Ref No. : Ex/EE/PC/B/T/323/2023

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2023
(3rd Year, 2nd Semester)

ELECTRICAL UTILIZATION AND ILLUMINATION ENGINEERING

Time: Three Hours | Full Marks: 100

Use a separate Answer-Script for each part

PART – I (50 marks)

Answer any three. Question no. 4 carries the maximum marks

1. (a) Sketch a schematic of a coreless induction furnace. **4**

(b) Discuss the factors on which the selection of frequency for induction heating depends. **5**

(c) Eight resistances each of 10 ohms are used in a resistance oven. If H is the maximum heat obtained from the oven with a supply voltage of 110V, 50 Hz, determine all possible heat output with the same supply. **7**

2. (a) A 6 cell, 500Ah lead acid battery takes a ripple free charging current of 5A DC at 13.8V DC. By analyzing the line current of the charger a fundamental frequency of 50 Hz and a third harmonic component of 150 Hz are obtained with a value of 4.8A rms and 1.0A rms respectively. Calculate the input power factor (approx.) and percent THD of the input line current. If an LC tuned filter is installed to arrest the third harmonic component totally what will be the modified THD and power factor (approx.)? **10**

(b) What the adverse effects of harmonics present in the line current? **6**

3. (a) What are the characteristics of storage batteries? **6**

(b) What is shedding? **3**

[Turn over

(c) Discuss different charge termination processes. 7

4. (a) Draw a schematic of electrode regulation system? 3

(b) How does stirring take place in a Direct Electric Arc Furnace (EAF)? 2

(c) Why is heavy rocking necessary in an indirect EAF? 3

(d) A 1.7 kW 220V, single phase resistance oven is to have Nichrome wire heating elements. If the wire temperature is to be 730°C and that of the charge 230°C, estimate the diameter and length of the wire and coil. The resistivity of Nichrome alloy is 42.5 μΩ-cm. Assume the radiating efficiency and the emissivity of the element as 1 and 0.85 respectively. 10

5. Write short notes on (**any two**) **8 x 2**

(a) Different types of uninterruptable power supplies (UPS)

(b) Dielectric heating

(c) Salt bath furnace

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Time: Three Hours Full Marks: 100

Part-II (50 marks)

Use separate answer scripts for each part

Question number 1 is compulsory and answer **any two questions from the rest** (20 + 15X2)=50

Answer **any 5** from **Question number 1**

Justify the following with necessary corrections, if any (4X5 =20)

1. a) A 100W incandescent lamp has same efficacy than a 60W incandescent lamp.
   b) Luminous flux of a light source doesn't relate with human vision; it is a fixed quantity.
   c) S/P ratio of a light source doesn't have any role in lighting design.
   d) Detector, sensor and meter for any photometric measuring instrument means same.
   e) SPD of a light source carries only color information.
   f) Coefficient of Utilization (COU) and Light Output Ratio (LOR) of a luminaire are same for an Indoor lighting luminaire.
   g) 1/10 V analogue lighting control protocol is better than any digital lighting control protocol.
   h) V(λ) filters are not mandatory requirement for lux meter.
   i) There is no fundamental difference between visual photometry and physical photometry.

2. a) Discuss the method associated with substitution based luminous flux measurement of a light source by Integrating Sphere . 8
   b) What is the function of auxiliary lamp and baffle used in Integrating Sphere during luminous flux measurement of a light source. 2
   c) Prove that in case of flat perfect diffuser Luminous Flux $\Phi = \Pi I_n$ where I_n = Intensity at normal position? 5

3. a) What do you mean by indoor lighting design? How it is different from outdoor lighting ? 4
   b) Design a Lighting Scheme with two different options with different types of lighting system (mentioned) for the Seminar room of Electrical Engineering Department, Jadavpur University with the dimensions 36.5 m X 13 m X 5.5 m . The target illuminance level is 500 Lux . The overall light loss factor of the room to be considered as 0.8. Compare the energy consumptions and lighting power densities for each design option. 8

   Option-1

   Lighting System type –Luminaire with 2 X 36 W TL'D lamp & Electronic Ballast
   Luminous flux per Lamp = 3250 Lumen
   Coefficient of Utilization Value = 0.7
   Power consumption per luminaire (including Ballast) = 82 W
   CCT of the lamp :- 5000 K

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Part-II(50 Marks)

Option-2
Lighting System type –Luminaire with 2 X 24 W LED tubes
Luminous flux per Lamp = 2160 Lumen
Coefficient of Utilization Value = 0.8
Power consumption per luminaire (including Driver loss) = 56 W
CCT of the lamp: - 6500 K
Consider working schedule for the room is 10 hours per day & 300 days per year

Option-3
Lighting System types: - RGB 28W LED downlighers
Luminous flux per Lamp = 2600 Lumen
Coefficient of Utilization Value = 0.85
Power consumption per luminaire (including Driver loss) = 30 W
Consider working schedule for the room is 10 hours per day & 300 days per year
CCT of the lamp: - 5600 K

c) What do you mean by Human Centric Lighting? 3

4. a) What is the fundamental difference between type-B and type-C goniophotometers? 3

b) Explain how the intensity distribution of a luminaire can be represented? 2

c) What are the fundamental characteristics we need to consider for indoor luminaires? 6

d) Develop the expressions of direct luminous flux transfer between a point source and point receiver. 4

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Part-II (50 Marks)

5. a) What do you mean by spectral power distribution (SPD) of a light source? 3
   b) What are the fundamental information available from the SPD of a light source? 4
   c) A lamp has five lines in the visible spectrum at 420.1, 452.4, 510.78, 553, 590.1 nm with radiant power densities of 1.0, 0.9,08,.02,.01 mW/cm^2, respectively. Assuming 40 % of the input power density to the lamp is in these visible lines, compute the Photopic lumens per square centimeter emitted by the lamp and the lamp's luminous efficacy (Photopic) in lumens per watt. Further calculate Scotopic to Photopic lumen ratio for the source. 8

Spectral luminous efficiency values few wavelengths for photopic as well as scotopic vision are mentioned as

Wavelength λ (nm)	Photopic Luminous Efficiency V_λ	Scotopic Luminous Efficiency V'_λ
410	0.00121	0.03484
420	0.004	0.0966
430	0.0116	0.1998
440	0.023	0.3281
450	0.038	0.455
460	0.06	0.567
470	0.09098	0.676
480	0.13902	0.793
490	0.20802	0.904
500	0.323	0.982
507	0.44431	1
510	0.503	0.997
520	0.71	0.935
530	0.862	0.811
540	0.954	0.655
550	0.99495	0.481
555	1	0.402
560	0.995	0.3288
570	0.952	0.2076
580	0.87	0.1212
590	0.757	0.0655
600	0.631	0.03315
610	0.503	0.01593