

Course ID
SPECMON
Course Duration
3-5 days

Course Title
Spectrum Monitoring Workshop: Principles and Practice

- Spectrum Management: Planning, Monitoring, Licensing, and Economics (SPECMGT, 2-3 days)
- Radio Measurements Equipment: Principles and Operation (RMEQUIP, 2-3 days)
- Spectrum Monitoring: Principles of Vector Network Analysis, Procedures, and Key Results (VECTOR, 3-5 days)
- Wireless All-in-One: RF Propagation, Cellular Principles, Personal Radio Services, WiFi, WiMAX, CDMA, and GSM (ALL-IN-ONE, 5 days)
- LTE: A Comprehensive Three Day Course (LTE-C3DC, 3 days)
- WIMAX: A Comprehensive Three Day Course (WIMAX-C3DC, 3 days)
- 3G Systems: WCDMA/UMTS and CDMA2000 (3G5D, 5 days)
- 3G Systems: WCDMA/UMTS and CDMA2000 Overview (3G3D, 3 days)
- GSM, GPRS, and EDGE: An Intensive Tutorial (GSMPLUS, 3 days)

Aimed At Those with some RF/wireless background who wish to study the theory and process of spectrum monitoring.

Group Size 5-25

Prerequisites

- RF Propagation Models, Fading Characteristics, and Link Budget Analysis (RFPROP, 3 days)
- RF Systems: Principles, Design, and Deployment (RFSYS, 3 days)
- Wireless Network Structure, Operation, and Technologies (3 days, WIRELESSNET)

Participants should have a basic understanding of RF and wireless technologies and at least one year experience in spectrum monitoring or RF/cellular technologies.

Course In a Nutshell This is one of a series of courses that pull together in one place the concepts and techniques that are important for those engaged in spectrum monitoring and management. Covered are the basic principles, spectrum monitoring/management process, measurement equipment characteristics, and vector network analysis. The present course deals with spectrum clearance issues and radio measurements. Other courses in this series cover radio measurements equipment and vector network analysis. This variable length course can be taught in three to five days depending on the desired depth of coverage and the amount of hands-on lab work included in the course.

Customize It!

Customize this course to your own requirements at little-to-no additional cost. The content, duration, and level of technical detail can be adjusted to suit the needs of participants. The course is available in a 3-day theory only version as well as a 5-day workshop that includes demonstrations and/or hands-on work on the spectrum measurement/analysis equipment.

Course Outline

- Introduction and Course Overview
- Radio-Spectrum Fundamentals
 - Current Trends in Spectrum Usage
 - Administrative Division of the Frequency Spectrum
 - Cognitive Radio
 - Modern Modulation Techniques and Systems
 - Spectrum Monitoring Future and Challenges: A Summary and Discussion
- Modulations and Signal Types
 - Signals
 - Signals Displayed in Time Domain
 - Relationship between Time and Frequency Domain
 - Modulations in Communication and Broadcasting Systems
 - Types of Analog Modulations and Signal Reception
 - Amplitude Modulation
 - Angle Modulations (FM/PM)
 - Types of Digital Modulations and Signal Reception
 - Amplitude Shift Keying
 - Phase Shift Keying
 - Frequency Shift Keying
 - Multiplex and Multiple Access
 - TDM/TDMA
 - FDM/FDMA
 - CDM/CDMA
 - OFDM
 - Modulations and Signal Types: Session Review and Discussion
- Interference Modeling
 - Interference Modeling and Performance Evaluation
 - Interference Avoidance and Coexistence Strategies
 - Interference Performance Evaluation
 - Interference Model
 - Performance Metrics
 - PHY Layer Performance Metrics
 - Higher Layer Performance Metrics
 - Factors Affecting Performance
 - Spectrum Spreading
 - Hop Rate
 - Transmission Power

- Interference Modeling: Open Loop
 - Theoretical BER Estimation
 - Modeling BER in Wireless Channels
 - Example of Packet Error Model
- Interference Modeling: Closed Loop
 - Usage Definition
 - Application Model
 - Network Topology
 - Channel and Protocol Layer Modeling
 - Example of Interference Modeling
- Interference Modeling and Analysis: Session Review and Discussion
- Spectrum Management, Monitoring and Measurements System
 - System Overview
 - What is Spectrum Management
 - The Challenge, Objectives and Value of Spectrum Management
 - Spectrum Management System Planning
 - 1dB Compression Point and Maximum Input Level
 - Dynamic Range
 - Immunity to Interference
 - LO Feed-through
 - Filter Characteristics
 - Frequency Accuracy
 - Level Measurement Accuracy
 - Error Components
 - Calculation of Total Measurement Uncertainty
 - Error Due to Low Signal-to-Noise Ratio
 - Sweep Time and Update Rate
 - Attenuators and Associated Elements
 - Strategic Steps in Building Spectrum Management and Monitoring System
 - What ITU Recommendations Should Be Followed
 - Types of Monitoring and Measurement Stations
 - Fixed Stations
 - Mobile Stations
 - Portable Stations
 - Why Do We Need Different Types of Spectrum Monitoring and Measurement Stations?
 - What Are the Benefits of and Differences between the Various Types of Stations?
 - Fixed Monitoring and Measurement Stations
 - Usual Configuration
 - Available Measurements
 - Software Selection
 - How to Determine the Number of Fixed Stations?
 - Site Preparation and Civil Engineering Requirements

