



ICE008

Advanced Fiber Optics Technology

Course Introduction:

This course provides knowledge which will enable evaluation of system upgrades with improved data transfer to overcome present day problems. This course provides an understanding of the theory of optics and its application in the transmission of data along fiber optic cabling. Most courses on fiber optics concentrate on the most common use of fiber optics, in the transmission of telecommunication signals.

The advantages of using fiber optics are discussed such as: a large amount of data (wide bandwidth) can be transmitted over a single piece of fiber at high speeds. Optical transmission is also less susceptible to electromagnetic interference (EMI), reducing problems due to noise and increasing the security of data transmission.

Disadvantages of fiber optics and measures needed to overcome them are discussed, such as selecting good quality connectors and preparing procedures and training for fiber optic system assemblers.

The course covers each item in the fiber optic system, such as types of fiber, light source, transmitters, receivers, repeaters, amplifiers, together with test and measurement techniques. Fiber optic sensors and other applications, both military and commercial, are discussed.

Course Objectives:

Upon successful completion of this course, the delegates will be able to:

- Practical hands-on experience in jointing, splicing and testing fibre optics systems
- A solid knowledge of fibre optics communications systems
- State of the art fibre optics technology and installations practices
- Correct procedures for cable installations and termination
- How to design and install your own fully operational fibre optics systems
- New approaches to troubleshooting including how to use an OTDR

Who Should Attend?

This course provides an excellent foundation in optics and the use of fiber optic cabling for business managers, division chiefs and QA/QC personnel as well as technical personnel involved in design, manufacturing and testing of fiber optic cables and laser applications. It is especially useful for engineers involved in telecommunications design as well as those designing and testing fiber optics replacement systems for traditional wiring, especially on-board systems such as aircraft, military vehicles, space and naval vessels and automotive platforms.

Course Outline:

Day 1:

Basic Telecommunications Theory

- Introduction
- Plain Old Telephone Service (POTS)
 - Telephones
 - Telephone Numbers
 - Central Office (CO)
- Enhanced Telephone Services
- Telecommunication Protocols
- Standards
 - ITU-T Study Groups
 - ITU-T Study Group 15
 - MIL-STD-188
 - Federal Standard 1037C
- Telecommunications Network
- Open Systems Interconnection Reference Model (OSI Model)
 - "End-to-end" Layers
 - Application Layer
 - Presentation Layer
 - Session Layer
 - Transport Layer
 - Switched Network, Standards
 - "Chained" Layers
 - Routing Protocols, Dynamic
 - Congestion Control
 - Packet
 - Data Link Layer
 - Frames
 - Physical Layer
 - OSI Model Summary
- Transmission Control Protocol (TCP)

Introduction to Light Properties

- Light
- Wave Theory
- Particle Theory
- Light Phenomena
- Light Properties - Wavelength

- Electromagnetic Spectrum
- LW Transmission Bands
- Light Energy
- Coherence
- Interference
- Unwanted Transmission Reflections
- Reflections
- Polarization of a Light Beam
- Spectrum
- Poincaré Sphere
- Logarithmic Scale

Optical Fibers

- Disadvantages of Using Copper Cable
- Advantages, Disadvantages of Fiber-Optic Cables
- Typical Glass Optical Fiber
- Plastic Optical Fiber (POF)
- Propagation of Light Waves
- Refractive Index (n)
- Speed of Light
- Optical Dielectric Wave Guide
- Critical Angle (θ_c)
- Snell's Law
- Numerical Aperture (NA) Number
- Inverse Functions
- Table of Radians / Degrees
- Example
- Table of Trigonometric Functions (in radians)
- Optical Fiber Modes
- Single and Multimode Optical Fiber
- Multi-Mode (multi rays)
- Refractive Index for Various Modes Types
- Common Fiber Mode Types and Properties
- High and Low Order Transmission Modes
- Modal Dispersion
- Material Dispersion
- Chromatic Dispersion
- Optical Fiber Signal Attenuation
- Typical Attenuation/Wavelength for Silica Fiber
- Attenuation Coefficient (α)

- Fraction of Power (T) Transmitted through Fiber
- Bending Loss
- Optical Fiber Cut-off Wavelength and Example

Day 2:

