Course of Optical Communications – Telecommunication Engineering

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Practice Work n°2 – 03/05/2006

Last Name:____________________ **First Name: ____________________**

PROBLEMS

2.1 A 100-watt bulb emits a total luminous flux of 1200 lm, uniformly distributed over a hemisphere. Find the illuminance and the luminous intensity at a distance of 1 m, and at 5 m.

2.2 Let us consider an Orange light of wavelength $\lambda = 600$ nm propagating in air.

a) What is the frequency of this light?

If the light enters water, having an index of refraction of n = 1.33:
b) What is the speed of the light in the water?

c) What is the wavelength of the light in the water?

2.3 A light of frequency 3.5×10^{15} Hz and irradiance $I = 2.7 \times 10^{3}$ W/m^2 is incident on an emitter, which has an area $A = 1.8$ cm^2.

a) What is the energy of a single photon in the incident light?

b) Assuming that all of the incident light hits the emitter, how many photons are incident on the emitter per second?

2.4 Water has an index of refraction $n_{water} = 1.33$, and glass has an index of refraction $n_{glass} = 1.50$.

a) What is the value of the critical angle for total internal reflection if light travels from water into air?

b) What is the value of the critical angle for total internal reflection if light travels from glass into air?

c) What is the value of the critical angle for total internal reflection if light travels from glass into water?

d) What is the value of the critical angle for total internal reflection if light travels from water into glass?

2.5 A small sphere of height 1.3 cm is placed 20 cm in front of a lens of focal distance 10 cm. Find the value of the image position d_i and height h_i by using the thin lens equation, and represent it graphically, if:

a) the lens is a converging lens:

b) the lens is a diverging lens:

2.6 An object of height h_o=3.00 cm stands facing a diverging lens with a focal distance of 20.0 cm. The object is 10.0cm from the centre of the lens. You observe the object through the lens.

a) How far from the lens does the object appear to be as viewed through the lens?

b) How high does the object seem to be when viewed through the lens?

2.7 Find the position and the height of the image of the object in the situations described in problems a) through g), listed below. You should be able to solve these problems using both analytical and graphical (ray diagram) methods.

a) A 1.5-cm tall candle stands 30 cm in front of a 10-cm focal distance converging lens.

b) A 1.5-cm tall candle stands 20 cm in front of a 10-cm focal distance converging lens.

c) A 1.5-cm tall candle stands 15 cm in front of a 10-cm focal distance converging lens.

d) A 1.5-cm tall candle stands 10 cm in front of a 10-cm focal distance converging lens.

e) A 1.5-cm tall candle stands 5.0 cm in front of a 10-cm focal distance converging lens.

f) A 1.5-cm tall candle stands 15 cm in front of a 10-cm focal distance diverging lens.

g) A 1.5-cm tall candle stands 5.0 cm in front of a 10-cm focal distance diverging lens.

2.8 Consider the optical communication system in Figure 1.

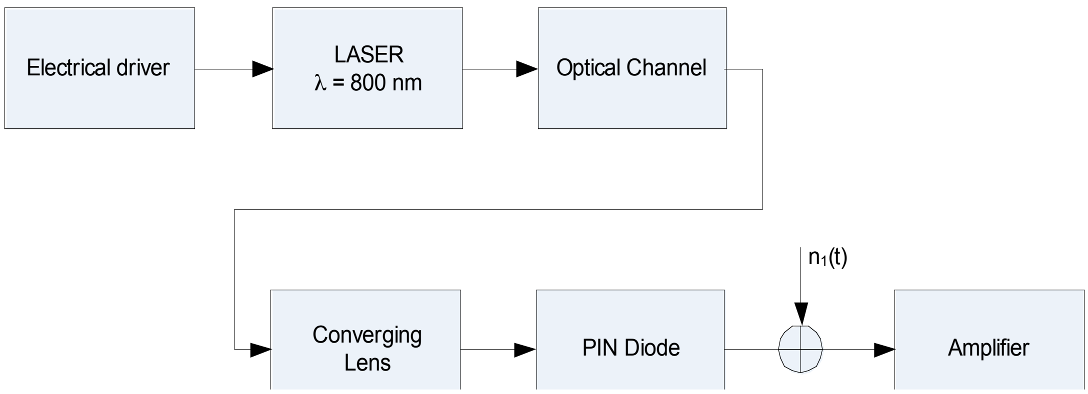

Figure 1 – Optical communication system

The electrical driver generates a driving current I_D = 20 mA that forms the input of a LASER generating quanta of light at a wavelength λ = 800 nm. The LASER is characterized by a quantum efficiency η_T = 0.75, and generates an optical power P_T. The light emitted by the LASER travels through an optical channel that introduces an attenuation A_{OC} = 50 dB. At receiver side, light is collected by a CPC lens that increases by a factor G_T = 10 the optical power entering the receiver, P_R. Such a receiver is composed of a PIN diode followed by an amplifier. At the wavelength of interest, the PIN diode is characterized by a quantum efficiency η_R = 0.8, and produces a current I_{PIN}. The PIN is characterized by a bandwidth B = 50 MHz. The amplifier connected at the output of the PIN diode is characterized by an input resistance R_L = 50 Ohm and a noise factor F = 3 dB, introducing a noise characterized as a current I_J.

For the system described above, determine:

a) The energy E_p of each photon emitted by the LASER;
b) The emitted optical power P_T;
c) The received optical power P_R;
d) The responsivity of the PIN diode
e) The photodiode current I_{PIN};
f) The Signal to thermal Noise Ratio at the output of the PIN diode.