
3. Total number of platforms available on the station.
4. The total length of every platform.
5. The total indoor facilities of the railways station for e.g. waiting room, guest room, booking counter & booking office, signal & controlling room, TC chamber, go downs, canteen, book stall.
6. The platform lighting is generally done as outdoor lighting of factory premises or It is similar to street lighting.
7. For indoor lighting the standard lux level available is common but for the platform lighting the 60 to 80 lux should be available on the railway track & platform.
8. The signaling is very important part. At the time of illumination design we have to consider it.

OR Student may be write (Any Four point expected : 1/2 Mark each)

1. Selection of correct source of light.
2. Adequate level of illumination on the W.P.
3. Correct brightness, relationship eliminating glare and reflection.
4. Appropriate colour of light having regards to: a) requirement of work or process
   b) Psychological effects and combination with natural light.
5. Proper shadow characteristics.
6. Provision of auxiliary and emergency lighting for safety.
7. Provisions for operation i.e. current, switching groups, proper switching control.
8. Maximum overall economy consistent with efficiency.
9. Aesthetic blending of light and décor.

b) What is meant of flood lighting ? Define the terms : (i) beam factor (ii) waste light factor related to flood lighting.

Ans:

1. Flood lighting: **(2 Mark)**

Flood lighting means flooding of large surface area with light from powerful sources using projector

(i) beam factor related to flood lighting: **(1 Mark)**

It is defined as the ratio of total lumens in the beam of projector to the total lumens given out by the sources (Lamp)

(ii) Waste light factor related to flood lighting: **(1 Mark)**

When a surface is illuminated by the number of lamps, there is certain amount of wastage of light due to overlapping of light ways, so it is called Waste light factor.

c) A hall 30 x 12 m is to be illuminated with 50 m candles, DF = 1.3 and OF = 0.5. Calculate space to height ratio and work out the number of lamps from the following table and select suitable wattage lamp for uniform light disposition.

Watts	**100**	**200**	**300**	**500**	**1000**
Lumens	**1615**	**3650**	**4700**	**9950**	**21500**

Ans:

i) Area of room=A=30 × 12 m= 360 ii) MSCP of each lamp = 250

iii) Depreciation factor=D.F= 1.3 iv) Co-efficient of utilization= U.F=0.5

v) Illumination required E = 50 m candle

Find: Average illumination=E=?

Solution:

$$\text{Total Gross lumens required} = \frac{A \times E \times D.F}{U.F}$$ ---------- **(1/2 Mark)**

$$= \frac{360 \times 50 \times 1.3}{0.5}$$

$$= 46800 \ Lumens$$ ----------**(1/2 Marks)**

1) If 100 watt lamps are used: ---------- **(1/2 Mark)**

$$\text{Number of lamps required} = \frac{Total\ Gross\ lumens}{Lumens\ of\ 100\ watt} = \frac{46800}{1615}$$

$$\text{Number of lamps required} = 29 \ Nos$$

2) If 200 watt lamps are used: ---------- **(1/2 Mark)**

$$\text{Number of lamps required} = \frac{Total\ Gross\ lumens}{Lumens\ of\ 200\ watt} = \frac{46800}{3650}$$

$$\text{Number of lamps required} = 13\ \ Nos$$

3) If 300 watt lamps are used: ---------- **(1/2 Mark)**

$$\text{Number of lamps required} = \frac{Total\ Gross\ lumens}{Lumens\ of\ 300\ watt} = \frac{46800}{4700}$$

$$\text{Number of lamps required} = 10\ \ Nos$$

4) If 500 watt lamps are used: ---------- **(1/2 Mark)**

$$\text{Number of lamps required} = \frac{Total\ Gross\ lumens}{Lumens\ of\ 500\ watt} = \frac{46800}{9950}$$

