San José State University
Computer Engineering Department
CMPE 245 Embedded Wireless Systems, Section 1, Fall 2021

Course and Contact Information

Instructor:	Hua Harry Li, Ph.D.
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Office Hours:	Mondays and Wednesdays 3:40 – 4:40 pm
Class Days/Time:	Monday and Wednesday 12:30 – 1:45 pm
Classroom:	On Line Zoom Meeting
Prerequisites:	CMPE 180A and 180D, classified standing, or instructor consent

Course Format

Technology Intensive, Hybrid, and Online Courses (Required if applicable)

This course requires use of computer/laptop, special microprocessor/RF hardware for system prototyping, and C/C++ compiler for software programming. Students must have to participate in classroom activities and after class homework and projects assignment.

Faculty Web Page and MYSJSU Messaging (Optional)

Copies of the course reference materials including handouts, lecture notes, datasheets, project references, schematics are posted on github: https://github.com/hualili/CMPE245-Embedded-Wireless/tree/master/2018F ;

Course Description (Required)

Embedded Wireless architecture with basic communication protocols, hands on labs with state of the art embedded system development tools. Prerequisites: CMPE 180A and 180D, classified standing, or instructor consent.

Course Learning Outcomes (CLO) (Required)

Course Learning Objectives (CLO):

CLO 1	Understand Embedded Wireless Systems Architecture
CLO 2	Understand Base Band Signal and its frequency characteristics;
CLO 3	Understand modulation techniques such as ASK, FSK, PSK and their implementations in IEEE wireless communication protocols.
CLO 4	To be able to design and implement MAC layer coding techniques and build real working embedded wireless systems

Upon successful completion of this course, students will be able to:

1. Understand Embedded Wireless Systems Architecture
2. Understand Base Band Signal and its frequency characteristics;
3. Understand modulation techniques such as ASK, FSK, PSK and their implementations in IEEE wireless communication protocols.
4. To be able to design and implement MAC layer coding techniques and build real working embedded wireless systems.

Required Texts/Readings (Required)

Textbooks and Reference Materials

1. IEEE 802.11x standards,https://github.com/hualili/CMPE245-Embedded-Wireless/tree/master/2018F ;
2. (Optional) On line 5G tutorials: (1) 5G tutorial book chapter (partial) https://www.slideshare.net/romeo838586/5-g-wireless-technology-full-report-pdf (2) 5G basic concepts PPT https://slideplayer.com/slide/12004878/ ; (3) spectrum and cloud aspects https://www.5gamericas.org/wp-content/uploads/2020/10/5G-Technology-in-Private-Networks-PPT-.pdf

Other Readings

Insert the list of any additional readings here and specify where they can be found. Include if applicable.

1. Class handout materials, lecture notes are posted on gitbuh https://github.com/hualili/CMPE245-Embedded-Wireless/tree/master/2018F
2. Datasheets, lab design reference materials and the reference material for embedded target platform and wireless hardware modules, application notes, lab material and reports are posted at https://github.com/hualili/CMPE245-Embedded-Wireless/tree/master/2018F

Other technology requirements / equipment / material

Students are quired to have adequate embedded hardware and/or microprocessor systems background, to be able to implement system prototype with hardware prototyping board and software C/C++ programming capability. C/C++ compiler are open source and are free accessible to the class.

Course Requirements and Assignments (Required)

Course requirements and assignments: (1) to understand the basic concepts of embedded wireless systems, (2) to be able to conduct mathematical formulation and design verification, (3) to be able to design, build, and debug embedded wireless systems, and (4) to be able to complete the homework and projects and pass the examinations. The students will be required to finish the homework independently, and submit the homework and project on time. Teamwork is encouraged and team will be formed throughout the semester, but all the homework and project will have to be finished independently. The projects are: (1) design, implement and build embedded RF system with ASK RF module to demonstrate LISA (linear invariant synchronization algorithm), to communicate between RF node i and node j, establish handshaking, by transmitting and receiving “hello the world, SJSU CMPE245, your name, and your student ID”; (2) design and implement scrambling/de-scrambling algorithm and integrate this algorithm with LISA, to demonstrate the improved RF communications per IEEE 802.11b standard; (3) design and implement LORA industrial IoT RF module to enhance the performance and

to realize the functions of cognitive radio. These assignment and project will allow the students to have a good understanding of Course Learning Objectives (CLOs) from 1 to 4. The total homework and project weights 30% of the entire class grade (see details in the following grading section.) The due date of these homework and projects are given in class, usually, each homework is due one week after the assigned date, and the projects are due 10 days to 2 weeks after the assigned date, which is to be formally announced in class and in-writing on line (CANVAS). The general expectations, roles and responsibilities of the students include finishing the homework/project and make in-class demo on time, finish programming and system prototyping assignment on time, submit the programs and report on time.

