Ref No. : **Ex/EE/PC/B/T/323/2024**

B.E. ELECTRICAL ENGINEERING 3RD YEAR, 2ND SEMESTER EXAMINATION, 2024

ELECTRICAL UTILIZATION AND ILLUMINATION ENGINEERING

Time: Three Hours | Full Marks: 100

Use a separate Answer-Script for each part

PART – I (50 marks)

Answer question no. 3 and any two from the rest

1. Answer the following **4x4**

(a) If the current and voltage contain the same harmonics, the power factor may not reduce.

(b) Show that when an electric arc furnace is running at maximum power condition the transformer feeding it is operating at 0.707 lagging power factor.

(c) How the operating frequency is limited for dielectric heating?

(d) What is a rocking arc furnace? Give justification of its name.

2. (a) The total harmonic distortion of current is 10% in a resistive circuit with load resistance 20 ohm. If the maximum value of the fundamental current is 4A, calculate the total average power consumed. **8**

(b) What is the total power factor when the displacement between voltage and current is 25°, and the THD is 49% ? **4**

(c) How a tuned LC filter installed by a consumer could be saved from being overloaded by neighbor's non-linear load consumption? **2**

[Turn over

(d) Relate Average Power and THD_I. **2**

3. (a) What form of heating is the most efficient for cooking? – write your view with justification. **4**

(b) Highlight the charge termination modes used for rechargeable batteries. **6**

(c) How do you choose a battery for a space shuttle? **4**

(d) What are the factors on which the selection of the frequency for induction heating depends? **4**

4. (a) A 10 kw single phase 220V resistance oven employs a rectangular strip of 1 mm thick for its heating element. If wire temperature is not exceeding 1170°C and the temperature of the charge is to be 500°C calculate the width and length of the wire. Take K=0.57, e=0.95, ρ=1.09$\mu\Omega$-m. **11**

(b) What should be properties of good electrode materials used for arc furnace? **3**

(c) What is Soderberg electrode? **2**

5. Write short notes on : **8x2**

(a) Core-type and core-less type Induction furnace

(b) Salt Bath furnace

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Full Marks 100

Time : Three hours **(50 marks for each part)**

Use a separate Answer-Script for each part

No. of questions		Part II	Marks
		Question No 1 (5 X 4) is compulsory & Answer any 2 (2 X 15) from the rest **Answer any 5 of Question No 1** **Justify or do the necessary corrections, if any for the following statements**	
1.	a)	There is no fundamental difference found between the Light Output Ratio (LOR) and the Coefficient of Utilization (COU) of an indoor luminaire.	
	b)	Color Rendering Index (CRI) of a light source can be predicted from Spectral Power Distribution (SPD) of the source.	
	c)	Photometry and radiometry is same for a light source.	5 X 4 =20
	d)	A ballast is required to operate a fluorescent lamp.	
	e)	There is no role of $v(\lambda)$ & $v'(\lambda)$ curve for illuminance calculation under a light source.	
	f)	V-I characteristics of LED is linear.	
	g)	Luminous efficacy of a 200W incandescent lamp is always same with 60W incandescent bulb.	
	h)	Cosine correction is very much necessary for a detector .	
	i)	What do you mean by retrofit Compact Fluorescent Lamp & why it is called energy saver?	
	j)	There is a necessity to consider Light loss factor (Maintenance Factor) while designing the lighting scheme for an interior space.	

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Time : Three hours **(50 marks for each part)**

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No. of questions		PART II	Marks
2.	a)	What are the fundamental information we can get from the Spectral Power Distribution (SPD) of the source? Compare the SPDs of a low pressure sodium vapor lamp (SOX), incandescent lamp and LEDs	4
	b)	The filament of a tungsten halogen lamp is 0.006 cm in diameter and 60 cm long. It consumes 100 W. Assuming that the filament can be considered a blackbody radiator, at what temperature it is operating? How many watts would it consume at a temperature of 3000 K?	4
	c)	Develop an algorithm to calculate the Photopic and Scotopic lumen from the SPD of a source with a suitable example.	7
3.	a)	What is the difference between visual and physical photometry?	5
	b)	Explain the fundamental steps to be followed for measurement of luminous flux of a light source using integrating sphere. Furthermore, discuss the role of baffle and the auxiliary lamp in the measurement.	5
	c)	The intensity distribution of a luminaire is given below. Find out the total luminous flux (in Lumen) by using Zonal Lumen Method. Find out LOR , ULOR & DLOR for the luminaire. Consider lamp lumen as 6000.	5

Angle(Degree)	Intensity(candela)
5	1800
15	1542
25	1375
35	1122
45	995
55	843
65	690
75	300
85	138
95	76
105	37
115	13
125	06
135	85
145	96
155	182
165	250
175	389

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Use a separate Answer-Script for each part

No. of questions		PART II	Marks
4.	a)	What are the basic design steps for Indoor Lighting?	3
	b)	What do you mean by Human Centric Lighting (HCL)? Write down the basic aspects of HCL.	3
	c)	Design a general Lighting Scheme with two different options with different types of lighting system (mentioned below) for the Electrical Machine Laboratory of Electrical Engineering Dept, Jadavapur University. The tentative dimension of the laboratory room is 30 m X 20 m X 5 m . The target maintained average illuminance level is 300 Lux as recommended by IS 3646, Part-I & II , 1992. The overall Light Loss Factor to be considered as 0.8. Calculate LPD for both. **Option-1** Lighting System type –Luminaire with 2 X 36 W , T8 Fluorescent lamp & Electro Magnetic Ballast. Luminous flux per Lamp = 2800 Lumen Coefficient of Utilization Value = 0.75 Cost per Luminaire (including Ballast) = Rs 2000/- Cost per Lamp = Rs. 50/- Power consumption per luminaire (including Ballast) = 80 W **Option-2** Lighting System type –Luminaire with 2 X 20 W LED tube based lighting system Luminous flux per Lamp = 3250 Lumen Coefficient of Utilization Value = 0.85 Cost per Luminaire (including Driver) = Rs 6000/- Power consumption per luminaire (including Driver lost) = 42 W	9