

M.TECH ILLUMINATION TECH. AND DESIGN 1ST YR, 2ND SEM., EXAMINATION, 2018**(1st Year, 2nd Semester)****INDOOR LIGHTING DESIGN****Time : Three hours****Full Marks : 100****Use separate Answer-script for each part****PART – I (50 Marks)****Answer Q1 and any two from rest.**

1.(a) Describe Parallel Plane Aspect Factor with necessary diagram. If, for a Uniform linear diffuser, $I(\alpha) = I(0) \cos \alpha$, what will be the value of Parallel Plane and Perpendicular plane Aspect Factors? Describe their relevance in linear source illuminance calculation. 8

(b) Explain with necessary diagrams the SEMI-CYLINDRICAL and CONICAL Illuminance calculation methods. 5+5=10

Or,

1.(a) If a diffused disc has luminance of 800 cd/m^2 and radius of 1.15 m , what will be the illuminance value on a parallel plane 3.0 m below? If the source diameter is made doubled, four times, what will be the illuminance values at that point? Drawing a graph, show the variation.

(b) Describe the method of Illuminance calculation at a point on the floor from large right-angled triangular shaped ceiling and rectangular shaped wall, draw necessary diagrams clearly.

(c) Mention any six places of non-maintained type good Emergency Lighting system, which should be installed for the building of EE Dept., JU. Describe the necessary Power sources generally used for Emergency system. Mention merits & demerits of using High Frequency Inverter based Lighting system in Emergency lighting system. 5+8 + 5 = 18

Answer any two

2(a) How would you select the particular illuminance level in an interior design from the given illuminance ranges of IS 3464? Describe with proper table.

(b) "The effective cavity reflectance of a particular shaped ceiling (other than flat) does not depend on its dimension." Justify this statement with a proper example.

P.T.O

- (c) A room of 44' length and 26' 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%. If the distance of the lamp to ceiling is 2ft. 6 inches, the distance of the lamp to working plane is 8ft, and the distance between the working plane and floor is 2ft. 6 inches, using the given Tables I to III ,
- Find out the effective ceiling and effective floor cavity reflectances.
 - Choose the correct luminaire from the given Table which would provide maximum efficacy and find out the CU value of that luminaire.
 - How many luminaires are required to illuminate the room with average 100 lux?(Use 18W LED with 90 lm/W efficacy.)
 - Show their spacing arrangement.

Given: Lamp lumen depreciation factor=0.8,
 Lumen dirt depreciation factor=0.7,
 Room surface dirt depreciation factor=0.8

$$3+3+10=16$$

3. In a room of 4 m x 4 m x 3.4 m (as shown in fig 1), the average 450-550 lux is to be provided by any type of symmetrically placed four CFL fitted recessed luminaires (600mmx600mm size). Considering $p_c=0.7$, $p_w=0.45$, $p_f=0.23$, $MF=0.7$, $UF(c)=0.1$, $UF(w) = 0.42$, $UF(f) = 0.6$, inter illuminance scalar factor of ceiling = 0.24, inter illuminance cylindrical factor of ceiling =0.12, DLOR=0.5 find out the followings:

- the direct flux/klm for one luminaire (using inverse square law) at the centre of each small area (using Table IV), the total working plane being divided in 16 small equal areas.
- the average Vector / Scalar ratio, considering Direct and Reflected components .Comment on this ratio.
- Find out the direct and reflected component of E_{cyl} and find out the ratio E_{cyl}/E_h . Why this ratio is important in Lighting Design.

16

4. (a) Two same types of lamps (Intensity Distribution Chart is given in Table V) are suspended from the ceiling with 1.2' suspension string. The height of the room is 14'. The length of the room is 30' and the width is 18'. The 18' wide walls hold the rod in which luminaires are mounted. The rod is fixed at the middle position of this wall. Find the illuminance at the centre of the 30' x 18' wall. The luminaires are spaced at 10' and the distance from the wall to each luminaire is also 10'.

P.T.O

When multiple coloured walls are being used, how would you calculate the weighted average reflectance?

What is the significance of Room Position Multiplier? Justify the importance of Wall Exitance and Ceiling Cavity Exitance coefficients in lighting design calculation.

