Instructor: Hüseyin Arslan
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Instructors research interests and background:

Dr. Arslan has received his PhD. degree in 1998 from Southern Methodist University (SMU), Dallas, Tx. From January 1998 to August 2002, he was with the research group of Ericsson Inc., NC, USA, where he was involved with several project related to 2G and 3G wireless cellular communication systems. Since August 2002, he has been with the Electrical Engineering Dept. of University of South Florida. He has worked for Anritsu Company, Morgan Hill, CA as a visiting professor during the summers of 2005 and 2006 and as a part-time consulting between August 2005 and August 2007. In addition, he has worked for The Scientific and Technological Research Council of Turkey- TUBITAK as a visiting professor over the summer 2008. His involvement with Tubitak has been continuing as a part time consultant since August 2008.

Dr. Arslan's research interests are related to advanced signal processing techniques at the physical layer, with cross-layer design for networking adaptivity and Quality of Service (QoS) control. He is interested in many forms of wireless technologies including cellular, wireless PAN/LAN/MANs, fixed wireless access, and specialized wireless data networks like wireless sensors networks and wireless telemetry. The current research interests are on UWB, OFDM based wireless technologies with emphasis on WIMAX and IMT-Advanced, and cognitive and software defined radio. He has served as technical program committee chair, technical program committee member, session and symposium organizer, and workshop chair in several IEEE conferences. He is a member of the editorial board for "Wireless Communication and Mobile Computing Journal" and "Research Letters in Communications". Dr. Arslan is a senior member of IEEE.
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Catalog Description: Providing the students with a comprehensive knowledge of most technical aspects, operations, and applications of second/third generations and future cellular mobile and personal communication technology. Offering technical, practical, and up-to-date treatment of the latest wireless communication technologies and system design implementations. Also, describing the emerging personal communications systems and emerging personal communications services.

Course Prerequisites:
Basic knowledge of Fourier transforms and linear system analysis, digital signal processing, communication systems, programming skill in MATLAB or equivalent will be very helpful in understanding the course better. An undergraduate level "Introduction to communication systems" and an undergraduate level probability theory is an excellent preparation for this course. Students without any communications background should be prepared that certain portions of the course may be difficult to follow.

Courses that require this as a direct prerequisite: None (for Advanced topics in Wireless Communications and Cognitive & Software Defined Radio Courses, this course might be an excellent preparation)

Level: Senior level undergraduate and entry level graduate

Credits: 3 **Class Time:** Three hours lecture

DETAILED DESCRIPTION

- Focus is on cellular mobile radio. GSM, TDMA, CDMA and 3G wireless cellular telephony, cellular data, cellular multimedia.
- Limited coverage on wireless LAN, wireless PAN, and fixed wireless (specifically on OFDM based wireless communication systems and Ultra wideband) will be given.

Coarse Objectives:

- Providing the students with a comprehensive knowledge of most technical aspects, operations and applications of second/third generation and future cellular mobile and personal communication technology.
- Offering a technical, practical and up-to-date treatment of the latest technologies, and system design implementations. Also, describing the emerging personal communications systems and emerging personal communications services.
- Introduction to the technology and underlying principles of wireless communications; building blocks of wireless networks; elementary examination of the science and technology of wireless communications including radio signal propagation (including multipath effect), radio channel modeling, interference-limited communications, coding, modulation, anti-fading techniques like transmit and receiver antenna diversity, equalization etc.; essential functions of all cellular telephone systems like frequency re-use, cellular hierarchy, sectorization, handoff and power control etc. are discussed.
- Review of the various standards and systems which have been developed (including 2G and 3G systems), and basic issues involved in the design of wireless systems. Discussion of the potential problems associated with the access technology for the second/third-generation systems and providing the vision of the future-generation systems.
- Introduction of other subjects related to wireless communications, like spread spectrum techniques (Direct sequence and Code division multiple access (CDMA), Frequency hopping); Multicarrier techniques including Orthogonal Frequency division multiple access (OFDM) and Multicarrier CDMA (MC-CDMA); Ultra Wideband communications etc.

Relation of the Course to Program Objectives and Outcomes: 1 (a) (b) (c) (d) (e) (g) (h) (j)

Assessments: Homeworks, Midterm, Final, Course Project, and Project Presentation.

GRADING: (two options)

	A	**B**
Midterm exam	**0**	**40**
Final exam	**40**	**60**
Term project	**60**	**0**
Homework (Bonus)	**0**	**10**
Project presentation (Bonus)	**10**	**0**
Total	**110**	**110**

Course Hours: Tuesday and Thursday 5:00 to 6:15 pm
Office hours: Tuesday: 3:45 to 5:00 pm
Thursday 3:45 to 5:00 pm

Off-campus students: Please e-mail me to get an appointment for telephone conversation
On campus students: Please do not send me an e-mail unless it is necessary. I prefer office hours for technical discussions.

If you choose option A, project is very important. Only outstanding projects will get full credit. A paper quality project is considered as an outstanding project. Students need to meet with the instructor for project updates to avoid last minute project rushes. For group projects, every individual needs to contribute to the project. Group evaluation as well as individual evaluation will be done. High quality projects can be presented at the end of semester in the class. Extra credit will be provided for class presentation of excellent projects. Note that only well prepared projects will be allowed to be presented.

