



TECHNICAL UNIVERSITY OF MOMBASA

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INSTITUTE OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

UNIVERSITY EXAMINATION FOR:

BTIT/AUG2021/J/S-FT

CIT 4406: FIBER OPTICS NETWORKS

END OF SEMESTER EXAMINATION

**SERIES:** DECEMBER 2024

**TIME:** 2HOURS

**DATE:** Pick DateDec2024

**Instructions to Candidates**

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt question ONE (Compulsory) and any other **TWO** questions.

**Do not write on the question paper.**

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**Question ONE**

- a) State and explain the advantages of optical fiber. [5Mrks]
- b) Mention the method employed for measuring attenuation in optical fiber? [4Mrks]
- c) Discuss Core and Cladding Losses and explain the mechanism which causes Absorption. [4Mrks]
- d) Draw the block diagram of optical fiber transmission link and describe the function of each component. [8Mrks]
- e) Differentiate between single mode and multimode fiber. [4Mrks]
- f) State Snell's Law and write the expression for the refractive index in Graded index fiber. [5Mrks]

**Question TWO**

- a) Discuss the difference between acceptance angle, critical angle and numerical aperture? [6Mrks]
- b) Find the total internal reflection we need  $\sin\theta_1 \geq \sin\theta_c = n_2/n_1$ . Prove the expression for the following,
  - i. Angle of refraction,  $\theta_2$  [2Mrks]
  - iii. Angle of incidence,  $\theta_1$  [2Mrks]
- c) The index of refraction for polystyrene is found to be 1.49, and the index of refraction of air can be taken to be 1.00. Here, then,  $n_2=1.00$  and  $n_1=1.49$ . Find the critical angle  $\theta_c$ . [5Mrks]

### Question THREE

- a) Describe GPON (Gigabit Passive Optical Network) and EPON (Ethernet Passive Optical Network). What are the advantages and disadvantages of each in terms of bandwidth, deployment costs, and network performance? [6Mrks]
- b) A city is planning to upgrade its communication infrastructure by implementing a Metro Optical Network (MON). What factors should the city evaluate when choosing between Dense Wavelength Division Multiplexing (DWDM) and Coarse Wavelength Division Multiplexing (CWDM) technologies for their MON in terms of network scalability, cost, and data capacity. [6Mrks]
- c) An optical transmission system is constrained to have 600 GHz channel spacing. How many wavelength channels can be utilized in the 1536 to 1556 nm spectral band? [3Mrks]

### Question FOUR

- a) A cut-off wavelength for a single-mode fiber is given by:  $\lambda_c = \frac{2\pi a \sqrt{(n_1^2 - n_2^2)}}{Vc}$ . Determine the theoretical wavelength. [5Mrks]
- b) Calculate number of modes of an optical fiber having diameter of 50  $\mu\text{m}$  &  $n_1 = 1.48$  &  $n_2 = 1.46$  having operating wavelength 0.82  $\mu\text{m}$ . [5Mrks]
- b) Given a network with four nodes A, B, C, and D, each capable of handling only a single connection at a time, how would you design a virtual topology that maximizes connectivity and minimizes the number of hops for data transfer between any pair of nodes? [5Mrks]
- c) In a fiber-optic network with multiple nodes and limited wavelengths, explain how the placement of wavelength converters at certain nodes enhance the network's ability to handle multiple simultaneous connections and what factors to be considered. [5Mrks]

### Question FIVE

- a) ) Illustrate on ray optics theory in detail with neat diagrams. [6Mrks]
- b). Explain the phenomenon of Rayleigh scattering in scattering loss. [4Mrks]
- c) What are the main differences in data transmission between Optical Packet Switched Networks (OPSN) and Optical Burst Switched Networks (OBSN), and how do these differences impact network performance, particularly regarding latency and data loss? [5Mrks]