Ref: Ex/PG/IlluE/T/129A/2024

Examination: M.E. Illumination Engineering 1st Year 2nd Semester 2024

Time: 3 Hours Full marks 100

Subject: Daylighting Design & Analysis
Part-I (50 Marks)
Use separate Answer script for each Part

Answer any 3 Questions
(Q.1 carries 18 marks)

1. a) For CIE General Sky Standard Luminance Model, the indicatrix function depends on solar position; whereas the gradation function is independent of it. -Explain.
   b) Will the CIE General SSLD Model be applicable for Indian climatic conditions?
   c) Apply the CIE SSLD model to estimate the luminance ($L_{\gamma\alpha}$) of a sky element under the 'white blue turbid sky' (CIE sky Standard VI.6) in the direction describe by azimuth(α)=130^0, altitude(γ)=15^0 while the corresponding position of the sun is described by altitude(γ_s)=35^0 and sun azimuth(α_s)=135^0.
   The value of parameters for the luminance distribution on the sky type VI.6 are a = -1.0, b = -0.15, c = 24, d = -2.8, e = 0.15 and the zenith luminance for the site is given as L_{vz} = 4300 cd/m^2.

   3+1+14=18

2. a) Daylight is free but daylighting is expensive. -- Explain.
   b) Describe the design steps of the Daylight integrated indoor lighting system.
   c) What are the components of a tubular daylight pipe (DLP) system? Write down the theory of measurement of Lumen Delivery of a DLP system with the help of an Integrator.

   2+5+9=16

3. a) What is luminous efficacy? Write down the necessity of the 'Luminous Efficacy' model in daylighting.
   b) What are the input parameters to the Perez Luminous Efficacy models?
   c) How the diffuse horizontal illuminance can be estimated from the measured data of diffuse horizontal irradiance? What are the typical values of diffuse luminous efficacy?

   4+6+6=16

4. a) What is the basic daylight data required for the daylight design? What is the difference between a research class and a general class daylight measurement station?
   b) What is 'Artificial Skies'? Mention the advantages and disadvantages of using artificial sky over real sky.
   c) Write a short note on any one type of artificial sky, mentioning the type of errors that can introduced during the measurement.

   3+4+9=16

5. a) What do you mean by lighting control strategy? Briefly discuss the lighting control strategies of daylight adaptation.
   b) State with reasons -- the preferable position of a light sensor among the workspace or ceiling in case of smart lighting control in an office space.
   c) Briefly discuss the evolution of the lighting control system over the past decade that leads to the transformations in the lighting industry.

   7+2+7=16

[Turn over

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Part-II (50 Marks)

Use separate Answer script for each Part

ANSWER Q.NO. 1 AND ANY TWO QUESTIONS

Q.1. Answer any four-

A) Daylight is dynamic in terms of both quality and quantity - explain.

B) Depth of penetration of a top-lighting scheme is higher than a side-lighting scheme for an interior- justify.

C) What is 'VLT' for a glazing material? Write down its mathematical expression.

D) DC (Daylight Coefficient) method is applicable for any sky types, whereas DF(Daylight Factor) method is applicable only for overcast sky types - explain.

E) Why 'Light to solar heat gain ratio' is to be given more priority compared to 'Solar heat gain ratio' during selection of a glazing material?

F) Diffuse daylight efficacy is higher than Global daylight efficacy - explain.

G) Reflectance and transmittance of clear glass, a typical glazing material, depend on angle of incidence of solar beam – illustrate with suitable diagram.

5 x 4 = 20

Q.2. A) Derive the mathematical expression of point-specific horizontal illuminance (E_{p_ext}) due to an unobstructed sky.

B) Show that

$$E_{p\_ext} = \frac{7\pi}{9} L_z \, kLux$$

for the CIE Standard overcast sky model with the following sky luminance distribution.

$$L_\gamma = \frac{L_z}{3}(1 + 2Sin\gamma)\frac{kcd}{m^2}$$, [symbols have their usual meaning]

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Q.3. A) Explain the following energy related parameters of glazing material-

i) U-value; ii) Solar Heat Gain Coefficient.

B) Discuss the procedure of measurement of (i) Diffuse daylight efficacy and (ii) Global daylight efficacy.

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Q.4. Write down conceptual design matrices for designing a daylighting scheme and discuss the goal and evaluation procedure of any one out of them.

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Q.5. A) Write down mathematical expression of Daylight Coefficient(DC) and derive the expression of DC for horizontal illuminance.

B) For a side-lighting scheme show, with suitable diagram, the limits of horizontal and vertical acceptance angles with respect to a grid point on horizontal working plane. Identify the sky-zone on a projection of sky-dome for a south-facing window.

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