

B.E. ELECTRICAL ENGINEERING SUPPLEMENTARY EXAMINATION, 2024

(4th Year, 1st Semester)

ILLUMINATION SCIENCE & LIGHTING DESIGN (ELECTIVE-I)

Time : Three hours

Full Marks : 100
(50 marks for each part)

Use separate Answer-script for each part

PART – I

Q1. is compulsory

Answer any Two from rest

1. (a) How would you determine the Effective Cavity Reflectance for various types of non-horizontal ceilings ? Explain with any two types of examples. 6

(b) A room of 36' length and 24' width is illuminated with suspended direct type retrofit LED luminaire. The reflectances of ceiling surface is 80%, wall surface of the ceiling cavity is 90%, wall surface below the luminaires is 50%, wall from floor to working plane is 10% and floor reflectance is 30%. The distance of the luminaire to ceiling is 2ft. 6 inches, the distance of the luminaire to working plane is 8ft. and the distance between the working plane and floor is 2ft. 6 inches.

i) Find out the effective ceiling and effective floor cavity reflectances.

ii) Choose the correct luminaire from the given Table and find out the CU value of the luminaire. Given: Lamp lumen depreciation factor=0.85, Lumen dirt depreciation factor=0.75, Room surface dirt depreciation factor=0.8.

(Use the given Tables 2,3,4 and submit these with your answerscripts) 8

iii) What is the efficacy of the chosen LED luminaire and how much total Wattage is being consumed for this designed lighting system? 3

iv) Arrange the luminaires in the room properly. 3

Answer any TWO from rest

2.(a) Describe the production of radiation in low Pressure Mercury vapour lamp with necessary transition diagram. 4

[Turn over

(b) A 36W fluorescent lamp and a magnetic choke are connected in series across a 230 V r.m.s, 50 Hz supply.

- i) Draw its circuit diagram with glow starter and one power factor improving capacitor..
- ii) Design a magnetic ballast and find out its inductance , when the following r.m.s. measurements were obtained : $V_{\text{lamp}} = 107 \text{ V}$, $I = 411 \text{ mA}$, $P_{\text{lamp}} = 36 \text{ W}$, $P_{\text{ballast}} = 11 \text{ W}$.
- iii) Draw necessary vector diagrams.
- iv) What value of capacitor will be used to obtain unity power factor? 2+7+1+1 = 11

3. (i) Write short notes on (any four) : 4×3=12

(a) Filament making, (b) Sodium-resistant glass, (c) Glass-metal seal, (d) Penning mixture, (e) the functions of buffer gases .

(ii) Name different types of high pressure discharge lamps and mention their applications. 3

4.(a) Discuss on the Colour characteristics of Low pressure and High pressure Na-vapour lamps .2

(b) Compare between Spherical and Cylindrical Illuminance with suitable diagrams. 4

(c) Find the Total Downward Flux output of the luminaire, whose Angle vs. Intensity values are given in Table 1. 5

(d)(i) Explain the method of selection of the illuminance value of a particular place from the ranges of values given in IS 3646 with any one practical example. 4

OR,

(ii) Explain the Dynamic V-I characteristic of a low pressure gas discharge lamp necessary curves. 4

Table 1

Angle (deg)	Mean intensity in vertical plane (cd/1000 lumens)
0	220
5	219
10	214
15	214
20	207
25	198
30	180
35	170
40	140
45	108
50	85
55	72
60	46
65	30
70	25
75	18
80	12
85	7
90	0

