



MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

**BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION
TECHNOLOGY)**

SPH437: FIBER OPTIC COMMUNICATION

DATE:

TIME:

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- (a) Distinguish between micro bending and macro bending in reference to optical fiber (2 marks)
- (b) With suitable diagrams, explain the following
 - (i) Step index fiber
 - (ii) Graded index fiber (4 marks)
- (c) An optical fibre made up the glass with refractive index $n_1 = 1.5$ which is surrounded by another glass of refractive index n_2 . Find the refractive index n_2 of the cladding such that the critical angle between the two cladding is 80° . (3 marks)
- (d) Differentiate between intrinsic and extrinsic absorption (4 marks)
- (e) Explain the important conditions for TIR to exit in fiber (4 marks)
- (f) Find the refractive index of the medium whose critical angle is 40° . (3 marks)
- (g) Describe the material dispersion and waveguide Dispersion (4 marks)
- (h) Define numerical aperture and state its significance (2 marks)
- (i) Discuss two advantages and two disadvantages of optic fiber communication (4 marks)

QUESTION TWO (20 MARKS)

- (a) Explain various types of misalignment that occur in fiber cables. (6marks)
- (b) A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47.
Determine:
 - (i) the critical angle at the core–cladding interface;
 - (ii) The NA for the fiber;
 - (iii) The acceptance angle in air for the fiber. (6 marks)
- (c) A multimode step index fiber with a core diameter of 80 μm and a relative index difference of 1.5 % is operating at a wavelength of 0.85 μm . If the core refractive index is 1.48, estimate the normalized frequency for the fiber and number of guided modes. (8 marks)

QUESTION THREE (20 MARKS)

- (a) Discuss briefly the characteristic of light used for communication. (4 marks)
- (b) Using illustration, explain how Light Emitting Diode (LED) is used as a detector (6 marks)
- (c) Compare the features of Laser diode and LED (4 marks)
- (d) Explain the structure of surface emitting and edge emitting LEDs (6 marks)

QUESTION FOUR (20 MARKS)

- (a) Give three reasons for cladding in an optical fiber (3 marks)
- (b) Differentiate between meridional rays and skew rays. (4 marks)
- (c) Differentiate linear scattering from non-linear scattering. (4 marks)
- (d) Explain three factors that cause Mie scattering in optical fibers (6 marks)
- (e) Give three types of losses responsible for attenuation in optical fibers. (3 marks)

QUESTION FIVE (20 MARKS)

- (a) Give three methods of fiber splicing (3 marks)
- (b) A step index multimode fiber with a numerical aperture of 0.20 supports approximately 1000 modes at an 850 nm wavelength.
 - i) Determine the diameter of its core (3 marks)
 - ii) How many modes does the fiber support at 1320 nm? (3 marks)
 - iii) How many modes does the fiber support at 1550 nm? (3 marks)
- (c) A continuous 12 km long optical fiber link has a loss of 1.5 dB/km.
 - i) Determine the minimum optical power level that must be launched into the fiber to maintain an optical power level of 0.3 μW at the receiving end?
 - ii) Find the required input power if the fiber has a loss of 2.5 dB/km? (8 marks)