NORTHERN ARIZONA UNIVERSITY

College of Engineering, Forestry & Natural Sciences
Department of Electrical Engineering & Computer Science

EE 599 COURSE SYLLABUS

ADVANCED TOPICS IN EE: CONTEMPORARY DEVELOPMENTS
ADVANCED COMMUNICATIONS AND WIRELESS SENSING
(Co-convenes with EE490)

Spring 2016 (3 credit hours)

Class Number:	EE599 (1161-2433)
Instructor:	Dr. Abolfazl Razi
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E-mail:	abolfazl.razi@nau.edu (Please write 'EE490/599' in subject line when you email me)
Phone:	(928) 523 8078
Class Time:	MoWeFr 10:20-11:10 a.m. (Engineering Bldg. Room 321)
Office Hours:	MoWeFr 11:10-13:00 a.m. and Tu 10:00-12:00 a.m., or by appointment

Course Prerequisites:

- EE 348 (Signals and Systems) with grade C or better.
- EE 325 (Engineering Analysis II) with grade C or better.
- EE 430 (Communications Systems) or EE 434 (Wireless Communications) with grade C or better.
- You are also expected to have good programming skills in MATLAB.

Textbooks:

The material for this course is from different sources. As a special topics course, no one communications textbook contains all topics presented in this course. The material sources include wireless textbooks, standards, online resources, journal articles and recent conference papers relevant to the course topics. Material appropriate to each topic will be made available to students (either will be handed in class or posted online). The following books are not required but highly recommended:

- F. Akyildiz and M. C. Vuran, "Wireless Sensor Networks", 2010, *John Wiley and Sons Publications*, ISBN-13: 9780470036013 (Highly Recommended).

- Ha H. Nguyen, Ed. Shwedyk, "A First Course in Digital Communications", 2009, *Cambridge University Press*, ISBN-13: 9780521876131 (Highly Recommended).

- Leonard Kleinrock, “Queueing Systems. Volume 1: Theory”, 1975, *John Wiley& Sons Publications,* ISBN: 0471491101, ISBN-13: 9780471491101.

- John G. Proakis and Masoud Salehi, “Fundamentals of Communication Systems”, 2013, *Prentice Hall Publications*, ISBN-10: 0133354857, ISBN-13: 9780133354850.

- H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks”, 2005, *John Wiley and Sons Publications*, ISBN: 0470095105.

- William Stalling, “Wireless Communications and Networking”, 1st Ed., 2002, *Prentice Hall Publications*, ISBN: 0130408646.

Course Description:

In this course, students will learn fundamental theoretical concepts in communications systems and will get familiar with related technologies and research challenges in wireless systems and sensor networks. The following subjects will be covered: Wireless systems and applications: OSI reference model, physical layer design (wireless channels, fading and nose, modulation, coding), medium access control, error control, scheduling and routing, localization and topology management, authentication, ciphering and compression techniques, wireless standards and implementations.

Student Learning Expectations/Outcomes for this Course:

At the completion of this course, students will understand basics, theoretical foundations and practical aspects of wireless sensor networks. In particular, they will know the following subjects:

1. Fundamentals and Applications of Wireless Sensor Networks
2. Protocols and the OSI reference model.
3. Physical Layer (Modulation, Channel Coding, Wireless Channels)
4. Medium Access Control Protocols
5. Error Control (FEC, ARQ)
6. Routing Protocols
7. Queuing and Scheduling
8. Distributed Source Coding and Compression
9. Wireless Cellular Systems (GSM, UMTS, LTE)
10. Cellular Network Operations
11. Wireless LAN and Mesh Networks (IEEE 802.11)
12. Wireless PAN and Bluetooth (IEEE 802.15.1)
13. Zigbee Protocol (based on IEEE 802.15.4)
14. Passive Sensor Networks

Students will also develop their abilities to read and gain understanding from current literature on wireless sensor networks. The students will gain capability of developing their own algorithms and projects suitable for these networks. Graduate students will develop deeper understanding of the above topics in order to help students in the undergraduate section with their in class exercises, provide them with constructive feedback on their term papers, and learn how to, and learn how to teach them via a tutorial and software demonstration.

Course Structure/Approach:

We will be following the textbooks and other provided materials rather closely most of the time, with the topic order as shown in the "Course Outline" section below. The format will largely be lecture and discussions. We will not only focus on theoretical aspects, but also explore the actual implementations and current technologies. The students frequently will be provided with materials out of the textbooks. There will often be important material in the text that we will not have time to cover in class.