In a room with Coffered ceiling, each coffer cavity of 2'x2'x1' dimension is separated by 1 foot band. All ceiling surfaces have reflectances of 80%. Using the given Tables, find out weighted average ceiling reflectance.

$$6+2+4+4=16$$

Table I - Continued*

Per Cent Basal Reflection	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	90	80	70	60	50	40	30	20	10	0		
Per Cent Wall Reflection	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Cavity Ratio	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	7.0	8.0	9.0	10.0								
0.2	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	
0.4	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	
0.6	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	
0.8	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	
1.0	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	
1.2	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	
1.4	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	
1.6	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	
1.8	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	
2.0	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	
2.2	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	
2.4	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	
2.6	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	
2.8	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	
3.0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	
3.2	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	
3.4	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	
3.6	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	
3.8	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	
4.0	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	
4.2	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
4.4	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	
4.6	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	
4.8	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	
5.0	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	
5.2	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	
5.4	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	
5.6	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	
5.8	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	
6.0	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	
7.0	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	
8.0	67	67	67	67	67	67	67	67	67	67	67	67																														

* Values in this table are based on a length to width ratio of 1.6.

† Ceiling, floor or floor of cavity.

TABLE II
Coefficients of Utilization


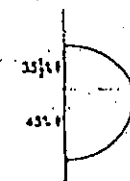

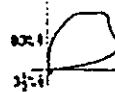

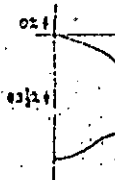

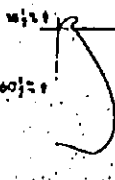
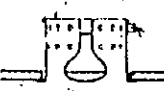
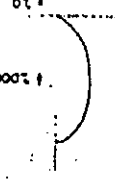
