PURDUE
UNIVERSITY

SCHOOL OF ELECTRICAL
AND COMPUTER ENGINEERING
Graduate Office

To: The Engineering Faculty
From: School of Electrical and Computer Engineering
Re: ECE 60422 Primer in RF Design

The School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 60422 Primer on RF Design (Radio Frequency)
Semesters offered: Fall, Spring Summer
Non-repeatable
Credit 1
Pre/Co-requisites: ECE 31100 or equivalent

Course Description
This 1-credit-hour course covers the fundamentals of RF design. It is designed as a first course for students or engineers with limited background in high-frequency electronics. Engineers that need to understand the 'RF language' and gain working knowledge of critical RF concepts will benefit from taking this course. Students in this class will learn the basic RF tools and design principles. By the end of this class students will be able to understand important RF concepts and how these are related to the design of practical RF blocks.

Reason
The content of this course has been taught as an experimental course for about 10 years. It was approved for a permanent number by ECE, but the request was not submitted. The course title was RF and Microwave Wireless Components This is the first third of that course material.

History of Previous Offering
Spring 2019 and as a portion of RF and Microwave Wireless Components for about 10 years.

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Primer on RF Design

CRN 20180 – ECE 69500RF – Wang 2555

Spring 2019

A. LEARNING OUTCOMES

After successfully completing this class, students will be able to

- Describe and articulate the basic design principles of RF systems and modules.
- Use common tools and techniques in the RF design space.

B. CLASS POLICY

1. Instructor

Dimitrios Peroulis, Reilly Professor of Electrical and Computer Engineering
Associate Dean for External Affairs, College of Engineering
Office: Wang 3057, phone: (765) 494-3491, email: dperouli@purdue.edu
https://sites.google.com/site/peroulisteam/
Office hours: M,W,F: 11:30am-12.30pm (WANG 3057) and by appointment. Additional office hours through Webex for online students are available upon request via my personal Webex room.

2. Lecture times

M,W,F: 10.30am-11.20am, Wang 2555, Jan. 7, 2019 – Feb. 8, 2019

3. Textbook and class notes

- Michael Steer, Microwave and RF Design: A Systems Approach, 2nd edition, Scitech Publishing, 2013, ISBN-13: 978-1613530214
- Class notes will be distributed through blackboard.

4. Class participation – piazza.com

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. *It is likely that you will get an answer to your question much faster if you post it in piazza.com rather than if you email it to me or the TA.* The class on piazza is structured so you can discuss each homework and topics on each exam. Please post to the relevant thread to ensure a proper response.

You will receive an invitation to join piazza. If you register late for the course or if you don't receive the email, please go to piazza.com and register for the class yourself using the link https://piazza.com/purdue/spring2019/ece69500rf/home.

5. Prerequisites

Basic undergraduate-level electromagnetics (ECE 31100 at Purdue with a grade of C or better) including fundamental concepts of RF waves and transmission lines (a comprehensive review will be provided in this class though).

6. Course objectives

This 1-credit-hour course covers the fundamentals of RF design. It is designed as a first course for students or engineers with limited background in high-frequency electronics. Engineers that need to understand the 'RF language' and gain working knowledge of critical RF concepts will benefit from taking this course. Students in this class will learn the basic RF tools and design principles. By the end of this class students will be able to understand important RF concepts and how these are related to the design of practical RF blocks.

7. CAD Tool

In this class you will use Agilent's Advanced Design System (ADS) to help you simulate simple RF circuits. ADS is an industry standard RF/Microwave design package that is really worth learning. It can simulate an extremely wide variety of problems starting from the device level up to the system level. In some sense you can view it as the equivalent of SPICE for high-frequency electronics. However, it is a lot more powerful than that. This software will be available for you (through the ECN networks) to use and through homework problems and laboratory you will explore some of its features.