TABLE II
Coefficients of Utilization

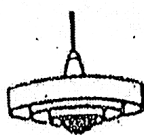
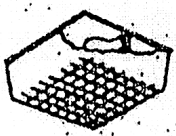
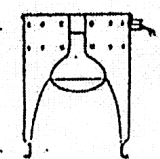
Typical Luminaire	Typical Intensity Distribution and Per Cent Lamp Lumens	P.C.C. →			70°			50°			30°			10°			0°			W.D.R.C.	P.C.C. →	
		P.W. →			50°			30°			10°			30°			10°					
		Maint. Cal.	SC	RCR	Coefficients of Utilization for 20 Per Cent Effective Floor-Cavity Reflectance (ρ _{fc} = 20)																	
1		V	1.5	0	.87	.87	.87	.81	.81	.81	.70	.70	.70	.59	.59	.59	.49	.49	.49	.45	.368	1
				1	.71	.66	.62	.65	.61	.58	.55	.52	.49	.46	.44	.42	.38	.34	.34	.30	.279	2
				2	.60	.53	.48	.55	.50	.45	.47	.42	.38	.39	.35	.32	.31	.29	.29	.23	.227	3
				3	.52	.44	.38	.48	.41	.38	.40	.35	.31	.33	.29	.26	.27	.24	.21	.18	.192	4
				4	.45	.37	.32	.42	.35	.29	.35	.30	.25	.29	.25	.21	.23	.20	.17	.14	.148	5
				5	.40	.32	.27	.37	.30	.25	.31	.25	.21	.28	.21	.18	.21	.17	.14	.12	.148	6
				6	.35	.28	.23	.33	.26	.21	.20	.22	.18	.23	.19	.15	.19	.15	.12	.10	.148	7
				7	.32	.25	.19	.29	.23	.18	.25	.20	.16	.21	.18	.13	.17	.13	.11	.09	.130	8
				8	.29	.22	.17	.27	.20	.16	.23	.17	.14	.19	.15	.12	.15	.12	.09	.07	.117	9
				9	.26	.19	.15	.24	.18	.14	.21	.16	.12	.17	.13	.10	.14	.11	.08	.07	.107	10
				10	.24	.17	.13	.22	.16	.12	.19	.14	.11	.16	.12	.09	.13	.10	.08	.06	.098	10
Pendant diffusing sphere with incandescent lamp																						
2		I	N.A.	0	.83	.83	.83	.72	.72	.72	.50	.50	.50	.30	.30	.30	.12	.12	.12	.03	.018	1
				1	.72	.69	.66	.62	.60	.57	.43	.42	.40	.28	.25	.25	.10	.10	.10	.02	.015	2
				2	.63	.59	.54	.54	.50	.47	.38	.35	.33	.23	.22	.20	.09	.09	.08	.02	.013	3
				3	.55	.49	.45	.47	.43	.39	.33	.30	.28	.20	.19	.17	.08	.07	.07	.02	.012	4
				4	.44	.42	.37	.42	.37	.33	.29	.26	.23	.18	.16	.15	.07	.06	.06	.02	.011	5
				5	.43	.38	.32	.37	.32	.28	.26	.23	.20	.16	.14	.12	.06	.05	.05	.01	.011	6
				6	.38	.32	.27	.33	.28	.24	.23	.20	.17	.14	.12	.11	.05	.04	.04	.01	.010	7
				7	.34	.28	.23	.30	.24	.21	.21	.17	.15	.13	.11	.09	.05	.04	.04	.01	.009	8
				8	.31	.25	.20	.27	.21	.18	.19	.15	.13	.12	.10	.08	.05	.04	.03	.01	.008	9
				9	.28	.22	.18	.24	.19	.16	.17	.14	.11	.10	.09	.07	.04	.03	.03	.01	.006	10
				10	.25	.20	.16	.22	.17	.14	.16	.12	.10	.10	.08	.06	.04	.03	.03	.01	.007	10
Concentric ring unit with incandescent silvered-bowl lamp																						
3		IV	1.3	0	.99	.99	.99	.97	.97	.97	.93	.93	.93	.88	.88	.88	.85	.85	.85	.83	.323	1
				1	.87	.84	.81	.85	.82	.79	.82	.79	.77	.79	.76	.74	.76	.74	.72	.71	.288	2
				2	.76	.70	.65	.74	.69	.65	.71	.67	.63	.68	.63	.62	.64	.63	.60	.59	.264	3
				3	.68	.59	.54	.65	.59	.53	.62	.57	.53	.60	.56	.52	.58	.54	.51	.49	.241	4
				4	.58	.51	.45	.57	.50	.45	.55	.49	.44	.53	.48	.44	.51	.47	.43	.41	.221	5
				5	.52	.44	.39	.51	.44	.38	.49	.43	.39	.47	.42	.37	.44	.41	.37	.35	.221	6
				6	.46	.39	.33	.46	.38	.33	.44	.38	.33	.43	.37	.33	.41	.36	.32	.31	.203	7
				7	.42	.34	.29	.41	.34	.29	.40	.33	.29	.39	.33	.29	.38	.32	.28	.27	.203	8
				8	.38	.31	.26	.37	.31	.26	.36	.30	.26	.35	.30	.26	.34	.29	.25	.24	.187	9