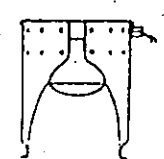
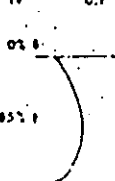
Typical Luminaire	Typical Intensity Distribution and Per Cent Lamp Lumens	Coefficient of Utilization for 20 Per Cent Effective Floor Cavity Reflectance (ρ _{fc} = 20)												WONC	RCR								
		ρ _c →			70°			50			30					10			0				
		ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →	ρ _c →			ρ _c →	ρ _c →	ρ _c →	ρ _c →				
Maint. Cat.	SC	RCR																					
 Pendant diffusing sphere with incandescent lamp		V	1.5	0	.87	.87	.87	.81	.81	.81	.70	.70	.70	.59	.59	.59	.49	.49	.49	.45			
				1	.71	.66	.62	.65	.61	.58	.55	.52	.49	.46	.44	.42	.36	.36	.34	.30		.368	1
				2	.60	.53	.48	.55	.50	.45	.47	.42	.38	.39	.35	.32	.31	.29	.26	.23		.279	2
				3	.52	.44	.38	.48	.41	.36	.40	.35	.31	.33	.29	.26	.27	.24	.21	.18		.227	3
				4	.45	.37	.32	.42	.35	.29	.35	.30	.25	.29	.25	.21	.23	.20	.17	.14		.192	4
				5	.40	.32	.27	.37	.30	.25	.31	.25	.21	.28	.21	.18	.21	.17	.14	.12		.164	5
				6	.35	.28	.23	.33	.26	.21	.28	.22	.18	.23	.18	.15	.19	.15	.12	.10		.148	6
				7	.32	.25	.19	.29	.23	.18	.25	.20	.16	.21	.18	.13	.17	.13	.11	.09		.130	7
				8	.29	.22	.17	.27	.20	.16	.23	.17	.14	.19	.15	.12	.15	.12	.09	.07		.117	8
				9	.26	.19	.15	.24	.18	.14	.21	.16	.12	.17	.13	.10	.14	.11	.08	.07		.107	9
				10	.24	.17	.13	.22	.16	.12	.19	.14	.11	.16	.12	.09	.13	.10	.08	.06		.094	10
 Concentric ring unit with incandescent silvered bowl lamp		II	N.A.	0	.83	.83	.83	.72	.72	.72	.50	.50	.50	.30	.30	.30	.12	.12	.12	.03			
				1	.72	.69	.66	.62	.60	.57	.43	.42	.40	.28	.25	.25	.10	.10	.10	.03		.018	1
				2	.63	.58	.54	.54	.50	.47	.36	.35	.33	.23	.22	.20	.09	.08	.06	.02		.015	2
				3	.55	.49	.45	.47	.43	.39	.30	.29	.28	.20	.19	.17	.08	.07	.07	.02		.013	3
				4	.48	.42	.37	.42	.37	.33	.29	.26	.23	.18	.16	.15	.07	.06	.06	.02		.012	4
				5	.43	.36	.32	.37	.32	.28	.26	.23	.20	.16	.14	.12	.06	.06	.05	.01		.011	5
				6	.38	.32	.27	.33	.28	.24	.23	.20	.17	.14	.12	.11	.04	.05	.04	.01		.010	6
				7	.34	.28	.23	.30	.24	.21	.21	.17	.15	.13	.11	.08	.05	.04	.04	.01		.009	7
				8	.31	.25	.20	.27	.21	.18	.19	.15	.13	.12	.10	.08	.05	.04	.03	.01		.008	8
				9	.28	.22	.18	.24	.19	.16	.17	.14	.11	.10	.08	.07	.04	.03	.03	.01		.006	9
				10	.25	.20	.16	.22	.17	.14	.16	.12	.10	.10	.08	.06	.04	.03	.03	.01		.007	10
 Porcelain-enamelled ventilated standard dome with incandescent lamp		IV	1.3	0	.99	.99	.99	.97	.97	.97	.93	.93	.93	.88	.88	.88	.85	.85	.85	.83			
				1	.87	.84	.81	.85	.82	.79	.82	.79	.77	.79	.76	.74	.76	.74	.72	.71		.323	1
				2	.76	.70	.65	.74	.69	.65	.71	.67	.63	.68	.65	.62	.64	.63	.60	.59		.311	2
				3	.66	.59	.54	.65	.59	.53	.62	.57	.53	.60	.56	.52	.56	.54	.51	.49		.288	3
				4	.58	.51	.45	.57	.50	.45	.55	.49	.44	.53	.46	.44	.51	.47	.43	.41		.264	4
				5	.52	.44	.39	.51	.44	.38	.49	.43	.38	.47	.42	.37	.46	.41	.37	.35		.241	5
