Course Type	Course Code	Name of Course	L	T	P	Credit
DE	**NECD513**	Advanced Optical Communication Technologies for 6G and Beyond	3	0	0	3

Course Objective

The objective of the course is to provide a thorough grounding in advanced optical communications to address future needs for 6G and beyond.

Learning Outcomes

At the end of the course, the student must be able to
- Understanding basic principles of light propagation and modal analyses of optical fiber.
- Understand the concept of Advanced Optical Modulation Formats.
- Understand coherent communications system.
- Concept of Probability shaping techniques.
- Analyse Photonics-based THz communications system for 6G technology.

Module No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Overview of optical communication, Ray theory, mode theory of optical fibres, and attenuation and dispersion.	06	Brief understanding of the mode theory and propagation characteristics of optical fibers
2	Photodetectors- PIN and APD Detectors, Sources of Noise- shot noise, thermal noise, Homodyne and Heterodyne detectors, SNR in homodyne and heterodyne detection.	06	Basic Understanding and characteristic parameters of various detectors
3	Advanced Optical Modulation Formats: BPSK and DPSK optical systems, High-level PSK and QAM modulation, Analog optical systems and radio over fibre. Multiplexing techniques: Time-division, wavelength-division, and polarization-division multiplexing.	08	Fundamental concept of advanced optical modulation formats and various Multiplexing techniques
4	Coherent Optical Communication Systems: Introduction of coherent communication, Receiver SNR calculation of coherent detection. Balanced Coherent Detection and Polarization Diversity, Phase Diversity and I/Q Detection. Noise formulations. Advanced DSP in coherent Communications.	08	Understand the fundamental concepts of coherent detection and advanced digital signal processing techniques.
5	Information theory fundamentals: Shannon capacity, entropy, and mutual information. Introduction to probability shaping and techniques: Probabilistic Constellation Shaping (PCS), Probabilistic Amplitude Shaping (PAS), Probabilistic Geometric Shaping (PGS)	06	Concept of Probability shaping techniques for optimization of the probability distribution of transmitted symbols
6	Optical systems and network: optical Power budget analysis, optical fibre link design, Dispersion effect. Optical networks: network concept, optical switching, Data Centers	04	Basic understanding of the design of optical systems, future optical networks and switches.
7	Photonics-based THz communications system for 6G: Introduction to sub-Terahertz/THz band, Photonics-based THz transmitter and receiver.	04	Concept of Sub-Terahertz Optical Communication and THz Frequency Bands
	Total	**42**	

Textbook:

2. Optical Fiber Communication-principles and practice, J. M. Senior (Prentice Hall of India),2014
3. Introduction to Fiber-Optic Communications, Rongqing Hui (Academic Press), 2020

Reference Books:

3. Optical Fiber Communications, Gerd Keiser, TMH, 4th Edition, 2011

4. Digital Coherent Optical Systems Architecture and Algorithms, Darli Augusto de Arruda Mello , Fabio Aparecido Barbosa, 2021
5. Coherent Optical Wireless Communication Principle and Application, Xizheng Ke , Jiali Wu , 2022
6. Digital Signal Processing In High-Speed Optical Fiber Communication Principle and Application, Jianjun Yu , Nan Chi, 2020
7. Thz Communications - (Springer Optical Sciences) by Thomas Kürner & Daniel M Mittleman & Tadao Nagatsuma Springer Nature Switzerland AG; 1st ed. 2022 edition