ILLUMINATION ENGINEERING
(ELEC 3241)

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

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

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

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

(v) A 250V tungsten filament lamp draws a current of 0.4A 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) 17 lm/W.

(vi) Power factor is highest in case of
(a) Fluorescent lamp (b) Low pressure mercury vapour lamp
(c) Low pressure sodium vapour lamp (d) Tungsten filament lamp

(vii) Which of the following discharge lamps gives highest efficacy?
(a) High pressure mercury vapour (b) Low pressure sodium vapour
(c) Low pressure mercury vapour (d) High pressure sodium vapour.

(viii) Integrating sphere is used to measure
(a) luminous intensity (b) illuminance
(c) luminance (d) luminous flux.

(ix) Coefficient of utilisation is the ratio of
(a) total lamp flux reaching the working plane to the total lamp flux
(b) total upward flux to the total lamp flux
(c) total upward flux to the total lamp flux reaching the working plane
(d) total downward flux to the total lamp flux.

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

Fill in the blanks with the correct word

(xi) The distribution of luminous intensity of a lamp is represented by _____ curves.

(xii) The _____ error of a luxmeter can be reduced by using diffusing acrylic disk over the photocell.

(xiii) The peak of the spectral luminous efficacy function of human eye for photopic vision is at a wavelength of _____.

(xiv) The photometer used for measuring illuminance is _____.

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

Group - B

2. (a) A lamp of 500W having MSLI = 1000 cd is suspended 5m above the working plane. Determine
(i) the luminous flux emitted from the lamp
(ii) the efficacy of the lamp
(iii) the illumination directly below the lamp
(iv) the illumination at a point 5m away on the horizontal plane from vertically below the lamp. *[(CO1)(Apply/IOCQ)]*

(b) Distinguish between photopic and scotopic vision. *[(CO1)(Remember/LOCQ)]*

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

4 + 4 + 4 = 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. *[(CO1)(Analyse/IOCQ)]*

(b) A 28W T5 fluorescent lamp is fitted inside a symmetrical downlighter luminaire Determine the mid zonal intensity, zonal constant and zonal lumen of whose luminous intensity distribution (in cd) is given below. Also determine the efficacy of the lamp. *[(CO1)(Evaluate/HOCQ)]*

Gamma	C 0°	C 45°	C 90°
5°	200	170	150
15°	180	160	120
25°	160	140	90
35°	140	105	60
45°	110	70	35

Gamma	C 0°	C 45°	C 90°
55°	80	40	10
65°	50	15	0
75°	20	0	0
85°	0	0	0

4 + 8 = 12

Group - C

4. (a) Briefly discuss the construction and principle of operation of high pressure sodium vapour lamp with the help of a neat diagram. *[(CO2)(Remember/LOCQ)]*

   (b) Draw the block diagram of an electronic ballast. State the function of each block. *[(CO2)(Analyse/IOCQ)]*

6 + 6 = 12

5. (a) A 230V, 40W fluorescent lamp is connected in series with a magnetic choke. The circuit operates at a lagging power factor of 0.6. Determine the value of capacitance to be used to correct the power factor to unity. *[(CO2)(Analyse/IOCQ)]*

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

6 + 6 = 12

Group - D

6. An average illumination of 250 Lux is required on the horizontal working plane in a conference room in an office measuring 10m × 10m × 3.8m in size. The lamps are ceiling mounted and the working plane is 0.8m above the floor. The reflectance values of the ceiling, walls and floor are 70%, 60% and 20% respectively.
   (i) Determine the cavity ratios for the floor, room and ceiling.
   (ii) Which lamp can be used for the design and why?
   (iii) What is the efficacy of the lamp?
   (iv) Assuming utilisation factor of 0.7, maintenance factor of 0.85, estimate the number and wattage rating of the lamps.
   (v) Draw the disposition diagram of the luminaires.
   (vi) Determine the space-height ratio of your design. *[(CO3)(Evaluate/HOCQ)]*

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7. (a) What is ballast factor? *[(CO3)(Remember/LOCQ)]*

   (b) Explain the design considerations of emergency lighting. *[(CO3)(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

Table I		
Type of Activity	**Illuminance Category**	**Range of Illuminance (Lux)**
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. *[(CO3)(Apply/IOCQ)]*

1 + 6 + 5 = 12

Group - E

8. (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. *[(CO4)(Evaluate/HOCQ)]*

   (b) 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)]*

   (c) What is threshold increment in road lighting? *[(CO4)(Remember/LOCQ)]*

6 + 4 + 2 = 12

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

   (b) Define spread, throw and control of street light luminaires. *[(CO4)(Remember/LOCQ)]*

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

3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08	45.84	27.08

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.*