				6	.46	.39	.33	.46	.38	.33	.44	.38	.33	.43	.37	.30	.41	.36	.32	.31		.221	6
				7	.42	.34	.29	.41	.34	.29	.40	.33	.29	.39	.33	.26	.38	.32	.28	.27		.203	7
				8	.38	.31	.26	.37	.31	.26	.36	.30	.26	.35	.30	.24	.34	.29	.25	.24		.187	8
				9	.36	.28	.23	.34	.28	.23	.33	.27	.23	.32	.27	.23	.32	.26	.23	.21		.173	9
				10	.32	.25	.21	.32	.25	.21	.31	.25	.21	.30	.24	.21	.29	.24	.20	.18		.161	10
 Prismatic square surface trim		V	1.3	0	.89	.89	.89	.85	.85	.85	.77	.77	.77	.70	.70	.70	.63	.63	.63	.60			
				1	.77	.74	.71	.74	.71	.68	.67	.65	.63	.61	.59	.57	.55	.54	.53	.50		.264	1
				2	.68	.63	.59	.65	.61	.57	.59	.56	.53	.54	.51	.49	.49	.47	.45	.42		.224	2
				3	.61	.55	.50	.58	.53	.48	.53	.48	.45	.46	.43	.42	.44	.42	.39	.37		.197	3
				4	.54	.48	.43	.52	.46	.42	.48	.43	.39	.44	.40	.37	.40	.37	.34	.32		.176	4
				5	.49	.42	.36	.47	.41	.37	.43	.38	.35	.40	.36	.33	.37	.33	.31	.29		.158	5
				6	.44	.38	.33	.43	.37	.32	.39	.34	.31	.36	.32	.29	.34	.30	.27	.26		.145	6
				7	.40	.34	.30	.39	.33	.29	.36	.31	.27	.33	.29	.26	.31	.27	.25	.23		.133	7
				8	.37	.31	.27	.36	.30	.26	.33	.28	.25	.31	.27	.24	.29	.25	.22	.21		.124	8
				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
 FL-40 flood without shielding		IV	0.8	0	1.19	1.19	1.19	1.18	1.18	1.18	1.11	1.11	1.11	1.06	1.06	1.06	1.02	1.02	1.02	1.00			
				1	1.06	1.05	1.03	1.08	1.03	1.01	1.02	1.00	.96	.98	.97	.95	.95	.93	.92	.90		.241	1
				2	.99	.94	.89	.97	.92	.86	.90	.86	.80	.87	.84	.88	.85	.83	.81	.78		.238	2
				3	.90	.84	.79	.88	.83	.78	.85	.81	.77	.83	.79	.76	.81	.77	.74	.73		.227	3
				4	.82	.75	.70	.81	.75	.70	.79	.73	.69	.77	.72	.68	.75	.71	.67	.66		.215	4
				5	.78	.68	.63	.75	.68	.63	.73	.67	.62	.71	.66	.62	.69	.65	.61	.59		.202	5
				6	.70	.62	.57	.69	.62	.57	.67	.61	.57	.66	.60	.56	.64	.60	.56	.54		.191	6
				7	.65	.57	.52	.64	.57	.52	.62	.56	.52	.61	.56	.52	.60	.55	.51	.50		.180	7
				8	.60	.53	.48	.59	.53	.48	.58	.52	.48	.57	.52	.47	.56	.51	.47	.46		.169	8
				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
 FL-43 flood with specular anodized reflector sheet, 45° cutoff		IV	0.7	0	1.01	1.01	1.01	.99	.99	.99	.94	.94	.94	.90	.90	.90	.87	.87	.87	.85			
				1	.85	.83	.81	.83	.81	.80	.89	.88	.87	.88	.85	.84	.83	.82	.82	.80		.115	1
				2	.80	.76	.73	.77	.74	.72	.85	.82	.80	.82	.80	.78	.80	.78	.77	.76		.113	2
				3	.73	.69	.67	.72	.69	.67	.79	.76	.73	.78	.76	.74	.76	.74	.72	.71		.113	3
				4	.70	.67	.64	.70	.67	.64	.78	.73	.70	.74	.71	.69	.73	.70	.68	.67		.110	4
				5	.67	.64	.61	.67	.64	.61	.74	.69	.66	.71	.68	.65	.69	.67	.65	.63		.107	5
				6	.64	.61	.58	.64	.61	.58	.68	.63	.62	.67	.64	.61	.66	.63	.61	.60		.104	6
				7	.61	.58	.55	.66	.62	.59	.65	.61	.58	.64	.61	.58	.63	.60	.58	.57		.100	7
				8	.60	.59	.56	.63	.58	.55	.62	.58	.55	.61	.58	.55	.60	.57	.55	.54		.097	8
				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

