Introduction to Spectrum Systems	
Course 1	• Radio Frequency propagation • Basic properties of Electromagnetic Spectrum • Antenna • Processing chain gain & loss • Link budget • Spectrum management and frequency allocation
Course 2	• Signal concept • Signals properties • Radar introduction: general principles of how radar operates and frequency • Radio navigation systems introduction and frequencies • Radio Astronomy and frequency • Design considerations of different spectrum access systems

Advanced Spectrum Engineering: Systems & Applications	
Course 1	• Introduction to NTIA radio service categories • Tradeoff between coverage and bandwidth • Basic radio components • Radiotelegraphy • Radio broadcasting • AM, FM, and digital radio systems • From analog to digital TV • Maritime communication • The effect of atmosphere and medium on propagation • Land mobile radio • Software-defined radio
Course 2	• 3GPP LTE and 5G architecture • Duplexing and access schemes (FDD/TDD, TDMA/FDMA/CDMA) • Cell tower coordination: fractional frequency and sub-carrier-based reuse • Cellular system operation (resource blocks, channels, cell acquisition, mobility, etc.) • The evolution of the Wi-Fi system architecture • CSMA/CA • OFDM • MIMO • Bluetooth and spread spectrum techniques • Challenges of unlicensed spectrum • LTE-U and LAA vs Wi-Fi • Millimeter Wave communication
Course 3	• Passive versus active spectrum access • Radiolocation • Direction finding • Radar • Radionavigation • GNSS systems • Satellite Communication • Path loss and antenna directionality • Earth and space observation systems • Intentional and unintentional radiators