Ref. No. Ex/PG/IlluTD/T/121A/2024

M.TECH. ILLUMINATION TECH.& DESIGN EXAMINATION
1st year, 2nd Semester 2024

SUBJECT: -Lighting Economics, Audit & Management

Full Marks 100
(50 marks for each part) **Time: Three (03) hours**

Instructions: Students have to answer ANY FIVE (05) questions. Each question carries 10 marks. To-the-point answer and neatness will be appreciated. Each question has several parts with distinct marking as given in the right side of the question. Use separate answer scripts for Part-I and Part-II.

<table>
<tr><th>Question Number</th><th>Part- I</th><th>Marks</th></tr>
<tr><td>1.</td><td>The auditors have proposed the following retrofitting solution for saving electricity bill in a school:
<table>
<tr><td>Functional area</td><td>Existing lighting scheme</td><td>Proposed lighting solution</td><td>Daily Operating Hour</td></tr>
<tr><td>Classrooms</td><td>200 Nos. 40W FTL lamps with 12% ballast loss each</td><td>200 Nos. 25W LED tubelight</td><td>10 Hour</td></tr>
<tr><td>Library</td><td>80 Nos. 25W CFL with 10% ballast loss each</td><td>80 Nos. of 18W LED downlight</td><td>12 Hour</td></tr>
<tr><td>Laboratory</td><td>160 Nos. of 32W FTL with 10% ballast loss each</td><td>140 Nos. of 20W LED T-lights</td><td>8 Hour</td></tr>
</table>
It is estimated that, replacing the existing luminaires with the proposed LED product will require a total initial investment of Rs. 7.5 lakh. If the electricity tariff is Rs. 6 per unit and the estimated project life is 8 years, calculate the (A) return-on-investment and (B) payback period.</td><td>5+5 =10</td></tr>
<tr><td>2.</td><td>Write a comprehensive abstract of the paper “LES: An Innovative Development for Lighting System Performance Evaluation” authored by Frey et al (1996) within 250 words.</td><td>10</td></tr>
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3.	The total length of an expressway is 200 km. This expressway is illuminated presently by conventional luminaires housing one 250W MH lamp each. The poles are placed in both sides of the road in opposite arrangement at equal gaps of 50 meter. The ballast loss occurring in each luminaire is 15%. Authority is now planning to replace all of these luminaires with 135W LED luminaires to save electricity bill. (A) Calculate the saving in electricity bill in a month and in a year if the average burning hour is 12 hours and the tariff is Rs. 6 per unit? (B) Calculate payback period if the cost of replacement per luminaire is Rs. 8000. (C) Considering project life of 8 years, calculate return on investment.	4+3+3 =10
4.	In a town of West Bengal, there are total 5 high-masts for outdoor lighting. Each high-mast comprises total 12 numbers of 1000W metal halide luminaires. The ballast loss of each such luminaire is 12%. To cut down monthly electricity bills, the town development authority has planned to replace each of the existing luminaires with 750W LEDs. For this replacement, the supplier has quoted an estimated cost of Rs. 20 Lakh. If the average daily burning hour is 10 Hours and the electricity tariff is Rs. 4 per kWh, Calculate: i. The payback period. ii. Return-on-investment assuming project life of 10 years and iii. Annual saving in electricity bill.	4+4+2 =10
5.	(A) Elaborate the steps of conducting lighting evaluation using LES. (B) What are the disadvantages of LES? In your opinion, how to mitigate them?	7+3 =10
6.	(A) Explain how fluctuation in supply voltage causes flicker in HID lamps. (B) With a circuit diagram, explain the principle of operation of active PFC employed in LED luminaires. (C) What are the problems caused by current harmonic injection by lighting loads?	3+4+3 =10
7.	(A) Describe the steps and tools involved in a manual lighting audit. (B) Write down the disadvantages of manual lighting audit.	7+3 =10

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COURSE: M. TECH. ILLUMINATION TECHNOLOGY AND DESIGN
PAPER IV: LIGHTING ECONOMICS, AUDIT & MANAGEMENT
YEAR: 1ST YEAR 2ND SEMESTER (2024-25)
PART – II
QUESTION NO. 1 is COMPULSORY; WRITE ANY 3 FROM REST.

1. Answer Any Five Questions. 5x1=5
a. What Percentage of total generated power is used in illumination in case of India?
b. What is per capita energy usage in India as per Economic Survey of India 2018?
c. What is the key variable in case of Demand Side Management?
d. What is the minimum connected load value in KW for ECBC Building?
e. What do you mean by Negative Cash Flow?
f. What is the unit of Lighting Power Density and System Luminous Efficacy?
g. What are the two factors for determining ECBC?

