EE152
High Frequency Systems Laboratory

Abstract

To provide the student hands-on experience in the design and implementation of high-frequency components and systems from RF to millimeter wavelengths. The student will complete the course with a strong working knowledge of the essential tools and concepts necessary to implement systems in support of their own research.

I. High Frequency Systems Laboratory

12 units (3-7-2). Prerequisite: EE 45 or equivalent. EE 153 recommended.
The student will develop a strong, working knowledge of high-frequency systems covering RF to millimeter wavelengths. The essential building blocks of these systems will be studied along with the fundamental system concepts employed in their use. The first part of the course will focus on the design and analysis of core system building blocks. Lectures will introduce key concepts followed by weekly laboratory sessions where the student will design and characterize various system components. During the second part of the course, the student will develop their own high-frequency system, focused on a topic within radar, radio-astronomy, communications, power transmission, or a topic within their own field of research.

Instructor: Damon Russell drussell@caltech.edu
Time and Location: Lecture Mondays at TBD time and location. Laboratories Friday at appointed 2 hour time slot, Moore B242
Moodle Site: EE 152
Office Hours: Tuesday and Thursday @ 5:30 p.m., Moore B242.

II. Course Outline

- Week 1. Microwave Measurements. Lab: Introduce student to [s]-parameter and spectral measurements with Agilent's FieldFox (FFox). Students will measure the s-parameters of an amplifier and characterize its output power capability. Introduction to Microwave Office (MWO), which will be used to import data and to analyze results.
- Week 2. Passive elements, matching, and antennas I. Lab: Introduction to microwave passive circuit design and analysis using MWO. Students will design a branch line coupler and Wilkinson power divider in MWO. They will provide fabrication outputs for the Wilkinson power divider, assemble the routed circuits, and characterize them using the FFox. They will also design an impedance matching network to a 5.9 GHz antenna, install it on an evaluation board, and measure the results.
- Week 3. Receivers and antennas II. Lab: Students will design, assemble, and test their own low-noise amplifier, based on NXP's evaluation board, optimizing noise and gain across

5.8-6.1 GHz. They will also design, assemble, and test a band-pass filter to be used in front of the amplifier. These components will then be cascaded, their end to end performance established, and a simple link setup.

- Week 4. Frequency Translation Devices. Lab: Students will design, assemble, and test their own Schottky mixer circuit, used to down-convert 5.9 GHz RF signals to intermediate frequencies(IF). The mixer circuit will be based on the branch line coupler designed in Lab 2. They will then instantiate their mixer after a low-noise amplifier and antenna, and use it within a simple superheterodyne link.
- Week 5. Transmitters. Lab: Students will design their own 5.8-6.1 GHz power amplifier, and use it within the superheterodyne link from the previous week to extend its range.
- Week 6. Oscillators. Lab: Students will design, fabricate, and test their own VCO based on NXP's BFU730 SiGe HBT.
- Week 7. Systems I. Lab: Project formulation, design begins.
- Week 8. Systems II. Lab: Project concepts due, project design/fabrication.
- Week 9. Project design/fabrication.
- Week 10. Project testing/demonstration.
- Finals Week. Final project reports due.

III. Grading

1. Labs 40 %
2. Design Project 30 %
3. Project Report 30 %

IV. Lab/Project Teams

Weekly labs and the final project will be done in teams of two. Each team will be required to provide their design inputs (when applicable) no later than **noon on Thursday**. Teams will sign up for a 2 hour slot for the laboratory work on Friday, to be held in the sub-basement of Moore, B242. Although the labs preparation and execution will be done in teams, lab reports will be submitted individually. **Lab reports will be due the following Tuesday by noon.** Further instructions are provided in the laboratory procedure.