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

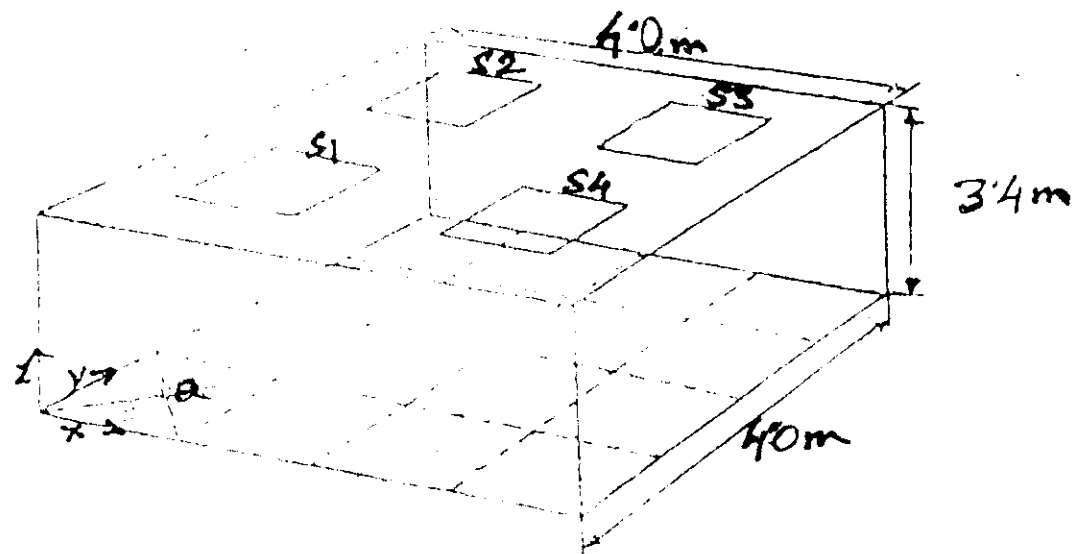
Wall Exitance Coefficients for 20 Per Cent Effective Floor Cavity Reflectance ($\rho_c = 20$)															Ceiling Cavity Exitance Coefficients for 20 Per Cent Floor Cavity Reflectance ($\rho_c = 20$)																																		
80					70					50					30					10					80					70					50					30					10				
50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10																	
128 .187 .059	.311 .178 .056	.280 .161 .051	.252 .145 .047	.226 .131 .042	.200 .117 .037	.174 .103 .032	.148 .089 .027	.122 .075 .022	.096 .061 .017	.070 .047 .012	.044 .033 .007	.018 .019 .002	.000 .000 .000	.000 .000 .000	.423 .423 .423	.361 .361 .361	.246 .246 .246	.142 .142 .142	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045	.045 .045 .045																		
175 .150 .046	.259 .143 .044	.231 .129 .040	.205 .115 .036	.181 .102 .032	.154 .085 .026	.128 .072 .022	.102 .058 .017	.076 .044 .012	.050 .30 .007	.024 .16 .002	.000 .02 .000	.000 .00 .000	.000 .00 .000	.000 .00 .000	.422 .396 .373	.361 .340 .321	.247 .234 .222	.142 .135 .129	.046 .044 .042	.045 .043 .040	.045 .042 .039	.045 .041 .038	.045 .040 .037	.045 .039 .037	.045 .038 .036	.045 .037 .035	.045 .036 .034	.045 .035 .033	.045 .034 .032	.045 .033 .031	.045 .032 .030																		
220 .128 .038	.226 .121 .036	.200 .108 .033	.176 .097 .030	.154 .085 .026	.128 .072 .022	.102 .058 .017	.076 .044 .012	.050 .30 .007	.024 .16 .002	.000 .02 .000	.000 .00 .000	.000 .00 .000	.000 .00 .000	.000 .00 .000	.412 .367 .332	.353 .317 .287	.242 .220 .202	.140 .128 .119	.045 .045 .041	.045 .041 .038	.045 .040 .037	.045 .039 .037	.045 .038 .036	.045 .037 .035	.045 .036 .034	.045 .035 .033	.045 .034 .032	.045 .033 .031	.045 .032 .030	.045 .031 .029	.045 .030 .028																		
265 .111 .033	.201 .105 .031	.177 .094 .028	.155 .083 .025	.135 .073 .022	.120 .064 .019	.109 .057 .017	.094 .044 .014	.088 .044 .013	.082 .041 .012	.077 .038 .011	.072 .035 .010	.067 .032 .009	.062 .029 .008	.057 .026 .007	.406 .358 .321	.348 .309 .279	.239 .215 .196	.138 .126 .116	.045 .045 .041	.045 .041 .038	.045 .040 .037	.045 .039 .037	.045 .038 .036	.045 .037 .035	.045 .036 .034	.045 .035 .033	.045 .034 .032	.045 .033 .031	.045 .032 .030	.045 .031 .029	.045 .030 .028																		
310 .098 .028	.181 .093 .027	.160 .083 .024	.145 .074 .022	.126 .066 .019	.109 .057 .017	.092 .047 .014	.085 .043 .013	.080 .040 .011	.074 .037 .010	.068 .034 .009	.062 .031 .008	.056 .028 .007	.050 .025 .006	.044 .022 .005	.400 .350 .314	.343 .303 .273	.236 .212 .193	.137 .124 .114	.044 .044 .041	.044 .041 .038	.044 .040 .037	.044 .039 .037	.044 .038 .036	.044 .037 .035	.044 .036 .034	.044 .035 .033	.044 .034 .032	.044 .033 .031	.044 .032 .030	.044 .031 .029	.044 .030 .028																		