				9	.35	.28	.23	.34	.28	.23	.33	.27	.23	.32	.27	.23	.32	.26	.23	.21	.173	10
				10	.32	.25	.21	.32	.25	.21	.31	.25	.21	.30	.24	.21	.29	.24	.20	.19	.161	10
Porcelain-enamelled ventilated standard dome with incandescent lamp																						
4		V	1.3	0	.89	.89	.89	.85	.85	.85	.77	.77	.77	.70	.70	.70	.63	.63	.63	.60	.264	1
				1	.77	.74	.71	.74	.71	.68	.67	.65	.63	.61	.59	.57	.55	.54	.53	.50	.224	2
				2	.68	.63	.59	.65	.61	.57	.59	.56	.53	.54	.51	.49	.49	.47	.45	.42	.197	3
				3	.61	.55	.50	.58	.53	.48	.53	.48	.45	.49	.45	.42	.44	.42	.39	.37	.176	4
				4	.54	.48	.43	.52	.46	.42	.48	.43	.39	.44	.40	.37	.40	.37	.34	.32	.159	5
				5	.49	.42	.38	.47	.41	.37	.43	.38	.35	.40	.36	.33	.37	.33	.31	.29	.145	6
				6	.44	.38	.33	.43	.37	.32	.39	.34	.31	.36	.32	.29	.34	.30	.27	.26	.145	7
				7	.40	.34	.30	.39	.33	.29	.36	.31	.27	.33	.29	.26	.31	.27	.25	.23	.133	8
				8	.37	.31	.27	.36	.30	.26	.33	.28	.25	.31	.27	.24	.29	.25	.22	.21	.124	9
				9	.34	.28	.24	.33	.27	.24	.31	.26	.22	.29	.24	.21	.27	.23	.20	.19	.115	9
				10	.32	.26	.22	.30	.25	.21	.28	.24	.21	.27	.23	.20	.25	.21	.19	.17	.108	10
Prismatic square surface luminaire																						
5		IV	0.8	0	1.19	1.19	1.19	1.16	1.16	1.16	1.11	1.11	1.11	1.06	1.06	1.06	1.02	1.02	1.02	.90	.241	1
				1	1.08	1.05	1.03	1.08	1.03	1.01	1.02	1.00	.98	.98	.97	.95	.95	.93	.92	.90	.238	2
				2	.99	.94	.89	.97	.92	.88	.93	.90	.86	.90	.87	.84	.88	.85	.83	.81	.227	3
				3	.90	.84	.79	.88	.83	.78	.86	.81	.77	.83	.79	.76	.81	.77	.74	.73	.215	4
				4	.82	.75	.70	.81	.75	.70	.79	.73	.69	.77	.72	.68	.75	.71	.67	.66	.215	5
				5	.78	.68	.63	.75	.68	.63	.73	.67	.62	.71	.66	.62	.69	.65	.61	.59	.202	6
				6	.70	.62	.57	.69	.62	.57	.67	.61	.57	.66	.60	.56	.64	.60	.56	.54	.191	7
				7	.65	.57	.52	.64	.57	.52	.62	.56	.52	.61	.55	.52	.60	.55	.51	.50	.180	8
				8	.60	.53	.48	.59	.53	.48	.58	.52	.48	.57	.52	.47	.56	.51	.47	.46	.169	9
				9	.56	.49	.44	.55	.49	.44	.54	.48	.44	.53	.48	.44	.52	.47	.44	.42	.160	9
				10	.52	.46	.41	.52	.45	.41	.51	.45	.41	.50	.45	.41	.49	.44	.41	.39	.152	10
R-40 flood without shielding																						
6		IV	0.7	0	1.01	1.01	1.01	.99	.99	.99	.94	.94	.94	.90	.90	.90	.87	.87	.87	.85	.115	1
				1	.85	.83	.81	.83	.81	.80	.89	.84	.87	.88	.85	.84	.83	.82	.82	.80	.115	2
				2	.80	.76	.73	.87	.84	.82	.85	.82	.80	.82	.80	.79	.80	.78	.77	.76	.113	3
				3	.83	.80	.77	.82	.79	.76	.80	.77	.75	.78	.76	.74	.78	.74	.72	.71	.113	4
				4	.79	.74	.71	.78	.74	.71	.76	.73	.70	.74	.71	.69	.73	.70	.68	.67	.110	5
				5	.74	.70	.67	.74	.69	.66	.72	.68	.66	.71	.68	.65	.69	.67	.65	.63	.107	6
				6	.70	.66	.62	.70	.65	.62	.68	.65	.62	.67	.64	.61	.66	.63	.61	.60	.104	7
				7	.67	.62	.59	.66	.62	.59	.65	.61	.58	.64	.61	.58	.63	.60	.58	.57	.100	8
				8	.63	.59	.56	.63	.58	.55	.62	.58	.55	.61	.58	.55	.60	.57	.55	.54	.097	9
				9	.60	.56	.53	.60	.56	.53	.59	.55	.52	.58	.55	.52	.58	.54	.52	.51	.094	9
				10	.57	.53	.50	.57	.53	.50	.56	.52	.50	.56	.52	.50	.55	.52	.49	.48	.091	10
R-40 flood with specular anodized reflector, 45° cutoff																						

