Sources and Detectors
Main points of the module

The terminology that you find in optics books or papers is often different from that in physics books. In addition optics books often do not use SI (radiometric) units but photometric units.

To specify the amount of light emitted by a source the following quantities are used.

Quantity	Radiometric name	Radiometric unit	Photometric name	Photometric unit
Energy (E)	Radiometric energy	Joule (J)	Photometric energy	Talbot (lm s)
Power (P)	Radiant flux	Watt (W = J/s)	Luminous flux	Lumen (lm)
Power per unit area (M)	Radiant emittance	W/m^2	Luminous emittance	lm/m^2
Power per unit solid angle (I)	Radiant intensity	W/sr	Luminous intensity	lm/sr or candela
Power per unit solid angle per unit projected area (L)	Radiance	$W/(sr\ m^2)$	Luminance or brightness	$lm/(sr\ m^2)$ or $candela/m^2$

Note in particular. That the word "Intensity" means something different in Optics that in Physics.

Many students have problems with the concept of solid angle. Read the notes and the example problems worked there carefully. Discuss it with your fellow students and ask me if you still have questions.

To amount of light received by a detector is called the irradiance E (W/m^2) in radiometric units and the illuminance E (lm/m^2 = lux) in photometric units.

It is not so important that you remember all these different units, but that you remember that they exist and where to look them up, so that you can work with them when needed.

"Thermal sources" reviews the radiation laws that you should have covered in your introductory physics course and you Modern Physics course.

"Detectors" reviews photodiodes. You have worked with a photodiode in lab 4.

A photodiode produces a photocurrent I is proportional to the power P of the light illuminating it.

$I = K_{PD} P$,

where K_{PD} is the responsivity of the photodiode. K_{PD} depends on the diode construction, the wavelength of the light, and on the temperature. The photodiode is a quantum device. Almost every incident photon generates an electron-hole charge pair.

We therefore have I = e N Q, where Q is the quantum efficiency and e is the magnitude of the electron's charge, and N is the number of incident photons per second Q is less than or equal to 100 %.

The optical power is equal to the number of photons per second, N, times the energy per photon, $E = hc/\lambda$.

$P = N E = Nhc/\lambda$

The PD responsivity therefore is given by $K_{PD} = Qe\lambda/(hc)$. The responsivity of a typical Hamamatsu model S2386 silicon photodiode is shown on the right. The value of the responsivity is $K_{PD} = 0.43$ A/W at 632.8 nm wavelength. The quantum efficiency at 632.8 nm is $Q = K_{PD}E/e = 84\ \%$.