ECE3082: Cooperative Communication in Next generation Systems

Programme: B.Tech. (ECE) Year: 3rd (2016-17) Semester: EVEN
Course: Program Elective Credits: 4 Hours: 40

Course Context and Overview (100 words): This course will analyze various performance measures like Bit error Rate performance, capacity analysis, diversity gain, etc. of cooperative communication based next generation wireless systems. Theoretical and simulation based analysis of Amplify and forward, Decode and forward based cooperative communication is analyzed in context of next generation (5G) wireless systems. Theoretical and simulation based analysis of single, multiple k-relay based communication. Review of Wire-line, Wireless communication under various channel conditions, MIMO, OFDM based communication under flat/multipath channel fading (Rayleigh, Nakagami, Kappa-mu…) scenarios. Review of Diversity schemes like Selection combining, maximal ratio combining, OSTBC in context of cooperative DF systems. Review of Femto-cell, Pico-cell based cooperative communication.

Prerequisites Courses: Digital communication, Probability theory.

Course outcomes (COs):

On completion of this course, the students will have the ability to:	
CO1:	**Explain** the key concepts of relay based single, multihop communication.
CO2:	**Explain and analyse** Decode and forward (DF), Amplify and forward (AF) based communication.
CO3:	**Differentiate** the characteristic, design understanding and requirements of cooperative communication for next generation (5G) systems like Femto-cell, Pico-cell based communication.
CO4:	**List** the various performance metric like Bit error rate, Capacity, diversity order for DF, AF based cooperative relay communication.
CO5:	**Simulate and practice** the algorithms with transmit, receive diversity over relay based communication under various wireless channel scenarios like Rayleigh, Rician, Kappa-mu, with various modulation schemes like BPSK, M-QAM.

Course Topics:

Topics	Lecture Hours	
UNIT – I **1. Direct Source-Destination Wireless Communication**		
1.1 Baseband, Passband Communication, Multipath fading.	3	9
1.2 BER over AWGN, Rayleigh channel with BPSK, M-QAM(rectangle, Square QAM	4	
1.3 BER Rayleigh: Wireless system, Average BER, Asymptotic BER, Deep fade Analysis, Average Rayleigh BER.	2	
UNIT – II **2. MIMO system analysis**		6
2.1 Diversity (SC, MRC), Avg. BER MRC, SC with L combiner, SIMO, MISO, MIMO Systems	3	
2.2 MIMO Receiver , ZF, MMSE, OSIC Receiver, Average BER,	1	
2.3 Asymptotic BER analysis, Deep Fade analysis	2	
UNIT – III **3. Selective DF**		12
3.1 Selective Decide and forward (DF) System Model	2	
3.2 SNR, Symbol error rate analysis, Asymptotic BER, Optimal Power Allocation	2	
3.3 Cooperative MIMO selective DF system model	2	
3.4 SER Analysis, Asymptotic BER	3	
3.5 Diversity order, Optimal power allocation	3	
UNIT – IV **4. STBC and Multiple Node Cooperative Systems**		6
4.1 Multiple Node Cooperative Systems; SER Analysis, Asymptotic BER, Optimal Power allocation	1	
4.2 MISO, Transmit Beam-forming, Alamouti code Co-operative STBC	1	
4.3 STBC SER Analysis, Asymptotic BER, Diversity order, Optimal power allocation	2	
4.3 Multiple Node Cooperative STBC Analysis	2	
UNIT-V **5. AF cooperative Communication,**		7

5.1 SER analysis, Diversity , Optimal power allocation	2	
5.2 Fixed Decode and forward Dual-hop Communication	2	
5.3 Theory to Practice : Simulation of all the above Cooperative communication model in Matlab/Simulink, Realization over Zed-Board.	3	

Textbook references (IEEE format):
Text Book:

1. K. J. Ray Liu, *"Cooperative Communications and Networking"*, Cambridge Press, 2008.
2. Wan-Jen Huang, *"Cooperative Communications and Networking: Technologies and System",* July 28, 2010.
3. Mischa Dohler *"Cooperative Communications: Hardware, Channel and PHY"*, January 1, 2010

Reference books:

1. M Uysal, "Cooperative Communications for Improved Wireless Network Transmission," January 1, 2009.

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

Evaluation Methods:

Item	Weightage
Assignment I-II-III	10
Seminar Presentation	15
Project	
Midterm I	35
Final Examination	40

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