Electrical & Computer ENGINEERING

Carnegie Mellon

Course Syllabus

18-452/18-750: *Wireless Networks and Applications*
http://www.cs.cmu.edu/~prs/wirelessS20/
Spring 2020

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Course Description:
This course introduces fundamental concepts of wireless networks. The design of wireless networks is influenced heavily by how signals travel through space, so the course starts with an introduction to the wireless physical layer, presented in a way that is accessible to a broad range of students. The focus of the course is on wireless MAC concepts including CSMA, TDMA/FDMA, and CDMA. It also covers a broad range of wireless networking standards, and reviews important wireless network application areas (e.g., sensor networks, vehicular) and other applications of wireless technologies (e.g., GPS, RFID, sensing, etc.). Finally, we will touch on public policy issues, e.g., as related to spectrum use.

The course will specifically cover:

- Wireless networking challenges
- Wireless communication overview
- Wireless MAC concepts
- Overview of cellular standards and LTE
- Overview of wireless MAC protocols WiFi, bluetooth and personal area networks, etc.
- Wireless in today's Internet: TCP over wireless, mobility, security, etc.

- Advanced topics, e.g., RFIDs, vehicular networks, sensor networks, DTNs, localization, sensing, etc.

All information regarding this course will be posted on this web page so please check the page regularly. We will also make announcements in class.

Number of Units: 12
Pre-requisites: 18-213, 15-213, or 15-513 or equivalent background. C/C++ and/or Java programming skills are also needed for the project.
Course Designation: Coverage
Course Area: Computer Software

Class Schedule:

- **Lecture**: *Monday and Wednesday* *2:30pm – 4:20pm* *WEH 5328*
- **Recitation**: *Friday* *12:30am – 1:50pm* *HH 1107*

The above room numbers are for the Pittsburgh section of the course. The course is also offered via video conferencing on the Silicon Valley campus.

Required Textbook:
The textbook for the course is *"Wireless Communication Networks and Systems",* Cory Beard and William Stallings, Pearson, first edition, 2015. It does not cover all the course material, but it is the "best fit".

Assignments:
Four assignments will be assigned throughout the course. Homeworks must be handed in (hardcopy) during class, or with the course secretary before class (by 2:30pm) by the due date. Homeworks cannot be submitted electronically through e-mail or blackboard. Late homeworks will be assessed a 30% penalty. No homeworks will be accepted more than one day late.

The homework schedule will be announced on the web site.

This course will also include a midterm and a final. The midterm will be on Monday, March 5th, during class time. It is closed book and will cover the material in lecture 1-13. The date and location for the final will be posted by the registrar.

Project:
The course includes two hands-on projects that are executed by small teams of students.

The educational objectives of the course project include the ability to apply knowledge of mathematics, science, and engineering; to design and conduct experiments, as well as to analyze and interpret data; to design a system, component, or process to meet desired

needs within real-world constraints; the ability to function on multi-disciplinary teams; and to identify, formulate, and solve engineering problems.

The due dates for the project miles stones will be announced on the course web site.

Survey Presentations:
A block of lectures in the course will be dedicated to more advanced topics. This part of the course will consist of presentations by both the instructor and by the students. Each student will prepare and present one survey. More details on the survey assignment, including list of topics, can be found in the Survey Handout. That page also includes a list of papers for each topic. The papers from a previous offering can be found on the schedule for the student talks can be found on the Survey Papers page.

The dates for survey presentations will be announced on the web site once the student teams have selected their topics.

The survey lectures are part of the course, and the material presented in the presentations will be covered in the homeworks and final. Specifically, the slides used in the survey presentation and one of the papers on the reading list, should be studied to prepare for the final. Both the slides and the selected paper can be found in the table with the course schedule.

The education goals for the survey presentations include a recognition of the need for, and an ability to engage in life-long learning; and an ability to communicate effectively.

