



## **Certification & Training on Transmission & Transport Network**

### **Course Duration (25 Days)**

#### **Objective:**

After completing this course, the audience will be able to:

- Understand Basic Concepts
- Describe transmission types
- Define Networks & Network Models
- Explain optical & microwave transmission

#### **Who Should Attend?**

This is beginner level course and suitable for professionals & students who have little or no understanding of Transmission systems.

### **Course Content**

#### **1). Introduction to Telecommunication (2 Days)**

##### **Overview**

- What is transmission?
- History
- Evolution
- Transmission types
- Challenges
- Usage in networks
- Components of a Transmission System





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## Modulation Schemes

- AM systems
- FM systems
- Digital Wireless systems
- Line codes
- ASK, FSK, PSK, MSK, QPSK, QAM modulation schemes presentation
- Modulation techniques over fading channels

## Antenna System Considerations; Transmission Lines

- Antenna classifications
- Antenna types
- Standard antennas
- High performance antennas
- Transmission lines basics
- Antenna electrical characteristics (Gain, Antenna Lobes, Beam width, Antenna Polarization, VSWR)

## Transmission basics

- Multiplexing
- Media and Media Characteristics,
  - Copper
  - Microwave
  - Optical fiber
- PDH Fundamentals
  - PCM CODEC

## SDH Basics

- Introduction to SDH
- STM-1 Frame Structure
- RSOH, MSOH and payload



*Quality*



*Cost Effective*



*Wireless Engineering*



*Service*



## 2). Microwave Radio Systems (3 Days)

### INTRODUCTION TO WIRELESS RADIO COMMUNICATIONS

- Wireless systems design challenges
  - The wireless channel
  - Propagation models
  - Large scale propagation
  - Small scale propagation
  - Rayleigh model
  - Wireless multipath channels
  - Spatial channel models and antennas
  - Space-Frequency Diversity

### RADIO PROPAGATION

- Electromagnetic Waves
- Radio Wave Propagation
- Refraction
- K-Factor
- Multipath Propagation
- Fading
- Formation Of a Duct
- Diffraction
- Reflection and scattering
- Absorption
- Rain Attenuation

### MICROWAVE ANTENNA

- Antenna Gain
- VSWR
- Side and Back lobe Levels
- Beam Width
- Antenna Characteristics - EIRP and ERP
- Antenna Characteristics - Polarization
- Cross Polarization
- Passive Repeater
- Plane Reflectors
- Back to back Repeater
- Mechanical Stability
- Antenna Datasheet





## ANTENNA SYSTEM CONSIDERATIONS

- Antenna classifications
- Antenna types
- Standard antennas
- High performance antennas
- Extra high performance antennas
- Transmission lines basics
- Antenna electrical characteristics (Gain, Antenna Lobes, Beam width, Antenna Polarization, VSWR)
- Antenna system accessories (Antenna Dehydrators, Antenna Grounding, Antenna Fields)

## ANTENNA INSTALLATIONS

- Feeder cables
- Safety regulations
- Mounting connectors
- Sealing connectors
- Antenna spacing and direction requirements
- Site Installation planning and procedures
- Site Installation documentation
- Earthing and lightning protection
- Roxtec installation
- Antenna system testing
- Practical exercises

## DIGITAL MAP AND TOOLS OVERVIEW

- Prediction Tools
- Tasks
- Prediction Tool - Database
- Digital Maps
- Geographical Databases
- Vector Data (Linear)
- Altitude
- Clutter (Land use)
- Resolution / Precision
- Map Coordinates – Geodesy





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- Map Coordinates - Projection
- Projection Systems

## PERFORMANCE AND QUALITY OBJECTIVES

- Degradation on quality
- The ITU standards
- Performance Objectives
- Availability Objectives
- Circuit Classification
- Performance Predictions
- Reliability
- Calculation of Unavailability

## 3). Transmission Planning (3 Days)

### TRANSMISSION NETWORKS

- Short haul microwave networks
- Long haul microwave networks

### TRANSMISSION RATES HIERARCHY

- PCM basics
- PDH network
- SDH network
- ATM basics

### NETWORK TOPOLOGIES

- Tandem configurations
- Star configurations
- Mesh configurations
- Star-Mesh configurations
- Mixed networks
- Transmission networks for Cellular
- GSM: PCM over Optical; PDH, SDH
- GPRS: IP over Ethernet and Frame Relay
- UMTS: Frames over ATM
- LTE: IP based traffic, the MBPN network



*Quality*



*Cost Effective*



*Wireless Engineering*



*Service*



## BRIEF INTRODUCTION TO WIRELESS RADIO COMMUNICATIONS

- Wireless systems design challenges
- The wireless channel
- Propagation models
- Large scale propagation
- Small scale propagation
- Rayleigh model
- Ricean model
- Nakagami model
- Wireless multipath channels
- Spatial channel models and antennas
- Space-Frequency Diversity