The University Policy S16-9, Course Syllabi (http://www.sjsu.edu/senate/docs/S16-9.pdf) requires the following language to be included in the syllabus:"Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus."

Final Examination or Evaluation

Final examination at the end of semester will be given on the date defined by the university final examination schedule. The final examination is close book, close notes, however, one paper formula sheet will be allowed. No cellphone will be permitted in the final examination, and calculators are allowed. The weight of the final examination is given in the Grading Section in the following.

Grading Information (Required)

Midterm Examination	30%
Homework and Projects	30%
Final Examination	40%

Option 1.
Nvidia Jetson NANO board as a target platform for wireless implementation.

Option 2.
AT&T wireless DTU module board as a target platform.

Option 3.
Open source architecture RISC-V FPGA board with Verilog Implementation of IP core and RTOS software tools for wireless implementation.

The examination grades are given based on the written answer in the examination. The homework and projects grades are given based on the work submitted, prototype system demonstration, project report, as well as programming source code. The detailed rubrics for each homework and project are posted on line when each assignment is given, check online both CANVAS and https://github/hualili The grade for each assignment and project will be given to students for each submission with multiple opportunities of the feedback of the student learning. Rubrics examples for project 1 submission, for example, hardware board prototyping counts 40%, software implementation counts 40%, report counts 20%, so the total add up to 100% for a project assignment.

Determination of Grades

Grade	*Points*	*Percentage*
A plus	*960 to 1000*	*96 to 100%*
A	*930 to 959*	*93 to 95%*
A minus	*900 to 929*	*90 to 92%*
B plus	*860 to 899*	*86 to 89 %*
B	*830 to 829*	*83 to 85%*
B minus	*800 to 829*	*80 to 82%*
C plus	*760 to 799*	*76 to 79%*
C	*730 to 759*	*73 to 75%*
C minus	*700 to 729*	*70 to 72%*
D plus	*660 to 699*	*66 to 69%*
D	*630 to 659*	*63 to 65%*
D minus	*600 to 629*	*60 to 62%*

Note: F for below 60%.

- Penalty for late submission of project is 10% per week.

Classroom Protocol

(1) Participation in class activities and attendance are required;

(2) Arrival in the class on time is required, a few minutes ahead is encouraged;

(3) No cell phone use in class and cellphone has to be submitted to the professor in class during examinations.

University Policies (Required)

Academic integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sa.sjsu.edu/judicial_affairs/index.html.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible,

or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

CMPE 245 Embedded Wireless Systems Fall 2021 Course Schedule

Course Schedule

Week	Topics, Readings, Assignments, Deadlines
1	Organizational Meeting and Introduction. Introduction to embedded wireless communications, overview of IEEE 802.11b standard and software defined radio to implement software for MAC layer functions. Concept of cognitive radio.
2	Design of a prototype system for software defined radios. Base band signals and its characteristics in frequency domain. Synchronization techniques. Homework assignment (2 points, total of 2% of the entire course).
3	Design and implementation of synchronization techniques, LISA algorithms for base band signals, and implementation of LISA on the prototype system. Fourier Transform, Modulation/Demodulation. Homework assignment (2 points, total of 2% of the entire course).
4	Scrambling and de-scrambling techniques for synchronization, and its software implementation on Rx/Tx RF modules of the prototype system. Lab 1 assignment (total 10 points, weights 10% of the course)
5	Modulation/Demodulation. Introduction to ASK, FSK, and PSK techniques, prototype board implementation to spread the spectrum for better communication performance. Homework assignment (2 points, total of 2% of the entire course).
6	Time-Frequency domain analysis, Base-band signal analysis. Homework assignment.
7	Source coding techniques, Huffman coding and arithmetic coding, and their implementation on the wireless prototype system. Lab 2 assignment, (total 10 points, weights 10% of the course)
8	Midterm Examination
9	Channel correction coding techniques. Linear Block Coding Techniques and its software implementation for the Rx/Tx RF modules.
10	Discussion of PSK modulation technique, and improvement of PSK, introduce BPSK, QPSK, and DQPSK techniques and system architecture for their modulation and demodulation. Homework assignment (2 points, total of 2% of the entire course).
11	CCK techniques and it mathematic description, software implementation of CCK technique. Lab 3 assignment (total 10 points, weights 10% of the course).
12	Software implementation of CCK techniques and discussion of implementation of CCK on Rx and Tx RF modules, performance comparison. Homework assignment (2 points, total of 2% of the entire course).
13	Cognitive radio techniques, information theory and performance index for wireless communications, spread spectrum technique.
14	Implementation of Cognitive Radio and frequency hopping.
15	Comparison of IEEE 802.11a/b/g/n techniques.

Week	Topics, Readings, Assignments, Deadlines
16	Research project presentations and demos
Final Exam	Comprehensive final