M.Sc.TE.(2 Yr) 4th Sem. Date: February 15, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination — Summer Semester, A. Y. 2021-2022
Course No.: EEE 6499 — Time: 90 Minutes
Course Title: Laser Theory and Optical Communication — Full Marks: 75

There are **4 (four)** questions. Answer **any 3 (three)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. All symbols bear their usual meanings. Assume reasonable value for missing data.

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1. a) What multiplexing technique is used in the fourth generation lightwave system? Why is dry fiber used in the fifth generation of fiber optic communication systems? If the minimum bit rate for analog TV transmission is 66 Mbps with a signal bandwidth of 4 MHz, find out the SNR value. 4+4

   b) Derive the equation that provides the minimum bit-rate required for digital representation of an analog signal of bandwidth Δf in terms of signal to noise ratio (SNR). 8

   c) Explain SONET, SDH and STM with their respective bit rates. 9

2. a) Draw cross-section and refractive index profile for step-index fiber and graded index fiber. Show that parabolic index fiber doesn't exhibit intermodal dispersion. 5+5

   b) Explain 'numerical aperture' and express it in terms of fractional index change, Δ. Draw ray trajectories in a graded-index fiber. 8

   c) Calculate an estimation of bit-rate distance product for a cladded graded-index fiber with $n_1 = 1.5$, $n_2 = 1.497$. Find out the index profile α for minimum dispersion in this case. Compare this α value with that of parabolic index profile. 7

3. a) Explain how and when a mode ceases to be guided highlighting the values of p, q parameters from Helmholtz equation. Explain fiber birefringence covering degree of modal birefringence, beat length, fast and slow axis. 5+8

   b) Find out effective core area, normalized propagation constant and confinement factor for a fiber with core radius 3.15 μm and normalized frequency, $V = 2.3$. Also calculate the value of numerical aperture and effective index taking wavelength, $\lambda = 1.2$ μm and fractional index, $\Delta = 3.25 \times 10^{-3}$. 12

4. a) From the expression of normalized spot size find out 'confinement factor' for $V = 1.5$ and calculate the corresponding normalized propagation constant value. 6+3

   b) Derive the extent of pulse broadening in group velocity dispersion for a single mode fiber of length L. Calculate the maximum attainable BL-product for dispersion parameter, $D = 1.05$ ps/(km-nm) and a corresponding spectral width, $\Delta\lambda = 2.9$ nm. 9

   c) Define zero dispersion wavelength. Explain dispersion shifted and dispersion flattened fibers. 7