Light Sources

- Light
- Spectrum
- Other Light Sources
- Light Amplification by Stimulated Emission of Radiation (Laser)
- Lasers
- Laser Pump
- Normal Mode Laser
- Flashlamp Pump
- Comparison between Normal and Laser Light
- Laser Design Parameters
- Laser Spatial Properties
- Low-SSE Tunable Laser Cavity
- Resonators and Oscillators
- Laser Beam
- Laser Safety Standards
- Laser Power Classification
 - Laser Power Limits Of Class I (for test equipment applications)
 - Laser Output Power
 - Increase Laser Output Power
- The Dye Laser
- Q-Switched Laser
- Polarized Light Q-Switch
- Light-Emitting Diode (LED)
- Fabry-Perot (FP) Laser
- Distributed Feedback (DFB) Laser
- Vertical Cavity Surface Emitting Lasers (VCSEL)
- External Cavity Laser (ECL)
- Optical Power vs. Optical Energy
- Energy Loss Heats Laser Components
- Laser Efficiency
- Laser Elements-Lifetime Reliability
- Eye Safety and High Voltage Supply
- Chirp

- Lasers and Hobbyists

Application of Fiber Optics to Telecommunications Systems

- Fiber Cable System vs. Copper Wire System
- Fiber Optic Telecommunication Systems
- Basic Fiber Optic Telecommunications Link
- Typical Long Fiber Optic Link
- Regenerators
- Optical Amplifiers (OAs)
- Data Communication Trends
- Telecommunications Network Standards
- Plesiochronous Digital Hierarchy (PDH)
- Synchronous Optical Network (SONET)
- Synchronous Digital Hierarchy (SDH)
- Data Communications Network Standards
- Typical Ring Structures
- Dense Wavelength-Division Multiplexing (DWDM)
- Frequency Grid from G.692
- Asynchronous Transfer Mode (ATM)
- Transmission Speeds
- Digital Modulation
- Time Division Multiplexing (TDM)
- DWDM Frequencies
- Optical Data Transmission
- Optical Time Domain Reflectometer (OTDR)
- Monitoring and Restoring Optical Network

Day 3:

Fiber Optical Cabling

- The Fiber-Optical Cable
- Cable Designs
- Fiber Optic Splices
- Physical Medium
- Fiber Core Misalignment
- Fiber Optic Connectors
 - Connector Inspection-Safety Concerns
 - Connector Care
 - Optical Connector Cleaning
 - Termination Kit
 - Fiber Optic Connector Inspector Tool

- Types of Fiber Optic Cable Terminations
- Fiber Optic Patch Cords: Single Mode, Multi Mode
- Breakout and Drop Fiber Optic Cables
- Automated Manufacture-Fiber Cable Assemblies

Erbium Doped Fiber Optical Amplifiers (EDFA)

- Erbium Properties
- EDF Amplifiers
- Basic EDF Amplifier Design
- Amplified Spontaneous Emission (ASE)
- Output Spectra
- Time-Domain Properties
- Optical Gain (G)
- Noise Figure (NF)
- EDF Amplifier
- Gain Compression
- Polarization Dependent Gain (PDG)
- Polarization Hole Burning (PHB)
- Spectral Hole Burning (SHB)
- EDFA Categories
- Commercial Amplifiers
- Commercial Designs
- Other Amplifier Types
- Security Features

Chromatic Dispersion Measurements

- Dispersion (CD) in Optical Fiber
- Dispersion Measurements
- Plot of Speed of Light vs. Signal Speed
- Chromatic Dispersion Definitions
- Dispersion Compensating Fiber (DCF)
- Chirped Fiber Bragg Gratings
- Chromatic Measurement System
- Relative Group Delay
- CD System "Test" and "Preview" Modes
- Typical Measurement Results for DS Fiber
- Reference Wavelength
- Impact of Modulation Frequency
- Effect of Reducing Modulation Frequency
- Wavelength Resolution
- Interference Filter - Thin Film Type

- Dispersion Compensating Fiber Bragg Grating
- Chirped FBG Measured in Step and Preview Modes
- Types of Dispersion in Optical Fiber
- Polarization Mode Dispersion (PMD)
- PMD - Birefringence
- PMD of Single-Mode Fibers
- PMD Effects on Optical Digital Transmissions
- PMD Tolerance vs. Bit Rate

Day 4:

Testing DWDM Passive Optical Components

- (DWDM)
- Increasing Bandwidth
- Increasing Total Capacity of DWDM System
- WDM Wavelengths
- Dense WDM Passive Components
- Dispersion Compensators
- Fiber Bragg Gratings (FBGs)
- Common Passive Optical Component Tests
- Polarization Dependent Loss (PDL)
- Return Loss (RL) or "all loss"
- Common Tests-Dispersion Measurements
- Increasing Transmission Capacity
- Generic Principal of Loss Measurement
- Common Tests - Generic Principle
- Increasing Transmission Capacity
- Swept Loss Measurement
- Loss Measurement
- Spectral Insertion Loss Measurement
- Polarization Dependent Loss (PDL) Tests
- Random Polarization Scanning Techniques
- Mueller Matrix Technique
- Polarization Test Methods
- Mueller Method vs. Polarization Scanning
- Return Loss (RL) Tests
- Calibration of the Set-Up
- Source Monitoring
- Test System Problems and Solutions
- TLS - Multiple PM Set-Up

- Measuring Insertion Loss vs. Wavelength
- Dynamic Range, Filters
- Low-SSE Tunable Laser Cavity
- Wavelength Accuracy
- High-Speed Wavelength Meter
- Real Time Wavelength Meter
- Gas Absorption Cells as Wavelength Reference
- Wavelength Accuracy / Speed
- Swept Insertion Loss Results

Application of Eye Diagrams

- Non Return-to-Zero (NRZ) vs. Return-to-Zero (RZ) Signals
- Dispersion
- Chromatic Dispersion
- Polarization Mode Dispersion
- NRZ and RZ signals
- Extinction Ratio Measurements
- Jitter
- Jitter Defined
- Digital Waveform with Jittered Edges
- Contrast Ratio or Suppression Ratio
- Eye Diagram
- NRZ and RZ Eye Diagrams
- Eye Mask Testing
- Bit Error Rate (BER)
- Stressed Eye Testing Procedure
- Referenced Receiver

Fiber Optic Sensors

- Fiber Optic Accelerometers
- Miniature Fiber Optic Microphone
- Fiber Optic Sensors for Downhole Applications
- Panasonic FX-500 Fiber Optic Sensor
- Optical Sensing System - Heavy Oil Wells
- Optical Sensors for Harsh Environments
- Continuous Monitoring of Downhole Conditions
- Reservoir Surveillance/Monitoring

Day 5:

Fiber Optic System Applications

- Medical Applications

- Fiber Optics in Automobiles
- Media Oriented Systems Transport (MOST)
- ByteFlight
- FlexRay
- The Fully Networked Automobile
- Airport Operations
- Fiber Optic Lighting
- Defense Industries
- Navy Aviation Fiber Optic Program
- Fiber Optics for Military Avionics
- High Temperature Photonic Sensors
- Fiber Optics in Space
- Fiber Optics in Space Vehicles
- Fiber Optics in Space: Thermal Shrinkage
- Fiber Optics in Space: Radiation Effects
- WaveStar OpticAir system-The Future

Optical Devices being developed at the Naval Research Laboratory

- Fiber Sensor Applications
- Immersive Input Display Device (I2D2)
- Optical Interferometer (NPOI)
- Fiber Optic Accelerometers
- Interferometric Fiber Optic Accelerometers
- Fiber Optic Strain Sensors
- Miniature Fiber Optic Microphone
- Fiber Optic Magnetic Field Sensors
- Fiber Optic Seismic Sensors
- Fiber Optic Hydrophones
- Depthimeter
- Fiber Optic Chemical Sensors
- Fiber Optic Biosensor

Modern Communication Systems for US Air Force Aircraft Fleet

- Telecommunications on Air Force Aircraft
- Fiber Optics as the Network Backbone
- Fiber Optic Backbone
- Versa Module Eurocard (VME)
- Modular Technology - VME
- Asynchronous Transfer Mode (ATM)
- ATM Technology
- The Airborne C4I Concept

Course Methodology:

A variety of methodologies will be used during the course that includes:

- (30%) Based on Case Studies
- (30%) Techniques
- (30%) Role Play
- (10%) Concepts
- Pre-test and Post-test
- Variety of Learning Methods
- Lectures
- Case Studies and Self Questionnaires
- Group Work
- Discussion
- Presentation

Course Certificate:

International Center for Training & Development (ICTD) will award an internationally recognized certificate(s) for each delegate on completion of training.

Course Fees:

To be advised as per course location. This rate includes participant's manual, and-Outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Timings:

Daily Course Timings:

08:00 - 08:20	Morning Coffee / Tea
08:20 - 10:00	First Session
10:00 - 10:20	Coffee / Tea / Snacks
10:20 - 12:20	Second Session
12:20 - 13:30	Lunch Break & Prayer Break
13:30 - 15:00	Last Session