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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   Which photometer is used for measuring luminous flux?
           (a) Luxmeter   (b) Bench photometer
           (c) Goniophotometer   (d) Integrating sphere.

    (ii)   Which photometer is used for comparing the lights of different colors?
           (a) Contrast type Lummer Brodhun photometer
           (b) Grease spot photometer
           (c) Equality of brightness type Lummer Brodhun photometer
           (d) Flicker Photometer.

    (iii) Cone cells are responsible for _____ vision and this is known as _____ vision.
           (a) color, scotopic   (b) color, photopic
           (c) dark, photopic   (d) dark, scotopic

    (iv)   The SI unit of Luminous exitance is
           (a) lux   (b) lumen/sqm   (c) candela   (d) steradian.

    (v)   A lamp has a luminous flux of 1600 lumen. Its mean spherical candle power (MSCP) is
           (a) 127.4   (b) 250   (c) 392.5   (d) 785.

    (vi)   Which of the following electric discharge lamp gives highest lumens/watt?
           (a) Low Pressure Sodium Vapor   (b) Low Pressure Mercury Vapor
           (c) High Pressure Sodium Vapor   (d) High Pressure Mercury Vapor.

    (vii) The output of a tungsten filament lamp depends on
           (a) size of lamp   (b) size of shell
           (c) temperature of filament   (d) material of the filament.

    (viii) A 250V tungsten filament lamp draws a current of 0.4A from the supply and
           emits 1500 lumen. Its luminous efficacy is
           (a) 15lm/W   (b) 37.5lm/W   (c) 18.75lm/W   (d) 17lm/W.

(ix)   The code of practice for interior illumination is
     (a) IS 3646   (b) IS 1944   (c) BIS 1981   (d) IS 11116.

(x)   In road lighting threshold increment (TI) value is a measure of
     (a) discomfort glare   (b) disability glare
     (c) transverse uniformity   (d) longitudinal uniformity.

Group - B

2.   (a)   State the assumptions of Inverse Square Law of illumination.
                                            [(CO1)(Remember/LOCQ)]

   (b)   Show that the illuminance received at any position on the inner surface of the integrating sphere from any point lying on the surface is independent of the position of the points on the inner surface.   [(CO1)(Analyze/IOCQ)]

   (c)   A light source having an intensity of 400cd in all directions is fitted with a reflector so that it directs 75% of its light along a beam having a divergence of 10°. Determine the total light flux emitted along the beam. Also determine the average illumination produced on a surface normal to the beam direction at a distance of 5m.   [(CO1)(Evaluate/HOCQ)]
                                            3 + 4 + (2 + 3) = 12

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

Gamma	C 0°	C 45°	C 90°
5°	60	60	60
15°	58	56	54
25°	56	50	46
35°	52	48	40
45°	48	42	32
55°	42	34	22
65°	36	26	12
75°	28	16	2
85°	20	6	0

   (b)   Explain the cosine error for a sensor of a Luxmeter. [(CO1)(Understand/LOCQ)]
                                            9 + 3 = 12

Group - C

4.   (a)   Discuss CIE classification of indoor luminaires based on proportion of upward and downward directed light output.   [(CO2)(Remember/LOCQ)]

   (b)   Distinguish between high pressure mercury vapour lamp and high pressure sodium vapour lamp on the basis of photometric characteristics.
                                            [(CO2)(Analyze/IOCQ)]
                                          6 + 6 = 12

5.   (a)   A 230V, 40W fluorescent lamp, connected in series with a magnetic choke, is driven by 230V, 50Hz supply. The circuit operates at a lagging power factor of

0.8. Determine the value of capacitance to be used to correct the power factor to unity. [(CO2)(Evaluate/HOCQ)]
(b) What do you mean by regenerative cycle in halogen lamps? [(CO2)(Understand/LOCQ)]
(c) Discuss the use of high frequency inverter in the circuit of electronic ballast with the help of a neat circuit diagram. [(CO2)(Analyze/IOCQ)]

5 + 3 + 4 = 12

Group - D

6. (a) A lecture hall measuring 18m × 9m × 3.6m has ceiling, wall and floor reflectances 80%, 60% and 20% respectively. The luminaire is suspended 0.6m from the ceiling and the horizontal working plane is 0.6m above the floor.
    (i) Determine the cavity ratios for the floor, room and ceiling.
    (ii) Determine effective floor and ceiling cavity reflectances.
    (iii) Which lamp can be used for the design and why?
    (iv) Determine the coefficient of utilisation. (Use the tables provided in attached sheet Table 1A, B and C)
    (v) Assuming a maintenance factor of 0.85, determine the number of lamps and luminaires required to achieve an average illumination of 300 lux over the working plane.
    (vi) Draw the disposition of the luminaires. [(CO3)(Evaluate/HOCQ)]

12

7. (a) The general workspace in an office is to be designed for proper illumination. Typical task consists of working on the computer. Age of the workers range from 30 to 60 and reflectance of the task background is 70%. Speed and accuracy of the task is mostly considered important.
    (i) Select the illuminance category from Table I, giving proper reason.

Table I		
Type of Activity	**Illuminance Category**	**Range of Illuminance (lux)**
Performance of visual task of high contrast or large size	D	200-300-500
Performance of visual task of medium contrast or small size	E	500-750-1000
Performance of visual task of low contrast or very small size	F	1000-1500-2000

    (ii) Select proper weighting factors from Table II.

Table II			
Task and worker	**Weighting factors**		
Characteristics	**-1**	**0**	**+1**
Worker's age	Under 40	40-55	Above 55
Reflectance of task background	>70%	30-70%	<30%
Speed and/or accuracy	Not important	Important	Critical

    (iii) Determine the recommended illuminance level for the area. [(CO3)(Analyze/IOCQ)]

    (b)   Derive the formula for computation of effective ceiling cavity reflectance of a barrel vaulted ceiling.   [(CO3)(Evaluate/HOCQ)]

    (c)   What do you mean by the Watts per square metre method of indoor lighting design?   [(CO3)(Understand/LOCQ)]

        5 + 4 + 3 = 12

Group - E

8.   (a)   The front of the building measuring 60m and 15m is to be floodlighted by means of projectors placed at a distance of 8m from the wall. The average illumination required is 100 lux.

        (i)   Which lamp is used for the design and why?

        (ii)   Assuming waste light factor of 1.2, maintenance factor of 0.6 and coefficient of utilisation of 0.5, determine the number of projectors used.

        (iii) Determine the beam angle of the projector.   [(CO4)(Evaluate/HOCQ)]

    (b)   Compare beam lumen method and point-by-point method of illumination calculation used in area lighting.   [(CO4)(Analyse/IOCQ)]

        6 + 6 = 12

9.   (a)   Explain why we should consider the level of luminance as a design parameter for road lighting.   [(CO4)(Analyse/IOCQ)]

    (b)   Explain spread, throw and control for a roadlighting luminaire.

        [(CO4)(Understand/LOCQ)]

    (c)   What are the different types of arrangement of road lighting luminaires according to the width of the road and mounting height of the luminaires?

        [(CO4)(Remember/LOCQ)]

    (d)   Distinguish between transverse, longitudinal and overall uniformity in case of road lighting.   [(CO4)(Analyse/IOCQ)]

        3 + 3 + 3 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	41.67	33.33

Course Outcome (CO):

After the completion of the course students will be able to
1.   Understand the principles of operation of different photometers and apply the laws of photometry for calculation of photometric quantities for different lighting applications
2.   Understand the principles of operation of different lamps and their accessories
3.   Analyse indoor lighting schemes and design energy efficient installations complying with lighting codes
4.   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