# 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
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> 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) Integrating sphere is used to measure
   (a) luminous flux     (b) luminance     (c) illuminance     (d) luminous intensity

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

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

   (iv) Light is produced in electric discharge lamps by
   (a) ionization in a gas or vapor     (b) magnetic effect of current
   (c) heating effect of current     (d) carbon electrodes.

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

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

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

(viii)　Overall uniformity is the ratio of
　　　　(a) Minimum illuminance to Maximum illuminance
　　　　(b) Maximum illuminance to Average illuminance
　　　　(c) Maximum illuminance to Minimum illuminance
　　　　(d) Minimum illuminance to Average illuminance

(ix)　What is the primary purpose of road lighting?
　　　(a) To improve visibility and safety at night
　　　(b) To increase vehicle speed
　　　(c) To reduce electricity consumption
　　　(d) To enhance the aesthetic appeal of streets

(x)　The spacing between streetlights is generally based on
　　　(a) Width of the road and height of poles　(b) Power consumption of the bulbs
　　　(c) Type of the road surface　　　　　　　(d) Traffic speed limits.

*Fill in the blanks with the correct word*

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

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

(xiii)　The colour rendering index of tungsten filament lamp is _____.

(xiv)　_____ beam floodlights are used where greater distances are involved.

(xv)　The unit of luminous flux is _____.

# Group - B

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

| 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 |

**4 + 8 = 12**

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

(b)    A lamp having a uniform luminous intensity of 200 cd in all directions is fitted with a reflector which directs 60% of the total light uniformly on a circular area of 10m diameter. The lamp is hung 6m 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)    Briefly explain the principle of operation of light emitting diode. What do you mean by internal efficacy?    *[(CO2)(Understand/LOCQ)]*

    (b)    Distinguish between high pressure mercury vapour lamp and high pressure sodium vapour lamp on the basis of photometric characteristics.
    *[(CO2)(Analyse/IOCQ)]*

    (c)    Why do we use an auxiliary electrode in high pressure mercury vapour lamp?
    *[(CO2)(Remember/IOCQ)]*

**4 + 6 + 2 = 12**

5.  (a)    Draw the block diagram of an electronic ballast. State the function of each block.
    *[(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)]*

**12**

7.  (a)    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.

Table I

| Type of Activity | Illuminance Category | Range of Illuminance (lux) |
|---|---|---|
| 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.

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

Table II heading: **Table II**

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

(b)   Explain the design considerations of emergency lighting. *[(CO3)(Analyse/IOCQ)]*

(c)   What is ballast factor? *[(CO3)(Remember/LOCQ)]*

**4 + 6 + 2 = 12**

# Group - E

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

(b)   Name the different classes of sports lighting. *[(CO4)(Remember/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 cut-off, semi cut-off and non cut-off luminaires. Which type is suitable for A1 category of roads? *[(CO4)(Analyse/IOCQ)]*

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

9. (a)   An advertisement banner measuring 6m × 5 m is to be floodlighted by means of projectors placed at a distance of 1m from the banner. The average illumination required is 100lux.

(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)   What are the classifications of roads according to IS1944? Briefly describe each type. *[(CO4)(Remember/LOCQ)]*

**6 + 6 = 12**

| Cognition Level | LOCQ | IOCQ | HOCQ |
|---|---|---|---|
| Percentage distribution | 29.2 | 43.8 | 27 |