Table II - Continued
Coefficients, Luminaire Spacing Criterion and Maintenance Categories of Typical Luminaires.

80												70												50												30												10												80												70												50												30												10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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Table IV Per Cent Effective Ceiling or Floor Cavity Reflectances for Various Reflectance Combinations

Per Cent Basal Reflectance	60																				70																				80																				50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Per Cent Wall Reflectance	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
Cavity Ratio	0.2	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
0.4	89	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Values in this table are based on a length to width ratio of 1.6.

at Ceiling, floor or floor of cavity.

B.E.Electrical Engg. Supplementary Examination 2024**[4th Year; 1st Semester]****Subject: Illumination Science and Lighting Design****Part-II**

Time: 3 hours

Use Separate Answer script for each part

Full Marks:100

(50 marks for each Part)

[Answer any three Questions. Q.4 carries 18 marks]

Q.1.	A. Explain visual acuity and contrast sensitivity. B. Illustrate the variation of these two factors with background luminance with suitable diagram; clearly show the ‘region of seeing’ and the ‘region of non-seeing’.	8+8= 16 [CO1]																				
Q.2.	A. Describe the colour matching experimentation and hence show the procedure of development of the R-G-B chromaticity system. B. Compare between source colour theory and object colour theory with suitable diagram.	10+6= 16 [CO2 & CO5]																				
Q.3	A. What do you understand by CIE Standard Illuminant? Mention their applications in lighting industries. B. B) Describe McCamy model of CCT computation of a light source from its chromaticity.	6+10= 16 [CO2]																				
Q.4.	A. Write down the Grassman’s colour mixing law for ‘n’ number of light sources. B. Compute the chromaticity of the resultant radiation produced by mixing of three radiations from the lamps as given below using Grassman’s colour mixing law. <table><tr><td>Lamp (Wattage)</td><td>x</td><td>y</td><td>luminous efficacy (lm/W)</td><td>Number of lamps</td></tr><tr><td>A (150W)</td><td>0.510</td><td>0.415</td><td>114</td><td>4</td></tr><tr><td>B (250W)</td><td>0.360</td><td>0.371</td><td>82</td><td>2</td></tr><tr><td>C (150W)</td><td>0.310</td><td>0.340</td><td>67</td><td>2</td></tr></table>	Lamp (Wattage)	x	y	luminous efficacy (lm/W)	Number of lamps	A (150W)	0.510	0.415	114	4	B (250W)	0.360	0.371	82	2	C (150W)	0.310	0.340	67	2	6+12= 18 [CO4]
Lamp (Wattage)	x	y	luminous efficacy (lm/W)	Number of lamps																		
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C (150W)	0.310	0.340	67	2																		
Q.5.	A. Compare between specific CRI and general CRI. B. Write down the steps of evaluation of the general CRI of a light source.	6+10= 16 [CO5]																				