Course Outline:

First Quarter: Fundamentals and Applications of Wireless Sensor Networks. Communications Protocols and OSI reference model. Review of Physical Layer Design including Modulations (Single Layer and Hierarchical), Channel Capacity, Channel Coding (Block Codes, Convolutional Codes, LDPC, and Turbo Codes), Wireless Channels (Noise, Fading, Doppler Effect).

Second Quarter: Medium Access Control Protocols (including multiple access techniques, TDMA/FDMA/CDMA, Frequency Hopping, OFDM, Space-Time Coding), Error Control Mechanism (CRC Codes, Forward Error Correction, ARQ re-transmission), Routing Protocols, Queuing Systems (M/M/1 Queues) and Scheduling, Entropy and Source Coding, Second Exam.

Third Quarter: Wireless Cellular Systems (GSM, UMTS, LTE), Network Infrastructure (Switching and Radio Parts), Cellular Network Operations (Location Update, Handover, Authentication, Ciphering), Wireless Internet Access Standard: Wireless LAN and Mesh Networks (IEEE 802.11) and Wireless PAN and Bluetooth (IEEE 802.15). Third Exam.

Fourth Quarter: Wireless Sensor Networks, Issue and challenges (Power constraint, topology managements, ad-hoc networks), Wireless sensor implementations (IEEE 802.15.4, Zigbee Protocol), Passive Wireless Sensor Networks (SAW Devices), Nano Sensors. Final Project Presentations.

Assessment of Student Learning Outcomes:

Assessment will be based on three in-class exams, homework, participation, and final project. The three exams will be after completing the first three quarters of the class and by prior arrangement. The quizzes will be on random basis with or without prior announcement.

In-class Exam	250 points	100 for each of the two highest exams, 50 points for the lowest exam
Homework	100 points	approximately biweekly
Participation/Activity	50 points	
Quiz	100 points	
Term Project	150 points	30 pts for proposal, 50 pts for final report and 70 pts for final presentation
Total	650 points	

Final grades will be determined by the following percentages:

A = 90+, B = 80-89, C = 70-79, D = 60-69, F = below 60

At the professors' discretion, grading thresholds may be lowered slightly.

Term Project:

Each final project will include a study of a specific aspect of wireless networks and wireless sensor networks based on the student's interest. Students must specify their projects by Feb 19. Each student is supposed to review the recent literature (at least 5 articles) in the adopted topic and provide a comprehensive summary of

the problem, its importance, current solutions, and future direction to solve the remaining challenges. The topics shall be chosen by students and finalized after instructor approval. Project reporting includes multiple activities: i) proposal tentative in one page, ii) proposal defense in a 5 minute presentation (at most 10 slides) followed by 5 minute questions addressing the following question: "why this problem is chosen and why it is important?", iii) 5-page final report in IEEE conference paper format, due by April 29, and iv) final presentation due by the end of the semester as a 10 min presentation followed by 5 minute questions and discussions.

Remark: Proposing new ideas to solve an existing problem and verifying the results by numerical simulation in MATLAB or by analytical derivations is strongly recommended and will be given extra credit up to 50% of the project score.

Course Policies:

- Late Work

  Assignments are due when specified and can be submitted on BBLearn (preferred) or on paper at the beginning of the class period. Late work will be accepted electronically only (on BBLearn, not by e-mailing the professor!) up to 24 hours late for a 20% penalty, and not accepted after 24 hours late.
- Retests and Makeup Tests

  No makeup exams will be given except by prior arrangement in exceptional or emergency situations at the discretion of the instructor. Please contact me immediately if such a situation arises. (Procrastination is not an emergency.)
- Attendance

  Attendance is required and will be recorded on a random basis. Attendance data will be included in the participation portion of your grade.
- Cell Phone Use

  If you have a cell phone or beeper, turn it off or to silent mode while in class. Do not make calls during class, speak on your phone or text message. If you do receive an emergency call during class time, ask to be excused and take your call outside the classroom.
- Academic Dishonesty

  Cheating and plagiarism are strictly prohibited. Incidents of cheating or plagiarism are treated quite seriously. The NAU policy on academic dishonesty in Appendix G of the current Student Handbook applies. All work you submit for grading must be your own.
  https://policy.nau.edu/policy/policy.aspx?num=100601

You are encouraged to discuss the intellectual aspects of homework assignments with other class participants. However, each student is responsible for formulating solutions in his or her own words.

University policies:

See the following link for more information on the NAU policies listed below:
https://policy.nau.edu/policy/results.aspx?fam=1

- Academic Contact Hour Policy
- Academic Integrity
- Institutional Review Board
- Safe Working and Learning Environment (SWALE) Policy
- Students with Disabilities