Software Defined Radio(404191)

Teaching Scheme:
Lectures: 4 Hrs/ Week

Examination Scheme:
In Semester Assessment:
Phase I : 30
End Semester Examination:
Phase II: 70

Course Objectives:

- To understand "Modern Radio Communication System " that can be reconfigured
- To understand GNU Radio
- To understand how SDR platform provides easy access to wireless network system
- To understand how unlike simulation in Communication Projects, SDR allows easy access to both PHY and MAC layer
- To understand the concept of Cognitive Radio and Spectrum sharing

Course Outcomes:

After successfully completing the course students will be able to

- Compare SDR with traditional Hardware Radio HDR
- Implement modern wireless system based on OFDM, MIMO & Smart Antenna
- Build experiment with real wireless waveform and applications, accessing both PHY and MAC, Compare SDR versus MATLAB and Hardware Radio
- Work on open projects and explore their capability to build their own communication system.

Unit I : Software Defined Radio fundamentals 8L

Introduction to SDR, Need of SDR, Principles of SDR , Basic Principle and difference in Analog radio and SDR , SDR characteristics, required hardware specifications, Software/Hardware platform, GNU radio -What is GNU radio, GNU Radio Architecture, Hardware Block of GNU, GNU software , MATLAB in SDR , Radio Frequency Implementation issues, Purpose of RF front End, Dynamic Range ,RF receiver Front End topologies, Flexibility of RF chain with software radio, Duplexer ,Diplexer ,RF filter ,LNA ,Image reject filters , IF filters , RF Mixers Local Oscillator , AGC, Transmitter Architecture and their issues,Sampling theorem in ADC, Noise and distortion in RF chain, Pre-distortion
Case study : AM/FM/BPSK/QPSK/OFDM Simulation in Matlab

Unit II : SDR Architecture 8L

Architecture of SDR-Open Architecture, Software Communication Architecture, Transmitter Receiver Homodyne/heterodyne architecture, RF front End, ADC, DAC, DAC/ADC Noise Budget, ADC and DAC Distortion, Role of FPGA/CPU/GPU in SDR, Applications of FPGA in SDR, Design Principles using FPGA, Trade –offs in using DSP, FPGA and ASIC, Power Management Issues in DSP,ASIC,FPGA

Case Study : JTRS –Goals of SCA ,Architectural details ,SDR forum Architecture

Unit III : Multi Rate Signal Processing 6L

Sample timing algorithms, Frequency offset estimation and correction, Channel Estimation, Basics of Multi Rate, Multi Rate DSP, Multi Rate Algorithm, DSP techniques in SDR, OFDM in SDR

Unit IV : Smart/MIMO Antennas using Software Radio 6L

Smart Antenna Architecture, Vector Channel Modeling , Benefits of Smart Antenna Phased Antenna Array Theory, Adaptive Arrays, DOA Arrays, Applying Software Radio Principles to Antenna Systems, Beam forming for systems-Multiple Fixed Beam Antenna Array, Fully Adaptive Array , Relative Benefits and Trade-offs OF Switched Beam and Adaptive Array, Smart Antenna Algorithms , Hardware Implementation of Smart Antennas, MIMO -frequency, time, sample Synchronization, Space time block coding-Space Time Filtering, Space Time Trellis Coding .

Case Study : Principles of MIMO-OFDM

Unit V : Cognitive Radio 6L

Cognitive Radio Architecture, Dynamic Access Spectrum, Spectrum Efficiency, Spectrum Efficiency gain in SDR and CR ,Spectrum Usage, SDR as a platform for CR, OFDM as PHY layer ,OFDM Modulator, OFDM Demodulator, OFDM Bandwidth, Benefits of OFDM in CR, Spectrum Sensing in CR, CR Network

Unit VI : Applications of SDR 6L

Application of SDR in Advance Communication System-Case Study, Challenges and Issues, Implementation, Parameter Estimation –Environment, Location, other factors, Vertical Handoff, Network Interoperability.

Case Study : 1)CR for Public Safety –PSCR , Modes of PSCR, Architecture of PSCR
2)Beagle board based SDR 3)Embedded PCSR using GNU radio

Text Books

1. Jeffrey.H.Reed ,Software Radio : A Modern Approach to Radio Engineering , Pearson , LPE

Reference Books

1. Markus Dillinger , Kambiz Madani ,Nancy Alonistioti, Software Defined Radio : Architectures , Systems and Functions ,Wiley
2. Tony .J. Rouphael , RF and DSP for SDR, Elsevier Newness Press ,2008
3. Dr.Taj Struman ,Evaluation of SDR –Main Document
4. SDR –Handbook , 8th Edition , PENTEK
5. Bruce a. Fette , Cognitive Radio Technology, Newness, Elsevier

List of the Experiments (Minimum 8 experiments are to be performed).

1. Introduction to GNU Radio
2. Introduction to USRP
3. Implementation of AM using SDR
4. Implementation of FM using SDR with application such as transfer of files
5. Implementation of M-PSK transmitter using SDR
6. Implementation of M-PSK receiver using SDR
7. Implementation of M-QAM transmitter using SDR
8. Implementation of M-QAM receiver using SDR
9. Implementation of Transmission of files on Wireless media using SDR
10. Implementation of OFDM using SDR
11. Implementation of Cognitive radio using SDR