ILLUMINATION ENGINEERING
(ELE3131)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Candelа is the unit of
(a) Luminous intensity (b) Luminous flux
(c) Luminance (d) Wavelength

(ii) A 230V tungsten filament lamp draws a current of 0.4A from the supply and emits 1564 lumen. Its luminous efficacy is
(a) 15 lm/W (b) 37.5 lm/W (c) 18.75 lm/W (d) 17 lm/W

(iii) A lamp has a total luminous flux of 3140 lumens. Its mean spherical luminous intensity (MSLI) is
(a) 125 (b) 250 (c) 200 (d) 500

(iv) Which of the following lamps give nearly monochromatic light?
(a) High pressure mercury vapour lamp (b) High pressure sodium vapour lamp
(c) Low pressure mercury vapour lamp (d) Low pressure sodium vapour lamp

(v) The phosphor coating in a fluorescent lamp converts
(a) ultraviolet rays to infrared rays (b) ultraviolet rays to visible light
(c) infrared rays to visible light (d) visible light to ultraviolet rays

(vi) Which of the following has the least diameter?
(a) T4 lamp (b) T5 lamp (c) T8 lamp (d) T12 lamp

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

(viii) IEC is the abbreviation of
(a) International Electrochemical Commission
(b) International Electrotechnical Committee
(c) International Electrotechnical Commission
(d) International Electrochemical Committee

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

(x) Which one of the following is the most suitable IP rating for luminaire used in high mast lighting?
(a) IP65 (b) IP60 (c) IP32 (d) IP10

Fill in the blanks with the correct word

(xi) The efficacy of tungsten halogen lamp is improved due to the _____ cycle.

(xii) The color temperature of a light source is measured in _____.

(xiii) The code of practice for road lighting is _____.

(xiv) The unit of luminous flux is _____.

(xv) If the colours of objects under a light source appear the same as they would under natural sunlight, then the CRI of the light source is _____.

Group - B

2. (a) Derive the units of Luminous exitance and luminous flux in SI system in terms of fundamental physical quantities. *[(CO1)(Apply/IOCQ)]*

(b) Determine the mid zonal intensity, zonal constant and lumen total output of the luminaire whose intensity distribution is as follows:

Gamma	C 0°	C 45°	C 90°
	I (cd)		
5°	300	300	300
15°	280	270	260
25°	260	230	210
35°	230	180	150
45°	200	130	80
55°	160	75	10
65°	120	10	0
75°	70	0	0
85°	20	0	0

[(CO2)(Apply/IOCQ)]

4 + 8 = 12

3. (a) 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. *[(CO2)(Analyse/IOCQ)]*

(b) A lamp having a uniform luminous intensity of 400cd in all directions is fitted with a reflector which directs 70% of the total light uniformly on a circular area of 4m diameter. The lamp is hung 3m above the area. Calculate the illumination
(i) at the center without reflector
(ii) at the edge of the surface without reflector
(iii) at the center with reflector

(iv) at the edge of the surface with reflector? *[(CO1)(Analyse/HOCQ)]*

4 + 8 = 12

Group - C

4. (a) A 230V, 40W 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 connected across the supply to correct the power factor to unity. *[(CO3)(Analyse/IOCQ)]*

   (b) Draw the block diagram of an electronic ballast. State the function of each block. *[(CO3)(Analyse/IOCQ)]*

6 + 6 = 12

5. (a) Briefly discuss the construction and principle of operation of metal halide lamp with the help of a neat diagram. *[(CO3)(Remember/LOCQ)]*

   (b) Briefly explain the principle of operation of light emitting diode. What do you mean by internal efficacy? *[(CO3)(Understand/LOCQ)]*

   (c) Define colour rendering index (CRI). *[(CO3)(Remember/LOCQ)]*

6 + 4 + 2 = 12

Group - D

6. 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.
   (i) Determine the cavity ratios for the floor, room and ceiling.
   (ii) Determine effective floor and ceiling cavity reflectances. (Use the tables provided in attached sheet Table 1A and 1B)
   (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 1C)
   (v) 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.
   (vi) Draw the disposition of the luminaires. *[(CO5)(Evaluate/HOCQ)]*

12

7. (a) Define coefficient of utilisation and maintenance factor. *[(CO4)(Remember/LOCQ)]*

   (b) Explain the design considerations of emergency lighting. *[(CO4)(Analyse/IOCQ)]*

   (c) The walls of the electrical engineering laboratory have a reflectance of 50%.
   (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 tasks of high contrast or large size	D	200 – 300 – 500
Performance of visual tasks of medium contrast or small size	E	500 – 750 – 1000
Performance of visual tasks of low contrast or very small size	F	1000–1500–2000

(ii) Select proper weighting factors from table II.

Table II			
Task and Worker Characteristics	**Weighting Factors**		
	-1	**0**	**+1**
Workers' age	Under 40	40 – 55	Above 55
Reflectance of task background	Greater than 70%	30 – 70 %	Less than 30%
Speed and/or accuracy	Not important	Important	Critical

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

[(CO5)(Analyse/IOCQ)]

2 + 5 + 5 = 12

Group - E

8. (a) Distinguish between transverse, longitudinal and overall uniformity in case of road lighting. *[(CO6)(Remember/LOCQ)]*

(b) Define spread, throw and control of street light luminaires. *[(CO6)(Remember/LOCQ)]*

(c) What are isolux diagrams? How are they used in road lighting calculations? *[(CO6)(Analyse/IOCQ)]*

3 + 3 + 6 = 12

9. (a) The front of a building measuring 30m × 12m is to be floodlighted by means of projectors placed at a distance of 2m from the wall. The average illumination required is 50 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 wattage and number of projectors used.

(iii) Determine the beam angle of the projector. *[(CO6)(Evaluate/HOCQ)]*

(b) What are the photometric properties of a floodlight luminaries? *[(CO6)(Understand/LOCQ)]*

(c) If a floodlighting luminaire is designated "NEMA 6X5", what does it imply? *[(CO6)(Analyse/IOCQ)]*

(d) What do you mean by waste light factor? *[(CO6) (Remember/LOCQ)]*

6 + 2 + 2 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	48	27