Homeworks are not mandatory, however, for those who have done homeworks alone and spend decent amount of time on the homeworks will get extra credit up to %10 of the total grade. Check the Blackboard for the homework schedule and assignments. Note that homeworks are for your benefit. Doing the homeworks will not only provide you some extra credit, but also will help you prepare for the exams. On the top of that you will learn something, which is actually the most important benefit.

Note: All quizzes, tests, exams, etc. MUST be taken during regularly scheduled class or exam times either on campus or with an approved proctor. Any deviation from this policy MUST be pre-approved by the instructor in writing.

BOOKS & REFERENCES

There are so many books written in this area, and most of the books are good and beneficial. Thanks for the contributors. We will not follow a specific book all the time; technical papers and other reference books will also be used along with the text book that is chosen. When necessary, the instructor will provide you the links for some reference materials.

Text Book:
Wireless Communications: T. Rappaport

Other books:
- The Mobile Communications Handbook: Jerry D. Gibson, CRC Press
- Mobile Cellular Telecommunications: W.C.Y. Lee, McGraw Hill
- Digital Communications: John Proakis, McGraw Hill
- B.P. Lathi, Modern Digital and Analog Communication Systems, Oxford Press, 1998 (for communication background)
- G.L. Stuber, Principles of Mobile Communication, Kluwer Academic Publishers, 1996.
- V.K. Garg and J.E. Wilkes, Wireless and Personal Communication Systems, Prentice Hall, 1996.
- W.C.Y. Lee, Mobile Cellular Telecommunications, McGraw-Hill, 1995.
- M.D. Yacoub, Foundations of Mobile Radio Engineering, CRC Press, 1993.

Magazines:
- IEEE Commun. Mag.
- IEEE Personal Commun. Mag.

Check the course web-site for other useful references. Feedbacks on course material, slide errors, and others for the improvement of the course are welcomed.

Lectures will be based on required reading from magazine and journal articles, textbook sections, or supplemental handouts.

Outline of the course:

Basics of wireless

- Important terminology and definitions (wireless, mobile, cellular, degrees of mobility, fixed wireless, etc.)
- Duplexing and multiplexing techniques
- History and evolution of wireless systems
  - Comparison of cellular to old single cell systems
  - Cellular transition, introduction of re-use
  - Transition and characteristics of 1G, 2G, 3G, 4G cellular
  - Requirements of cellular over time
- Spectrum, regulations, and frequency allocation

Overview of a simple and basic communication system

- Basic block diagram of a system
  - Source and channel coding (FEC and CRC coding)
  - Modulation/mapping, interleaving, and pulse shaping
  - Wireless channel
- Brief functionality of each block
- Brief introduction of the wireless channel
  - Short and long term fading
  - Path loss
- Refreshing memory on some background information
  - Time domain and frequency domain characteristics
  - Statistics of the signals, random process

Cellular Concept

- Motivation and design objectives
- Cellular patterns
- Frequency re-use
- Interference and system capacity
- Channel allocations and planning
- System expansion techniques (capacity and coverage improvements)
- Hand-off
- Cellular wireless architecture
- Trunking and grade of service

Wireless Mobile Radio Channel

- Nature of the Mobile Radio Environment
- Propagation Models
  - Distant dependent path loss
  - Reflection, Scattering, Diffraction
  - Log-Normal Fading (also known as Large-Scale Fading)
  - Raleigh Fading (also known as Small-Scale Fading or Multipath Fading)
  - Path loss models
  - Interference characteristics and models

Channel statistics in time/frequency/space

- Types of fading
- Time/frequency/space variation of channel
  - Coherence time, coherence frequency, coherence distance
  - Doppler spread, delay spread, angular spread

- Relation between channel statistics
- Interpretation of channel statistics in time/frequency/space domains
- Understanding the channel selectivity in wireless system and transceiver design

Channel Counteractions

- Diversity
- Adaptive Beam-forming and MIMO
- Rake receiver
- Equalization
  - Time domain
  - Frequency domain
- Coding and interleaving
- Power control
- Interference cancellation

Modulation

- Analog vs. digital
- Metrics in comparing modulation options
- Overview of different modulation techniques
- Discussion of the advantages and disadvantages of several modulation options
- Modulations used in several wireless standards and motivations behind those
- Adaptive modulation and coding (link adaptation)

CDMA Technology overview

- Block diagram of CDMA transceiver
- Basics of CDMA
  - Spreading
- PN code properties
- OVSF codes
- Overview of cellular standards that employ CDMA

Other futures wireless communication systems (*an overview*)

- WLAN (802.11a, 802.11g, 802.11n)
  - Multi-carrier and OFDM
- WPAN
  - UWB
- WMAN (802.16a, 802.16e)
  - OFDM, OFDMA
- 4-G cellular
  - LTE and IMT-advanced
- XG
- Software defined radio
- Wireless ad-hoc and wireless sensor networks

Actions Taken to Improve the Course:

Some Matlab demonstrations are included to improve the understanding of the course.

Standard Syllabus Prepared by: Huseyin Arslan