## MODULATION SCHEMES

- AM systems
- FM systems
- Digital Wireless systems
- Line codes
- ASK, FSK, PSK, MSK, QPSK, QAM modulation schemes presentation
- Modulation techniques over fading channels

## KEY RADIO FUNDAMENTALS

- Equalization principles
- Fundamental principles of channel coding
- Error correction & error detection principles
- Introduction to Forward Error Correction Coding (FEC)
- Block coding
- Convolutional coding
- Interleaving
- Diversity principles
- Multiple Access Techniques
- FDMA / TDMA
- Direct sequence spread spectrum principles
- Automatic Transmission Power Control (ATPC)
- Errorless Vs. Hitless Receiver Switching





## TRANSMITTER RECEIVER CHARACTERISTICS

- System Gain
- Dispersive Fade Margin
- Radio Thermal Noise
- Signal to Noise ratio S/N
- Receiver sensitivity
- Modulation and S/N
- Design principles

## MW RADIO PLANNING

- Propagation and prediction methods
- Frequency planning and interference calculations
- Far interference planning principles
- Radio spectrum and channel arrangements

## TOOLS FOR PLANNING

- Planning with ATPC
- TEMS link planner tool
- Planning examples – case studies

## 4). Frequency Planning and Optimization (2 Days)

### EXECUTIVE SUMMARY

- What is interference?
- Frequency spectrum and microwave bands
- Channel plans
- Frequency planning
- High/low sites
- Interference calculations
- Nodal interference
- Over-shoot interference

### LINK CALCULATIONS

- Choosing antenna heights
- -clearance rules
- Choosing antenna size
- -power budget
- -fade margin
- Outage prediction





- -rain fading
- -multipath fading

## **GRAPHIC METHOD FOR PATH-LENGTH OPTIMIZATION**

- Optimization of maximum path lengths
- Optimization antenna size
- Optimization of output power
- Determine values of Q&A parameters for a given path length

## **Q&A RECOMMENDATIONS FOR MICROWAVE PLANNING**

### **Q&A CALCULATIONS**

- Influence of “path-type parameters” on the calculations
- Antenna separation
- Space-diversity aspects

## **RAIN ATTENUATION MODELS**

## **5). SDH Basic (4 Days)**

### **EXECUTIVE SUMMARY**

- Optical Networks
- Fiber Optic Fundamentals
- Access, metro, long hual networks
- SONET/SDH Overview
- Overview, Architectures and Services
- SDH in Enterprise Networks & LANs
- Convergence of Services
- Overview of SDH Structure & Formats
- Overview of SDH Products & Features
- Overview of SDH Networking

### **OVERVIEW OF FIBER OPTICS COMMUNICATIONS**

- Fiber optic transmission
- Optical fibers structure
- Optical amplifiers
- Light sources and transmitters
- Photodiodes and receivers
- Optical communication systems
- Optical components







## **SONET/SDH ARCHITECTURES & SERVICES**

- Evolving CPE/ILEC/IXCs Infrastructure & Services
- Inter-Office & Core Networking with SONET/SDH
- SONET/SDH in the Feeder Section
- Loop Section & the Last Mile
- ADSL (Twisted Pair)
- HFC (Coax)
- Strategies for DWDM & SDH in the 21st Century

## **WHAT ARE THE BENEFITS OF SONET/SDH?**

- Pointers, MUX/ DEMUX
- Reduced Back-to-Back Multiplexing
- Optical Interconnect
- Multipoint Configurations
- Convergence, ATM, Video, and SDH
- Grooming
- Reduced Cabling and Elimination of DSX Panels
- Enhanced OAM&P
- Enhanced Performance Monitoring

## **SYNCHRONOUS DIGITAL HIERARCHY (SDH)**

- Basic Rates
- Frame Structure
- Overhead Bytes
- STM-4, STM-16 and STM-64
- Tributary Units (TUs)
- SONET and SDH Compatibility

## **SDH OVERHEAD**

- Regenerator Section Overhead
- Multiplex Section Overhead
- Higher-Order Path Overhead (VC-4/VC-3)
- Lower-Order Path Overhead (VC-2/VC-1)
- SDH Anomalies, Defects, Failures, and Alarms
- SDH Error Performance Monitoring
- SDH Pointers
- Payload Pointers
- Positive Pointer Justification
- Negative Pointer Justification
- SDH Multiplexing





- SDH Tributary Multiplexing
- Tributary Unit Group
- TU Multi-frame
- TU Payload Pointer
- Automatic Protection Switching
- Multiplex Section Protection, K1/K2 Bytes
- 1+1 Protection
- 1:N Protection

