DISCIPLINE SPECIFIC ELECTIVES (DSE-4)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Optical Communication System ELDSE7D	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**-**

Learning Objectives

This course introduces the student to the fundamentals of optical communications, including the optical sources at the transmission station, the transmission medium, and the optical detectors at the reception station. The course aims to develop an understanding of the LASERS, optical amplifiers, and design considerations of a fiber optic communication systems, bit error rate and rise time budgeting and power budgeting.

Learning outcomes

On successful completion of this course, students will be able to:

- Describe the difference between LED and Laser diode (LD) and choose a proper light source for optical communication.
- Understand the design of an optical communication system, to calculate the power requirements for a given fiber optic communication link, and hence compute loss and dispersion.
- Understand various low loss optical communication windows, importance of 1330nm and 1550nm wavelengths in optical communications.
- Understand optical fiber amplifier including erbium doped fiber amplifier.

SYLLABUS OF ELDSE-7D **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (12 Hours)

Sources for optical fiber communication: Optical Communication requirements, LASER fundamentals: Absorption and emission of radiation, condition for amplification of radiation, LASER oscillations. Basics of semiconductor lasers, laser diode characteristics, LED characteristics.

UNIT – II (10 Hours)

Detectors for optical fiber communication: Principle of optical detection, PIN photodetector, responsivity and quantum efficiency, speed of response, avalanche photodetector

UNIT – III (12 Hours)

Design considerations of fiber optic communication system: Characterization of an optical fiber: measurement of its radius, numerical aperture, cut-off wavelength (Marcuse's formula) Analog and digital modulation (direct), noise in detection process: shot noise, thermal noise, SNR, Bit error rate (BER), system design: power budgeting, rise time budgeting

UNIT – IV (11 Hours)

Optical Fiber amplifiers: Wavelength dependence of loss and dispersion of a single mode fiber and various loss windows: significance of 1300nm and 1550nm wavelength in optical communications. Introduction to semiconductor optical amplifiers, Block diagram of an optical amplifier at 1550nm communication wavelength, Optical amplification, absorption and emission cross-sections for a typical erbium doped fiber amplifier, Energy levels of erbium ions in silica matrix

Practical component (if any) – Optical Communication System Lab
(Hardware and/or software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments based on LEDs and laser diodes.
- Characterize an optical fiber in terms of measuring its radius, numerical aperture, and cut-off wavelength.
- Design an optical link and calculate the power budgeting.
- Understand an optical fiber amplifier.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To study the characteristics of LED.
2. To study the characteristics of semiconductor laser diode.
3. To study the characteristics of Silicon and Germanium photo-detectors.
4. To couple optical light into SMF and MMF and study the fundamental mode pattern and the speckle pattern.
5. To measure the parameters of a single mode optical fiber: radius, numerical aperture, cut-off wavelength.
6. To design an optical communication link and study power budgeting (simulation).
7. To design an optical circuit showing direct analog and digital modulation schemes.
8. To study the bending losses in an optical fiber link.
9. To study an EDFA (simulation).
10. Study of an OTDR instrument.

ONLINE virtual lab:

1. Amrita Vishwa Vidyapeetham Virtual Lab
2. Virtual Labs ofcvlab.vesit.ves.ac.in

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Ajoy Ghatak and K Thyagarajan, Introduction to Fiber Optics, Cambridge University Press, New Delhi (2024)
2. D.K. Mynbaev and Lowell L. Scheiner, Fiber-Optic Communication Technology, Pearson Education (2024).

Suggestive readings

1. J. M. Senior, Optical fiber communication systems: principles and practice, Pearson Education in south Asia, (2009).
2. J. Gower, Optical communication systems, Pearson Education
3. G. Keiser, Optical communications, McGraw Hills education (2003)
4. M. R. Shenoy, S. K. Khijwania, et al., Fiber optics through Experiments, Viva books (2011)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.