APPE3002 OPTICAL INSTRUMENTATION (3-0-0)

Course Objectives:

This course aims to provide fundamental knowledge of optical instrumentation, covering wave optics, fiber optics, and optoelectronic devices. Students will analyze fiber characteristics, losses, and dispersion, evaluate optical sources/detectors, and understand modulation techniques. Emphasis is placed on practical applications, including fiber-optic sensors and instrumentation for measuring physical parameters like displacement, pressure, and temperature.

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.