2. Describe different types of costs of an illumination system with the basis of economic analysis.
In a laboratory to maintain 500Lux, Total 54000Lumen is required. Shyam buys 15nos 36W LED recessed mounted 2x2 Luminaires and Madhu buys 15nos 2x36W CFL recessed mounted 2x2 lamps and Luminaires. Who has got the advantage in costing. Considering Labour Cost per Luminaires Rs. 50 and electricity tariff: Rs. 10/ Unit and LED Luminaire Efficacy 110 Lumen/Watt, FTL Lamp Efficacy 68Lumen/Watt and FTL Fitting LOR: 80%. Cost to Buy LED Batten: Rs. 450; Cost to Buy FTL Lamps: Rs. 50; Cost to Buy FTL Luminaires: Rs. 110; Cost to Buy Control Gear for FTL: Rs. 200. Transportation cost is Rs. 500 for each of them. 5+10

3. In a field, To maintain 40Lux, total maintained luminous flux is required 5,28,000Lumen from one. The authority calls up three consultancy to give electrical solution. Consultancy A provides solution of 12nos 400W LED Floodlight. Consultancy B provides solution of 12nos 2X400W HPSV Floodlight. And Consultancy C provides solution of 10nos 2X400W MH Floodlight. Compare the three consultancy solutions based on economic analysis. Considering Labour Cost per Luminaires Rs. 150 and electricity tariff: Rs. 10/ Unit and LED Luminaire Efficacy 110 Lumen/Watt, MH Lamp Efficacy 88Lumen/Watt and MH Fitting LOR: 70%. HPSV Lamp Efficacy 120Lumen/Watt and HPSV Fitting LOR: 60% Cost to Buy LED Luminaire: Rs. 12500; Cost to Buy MH Lamps: Rs. 350; Cost to Buy MH Luminaires: Rs. 2000;

Cost to Buy Control Gear for MH: Rs. 4000; Cost to Buy HPSV Lamps: Rs. 200; Cost to Buy HPSV Luminaires: Rs. 1400; Cost to Buy Control Gear for HPSV: Rs. 3800; Per Year Conventional Luminaire Maintenance Cost for Cleaning: Rs. 250/Luminaire. 15

4. Write short note any five: 5x3
a. Payback Period
b. Life Cycle Cost analysis
c. Retrofitting Installation
d. Check lists for Lighting Audits
e. Green Building
f. Lighting Control Techniques
g. Demand Side Management

5. Rabin has a contract from JU to install streetlight along the interior of main road. Total No. of Pole is 50nos and per pole has as a provision to mount 1no. Streetlight. It is seen that total Lumen required to maintain average illuminance of 15Lux. 4,42,500Lumen is required. Rabin is confused to choosed between 1. 70W LED Streetlight from Indore of 130 Lumen/Watt. 2. 90W LED Streetlight from Kolkata of 110 Lumen/Watt. Consider the Luminaire Operational Hour is 12hours. The costs involves in this case are mentioned as below: 1. Cost to buy 70W LED Unit Luminaire Rs. 2400 2. Cost to buy 90W LED Unit Luminaire Rs. 4000 3. Installation Cost Rs. 850 per Luminaire 4. Transportation Cost to take all Luminaires from Indore to Kolkata Site: Rs. 15000 5. Transportation Cost to take all Luminaires from Kolkata Store to Site: Rs. 2000 6. Annual Maintenance cost per Luminaire to clean the dust: Rs. 500 7. Electricity Tariff: Rs. 10/Unit 8. End life Disposal Cost: Rs. 200/Unit Luminaires Compare the Life Cycle cost of Two Luminaires. 15

6. In a Classroom there are 36nos 2X2 Conventional Luminaires (LOR 65%) and 80nos Conventional Downlight (LOR 67.1%). Each 2x2 Conventional Luminaires contains 4nos 14W T5 Lamp (Luminous Efficacy of LAMP 87 Lumen/Watt) and each Downlight contains 2nos 18W CFL (Luminous Efficacy of LAMP 67 Lumen/Watt). To maintain the Lux level, each 2x2 Conventional is retrofitted with 30W LED 2x2 110LPW and each Conventional Downlight is retrofitted with 18W LED Downlight 110LPW. Unit price for 30W 2x2 LED Luminaire is Rs. 1100 and unit price for 18W LED Downlight is Rs. 500. Labour cost to retrofitment the luminaire Rs. 200/unit. Consider 5days class in weeks and operational hours 5 hours in a day and Electricity Tariff Rs. 7/ unit. Determine

the Simple Payback period, 5 Year Cash flow and Simple Return on Investment. 15

7. In a stadium, There are 4nos HIGHMAST and each Highmast contains 30nos 1000W Metal Halide Floodlight Luminaire (LOR: 64.6%). 1000W MH Lamp Efficacy is 90 Lumen/Watt. Each Luminaire is retrofitted with 500W LED Floodlight of 120Lumen/Watt. Labour cost to retrofitment the luminaire Rs. 2400/unit. Unit Costing of 500W LED Floodlight is Rs. 20000. Consider operating hours of 4hours of weekends and Electricity Tariff Rs. 10/ unit. Determine the Simple Payback period, 5 Year Cash flow and Simple Return on Investment. 15