

**ILLUMINATION ENGINEERING**  
**(ELEC 3241)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A**  
**(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Rod cells are responsible for \_\_\_\_\_ vision and this is known as \_\_\_\_\_ vision.  
(a) color, photopic (b) color, scotopic  
(c) dark, photopic (d) dark, scotopic
  - (ii) The peak of the spectral luminous efficiency function of human eye for photopic vision is at a wavelength of  
(a) 380 nm (b) 400 nm (c) 507 nm (d) 555 nm.
  - (iii) Which one of the following statement is incorrect?  
(a) Low pressure sodium vapour lamps require a leakage reactance autotransformer  
(b) T5 fluorescent lamps have a smaller diameter compared to T8 lamps  
(c) The efficacy of high pressure sodium vapour lamp is less than the efficacy of low pressure sodium vapour lamp  
(d) Metal halide lamps are instant start lamps.
  - (iv) IEC is the abbreviation of  
(a) International Electrochemical Committee  
(b) International Electrochemical Commission  
(c) International Electrotechnical Committee  
(d) International Electrotechnical Commission.
  - (v) Which of the following lamps is mostly not used in emergency lighting?  
(a) Incandescent lamp (b) Compact fluorescent lamp  
(c) Fluorescent lamp (d) High pressure mercury vapour lamp.
  - (vi) Which photometer is used for measuring luminous flux?  
(a) Luxmeter (b) Bench photometer  
(c) Goniophotometer (d) Integrating sphere.
  - (vii) Light is produced in electric discharge lamps by  
(a) heating effect of current (b) magnetic effect of current  
(c) carbon electrodes (d) ionization in a gas or vapour

- (viii) The SI unit of radiant intensity is  
 (a) watt (b) lumen/sqm (c) candela (d) watt/steradian.
- (ix) A 220 V incandescent lamp draws a current of 0.2 A from the supply and emits 1500 lumen. Its luminous efficacy is  
 (a) 15 lm/W (b) 37.5 lm/W (c) 18.75 lm/W (d) 34 lm/W
- (x) The code of practice for interior illumination is  
 (a) IS:11116 (b) IS:1944 (c) IS:1981 (d) IS:3646.

**Group - B**

2. (a) Determine the mid zonal intensity, zonal constant and lumen total output of the luminaire whose intensity distribution is as follows: [[CO1](Analyse/IOCQ)]

Gamma	C 0°	C 45°	C 90°
	I (cd)		
5°	200	180	160
15°	190	165	140
25°	180	150	120
35°	160	125	100
45°	135	100	80
55°	110	75	60
65°	80	50	40
75°	50	30	20
85°	20	10	0

- (b) A lamp of 500 W, 230 V having MSLI = 1250 cd is suspended 2.7 m above the working plane. Determine  
 (i) the luminous flux emitted from the lamp  
 (ii) efficacy of the lamp  
 (iii) illumination directly below the lamp  
 (iv) illumination at a point 4m away on the horizontal plane from vertically below the lamp. [[CO1](Evaluate/HOCQ)]

**8 + 4 = 12**

3. (a) What do you mean by direct, substitution and relative photometry? [[CO1](Remember/LOCQ)]
- (b) Show that the expression of intensity for a Lambertian surface is given by  
 $I_{\theta} = I_0 \cos \theta$  (Symbols carry usual meanings). [[CO1](Analyse/IOCQ)]
- (c) Derive the unit of exitance in terms of fundamental physical quantities in SI system. [[CO1](Analyse/IOCQ)]
- (d) Two lamp posts are 10 m apart and are fitted with 100 cd lamp each at a height of 5 m above the ground. Calculate the illumination on the ground  
 (i) under each lamp, (ii) midway between the lamps. [[CO1](Evaluate/HOCQ)]

