UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 7 Examination in Engineering: June 2014

Module Number: EE7257 **Module Name: Optical Fiber Communication**

[Two Hours]

[Answer **all questions**, each question carries five marks]

Q1. a) What are the advantages of optical fiber communication?

[1.0 Mark]

b) i) What is the numerical aperture of an optical fiber?

ii) Derive an expression for the numerical aperture and the maximum acceptance angle of a step-index fiber in terms of refractive indices of core and cladding materials.

[2.0 Marks]

c) A lightwave is traveling in a semi-conductor medium (GaAs) of refractive index 3.6. It is incident on a different semi-conductor medium (AlGaAs) of refractive index 3.4 with an acceptance angle 80^0. Will this result in total internal reflection? Comment on the result.

[2.0 Marks]

Q2. a) Explain the difference between meridional rays and skew rays in optical fiber communication.

[1.0 Mark]

b) i) What is a graded- index fiber?

ii) How does it compare with a step-index fiber?

[1.0 Mark]

c) What is the importance of normalized frequency parameter V in optical fiber communication?

[0.5 Marks]

d) A multimode step-index fiber has a relative refractive index difference of 1% and a core refractive index of 1.5. The number of modes propagating at a wavelength of 1.3 μm is 1100. Find the diameter of the fiber core.

[2.5 Marks]

Q3. a) After traversing a distance of 400 m in an optical fiber, the optical signal has lost 75% of its input power. What is the loss in dB/km of the fiber?

[1.0 Mark]

b) Show that the pulse delay distortion of a step-index multimode fiber is given by, $\tau = \frac{Ln_1}{c}\Delta$ where parameters L, n_1, c and Δ denote the length of the fiber, the core refractive index, velocity of free space and relative refractive index difference respectively.

[2.5 Marks]

c) A multimode step-index fiber exhibits total pulse broadening of 0.1 μs over a distance of 10 km. Determine the maximum possible bandwidth on the link assuming no intersymbol interference.

[1.5 Marks]

Q4. a) Discuss the following parameters of optical fibers.

i) Absorption
ii) Material Dispersion
iii) Waveguide Dispersion
iv) Intermodal Dispersion

[3.0 Marks]

b) A glass fiber exhibits material dispersion $\left|\lambda^2\left(\frac{d^2n_1}{d\lambda^2}\right)\right|$ of 0.025.

i) Determine the material dispersion parameter at a wavelength of 0.85 μm.

ii) Estimate the rms pulse broadening per km for a good LED source with an rms spectral width of 20 nm at this wavelength.

Note: The rms pulse broadening due to material dispersion parameter M is given by $\sigma_m = \sigma_\lambda LM$ where σ_λ denotes the rms spectral width of the light source.

[2.0 Marks]