EE 520: Wireless and Mobile Communication

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| **Lecture Schedule** | | Monday and Wednesday (4:30 to 6:00 pm) | **Course Type, Semester** | | Core,  Spring 2019 | | | |
| **Credit Hours** | | Three | **Pre-requisite** | | Linear Algebra (UG), Digital Signal Processing (UG), Analog & Digital Communications (UG), Stochastic Processes (Graduate) | | | |
| **Instructor** | | Dr Syed Shah Irfan Hussain | **Contact** | | [ssirfanhussain@uet.edu.pk](mailto:ssirfanhussain@uet.edu.pk) | | | |
| **Office** | | Room No 206 or DSP lab, First Floor, EE Department | **Office Hours** | | TBA | | | |
| **Course Description** | | This course will provide an in-depth study of propagation characteristics of wireless channels, point to point communication issues and cellular systems. Key auxiliary concepts of continuous and pulsed signals-sampling and digitization as well as Estimation and Detection in AWGN channel will also be covered. | | | | | | |
| **Measurable Learning Outcomes** | **CLOs** | **Description** | | | | | **PLOs & levels** | **Domains & Levels** |
| CLO1 | Understand wireless channels, its key physical parameters and its modeling issues. | | | | | PLO 1 & Low | Cognitive & 2 |
| CLO2 | Analyze uncoded transmission in a narrowband fading channel with coherent and noncoherent detection. | | | | | PLO 2 & Medium | Cognitive, & 4 |
| CLO3 | Evaluate various diversity techniques over time, frequency or space for improved performance with or without the impact of channel uncertainty. | | | | | PLO 4 & High | Cognitive, & 5 |
| CLO4 | Explain how existing industrial digital wireless systems deal with Multiple access and interference management. | | | | | PLO 3 & Low | Cognitive, & 2 |
| **Textbooks** | | **Test book**:   1. Fundamentals of Wireless Communication (FWC), by D. Tse and P. Viswanath, Cambridge university press, 2005 2. Digital Communications (DC), by J. G. Proakis, Masoud Salehi, 5th edition, McGraw-Hill, 2008 3. Digital Communications: Fundamentals and Applications (DCFA) by B. Sklar, 2nd Edition, Prentice Hall, 2001 4. Introduction to Communication Science and Systems (ICSS), by J. R. Pierce and E. C. Posner, Spinger, 1980   **Reference books**:   1. Probability, Random variables and Stochastic processes, by A. Papoulis, 3rd edition, McGraw-Hill, 1991 2. Wireless communication, by A. Goldsmith, Cambridge university press, 2005 3. MIMO wireless communication, by E. Bigleiri, R. Claderbank, A. Constantinides, A. Goldsmith, A. Paulraj, H. V. Poor, Cambridge university press, 2007 4. Introduction to wireless communication, by P. M. Shankar, Wiley, 2002 5. Wireless communication, principles and practice, by T. S. Rappaport, Prentice hall, 2002 6. Microwave Engineering, by D. M. Pozar, 4th edition, John Wiley & sons, 2012 7. Electromagnetic Engineering and Waves (EEW), by Umran S. Inan, Aziz S. Inan and Ryan Said, 2nd Edition, Pearson Education, 2015 | | | | | | |
| **Grading Policy vis-à-vis CLO Mapping** | | Class Participation | | 10% | | CLO 1, 2, 3, 4 | | |
| Quiz1 | | 10% | | CLO 1 | | |
| Quiz 2 | | 10% | | CLO 3 | | |
| Midterm | | 30% | | CLO 1, 2, 3 | | |
| Final | | 40% | | CLO 3, 4 | | |

**Lecture Plan**

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| **Week\*(No of lectures)** | Topics | **Readings (Problems\*\*)** | **Related CLOs** |
| **1(1)** | **OBE based course outline** | **Course outline** |  |
| **1(0.5)** | **The link between continuous and pulsed signals-sampling and digitization**  The Sampling function and Sampling  Reconstructing a signals from samples | **Chapter 5 of ICSS** | **CLO 1** |
| **1-4 (5.5)** | **The wireless channel**  Physical modeling for wireless channels  Input/output model of the wireless channel  Time and frequency coherence  Statistical channel models | **Chapter 2 of FWC (2.1, 2.2, 2.3, 2.4, 2.5, 2.6.1, 2.6.2, 2.6.3, 2.10, 2.11, 2.13, 2.14, 2.15, 2.16, 2.19.1** | **CLO 1** |
|  | **Quiz 1** |  | **CLO 1** |
| **4 (1)** | **Detection and Estimation in Additive Gaussian noise**  *Gaussian random variables*: Scalar real Gaussian random variable, \* Real Gaussian random vectors, Complex Gaussian random vectors  *Detection in Gaussian noise:* Scalar detection | **Appendix A of FWC (No problems)** | **CLO 2** |
| **4-8 (8)** | **Point to Point Communications**  Detection in a Rayleigh fading channel,  *Time diversity:* Repetition coding, \*Beyond Repetition coding | **Chapter 3 of FWC (3.1, 3.2-1, 3.4, 3.5)** | **CLO 2, 3** |
|  | **Midterm** |  | **CLO 1, 2, 3** |
| **9(1)** | **Detection and Estimation in Additive Gaussian noise**  *Detection in Gaussian noise:* Detection in vector space | **Appendix A of FWC (No problems)** | **CLO 3** |
| **9-10(2.75)** | **Point to Point Communications**  *Time diversity:* *Beyond repetition coding:* Time diversity code design criterion, Time diversity in GSM | **Chapter 3 of FWC (3.8-1, 3.10-1, 2, 3.11-1, 2)** | **CLO 3** |
| **10 (0.25)** | **Linear Block code**  \*\*Basic definitions, \*\*General properties of linear block codes | **Chapters of DC/DCFA (No problems)** | **CLO 3** |
| **11-12 (2.5)** | **Point to Point Communications**  *Antenna diversity:*  Receive diversity, Transmit diversity | **Chapter 3 of FWC (3.15-1, 2, 3.16, 3.20)** | **CLO 3** |
| **12 (0.5)** | **A simple Transmit diversity technique for wireless communications** | **IEEE journal on select areas in communicaitons, vol. 16, no. 8, October 1998** | **CLO 3** |
|  | **Quiz-2** |  | **CLO 3** |
| **12-15 (7)** | **Point to Point Communications**  *\*Antenna diversity:*  MIMO: A 2×2 Example  *Frequency diversity:*  Basic concept, Single carrier with ISI equalization, Direct sequence spread spectrum, Orthogonal Frequency Division Multiplexing, Impact of Channel uncertainty | **Chapter 3 of FWC (, 3.21-1, 3.25, 3.27, 3.29-2, 3.33)** | **CLO 3** |
| **16(2)** | **Cellular Systems: Multiple Access and Interference Management**  Introduction, Narrowband cellular systems, Wideband systems: CDMA, Wideband systems: OFDM | **Chapter 4 of FWC** | **CLO 4** |
|  | **Final Exam** |  | **CLO 3, 4** |

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