Grading Algorithm:

10%	Homework
5% and 25%	Projects
10%	Survey Talk
20%	Midterm
30%	Final

Tentative Course Calendar:

Week of	Monday	Wednesday	Friday
Jan 13		Introduction, Wireless History	
Jan 20	MLK HolidayWireless	Physical Layer	
Jan 27	Physical Layer	Physical Layer	
Feb 3	Physical Layer	Physical Layer	
Feb 10	Random Access in Wireless	WiFi	
Feb 17	WLAN	Wifi Variants	
Feb 24	MIMO and UWB Paper	PAN	
March 2	Midterm	Sensor Networks	
March 9	Spring Break	Spring Break	
March 16		Wireless in the Internet	
March 23	Cellular	Cellular	
March 30	Cellular	RFID	
April 6	Research surveys	Challenged Networks: DTN & Vehicular	
April 13	Spectrum management	Research surveys	Spring Carnival;No Classes
April 20	DSA, WhiteFi Paper		
April 27	Research surveys	Project reviews	

Education Objectives (Relationship of Course to Program Outcomes):
*Keep only those that apply. Append a brief description of what is done in the course to address each outcome***.**

(a) an ability to apply knowledge of mathematics, science, and engineering:

The students use mathematical concepts to model signal propagation and learn how to apply engineering principles to optimize network bandwidth and design wireless networks.

(b) an ability to design and conduct experiments, as well as to analyze and interpret data:
The first project of the course is a measurement study of signal strength and quality for different types of channels. They are asked to explain their results based on the material they learned in class.

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability:

The students learn how to optimize individual radio channels, wireless network connections, and wireless networks. Besides technical constraints, constraints imposed by spectrum policy and economic realities are an important consideration.

(d) an ability to function on multi-disciplinary teams:

The second course project is performed in in teams of 2-3 students. Besides technical project goals, the students learn teamwork and team management skills. The course attracts student with very diverse backgrounds, including signal processing, computer engineering, and engineering and public policy, so some teams are inter-disciplinary in nature.

(e) an ability to identify, formulate, and solve engineering problems:

Project 2 requires students to identify and formulate a wireless networking problem and address it in the project.

(f) an ability to communicate effectively:

Students give several presentations. They must present a mid-semester update and a final report on their project 2. In addition, each student must present a "survey" of a specific wireless topic, effectively a 30 minute mini lecture on that topic based on ~3 research papers and background reading.

(g) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context:

The course emphasizes the role of economic, environmental and societal concerns in the design of wireless network technologies. A specific example is the difference between licensed and unlicensed spectrum bands, and its impact on the technology, standards, economic drivers, and society.

(j) a knowledge of contemporary issues:

Spectrum policy is a contemporary issues that is an important theme in the course.

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:

Students are taught a wide variety of techniques and skills in areas such as resource allocation in wireless networks and protocol design at different levels of the protocol stack.

ECE Academic Integrity Policy
(http://www.ece.cmu.edu/programs-admissions/masters/academic-integrity.html**):**

The Department of Electrical and Computer Engineering adheres to the academic integrity policies set forth by Carnegie Mellon University and by the College of Engineering. ECE students should review fully and carefully Carnegie Mellon

University's policies regarding Cheating and Plagiarism; Undergraduate Academic Discipline; and Graduate Academic Discipline. ECE graduate student should further review the Penalties for Graduate Student Academic Integrity Violations in CIT outlined in the CIT Policy on Graduate Student Academic Integrity Violations. In addition to the above university and college-level policies, it is ECE's policy that an ECE graduate student may not drop a course in which a disciplinary action is assessed or pending without the course instructor's explicit approval. Further, an ECE course instructor may set his/her own course-specific academic integrity policies that do not conflict with university and college-level policies; course-specific policies should be made available to the students in writing in the first week of class.

This policy applies, in all respects, to this course.

CMU Academic Integrity Policy (http://www.cmu.edu/academic-integrity/index.html**):**

In the midst of self exploration, the high demands of a challenging academic environment can create situations where some students have difficulty exercising good judgment. Academic challenges can provide many opportunities for high standards to evolve if students actively reflect on these challenges and if the community supports discussions to aid in this process. It is the responsibility of the entire community to establish and maintain the integrity of our university.

This site is offered as a comprehensive and accessible resource compiling and organizing the multitude of information pertaining to academic integrity that is available from across the university. These pages include practical information concerning policies, protocols and best practices as well as articulations of the institutional values from which the policies and protocols grew. The Carnegie Mellon Code, while not formally an honor code, serves as the foundation of these values and frames the expectations of our community with regard to personal integrity.

This policy applies, in all respects, to this course.

The Carnegie Mellon Code

Students at Carnegie Mellon, because they are members of an academic community dedicated to the achievement of excellence, are expected to meet the highest standards of personal, ethical and moral conduct possible.

These standards require personal integrity, a commitment to honesty without compromise, as well as truth without equivocation and a willingness to place the good of the community above the good of the self. Obligations once undertaken must be met, commitments kept.

