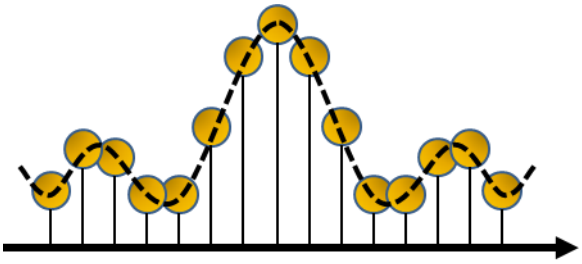
INTERLLIGENT
RF & Microwave Solutions

Training course programme:
Fundamentals of digital wireless communications



Advanced level training course

- Hands-on baseband experience
- VSA & VSG practical experiments
- Modem design and simulation
- Matlab introduction given
- Signal processing preface given

75 Hours:
50 theory + 25 hands-on practice

Introduction:

"Fundamentals of digital wireless communications" is an advanced level, 75 hours training course that deals with the physical layer of digital wireless communications systems.
This in-depth, hands-on training focuses on the theory, design and practical implementation aspects of modern digital wireless communication systems, and in specific software defined radio (SDR) architectures. The Course presents in a simple and intuitive approach - the fundamentals of modern wireless digital communication systems, and incorporates unique HANDS-ON lab and SW exercises, utilizing the latest Keysight test equipment, signal creation and signal analysis software.

Target audience:

The target audience for this seminar consists of RF & microwave system engineers, wireless hardware experts and electronics engineers who plan to make a transition into digital wireless communications technology, and wish to understand its basic concepts and unique challenges.

Presenter:

The seminar will be presented by Mr. Oren Hagai, the founder of INTERLLIGENT RF and Microwave Solutions. Bio available online at: https://www.linkedin.com/in/4x1vi

Short form syllabus with time allocations:

Subject	Subject Title	Study Hours	Practical Lab experiments
1	**Signal Processing refresher:** Properties of the Fourier transform, Nyquist and **Shannon** sampling theorems, Discrete time convolution and filtering, Matlab / Octave basic operations with hands on exercises.	5 Theory+ 5 Lab	**Signal Processing CAD intro lab**
2	**Introduction and basic terms in digital wireless communications:** Historical overview of digital wireless communications, End to End Performance metrics and physical resources of a digital wireless communication system. General block diagram of a digital wireless modem, Basic terms from Information theory, Shannon's capacity theorem.	2 Theory	**N/A**
3	**I/Q Modulation and Vector Signal Analysis (VSA)** Why I/Q Modulation? Occupied Bandwidth and orthogonal carriers' considerations. Complex vs. real signals. Presentation of Baseband and Band-pass signals. The quadrature modulator / demodulator Definition and attributes of the Signal Space, Selection of carrier waveforms using the Gram-Schmidt process, Vector projection, Presentation and interpretation of signals in the Signal-Space, Baseband Normalized Power analysis, PAPR calculations, Deterministic vs. Measured parameters. Primary Constellations: M-QAM, M-PSK, M-Orthogonal.	3 Theory+ 5 Lab	**Simulation of BB Signals,** **VSA CAD Implementation**
4	**Presentation of noise and common "distinct" distortions using the VSA.** VSA premier: block diagram, presentation modes, using Agilent's 89601B VSA platform. Presentation distinct signal deformation mechanisms in the VSA: Additive noise, Non Linearity, Phase Noise, I/Q Gain Imbalance, I/Q Phase imbalance, Carrier leakage (DC offset), Adjacent channel interference, Multipath constellation replicas.	2 Theory+ 3 Lab	**Distinct Signal deformations lab (VSA)**

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Short form syllabus with time allocations (continued):

Subject	Subject Title	Study Hours	Practical Lab experiments
5	**Demodulation in the presence of noise and distortion:** The ML and MAP criteria, Constellation Slicing, SER and BER calculations, Noise CDF and CCDF, Eb/No vs. BER Comparison between different constellations. Signal quality and system performance metrics: EVM, MER SER, BER, PER. Effects of multipath (ISI) on demodulation.	3 Theory+ 5 Lab	Demod. lab Using Keysight VSA
6	**Radio channel modeling and measurements:** Stationary vs. time varying channels, impulse and frequency response parameters, delay spread, coherence bandwidth, the Doppler effect, Doppler spread. Channel models for SISO and MIMO (the physical channel as a matrix). Practical set-ups for channel sounding (DRFM).	5 Theory+ 2 Lab	Real time HF Sounding
7	**Single carrier direct sequence spread spectrum and CDMA** Motivation for spread spectrum transmission. Analog vs. digital spreading, the concept of orthogonal coding, Walsh codes, C/I enhancements due to coding, the SC-CDMA concept	5 Theory	N/A
8	**Single / Multi Carrier transmission and OFDM:** Single carrier metrics, applications of single carrier systems, Spread Spectrum and CDMA, special case: Ultra Wide Band communications. Multi-Carrier spacing for orthogonal signals, PAPR calculations, The Creating OFDM Signals using IFFT, time domain and frequency domain attributes of OFDM signals, Channel equalization utilizing OFDM sub-carriers. OFDM add OFDMA, Cyclic Prefix.	8 Theory+ 3 Lab	OFDM Signals CAD lab
9	**From Baseband to Microwave - Advanced RF front end architectures:** Real-IF, Zero IF, Near Zero IF architectures, Weaver and Hartely architectures. Image rejection and DC-offset cancellation (Mixer Calibration).	2 Theory+ 2 Lab	Front-end lab VSG and VSA
10	**IF / RF Sampling:** Analog to Digital conversion: “Transparent” and “Non-Transparent” ADC’s, ADC’s block diagram, frequency transfer function (Nyquist zones), dynamic performance metrics: SQNR, SJNR, ENOB, SNRMax, Over-sampling processing gain. The Flash, Pipeline and SAR architectures. Sigma-Delta ADCs.	10 Theory	N/A
11	**Software defined radio:** Digital domain pulse shaping; Practical DSR systems: GNU-Radio concepts, Zipper and Myriad-RF applications: Field-Configurable RF transceivers. Flexible Back-end technologies:	5 Theory	Transceiver lab
Total 75 study hours: 50 Theory + 25 Lab.			