$$\text{Number of lamps required} = 5\ \ Nos$$

5) If 1000 watt lamps are used: ---------- **(1/2 Mark)**

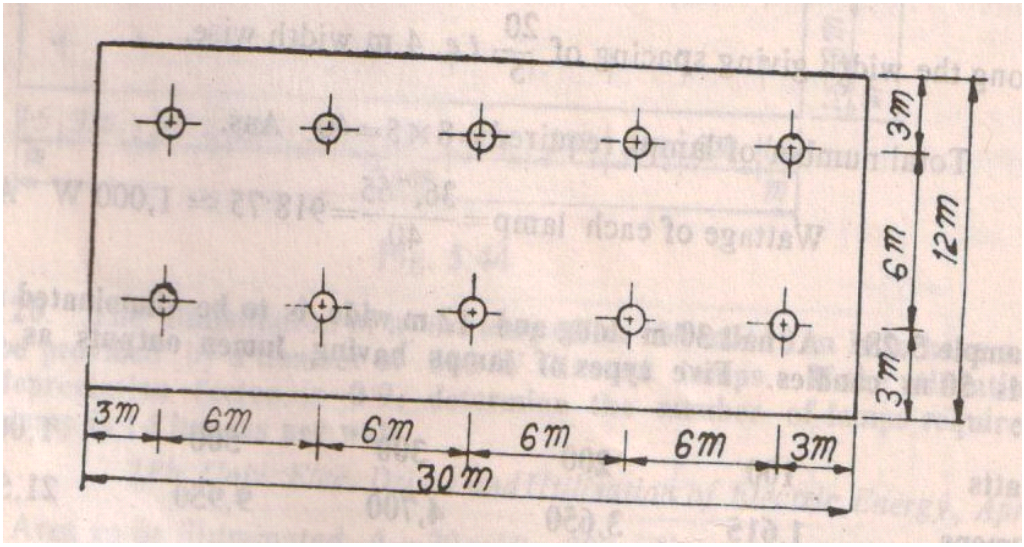
$$\text{Number of lamps required} = \frac{Total\ Gross\ lumens}{Lumens\ of\ 1000\ watt} = \frac{46800}{21500}$$

$$\text{Number of lamps required} = 2\ \ Nos$$

Space Height Ratio: **(1/2 Mark)**

Let the mounting height to be 5 Meter,

Most suitable type of lamps will be 300 Watt lamps requiring 10 lamps in two rows, each row having 5 lamps giving spacing of 6 meters in length as well as in width and space height ratio of $\frac{6}{5} = 1.2$

	Uniform light disposition: **(Figure not expected)** 
d)	**State the general requirements and lighting scheme adopted for hospitals and health care buildings.**
Ans:	**General requirement for illumination of Health care centers and hospitals:** **In Operation Theater:-** **(Any Two Point expected: 1/2 Mark each Total: 1 Mark)** ➢ In operation theater of hospital the direct lighting scheme is normally used. ➢ On operation table bunched filament lamps or focus lamps can be used. ➢ On operation table sometimes metal halide lamps of lower wattages with multiple sources are also used. ➢ Normally high illumination efficiency white colour emitted light source are preferred. ➢ In operation theaters some ultraviolet lamps or tubes are also used as a anti-bacteria source. ➢ Lux level on the working plane is high. (400 to 600 lux) **In General ward of the hospital and Health Care Centre :-** **(Any Two Point expected: 1/2 Mark each Total:1 Mark)** ➢ General lighting scheme is preferred. ➢ Reflectors are not used. ➢ Fluorescent tubes, CFL or incandescent lamps are used as a lighting source. ➢ Lux level on the working plane is less. (100 to 150 lux) ➢ Area of working Plane.

- $Calculate\ \ Total\ \ \ Lumens = \frac{A \times I \times W}{C. \times M.F}$
- Assume wattage and efficiency of the lamp
- Find out number of lamps =

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

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

OR

General requirement for illumination of Health care centers and hospitals:

(Any four Point expected: 1/2 Mark each Total:2 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. **lighting scheme adopted for hospitals and health care buildings:** **(2 Marks)** 1. Direct lighting scheme 2. Indirect lighting Scheme 3. Semi indirect scheme 4. General lighting scheme
e)	**Discuss the different factors on which the aquarium lighting design depends.**
Ans:	**The requirement of scheme for Aquariums:- (Any Four points Expected: 1 Marks Each)** 1. The aquarium lightly depends open the size of the aquariums tank (Length, width and depth. 2. The aquarium lighting depends upon the all sounding condition e.g. colour and size of the given hall in which the aquarium is placed. 3. The aquarium lighting depend open the maintenance schedule of the tank water and other aquarium accessories. 4. The aquarium lighting depends open the surrounding temperature and required temperature of water in the tank. 5. In sum type of aquarium the ultraviolet lamp are provided for the bacteria filling purpose. 6. The aquarium lighting also depends open the various aquarium lighting also depends open the various aquarium accessories used in the tank. 7. The aquarium lighting should be electricity and mechanically safe to the all type rises and operator also. 8. The aquarium lighting should be economical. 9. The life of the aquarium lighting should be long.

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