As members of the Carnegie Mellon community, individuals are expected to uphold the standards of the community in addition to holding others accountable for said standards. It is rare that the life of a student in an academic community can be so private that it will not affect the community as a whole or that the above standards do not apply.

The discovery, advancement and communication of knowledge are not possible without a commitment to these standards. Creativity cannot exist without acknowledgment of the creativity of others. New knowledge cannot be developed without credit for prior knowledge. Without the ability to trust that these principles will be observed, an academic community cannot exist.

The commitment of its faculty, staff and students to these standards contributes to the high respect in which the Carnegie Mellon degree is held. Students must not destroy that respect by their failure to meet these standards. Students who cannot meet them should voluntarily withdraw from the university.

This policy applies, in all respects, to this course.

Carnegie Mellon University's Policy on Cheating
(http://www.cmu.edu/academic-integrity/cheating/index.html) states the following:

According to the University Policy on Academic Integrity, cheating "occurs when a student avails her/himself of an unfair or disallowed advantage which includes but is not limited to:

- Theft of or unauthorized access to an exam, answer key or other graded work from previous course offerings.
- Use of an alternate, stand-in or proxy during an examination.
- Copying from the examination or work of another person or source.
- Submission or use of falsified data.
- Using false statements to obtain additional time or other accommodation.
- Falsification of academic credentials."

This policy applies, in all respects, to this course.

Carnegie Mellon University's Policy on Plagiarism
(http://www.cmu.edu/academic-integrity/plagiarism/index.html) states the following:

According to the University Policy on Academic Integrity, plagiarism "is defined as the use of work or concepts contributed by other individuals without proper attribution or citation. Unique ideas or materials taken from another source for either written or oral use must be fully acknowledged in academic work to be graded. Examples of sources expected to be referenced include but are not limited to:

- Text, either written or spoken, quoted directly or paraphrased.
- Graphic elements.
- Passages of music, existing either as sound or as notation.
- Mathematical proofs.
- Scientific data.
- Concepts or material derived from the work, published or unpublished, of another person."

This policy applies, in all respects, to this course.

Carnegie Mellon University's Policy on Unauthorized Assistance (http://www.cmu.edu/academic-integrity/collaboration/index.html) states the following:

According to the University Policy on Academic Integrity, unauthorized assistance "refers to the use of sources of support that have not been specifically authorized in this policy statement or by the course instructor(s) in the completion of academic work to be graded. Such sources of support may include but are not limited to advice or help provided by another individual, published or unpublished written sources, and electronic sources. Examples of unauthorized assistance include but are not limited to:

- Collaboration on any assignment beyond the standards authorized by this policy statement and the course instructor(s).
- Submission of work completed or edited in whole or in part by another person.
- Supplying or communicating unauthorized information or materials, including graded work and answer keys from previous course offerings, in any way to another student.
- Use of unauthorized information or materials, including graded work and answer keys from previous course offerings.
- Use of unauthorized devices.
- Submission for credit of previously completed graded work in a second course without first obtaining permission from the instructor(s) of the second course. In the case of concurrent courses, permission to submit the same work for credit in two courses must be obtained from the instructors of both courses."

This policy applies, in all respects, to this course.

Carnegie Mellon University's Policy on Research Misconduct (http://www.cmu.edu/academic-integrity/research/index.html) states the following:

According to the University Policy For Handling Alleged Misconduct In Research, "Carnegie Mellon University is responsible for the integrity of research conducted at the university. As a community of scholars, in which truth and integrity are fundamental, the university must establish procedures for the investigation of allegations of misconduct of research with due care to protect the rights of those accused, those making the allegations, and the university. Furthermore, federal regulations require the university to have explicit procedures for addressing incidents in which there are allegations of misconduct in research."

The policy goes on to note that "misconduct means:

- fabrication, falsification, plagiarism, or other serious deviation from accepted practices in proposing, carrying out, or reporting results from research;

- material failure to comply with Federal requirements for the protection of researchers, human subjects, or the public or for ensuring the welfare of laboratory animals; or

- failure to meet other material legal requirements governing research."

"To be deemed misconduct for the purposes of this policy, a 'material failure to comply with Federal requirements' or a 'failure to meet other material legal requirements' must be intentional or grossly negligent."

To become familiar with the expectations around the responsible conduct of research, please review the guidelines for Research Ethics published by the Office of Research Integrity and Compliance.

This policy applies, in all respects, to this course.

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you have questions about this or your coursework, please let me know.