355 .088 .025	.165 .084 .024	.145 .074 .022	.126 .066 .019	.109 .057 .017	.092 .047 .014	.085 .043 .013	.080 .040 .011	.074 .037 .010	.068 .034 .009	.062 .031 .008	.056 .028 .007	.050 .025 .006	.044 .022 .005	.038 .019 .004	.394 .344 .309	.338 .298 .269	.234 .209 .190	.135 .123 .113	.044 .044 .041	.044 .041 .038	.044 .040 .037	.044 .039 .037	.044 .038 .036	.044 .037 .035	.044 .036 .034	.044 .035 .033	.044 .034 .032	.044 .033 .031	.044 .032 .030	.044 .031 .029	.044 .030 .028																		
400 .080 .023	.152 .076 .022	.130 .067 .019	.116 .059 .017	.100 .052 .015	.085 .043 .013	.080 .040 .011	.074 .037 .010	.068 .034 .009	.062 .031 .008	.056 .028 .007	.050 .025 .006	.044 .022 .005	.038 .019 .004	.032 .016 .003	.388 .339 .305	.334 .294 .266	.231 .206 .188	.134 .122 .112	.043 .043 .040	.043 .040 .037	.043 .039 .037	.043 .038 .036	.043 .037 .035	.043 .036 .034	.043 .035 .033	.043 .034 .032	.043 .033 .031	.043 .032 .030	.043 .031 .029	.043 .030 .028	.043 .029 .027																		
445 .073 .021	.140 .069 .020	.123 .062 .018	.107 .054 .016	.092 .047 .014	.085 .043 .013	.080 .040 .011	.074 .037 .010	.068 .034 .009	.062 .031 .008	.056 .028 .007	.050 .025 .006	.044 .022 .005	.038 .019 .004	.032 .016 .003	.383 .335 .302	.330 .291 .264	.228 .204 .187	.133 .120 .111	.043 .043 .040	.043 .040 .037	.043 .039 .037	.043 .038 .036	.043 .037 .035	.043 .036 .034	.043 .035 .033	.043 .034 .032	.043 .033 .031	.043 .032 .030	.043 .031 .029	.043 .030 .028	.043 .029 .027																		
490 .067 .019	.131 .064 .018	.115 .057 .016	.100 .050 .014	.085 .043 .013	.080 .040 .011	.074 .037 .010	.068 .034 .009	.062 .031 .008	.056 .028 .007	.050 .025 .006	.044 .022 .005	.038 .019 .004	.032 .016 .003	.026 .013 .002	.378 .332 .300	.326 .288 .262	.226 .202 .186	.131 .119 .111	.043 .043 .040	.043 .040 .037	.043 .039 .037	.043 .038 .036	.043 .037 .035	.043 .036 .034	.043 .035 .033	.043 .034 .032	.043 .033 .031	.043 .032 .030	.043 .031 .029	.043 .030 .028	.043 .029 .027																		
535 .062 .017	.122 .059 .016	.107 .052 .015	.093 .046 .013	.080 .040 .011	.074 .037 .010	.068 .034 .009	.062 .031 .008	.056 .028 .007	.050 .025 .006	.044 .022 .005	.038 .019 .004	.032 .016 .003	.026 .013 .002	.020 .009 .003	.374 .328 .298	.322 .285 .260	.223 .201 .185	.130 .119 .110	.042 .042 .039	.042 .039 .037	.042 .038 .036	.042 .037 .035	.042 .036 .034	.042 .035 .033	.042 .034 .032	.042 .033 .031	.042 .032 .030	.042 .031 .029	.042 .030 .028	.042 .029 .027	.042 .028 .026																		
580 .128 .041	.195 .111 .035	.137 .078 .025	.083 .048 .015	.034 .020 .006	.796 .796 .796	.680 .680 .680	.564 .564 .564	.448 .448 .448	.332 .332 .332	.216 .216 .216	.100 .100 .100	.000 .000 .000	.000 .000 .000	.000 .000 .000	.796 .796 .796	.680 .680 .680	.564 .564 .564	.448 .448 .448	.332 .332 .332	.216 .216 .216	.100 .100 .100	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
625 .114 .035	.179 .099 .030	.126 .070 .022	.077 .043 .013	.031 .018 .006	.790 .772 .756	.676 .663 .651	.561 .550 .538	.446 .435 .423	.331 .320 .309	.215 .204 .193	.100 .090 .080	.000 .000 .000	.000 .000 .000	.000 .000 .000	.784 .755 .731	.671 .650 .632	.556 .545 .533	.441 .430 .418	.326 .315 .304	.211 .200 .189	.092 .082 .071	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