## **SDH NETWORK ARCHITECTURE**

- Technical Advantages
- Redundancy
- Layers & Functions
- Network path, line, and section
- Multiplexing Frame Structures/Formats
- Ring Configurations (terminals, drops, inserts)
- Network Synchronization (timing, modes, pointers, issues)
- Applications & Services

## **6). Optical Transport Networking (OTN) (3 Days)**

### **Introduction**

- The World Today—Growth and Limits
- Traffic Streams & Technical Limitations
- Facts about Fiber Optics
- Light and Light Propagation
  - Attenuation and Optical Windows
  - Dispersion
  - Optical Interfaces
  - Backscattering Measurement Using OTDR
- LASER—In the Focus of Interest
- Overview of Important LASER Types
- Tunable LASERs and their Application
- Optical Amplifiers—The Power of Light
- Application Examples





## Optical Transmission—High-Speed Technologies

- High-Speed in LANs and WANs
- Gigabit and 10 Gigabit Ethernet
- SDH with 10 and 40 Gbps
- DWDM—Principle and Technology
- Important Advantages
- Setup of a WDM Mux
- Channel Separation with DWDM
- DWDM Measurements
- DWDM—Practical Application
- Connection to Routers
- Data Communications in the Campus Area
- DWDM in the LAN
- DWDM in the MAN
- Pros and Cons—Disadvantages of WDM
- The World of Optical Fibers
- Optical Fiber Types of the Metro and WAN Area
- The New Generation: Hollow Fiber
- Network Optimization with Optical Fibers

## Optical Switching

- Optical Add/Drop Multiplexers (OADM)
- Application of OADMs
- Configurable OADMs
- Optical Cross-Connects
- Application Options
- Schematic Setup of Optical Cross-Connects
- Optical Switches—Various Solutions
  - MEMS—Technical Data
  - Thermo-Optical Switches
  - The Bubble Switch
  - Liquid Crystal Switches
  - Optical Routers
- Optical Transport Networks (OTN) and Digital Wrapper

## Optical Networks—Wavelengths all over the World

- Optical Networks in Practical Application
- DWDM Networks
- Transparent Optical Networks—Wavelength Path Routing
- The Future—Virtual Wavelength Path Routing
- MPLS and Optical Networks





- Optical Protection Concepts
- Dedicated Protection
- Shared Protection
- Unidirectional and Bidirectional Rings
- MS Shared Protection
- All-Optical Protection Mechanisms

## 7). Ethernet Overview (3 Days)

### INTRODUCTION

- 100BASE-T
- 10-Gigabit Ethernet
- Objective of 10G Ethernet
- IEEE 802.3 Higher Speed Study Group (HSSG)
- MAC Client server interface.
- IEEE 802 Functional Requirements
- 10Gb/s at MAC/PLS service interface
- What is the 10 Gigabit Ethernet Alliance (10 GEA)
- IEEE 802.3ae Task Force

### WHY 10G ETHERNET?

- Architecture
- MAC Layer
- Physical Layer
- 10Gigabit Ethernet in LAN, MAN & WAN
- Advantages and Disadvantages
- Future market of 10G Ethernet

### HOW DOES 10 GIGABIT ETHERNET DIFFER FROM PREVIOUS VERSIONS OF ETHERNET?

- Differences between 10 Gigabit Ethernet and other speeds of Ethernet.
- Long-haul (40+ km) optical transceiver
- physical medium dependent (PMD) interface for single mode fiber
- LAN physical layer (PHY) or wide area network (WAN PHY)
- Building metropolitan area networks (MANs)
- WAN PHY option
- 10 Gigabit Ethernet transported across existing SONET (synchronous optical network) OC-192c
- SDH (synchronous digital hierarchy) VC-4-64c infrastructures
- Advantages and Disadvantages





## 8). TCP/IP Basic (3 Days)

### Introduction to Data Networking

- LAN and WAN
- Network Topology
- Access Methods
- Types of Connection
- Circuit and Packet Switching
- Transfer Modes

### Physical Layer Fundamentals

- Physical Layer Overview
- Networking Components on Physical Layer
- Transmission Media
- Physical Structure

### Data Link Layer Fundamentals

- Data Link Layer Overview
- Networking Components on Data Link Layer
- Ethernet
- Asynchronous Transfer Mode (ATM)
- Frame Relay

### Network Layer Fundamentals

- Network Layer Overview
- Networking Components on Network Layer
- Introduction of the Internet Protocol (IP)
- The Address Resolution Protocol Family
- Routing
- Internet Control Message Protocol (ICMP)

### Transport Layer Fundamentals

- Transport Layer Overview
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)
- TCP/UDP in GPRS/UMTS and OAM networks

## Holiday for Test Preparation.....(2 Days)

**Course Assessment through written test & mock interview**

