Course Name: Optoelectronics
Course Code: ECE491
Spring Semester Midterm Exam.
BME Program
Level 300
Exam Date: 4 -4-2018
Allowed Time: 60 Minutes = one hour

Attempt all questions. Assume any missed data. Full mark is 15.

a) A multimode step index fiber gives a total pulse broadening of 95 ns over a 5 km length. Estimate the bandwidth–length product for the fiber when a nonreturn to zero digital code is used. **[2 Marks]**

b) A single-mode step index fiber has a bandwidth–length product of 10 GHz km. Estimate the rms pulse broadening over a 40 km digital optical link without repeaters consisting of the fiber, and using a return to zero code. **[2 Marks]**

c) A K_2O–SiO_2 glass core optical fiber has an attenuation resulting from Rayleigh scattering of 0.46 dB km^{-1} at a wavelength of 1 μm. The glass has an estimated fictive temperature of 758 K, isothermal compressibility of 8.4 × 10^{-11} m^2 N^{-1}, and a photoelastic coefficient of 0.245. Determine from theoretical considerations the refractive index of the glass. If Boltzmann's constant is $1.381 \times 10^{-23}\ J/K$ **[2 Marks]**

d) Design a single-mode step index fiber with a core refractive index of 1.49 and a critical bending radius of 10.4 mm when illuminated with light wavelength of 1.30 μm. If the cutoff wavelength for the fiber is 1.15 μm calculate its relative refractive index difference. **[3 Marks]**

e) Define optical fiber dispersion and drive an expression for the total root mean square pulse broadening in optical fiber? **[3 Marks]**

f) How to reduce various types of losses in optical fiber? **[3 Marks]**

Hints: solve using the following formulas

The Rayleigh scattering coefficient: $\gamma_R = \frac{8\pi^3}{3\lambda^4} n^8 p^2 \beta_c K T_F$	Critical radius of curvature R_c in MMF $R_c \cong \frac{3n_1^2\lambda}{4\pi(n_1^2 - n_2^2)^{3/2}}$
Relative refractive index difference $\Delta = \frac{n_1^2 - n_2^2}{2n_1^2}$	Critical radius of curvature R_{cs} in SMF $R_{cs} \cong \frac{20\lambda}{(n_1 - n_2)^{3/2}}(2.748 - 0.996\frac{\lambda}{\lambda_c})^{-3}$

My best wishes to all of you!

Dr. Bedir Yousif