Menoufia University
Faculty of Electronic Engineering
Electronics and Electrical Communications Eng. Dept.
Third Year – Spring 2019

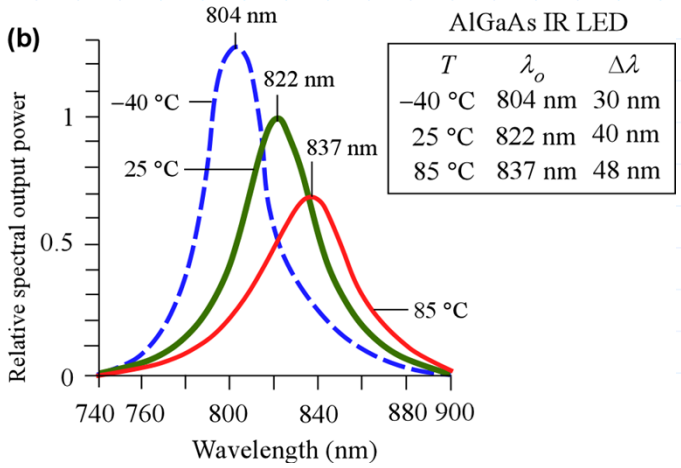
ECE 325 - Optoelectronics
Problem Set #6

LIGHT-EMITTING DIODES

Textbook: S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, international ed., Prentice Hall, 2012.

Chapter 3:

[P1] **3.18 -** An AlGaAs LED emitter for in a local optical fiber network has the output spectrum shown in Figure 3.32 (b). It is designed for peak emission at about 822 nm at 25°C. (a) Why does the peak emission wavelength increase with temperature? (b) What is the bandgap of AlGaAs in this LED? (c) The bandgap, E_g, of the ternary $Al_xGa_{1-x}As$ alloys follows the empirical expression, $E_g(\text{eV}) = 1.424 + 1.266x + 0.266x^2$. What is the composition of the $Al_xGa_{1-x}As$ in this LED? (d) When the forward current is 40 mA, the voltage across the LED is 1.5V and the optical power that is coupled into a multimode fiber through a lens is 25 μW. What is the efficiency?



[P2] **3.33** - For a particular AlGaAs LED emitting at 850 nm it is found that $\tau_r = 50$ ns and $\tau_{nr} = 100$ ns. What is the internal optical power generated at a current of 100 mA?

[P3] **3.29** - A particular 890 nm IR LED for use in instrumentation has a AlGaAs chip. The active region has been doped p-type with 4×10^{17} cm^{-3} of acceptors and

the nonradiative lifetime is about 60 ns. At a forward current of 50 mA, the voltage across it is 1.4 V, and the emitted optical power is 10 mW. Calculate the PCE, IQE, and EQE, and estimate the light extraction ratio. For AlGaAs, $B \approx 1 \times 10^{-16}$ m^3 s^{-1}.

[P4] **3.30** - (a) Consider a particular green LED based on InGaN MQW active region. The emission wavelength is 528 nm. At an LED current of 350 mA, the forward voltage is 3.4 V. The emitted luminous flux is 92 lm. Find the power conversion efficiency, external quantum efficiency, luminous efficacy, and the emitted optical power (radiant flux)?

(b) A deep blue LED emits at an optical power of 710 mW at 455 nm when the current is 350 mA and the forward voltage is 3.2 V. Calculate the power conversion efficiency, external efficiency, and luminous efficacy.