**3 + 2 + 3 + 4 = 12**

**Group - C**

4. (a) What do you mean by stroboscopic effect? How is it eliminated in case of fluorescent lamp? [[CO2](Analyse/IOCQ)]  
 (b) Briefly discuss the construction and principle of operation of low pressure sodium vapour lamp with the help of a neat diagram. [[CO2](Remember/LOCQ)]  
 (c) Define Correlated Colour Temperature. [[CO2](Remember/LOCQ)]  
**4 + 6 + 2 = 12**
5. (a) A 230 V, 36 W fluorescent lamp is connected in series with a magnetic choke. The circuit operates at a lagging power factor of 0.7. Determine the value of capacitance to be used to correct the power factor to unity. [[CO2](Evaluate/HOCQ)]  
 (b) Show that the diameter of the filament of an incandescent lamp is proportional to  $I^{2/3}$ , where I is the current passing through the filament. [[CO2](Analyse/IOCQ)]  
 (c) Why do we use an auxiliary electrode in high pressure mercury vapour lamp? [[CO2](Remember/IOCQ)]  
**6 + 4 + 2 = 12**

**Group - D**

6. (a) Derive the formula for computation of effective ceiling cavity reflectance of a hemispherical dome. [[CO3](Analyse/IOCQ)]  
 (b) The reflectance of the wall surfaces of the dining area of a café is 70%. The recommended illuminance range is as follows:  
 (i) Select the illuminance category from Table I, giving proper reason.

<b>Table I</b>		
<b>Type of Activity</b>	<b>Illuminance Category</b>	<b>Range of Illuminance (lux)</b>
Public spaces with dark surroundings	A	20 – 30 – 50
Simple orientation for short temporary visits	B	50 – 75 – 100
Working spaces where visual tasks are only occasionally performed	C	100 – 150 – 200

- (ii) Select proper weighting factors from Table II.

<b>Table II</b>			
<b>Room and Occupant</b>	<b>Weighting factors</b>		
<b>Characteristics</b>	<b>-1</b>	<b>0</b>	<b>+1</b>
Occupant's age	Under 40	40-55	Above 55
Room surface reflectance	>70%	30-70%	<30%

- (iii) Determine the recommended illuminance level for the area.

[[CO3](Analyse/IOCQ)]

- (c) State the advantages and disadvantages of passive infrared and ultrasonic sensors. [[CO3](Understand/LOCQ)]

**4 + 4 + 4 = 12**

7. A lecture hall measuring 15 m × 7.5 m × 4.3 m has ceiling, wall and floor reflectances 90%, 60% and 20%, respectively. The luminaire is suspended 0.8 m from the ceiling and the working plane is 0.5 m above the floor.
- Determine the cavity ratios for the floor, room and ceiling.
  - Determine effective floor and ceiling cavity reflectances. (Use the tables provided in attached sheet Table 1A and 1B)
  - Which lamp can be used for the design and why?
  - Determine the coefficient of utilisation. (Use the tables provided in attached sheet Table 1C)
  - Assuming a maintenance factor of 0.85, determine the number of lamps and luminaires required to achieve an average illumination of 300 lux on working plane.
  - Draw the disposition of the luminaires. [[CO3](Evaluate/HOCQ)]

**12****Group - E**

8. (a) The front of the building measuring 30 m and 15 m is to be floodlighted by means of projectors placed at a distance of 3 m from the wall. The average illumination required is 150 lux.
- Which lamp is used for the design and why?
  - Assuming waste light factor of 1.2, maintenance factor of 0.6 and coefficient of utilisation of 0.5, determine the number of projectors and wattage of lamps used.
  - Determine the beam angle of the projector. [[CO4](Evaluate/HOCQ)]
- (b) What are the classifications of roads according to IS:1944? Briefly describe each type. [[CO4](Remember/LOCQ)]

**6 + 6 = 12**

9. (a) Name the different classes of sports lighting. [[CO4] (Remember/LOCQ)]
- (b) Explain the terms related to road lighting installation with the help of a neat diagram: tilt angle, overhang, span, outreach, spacing. [[CO4] (Remember/LOCQ)]
- (c) Compare between discomfort and disability glare. [[CO4] (Analyse/IOCQ)]
- (d) What do you mean by IP rating of luminaires? [[CO4] (Remember/LOCQ)]

**3 + 5 + 2 + 2 = 12**


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<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	<i>32.3</i>	<i>34.4</i>	<i>33.3</i>

**Course Outcome (CO):**

After the completion of the course students will be able to

- Understand the principles of operation of different photometers and apply the laws of photometry for calculation of photometric quantities for different lighting applications
- Understand the principles of operation of different lamps and their accessories
- Analyse indoor lighting schemes and design energy efficient installations complying with lighting codes
- Understand the parameters of energy efficient road lighting and floodlighting installations in conformity with lighting codes.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.