670 .102 .030	.165 .086 .027	.116 .063 .019	.071 .039 .012	.029 .016 .005	.778 .743 .715	.667 .641 .620	.552 .541 .529	.437 .426 .414	.322 .311 .300	.207 .196 .185	.092 .082 .071	.000 .000 .000	.000 .000 .000	.000 .000 .000	.773 .734 .703	.664 .634 .611	.549 .538 .526	.434 .423 .411	.319 .308 .297	.204 .193 .182	.092 .082 .071	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
715 .092 .027	.153 .080 .024	.108 .057 .017	.066 .035 .011	.027 .014 .004	.768 .726 .696	.660 .629 .605	.545 .534 .522	.430 .419 .407	.315 .304 .293	.200 .189 .178	.085 .075 .064	.000 .000 .000	.000 .000 .000	.000 .000 .000	.764 .726 .696	.660 .629 .605	.545 .534 .522	.430 .419 .407	.315 .304 .293	.200 .189 .178	.085 .075 .064	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
760 .084 .024	.142 .073 .021	.100 .052 .015	.061 .032 .010	.025 .013 .004	.764 .721 .690	.656 .624 .601	.541 .530 .518	.426 .415 .403	.311 .300 .289	.196 .185 .174	.081 .071 .060	.000 .000 .000	.000 .000 .000	.000 .000 .000	.768 .726 .696	.660 .629 .605	.545 .534 .522	.430 .419 .407	.315 .304 .293	.200 .189 .178	.085 .075 .064	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
805 .077 .022	.133 .067 .019	.094 .048 .014	.057 .030 .009	.023 .012 .004	.759 .716 .686	.653 .621 .598	.538 .527 .515	.423 .412 .400	.308 .297 .286	.193 .182 .171	.078 .068 .057	.000 .000 .000	.000 .000 .000	.000 .000 .000	.768 .726 .696	.660 .629 .605	.545 .534 .522	.430 .419 .407	.315 .304 .293	.200 .189 .178	.085 .075 .064	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
850 .071 .020	.124 .062 .018	.088 .044 .013	.054 .027 .008	.022 .011 .003	.755 .712 .683	.650 .618 .595	.535 .524 .512	.420 .409 .397	.303 .292 .281	.188 .177 .166	.073 .063 .052	.000 .000 .000	.000 .000 .000	.000 .000 .000	.759 .716 .686	.653 .621 .598	.538 .527 .515	.423 .412 .400	.308 .297 .286	.193 .182 .171	.078 .068 .057	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
895 .066 .018	.116 .057 .016	.082 .041 .012	.050 .026 .007	.020 .010 .003	.751 .709 .680	.647 .615 .593	.532 .521 .509	.417 .406 .394	.300 .289 .278	.185 .174 .163	.068 .058 .047	.000 .000 .000	.000 .000 .000	.000 .000 .000	.755 .712 .683	.650 .618 .595	.535 .524 .512	.420 .409 .397	.303 .292 .281	.188 .177 .166	.073 .063 .052	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
940 .061 .017	.109 .053 .015	.077 .038 .011	.047 .024 .007	.019 .010 .003	.747 .706 .678	.644 .613 .592	.528 .517 .505	.413 .402 .390	.296 .285 .274	.181 .170 .159	.063 .053 .042	.000 .000 .000	.000 .000 .000	.000 .000 .000	.751 .709 .680	.647 .615 .593	.532 .521 .509	.417 .406 .394	.300 .289 .278	.185 .174 .163	.068 .058 .047	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000	.000 .000 .000																		
985 .057 .016	.103 .050 .014	.073 .036 .010	.045 .022 .006	.018 .009 .003	.747 .706 .678	.644 .613 .592	.528 .517 .505	.413 .402 .390	.296 .285 .274	.181 .170 .159	.063 .053 .042	.000 .000 .000	.000 .000 .000	.000 .000 .000	.747 .706 .678	.644 .613 .592	.528 .5																																