- Telecommunication Requirements
 - Fixed Stations
 - Mobile Stations
 - Portable Stations
- Mobile Monitoring and Measurement Stations
 - Usual Configuration
 - Available Measurements
 - Strategic Use of Mobile Stations
 - Example of Mobile Station Measurement Equipment Set
- Portable/Transportable Stations
 - Why Transportable Stations Are Needed
 - Equipment Solutions
 - Common Usage Modes
- Software Solutions
 - What Modules Should Be Included in Monitoring and Measurement Solutions?
 - Post-Processing Solutions
- Benefits and Full Results Exploitation
 - Inter-Site Connection
 - Integration with Document Management System and Processes
 - Integration with Spectrum Planning and Management Software
 - Storage Solutions for Data Storage
 - Web Portal for Results Publications
- Monitoring and Measurements System: Session Review and Discussion
- Spectrum Analysis and Spectrum Analyzer Elements
 - Configuration and Control Elements of a Spectrum Analyzer
 - Fourier Analyzer (FFT Analyzer)
 - Analyzer Operating According to the Heterodyne Principle
 - Main Setting Parameters
 - Practical Realization of an Analyzer Operating on the Heterodyne Principle
 - RF Input Section (Frontend)
 - IF Signal Processing
 - Determination of Video Voltage and Video Filters
 - Detectors
 - Trace Processing
 - Parameter Dependencies
 - Sweep Time, Span, Resolution and Video Bandwidths
 - Reference Level and RF Attenuation
 - Overdriving
 - Performance Features of Spectrum Analyzer
 - Inherent Noise
 - Nonlinearities
 - Phase Noise (Spectral Purity)
 - 1dB Compression Point and Maximum Input Level
 - Dynamic Range

- Immunity to Interference
- LO Feed-through
- Filter Characteristics
- Frequency Accuracy
- Level Measurement Accuracy
 - Error Components
 - Calculation of Total Measurement Uncertainty
 - Error Due to Low Signal-to-Noise Ratio
- Sweep Time and Update Rate
- Attenuators and Associated Elements
- Frequent Measurements and Enhanced Functionality
 - Phase Noise Measurements
 - Measurement Procedure
 - Selection of Resolution Bandwidth
 - Dynamic Range
 - Measurements of Pulsed Signals
 - Fundamentals
 - Line and Envelope Spectrum
 - Resolution Filters for Pulsed Measurements
 - Analyzer Parameters
 - Pulse Weighting in Spurious Signal Measurements
 - Detectors, Time Constants
 - Measurement Bandwidths
 - Channel and Adjacent-Channel Power Measurements
 - Key Parameters for Adjacent-Channel Power Measurement
 - Dynamic Range in Adjacent-Channel Power Measurement
 - Methods for Adjacent-Channel Power Measurement Using Spectrum Analyzer
 - Integrated Bandwidth Method
 - Spectral Power Weighting with Modulation Filter (IS-136, TETRA, WCDMA)
 - Channel Power Measurements in Time Domain
 - Spectral Measurements of TDMA Systems
- Fundamentals of Spectrum Analysis: Session Review and Discussion
- Features of Measurement Receiver and Spectrum Analyzer
 - R&S ESMB Reference and Measurement Receiver
 - Radio Receiver Applications for Monitoring System
 - Main Radio Receiver Parameters
 - Sensitivity Increase with the Help of Pre-Amplifiers
 - Pre-Amplifier Gain Selection
 - Features
 - Modular Design
 - Software Features
 - Measurements with Spectrum Master 2724B
 - Spectrum Analysis

- ◻ Interference Analyzer
- ◻ Channel Scanner
- ◻ AM/FM/PM Analyzer
- ◻ Measurements with Power Sensor
- ◻ Usage of Specific Software Modules in Measurements
 - Measurement Examples
- Spectrum Analyzer and Measurement Receiver: Session Review and Discussion
- Course Recap and Conclusion

How You Will Learn

- You will learn from an instructor who's well versed in a variety of RF and wireless technologies as well as spectrum monitoring and management issues.
- Along with the lecture, we will use exercises and interesting group activities to enrich the instruction and drive home the important points.
- If you already know something about the topics covered in this course, we will build on that knowledge. We'll compare and contrast what's familiar with what's new, making the new ideas easier to learn as well as more relevant.
- If your background is less technical, we will use meaningful examples and analogies to simplify the complex subject matter.
- The Participant Handbook will provide you with a framework to which you can add the information and insight provided in real-time, turning it into a valuable reference resource you can take back to your job.

Revised

November 1, 2010vf