

ETPE3004 OPTO ELECTRONICS DRIVE & INSTRUMENTATION (3-0-0)

Course Objectives : This course aims to provide a comprehensive understanding of optoelectronics and its applications in instrumentation. Students will learn the fundamental principles of wave optics and optical fibres, analyzing fibre characteristics and loss mechanisms. The course covers key optoelectronic components – sources, detectors, and passive devices – alongside modulation techniques. Finally, it explores practical applications in optoelectronic instrumentation, focusing on fibre optic sensors for diverse physical parameter measurements and techniques like OTDR. Upon completion, students will be equipped to design, analyze, and implement optoelectronic systems for instrumentation purposes.

Module - I: (06 Hours)

Fundamentals of Wave Optics and Optical Fibres: Wave nature of light: Reflection, Refraction Polarization and coherence, Transmission of light through dielectric slab, Numerical aperture and acceptance angle, Wave propagation in cylindrical dielectric waveguides, Modes in step-index and graded-index fibres, Single-mode and multimode fibres

Module - II: (06 Hours)

Fibre Characteristics and Loss Mechanisms: Fibre attenuation: Absorption, scattering, and bending losses, Dispersion characteristics: Material and waveguide dispersion, Impact of dispersion and losses on communication system performance

Module - III: (07 Hours)

Optical Sources, Detectors, and Passive Components: Sources: LED: Principle, structure, and operation, Lasers: Fundamentals, oscillation conditions, Construction and working of semiconductor lasers, Continuous vs. pulsed operation.

Detectors: Photodiodes: PIN and APD – principle and characteristics

Passive Optical Components: Couplers: Types and applications, Splicers: Fusion and mechanical, Polarizers, isolators.

Module - IV: (05 Hours)

Optical Modulation Techniques: Optical modulation principles, Intensity modulation, Overview of polarization modulation (basic level only), Electro-optic and electromagnetic modulation, Practical aspects of implementing modulation in fibre systems

Module – V: (06 Hours)

Optoelectronic Instrumentation and Fibre Sensors: Optical sensing techniques for: Displacement, pressure, acceleration, Fibre optic gyroscope (FOG): Working and applications

Distributed sensing: OTDR (Optical Time Domain Reflectometry, Real-life instrumentation examples: encoders, thermometers.

Course Outcome:

Upon completion of the course, the students will be able to:

CO1: Explain wave optics and fibre optics principles used in optical instrumentation.

CO2: Analyze fibre losses and dispersion and their effect on system performance.

CO3: Evaluate the performance of basic optical sources and detectors.

CO4: Apply basic modulation and optical coupling methods in instrumentation setups.

CO5: Demonstrate applications of fibre optic sensors and optical instruments for physical ` parameter measurement.

Text Books:

1. A. Ghatak and K. Thyagarajan, 'Introduction to Fiber Optics', Cambridge University Press, 2004.
2. A. Tripathy, 'Optoelectronics and Systems', Studium Press, New Delhi, 2016.

Supplementary Reading:

1. John M. Senior, 'Optical Fibre Communications: Principles and Practice', Pearson, 2010.
2. J.P. Bentley, 'Principles of Measurement Systems', 3rd Edition, Pearson Education, 2007.
3. J. Wilson and J.F.B. Hawkes, 'Optoelectronics: An Introduction', 2nd Edition, PHI, 2001.
4. R.P. Khare, 'Fibre Optics & Optoelectronics', Oxford University Press, 2010.