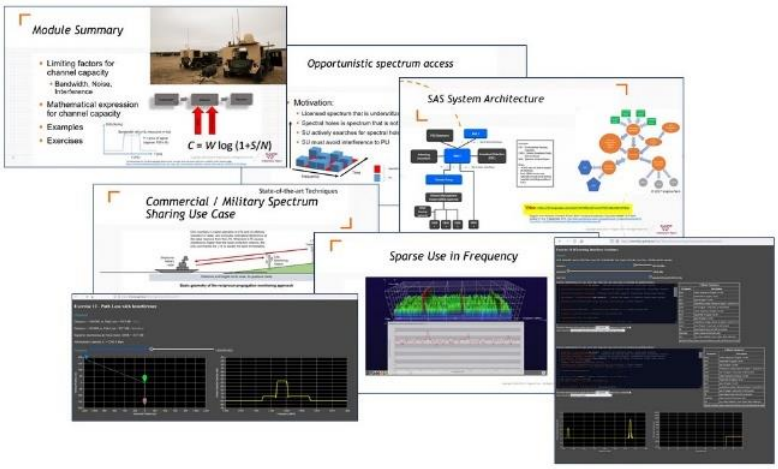
Self-Paced, Online Courses: Register now, complete by 08/31/2023

From Wireless Fundamentals to AI/ML Frequency Agility in 20 Hours (2 CEUs)

Use interactive simulations and AI/machine learning (ML) wireless link control mini-projects to learn key concepts for radio frequency (RF) spectrum sharing and spectrum superiority

The **Hands-on Learning for Radio Frequency Spectrum Innovation** course series introduces fundamental concepts and recent developments related to efficient, effective use of the radio frequency (RF) spectrum in complex RF environments, and application of AI and machine learning to communication in these environments.



Course participants explore concepts in depth through interactive simulations to apply and extend knowledge gained through lectures and diverse supplemental learning resources.

In the final course you will use rule-based artificial intelligence as well as machine learning approaches in challenging, non-graded, simulation-based mini-projects. In these projects you will modify provided transmission parameter adaptation code to maintain wireless link quality in fading channels and avoid an interfering and/or higher-priority signal in a shared RF band.

Included courses (2.0 CEUs Total, CEU badge for each course)

- **Fundamental Concepts for Wireless Communications** (0.5 CEU)
- **Introduction to the Radio Frequency Spectrum and Spectrum Management** (0.5 CEU)
- **Methods for Smart Control of Spectrum Agile Radio Frequency Systems** (0.3 CEU)
- **Controller Implementation for Spectrum Agility** (0.7 CEU)

Course resources

- **Interactive simulations** in which you control radio links manually or through AI/ML code
- **Video demonstrations** using software defined radio software and testbeds
- **Pre-module practice quizzes** to assess background knowledge and preview module content
- **Narrated slide presentations** with closed captioning and downloadable handouts
- Supplemental text notes
- Links to selected external videos, simulations, and documents

To Register: https://www.cpe.vt.edu/hlsi/registration.html or scan code:

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Course Sequence Topics

- Wireless communication links
  - Systems and subsystems: transmitters, receivers, antennas
  - Wireless channels, noise and interference
  - Signals and their properties
  - Information capacity of a channel
  - Analog and digital modulation
  - Multiplexing, duplexing, and multiple access
  - Orthogonal frequency division multiplexing (OFDM)
  - Decibels and how to use them to simplify calculations
- The RF spectrum, frequency agility, and spectrum management
  - Frequency-domain representation of signals
  - Wireless communication link performance metrics
  - Transmitter settings that can be adapted to optimize wireless link performance
  - RF spectrum management
  - Spectrum sharing/dynamic spectrum access with examples
  - Primary and secondary users
  - Spectrum sharing approaches: overlay, underlay, and interweave
  - Spectrum access systems (SAS), TV white space (TVWS) database
  - Defense-related RF spectrum concepts: electromagnetic battlespace, electromagnetic spectrum operations, electromagnetic maneuver warfare
- Software Defined Radio (SDR)
  - Concepts and definitions
  - Enabling technologies
  - Applications and examples
- Artificial Intelligence (AI)
  - Reinforcement learning; Recurrent neural networks and long short term memory (LSTM); Evolutionary generative adversarial networks; Knowledge based AI; Cognitive radio AI applications: Markov models; fuzzy logic; game theory; rule, case, and ontology based systems; multi-agent systems; game theory; biology-inspired
- Machine Learning (ML) techniques
  - Supervised Learning: Linear regression; Classification (logistic regression, support vector machines, kernel functions and parameter tuning, artificial neural networks,
  - Unsupervised Learning: Clustering (K-means, hierarchical); Dimensionality reduction (Principal component analysis, Singular value decomposition)
- Application of AI/ML to control wireless links
  - Modulation and coding scheme (MCS) selection based on channel conditions
  - Use of observations and/or machine learning to understand behavior of and/or avoid interference to and from primary-user and other transmitters and receivers within a shared band of RF frequencies