Table III Multiplying Factors for Other than 20 Per Cent Effective Floor Cavity Reflectance

% Effective Ceiling Cavity Reflectance, ρ_{ce}	60				70				50				30				10			
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10
For 30 Per Cent Effective Floor Cavity Reflectance (20 Per Cent = 1.00)																				
Room Cavity Ratio																				
1	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002
2	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003
3	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004
4	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005
5	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006
6	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007	1.007
7	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008
8	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009	1.009
9	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010
10	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011	1.011
For 10 Per Cent Effective Floor Cavity Reflectance (20 Per Cent = 1.00)																				
Room Cavity Ratio																				
1	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023
2	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031
3	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039
4	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044
5	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049
6	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053	1.053
7	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057
8	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060	1.060
9	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063	1.063
10	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065
For 0 Per Cent Effective Floor Cavity Reflectance (20 Per Cent = 1.00)																				
Room Cavity Ratio																				
1	1.059	1.070	1.079	1.086	1.093	1.100	1.106	1.112	1.118	1.124	1.130	1.136	1.142	1.148	1.154	1.160	1.166	1.172	1.178	1.184
2	1.071	1.087	1.095	1.103	1.111	1.119	1.127	1.135	1.143	1.151	1.159	1.167	1.175	1.183	1.191	1.199	1.207	1.215	1.223	1.231
3	1.082	1.104	1.115	1.126	1.137	1.148	1.159	1.170	1.181	1.192	1.203	1.214	1.225	1.236	1.247	1.258	1.269	1.280	1.291	1.302
4	1.093	1.121	1.135	1.149	1.163	1.177	1.191	1.205	1.219	1.233	1.247	1.261	1.275	1.289	1.303	1.317	1.331	1.345	1.359	1.373
5	1.103	1.137	1.155	1.173	1.191	1.209	1.227	1.245	1.263	1.281	1.299	1.317	1.335	1.353	1.371	1.389	1.407	1.425	1.443	1.461
6	1.111	1.151	1.173	1.197	1.221	1.245	1.269	1.293	1.317	1.341	1.365	1.389	1.413	1.437	1.461	1.485	1.509	1.533	1.557	1.581
7	1.119	1.165	1.191	1.219	1.247	1.275	1.303	1.331	1.359	1.387	1.415	1.443	1.471	1.499	1.527	1.555	1.583	1.611	1.639	1.667
8	1.126	1.178	1.208	1.241	1.273	1.305	1.337	1.369	1.401	1.433	1.465	1.497	1.529	1.561	1.593	1.625	1.657	1.689	1.721	1.753
9	1.133	1.191	1.225	1.262	1.299	1.336	1.373	1.410	1.447	1.484	1.521	1.558	1.595	1.632	1.669	1.706	1.743	1.780	1.817	1.854
10	1.139	1.202	1.240	1.281	1.322	1.363	1.404	1.445	1.486	1.527	1.568	1.609	1.650	1.691	1.732	1.773	1.814	1.855	1.896	1.937

Table – IV

Angle(deg)	Mean Luminaire intensity in vertical plane cd/1000 lumens
0	230
5	230
10	225
15	220
20	210
25	198
30	180
35	170
40	145
45	110
50	90
55	75
60	48
65	32
70	26
75	16
80	12
85	07
90	00



S1, S2, S3, S4 luminaires

Fig. 1

Table V : Intensity Distribution Chart									
θ in degrees	5	15	25	35	45	55	65	75	85
I in Candelas	1500	1450	1370	1270	1040	710	460	330	220
θ in degrees	95	105	115	125	135	145	155	165	175
I in Candelas	125	180	175	172	112	100	92	50	20

Use separate Answer script for each Part

Part-II (50 Marks)

Answer any three Questions.

Q.No.1. carries 18 marks

- Q.1. A) Derive the expression of average illuminance on a receiving plane due to a diffuse area source based on flux transfer theory and hence find out the expression of form factor.
B) Explain the principle of homogeneity of intensity distribution applied for non-diffuse area source.

14+4=18

- Q.2. Explain the procedure of application of finite element method to compute the indirect illuminance on room surface elements of a reflective enclosure.

OR

Write down the basic computational algorithm of Monte Carlo simulation of indoor lighting. Derive the expressions of horizontal and vertical angles of emission in terms of two random numbers for a diffuse source.

16

- Q.3. A) Briefly discuss the design considerations applicable for
i) hospital lighting OR ii) office lighting.

B) Write down the lighting design parameters applicable for indoor lighting as per relevant National standard. What additional parameters are included in relevant International standard?

10+6=16

- Q.4. A) Define Visual Comfort Probability (VCP).

B) Write down the steps of computation of either (i) VCP or (ii) Unified Glare rating (UGR).

C) Write down the standard conditions considered by luminaire manufacturers for the generation of VCP table for a particular luminaire.

2+10+4=16

- Q.5. Write down short notes on any two from the followings-

i) on-site measurement of cylindrical illuminance;

ii) Correlation between VCP and UGR;

iii) Computation of average indirect illuminance for a reflective enclosure.

8+8=16

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