Introduction to radiometry – Test

1 hour – No document permitted

Exercise 1

A yellow LED emits a flux of 0.3 W. Assuming that its spectral flux is uniform in the spectral band [572 nm, 587 nm] and zero in the rest of the spectrum, what is the spectral flux in the emission spectral band? Using the table of V(λ) in appendix, what is the visual flux emitted by this lamp?

Exercise 2

If N photons of wavelength 400 nm form a flux F, how many photons of wavelength 800 nm form the same flux? Same question with photons of 600 nm.

Problem

An isotropic light source emits a flux F_A. It is at a distance z of a wall, assumed infinite and Lambertian with reflectance ρ. We want to know the irradiance of a detector of (small) area S_d near the source (assume the detector and the source at same position).

Express the **intensity $I(x, y)$** emitted towards at a point (x, y) on the wall, point (0, 0) being the closest to the source. Express the **irradiance $E(x, y)$** at point (x, y), then the **exitance $M(x, y)$** at point (x, y) after reflection of the light, and the **radiance $L(x, y)$** toward the detector. Calculate the **flux element $d^2F(x, y)$** flowing from a small area $dxdy$ around point (x, y) to the detector, then the **total flux $\mathbf{F}_d$** received by the detector, and finally its **irradiance E_d**.

The lamp is now replaced with a Lambertian source of area S_A, emitting same flux F_A.

Express first the **exitance M_A** of the source and the **radiance L_A** emitted towards a given point (x,y) on the wall. Then, calculate the same quantities as for the point source.

Knowing that $F_A = 50$ lm, $z = 1$ m and $\rho = 0.9$, evaluate the irradiance E_d in the case of the point source and the extended source.

NB: We have, for any $k > 0$,

$$\int_0^\infty \int_0^\infty \frac{dudv}{\left(a + u^2 + v^2\right)^{k+1}} = \frac{\pi}{4\,k\,a^k}$$

Appendix

λ (nm)	CIE 1951 $V(\lambda)$
380	5.890e-004
385	1.108e-003
390	2.209e-003
395	4.530e-003
400	9.290e-003
405	1.852e-002
410	3.484e-002
415	6.040e-002
420	9.660e-002
425	1.436e-001
430	1.998e-001
435	2.625e-001
440	3.281e-001
445	3.931e-001
450	4.550e-001
455	5.130e-001
460	5.670e-001
465	6.200e-001
470	6.760e-001
475	7.340e-001
480	7.930e-001
485	8.510e-001
490	9.040e-001
495	9.490e-001
500	9.820e-001
505	9.980e-001
510	9.970e-001
515	9.750e-001
520	9.350e-001
525	8.800e-001
530	8.110e-001
535	7.330e-001
540	6.500e-001
545	5.640e-001
550	4.810e-001
555	4.020e-001
560	3.288e-001
565	2.639e-001
570	2.076e-001
575	1.602e-001
580	1.212e-001

λ (nm)	CIE 1951 $V(\lambda)$ (continued)
585	8.990e-002
590	6.550e-002
595	4.690e-002
600	3.315e-002
605	2.312e-002
610	1.593e-002
615	1.088e-002
620	7.370e-003
625	4.970e-003
630	3.335e-003
635	2.235e-003
640	1.497e-003
645	1.005e-003
650	6.770e-004
655	4.590e-004
660	3.129e-004
665	2.146e-004
670	1.480e-004
675	1.026e-004
680	7.150e-005
685	5.010e-005
690	3.533e-005
695	2.501e-005
700	1.780e-005
705	1.273e-005
710	9.140e-006
715	6.600e-006
720	4.780e-006
725	3.482e-006
730	2.546e-006
735	1.870e-006
740	1.379e-006
745	1.022e-006
750	7.600e-007
755	5.670e-007
760	4.250e-007
765	3.196e-007
770	2.413e-007
775	1.829e-007
780	1.390e-007