Ref No. : **Ex/EE/5/T/412/2024**

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FOURTH YEAR FIRST SEMESTER - 2024
ELECTRICAL UTILISATION & ILLUMINATION ENGINEERING

Time: Three Hours | Full Marks: 100

Use a separate Answer-Script for each part

PART – I (50 marks)

Answer question no. 1 and any two from the rest

1. Correct and/or justify the following statements with proper explanations. (4×5) — 20

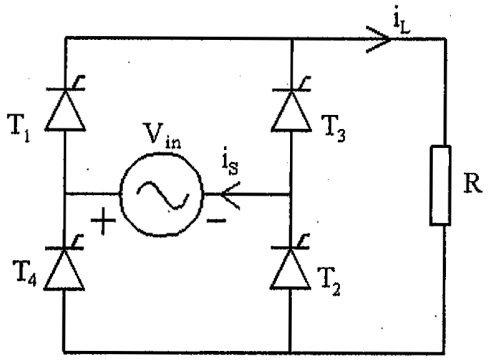
   (a) Power factor may not reduce if voltage and current both have harmonics.

   (b) Indirect Arc Furnaces should have three electrodes for three phase operation.

   (c) An Arc Furnace requires an external inductor.

   (d) Tuned LC filters can provide leading VAr

   (e) Memory effect reduces the SoC of a battery.

2. **(a)** 

   An electric heater (R) is supplied by a bridge rectifier as shown in the figure. Draw the waveform of the load current (I_L) and the source current (I_S) if T_1, T_2 are triggered at 0° and T_3, T_4 are triggered at 180° of the input sine wave. Also determine the average power, power factor, displacement factor and %THD of the source current. Here, $V_{in} = 155 * sin(314*t)$ *and* $R = 10\Omega$. — 7

   (b) Discuss the effects of harmonics on different electrical machines. — 5

   (c) How a tuned LC filter installed by a consumer could be saved from being overloaded by the non-linear loads in the neighborhood? — 3

3. **(a)** Explain the terms applicable to lead-acid batteries: (i) C-rate, (ii) DoD, (iii) Shedding — 6

   (b) Explain the charge termination techniques used for Ni-Cd and Ni-MH batteries. — 5

   (c) What is temperature compensation for battery charging? — 4

4. **(a)** Explain the principle of dielectric heating. — 5

   (b) With suitable derivation find the maximum power transfer condition in a Direct Arc Furnace. What is the power factor in this condition? — 6

   (c) What are the advantages of Induction Heating? — 4

5. Write short notes on :

   (a) Salt Bath Furnace — 8

   (b) Different types of UPS architecture. — 7

[Turn over

Form A: Paper-setting Blank *Ref. No. Ex/EE/5/T/412/2024*

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FOURTH YEAR FIRST SEMESTER EXAMINATION 2024
(1st/2nd ~~Semester/Repeat/Supplementary/Spl. Supplementary/Old/Annual/Bi-Annual~~)

SUBJECT Electric Utilization & Illumination Engineering
(Name in full)

PAPER

Full Marks ~~30~~/ 100

Time : ~~Two hours~~/Three hours/~~Four hours/Six hours~~ **(~~15~~/50 marks for each part)**

Use a separate Answer-Script for each part

No. of questions		~~Part I~~ / 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**	
1.	a)	Write down and explain Wien's Displacement Law of Black Body Radiation with a suitable example.	
	b)	Explain the significance of $V(\lambda)$ and $V'(\lambda)$ function in Photometric measurements.	
	c)	What is Spectral Power Distribution (SPD)? Draw typical SPDs for GLS Lamp and low pressure sodium vapour lamp (SOX).	
	d)	Explain the role of ballast for discharge lamp operation.	
	e)	What is the difference between the term efficiency & efficacy for Lighting System?	
	f)	Explain fundamental differences between Visual Photometry and Physical Photometry?	
	g)	Show that, for a flat perfect diffuser, luminance is independent of direction of view.	
	h)	Write down the expression for average Intensity for the five plane photometry System. Explain it's relevance in LED photometry.	
2.	a)	Define Illuminance & hence derive Inverse Square Cosine Law of Illuminance?	4
	b)	A lamp has five lines in the visible spectrum at 400.3 , 442.4, 502.78, 546, 587.1 nm with radiant power densities of 1.0, 0.9,08,.02,.01 mW/cm2 , respectively. Assuming 40 % of the input power density to the lamp is in these visible lines, compute the lumens per square centimeter emitted by the lamp and the lamp's luminous efficacy in lumens per watt.	6
	c)	The filament of an incandescent lamp is 0.008 cm in diameter and 80 cm long. It consumes 200 W. Assuming that the filament can be considered a black body radiator, at what temperature is it operating? How many Watt would it consume at a temperature of 3000K?	5

Form A: Paper-setting Blank *Ref. No. Ex/EE/5/T/412/2024*

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SUBJECT Electric Utilization & Illumination Engineering

(Name in full)

PAPER

Full Marks ~~30~~/ 100

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Use a separate Answer-Script for each part

No. of questions		~~Part I~~ / Part II	Marks
3.	a)	Discuss the Characteristics of different Photo-Electric Sensors?	4
	b)	What do you understand by Luminaire? What are the basic functions of a luminaire?	3
	c)	How luminaires are classified according to the application?	2
	d)	What are the photometric characteristics of indoor luminaire ?	2
	e)	Prove that in case of flat perfect diffuser Luminous Flux $\Phi = \Pi I_n$ where I_n = Intensity along normal direction	4
4.	a)	What are the basic design steps for Indoor Lighting?	5
	b)	What do you mean by Lighting Power Density?	2
	c)	Design a general Lighting Scheme with two different options with different types of lighting system (mentioned below) for the room of dimension 20 m X 16 m X 5 m . The target maintained average illuminance level is 500 Lux . The overall Light Loss Factor to be considered as 0.8. Consider the room is to be used for 300 days per year with 12 hours per day. Compute the energy consumption for both the options and clearly mention which one is the best option from energy saving point of view. **Option-1** Lighting System type –Luminaire with 2 X 40 W T12 Fluorescent lamp & Electro Magnetic Ballast Luminous flux per Lamp = 2450 Lumen Coefficient of Utilization Value = 0.65 Cost per Luminaire(including Ballast) = Rs 2000/- Cost per Lamp = Rs. 50/- Power consumption per luminaire (including Ballast) = 120 W	8

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SUBJECT Electric Utilization & Illumination Engineering
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PAPER

Full Marks ~~30~~/ 100

Time : ~~Two hours~~/Three hours/~~Four hours/Six ours~~ **(~~15~~/50 marks for each part)**

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No. of questions	~~Part I~~ / Part II	Marks

Option-2
Lighting System type –Luminaire with 2 X 36 W T8 Fluorescent lamp & Electronic Ballast
Luminous flux per Lamp = 3250 Lumen
Coefficient of Utilization Value = 0.7
Cost per Luminaire(including Ballast) = Rs 3000/-
Cost per Lamp = Rs. 80/-
Power consumption per luminaire (including Ballast) = 76 W

5. a) The intensity distribution of a luminaire is given below. Find out the total luminous flux (in Lumen) by using Zonal Lumen Method. 8

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

b) Write a note on luminous flux measurement using Integrating Sphere.Show that the illuminance received at any position on the surface of the Integrating Sphere from another part of the surface is independent of their relative positions. 7