8. Homework

- One homework assignment per week will be given. Homework will normally be due every Monday at 11:59pm ET.
- Gradescope is a tool you will use to submit your homework assignments. You can access Gradescope via the Blackboard course menu. In order to use Gradescope you will need a scanner. If you would like to use your phone as a scanner, Gradescope recommends using the "Genius Scan" app available via the App store and Google Play. If you need help using Gradescope to scan and submit your assignments, please visit the "Gradescope Help" folder in the course menu to find tutorials on scanning and submitting your homework.
- Late homework is not accepted, unless an email request has been submitted to the instructor at least 24h before the due date. The first extension request is automatically approved and the homework can be submitted 24h later. Additional extension requests may be granted at the discretion of the instructor and with sufficient documentation.
- Homework will be graded on the following scale: 0-1 : Practically no effort; 2-3 : Some effort with some results but with major problems; 4-5: Good effort with correct results with minor or no mistakes.
- In most cases, you can expect to receive graded homework and feedback within a week of your submission.

9. Design Project

- A design project that will utilize the CAD tool will be required. The project will be assigned at the end of the second week and will be due at the end of the class.
- Students are encouraged to work in teams of two on the project. Single-student teams are also allowed.

10. Exam

The exam will be provided to you via Blackboard. It will be released for everyone on February 8th, 2019 at a specific time that will be determined. Everyone will have the same amount of time to complete and submit the exam. You are allowed to consult the textbook and class notes but you cannot use any other resources, including discussions with other students. It is imperative that you prepare to take the exam by A) using a reliable computer and B) finding a place with limited distractions. You also need to ensure you have a stable internet connection and that you are ready to have your assignment scanned. Due to the fact I am allowing you to take this without a proctor, the exam will have to be submitted on time without exception. Failure to submit your exam to Gradescope time will result in a 0 for this exam and having to retake this course.

11. Grading

Your class grade will be determined based on your performance in class as follows

- Homework : 25%
- Design project : 25%
- Exam : 50%

  TOTAL : 100%

  The lowest homework grade will be dropped before calculating your class grade.

12. Academic honesty policy

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

In addition, the Purdue Honors Pledge applies to this course. The statement as written by our own students is ``As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.''

Based on the above, we expect every member of the Purdue community to practice honorable and ethical behavior in and outside of the classroom. Any actions which might unfairly improve a student's score on homework, quizzes, or examinations will be considered cheating, and will not be tolerated. A few examples of cheating are:

- Submitting homework that is not your own work. While I encourage you to learn from each other, your work should not be a copy of your partner's.
- Sharing results or notes during exams.
- Continuing work on your exam after we have called for papers.
- Requesting a re-grade on an exam or homework problem that has been altered.

Cheating on homework, quizzes, or exams will result in a zero score for the assignment/exam/quiz, or a failing grade for the course, at my discretion. I may also ask the Office of the Dean of Students to help me handle such cases.

13. Students with documented disabilities

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

14. Electronic mass email

A mass email list will be established so I can communicate with you easily. Important announcements and other information will be distributed through this email.

15. Campus emergencies

In the event of a major campus emergency, course requirements, deadlines, grading percentages, and other class requirements or policies are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Here are ways to get information about changes in this course: Blackboard web page, my email address: dperouli@purdue.edu, and the class email list.

C. TENTATIVE SYLLABUS

Topics and depth of coverage will be adapted, to some extent, to the background of the students in class.

Week	Dates	Principal Topics
1	1/7 – 1/11 hw1 release: 1/7	**Introductory remarks (Chapters 1, 2)** Ultimate RF receiver RF bands Power, voltage, frequency measured in the dB scale Modulation fundamentals Multiplexing techniques Transceiver critical parameters
2	1/14 – 1/18 hw 1 due: 1/14	**Transmission lines (Chapter 5, 6)** Line with mismatched load

Week	Dates	Principal Topics
	hw 2 release: 1/14 project release: 1/18	Line with mismatched source and load Time-domain response Physical transmission lines
3	1/21 – 1/25 hw 2 due: 1/21 hw 3 release: 1/21	**The Smith Chart (Chapter 10, 12)** Impedance and admittance charts Matching networks: lumped-elements and distributed solutions
4	1/28 – 2/1 hw 3 due: 1/28 hw 4 release: 1/28	**Lumped elements in Radio Frequencies (Chapter 11)** Inductors, capacitors, resistors **Antennas and RF Links (Chapter 3)** Antenna fundamentals RF link budgets
5	2/4 – 2/8 hw 4 due: 2/4 hw 5 release: 2/4 hw 5 due: 2/11 project due: 2/11 **Final exam: 2/8**	**Scattering Parameters (Chapter 9)** Fundamentals Power considerations Other Matrices Impedance, admittance, ABCD, and others EXAM