Main Examination

October 2015

Instructions

- Answer all questions and show all working.

- Time allowed = 2 hours

- Full marks = 100

Question 1

List 5 of 7 photometric quantities including the symbols, units and a description

[Total Marks: 10]

Question 2

Consider a library reading room with a length of 20 m, width of 15 m and height of 2.5 m. The required average illuminance level is 400 lux where the working plane is 0.6 above ground. The reflectances of the floor, walls and ceilings are 0.1, 0.5 and 0.7 respectively. A luminaire with 2 compact fluorescent lamps will be used where each lamp has an output of 700 lumens. The length of the luminaire is 0.3 m and width is 0.3 m. A table showing the coefficients of utilisation for the fluorescent fitting is shown below:

Table 1: Coefficients of Utilisation for Ratio of $S/H_m = 1.50$

Reflection Factors			Room Index									
Floor	Ceiling	Walls	0.60	0.80	1.00	1.25	1.50	2.00	2.50	3.00	4.00	5.00
		0.5		0.39	0.44	0.48	0.51	0.56	0.58	0.60	0.62	0.64
0.1	0.7	0.3		0.35	0.40	0.44	0.48	0.52	0.56	0.58	0.60	0.62
		0.1		0.32	0.37	0.41	0.45	0.50	0.53	0.56	0.59	0.60
		0.5		0.39	0.43	0.47	0.50	0.54	0.57	0.59	0.61	0.63
0.1	0.5	0.3		0.34	0.39	0.44	0.47	0.51	0.54	0.56	0.59	0.61
		0.1		0.32	0.36	0.41	0.44	0.49	0.52	0.55	0.58	0.60
		0.5		0.38	0.42	0.46	0.49	0.53	0.56	0.58	0.59	0.61
0.1	0.3	0.3		0.34	0.39	0.43	0.46	0.51	0.54	0.56	0.58	0.60
		0.1		0.32	0.36	0.41	0.44	0.48	0.52	0.54	0.57	0.59

Calculate the number of fittings required in the room. In your calculations assume a combined loss factor of 0.85. Perform a check to see if your layout is acceptable. [15 Marks]

Alternatives to the CFL are the incandescent lamp and the LED lamp. Briefly discuss each lamp and suggest which of the alternatives should be considered as a replacement for the CFLs. [5 Marks]

[Total Marks: 20]

Question 3

A long straight street is lighted by incandescent lamps on poles 3.5 m high and positioned 10 m apart. Each lamp has an intensity of 1500 cd, uniform in every direction.

- Find the horizontal illuminance on the street midway between any two poles. [5 Marks]

- Find the vertical illuminance on a small vertical sign 1.5 m off the ground at the same location. [5 Marks]

Derive any equations used from the inverse square law $E = \frac{I}{r^2}$
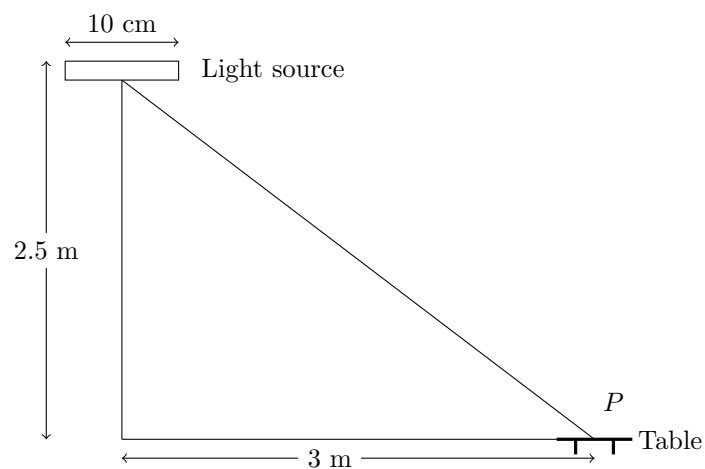
[Total Marks: 10]

Question 4

A flat circular lighting fixture 15 cm in diameter is mounted on a ceiling in a recreation room as shown in the figure below. The luminance in the direction of point P on a table is 65 cd/cm2.

Find:

a. The luminous intensity in the direction of P. [3 Marks]

b. The horizontal illuminance on the table at P. [1 Mark]

c. The vertical illuminance on the table at P.[1 Mark]

Derive any equations used from the inverse square law $E = \frac{I}{r^2}$

[Total Marks: 5]

Question 5

A interior lighting installation consists of linear fluorescent luminaires with a power rating of 58 W and power factor of 0.8 in arrangement of 5 rows of 8 luminaires per row covering an area of 20 x 20 m.

- Select the most appropriate conductor to wire the system so that the maximum voltage drop is 5%. [15 Marks]

- Select the most appropriate circuit breaker to protect the cable from short circuit and include any justification for selecting the cable in your answer. [5 Marks]

Table 2: Single Core Cable Parameters

Conductor Cross-section (mm^2)	Current Carrying Capacity (A)	Voltage Drop (mV/A/m)
1.5	13.5	29
2.5	18	18
4	24	11
6	31	7.3
10	46	4.4
16	61	2.8

Table 3: Circuit Breaker Rating for Single Phase Circuits

Conductor Cross-section (mm^2)	Conductor Length (m)					
	Current Rating (A)					
	10	15	20	25	30	40
1.5	39	26				
2.5	66	44	33	26		
4	104	69	52	41	34	
6	159	106	79	63	53	39
10	261	174	130	104	87	65
16	410	273	205	164	136	102

[Total Marks: 20]

Question 6

Using sketches where necessary, explain how one would determine the lighting levels required in a road tunnel during daylight hours (up to 8000 cd/m^2 before entering the tunnel) and why it is necessary to design it in such a manner.

