1. Using the expression $E = \frac{hc}{\lambda}$, show why the FWHM power spectral width of LEDs ($\Delta \lambda$) becomes wider at longer wavelengths and constant $\Delta E$.

2. A diode laser has a 500-µm cavity length and an effective absorption coefficient $\alpha$ of 10 cm$^{-1}$. For uncoated facets, the reflectivity at each end $R$ is 0.32. (a) What is the optical gain at threshold? (b) If the reflectivity at one face is increased to 90%, what does the gain at threshold become? Use Iizuka equation 14.29 (page 906) rather than Keiser equation 4-28 (page 166).

3. A diode laser emitting at 800 nm has a 400-µm cavity length with a refractive index of 3.6. If the gain $g$ exceeds the total loss $\alpha$ in the wavelength range 750-850 nm, how many longitudinal modes will be active in the laser?

4. A distributed feedback laser has a Bragg wavelength of 1570 nm, a second-order grating with $\Lambda$=460 nm, and a 300-µm cavity length. What are the zeroth, first, and second-order lasing wavelength, to a precision of 0.1 nm?

5. An avalanche photodiode has the following parameters: surface leakage current $I_L$=1 nA, dark current $I_D$=1 nA, $\eta$=85%, excess noise factor $F=M^{1/2}$, $R_L$=1000 $\Omega$, and bandwidth $B$=1kHz. A sinusoidally varying 850 nm optical signal with modulation index $m$=0.85 and average power level -50 dBm is directed onto the photodiode at room temperature. At what value of the gain multiplier $M$ is the signal-to-noise ratio optimized?

6. A silicon PIN photodiode with carrier diffusion rate equal to 4.4x10$^6$ cm/s depletion layer width 20µm, area 0.05 mm$^2$, and dielectric constant 11.7 is operated with a 10 k$\Omega$ load resistance at 800 nm where the absorption coefficient $\alpha$ is 1000 cm$^{-1}$. Which is longer, the carrier diffusion time or the RC time constant? Is carrier diffusion time important for this device?

7. A transmission system sends signals at 200 kb/s. During the process, fluctuation noise is added to the signal, so that at the decoder output the signal pulses are 1 V in amplitude and the rms noise voltage is 0.2 V. (a) Assuming that ones and zeros are equally likely to be transmitted, what is the average time in which an error occurs at the receiver? (b) If the voltage amplitude is doubled with the noise voltage remaining constant, how does the average time per error change?