What is the difference at night time?

[15 Marks]

Discuss the luminaires used in a road tunnel lighting system include in your answer

- the layout of the system including luminaire/lamp type and justification for the layout,

- conditions that may affect the light levels and,

- emergency lighting conditions

[5 Marks]

[Total Marks: 20]

Question 7

A group A road has a speed limit of 80 km/h and a traffic count of 260 vehicles per hour per lane. Given a dual carriageway with a width of 8 m without a medium separating the carriageway determine the recommended values from SANS 10198 for the road and describe what each value means.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
		Road cross-section																							
		Without median											With median												
Lighting category	Type of road	Maximum traffic volume during darkness (motor vehicles per hour per lane)																							
		> 600				300				100				> 900				600				200			
		Ln	U_o	U_L	TI	Ln	U_o	U_L	TI	Ln	U_o	U_L	TI	Ln	U_o	U_L	TI	Ln	U_o	U_L	TI	Ln	U_o	U_L	TI
A1	Freeway and expressway with median, free of level crossings; for speed limits exceeding 90 km/h.	2	0,4	0,7	15	1,5	0,4	0,7	20	1	0,4	0,6	20	2	0,4	0,7	15	1,5	0,4	0,7	20	1	0,4	0,6	20
A2	Major roads, for speed limits not exceeding 90 km/h.	1,5	0,4	0,7	20	1	0,4	0,6	20	0,8	0,4	0,5	20	1,5	0,4	0,7	20	1	0,4	0,6	20	0,8	0,4	0,5	20
A3	Important urban traffic routes, for speed limits not exceeding 60 km/h.	1	0,4	0,6	20	0,6	0,4	0,5	20	0,5	0,4	0,5	20	1	0,4	0,6	20	0,8	0,4	0,5	20	0,5	0,4	0,5	20
A4	Connecting roads, local distributor roads; residential major roads.	0,75	0,4	0,5	20	0,5	0,4	0,5	20	0,3	0,3	0,5	25	0,75	0,4	0,5	20	0,5	0,4	0,5	20	0,3	0,3	0,5	25

The proposed example luminaire from SANS 10198 is shown in the table below. Select the appropriate mounting height, overhang and spacing to approximately produce the required values. Consider which is the best engineering solution and comment on your selection.

Luminaire : ABC, Lamp : 150 W SON/T, Initial lamp flux : 16 000 lm, Arrangement staggered

1	2	3	4	5	6	7	9
Carriage-way width	Mounting height	Over-hang	Spacing	Average luminance	Overall uniformity	Longitudinal uniformity	Threshold increment
m	m	m	m	$(\bar{L})$, cd/m²	(U_O)	(U_L)	(TI), %
8	10	0	25	2,00	0,60	0,63	18
			30	1,80	0,54	0,50	18
			35	1,60	0,48	0,40	19
			40	1,50	0,44	0,35	19
			45	1,30	0,42	0,31	19
			50	1,15	0,41	0,30	20
		1	25	2,08	0,63	0,66	18
			30	1,87	0,57	0,52	18
			35	1,68	0,50	0,42	19
			40	1,58	0,46	0,37	19
			45	1,37	0,44	0,32	19
			50	1,23	0,43	0,31	20
		2	25	2,15	0,67	0,70	19
			30	1,95	0,59	0,55	19
			35	1,70	0,52	0,44	19
			40	1,65	0,48	0,38	20
			45	1,45	0,46	0,34	20
			50	1,30	0,45	0,33	21
	12	0	25	1,95	0,73	0,86	16
			30	1,70	0,67	0,74	16
			35	1,45	0,61	0,63	16
			40	1,30	0,57	0,54	17
			45	1,20	0,53	0,46	17
			50	1,10	0,51	0,43	17
		1	25	2,03	0,76	0,90	16
			30	1,78	0,70	0,77	16
			35	1,53	0,64	0,66	17
			40	1,38	0,59	0,56	17
			45	1,28	0,55	0,48	17
			50	1,18	0,53	0,45	18
		2	25	2,10	0,80	0,94	17
			30	1,85	0,73	0,81	17
			35	1,60	0,67	0,69	17
			40	1,45	0,62	0,59	18
			45	1,35	0,58	0,50	18
			50	1,25	0,56	0,47	18

The road is situated in an area where pollution is average. Select and justify the IP rating from the table below.

[Total Marks: 15]

Table 4: Dirt Depreciation Factors

IP Rating	Environment	Burning Period in months		
		12	24	36
IP2X	Clean	0.9	0.79	0.75
	Average	0.62	0.56	0.52
	Dirty	0.53	0.45	0.41
IP5X	Clean	0.92	0.9	0.88
	Average	0.9	0.86	0.82
	Dirty	0.89	0.84	0.76
IP6X	Clean	0.93	0.91	0.89
	Average	0.92	0.89	0.87
	Dirty	0.91	0.88	0.83