



Course Syllabus: Microwave Measurements Laboratory - EE 323

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	EE 323
Course Title	Microwave Measurements Laboratory
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	01:00 PM - 02:30 PM Mon Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Atif Shamim	atif.shamim@kaust.edu.sa	+966128084507		Tuesday 2-4pm Office 3276, Building 3

Teaching Assistant(s)

Name	Email
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Course Information

Comprehensive Course Description	<p>EE 323 (Microwave Measurements Laboratory) is an experimental course which covers advanced topics in microwave measurements such as power spectrum and noise measurement, introduction to state-of-the-art microwave test equipment (Network Analyzer, Spectrum Analyzer, etc), methods for measuring the dielectric constant of materials, antenna pattern and gain measurements, etc. A major component of the course is a design project that will include design, analysis, and construction of an antenna integrated microwave amplifier and its subsequent testing. The details of the labs are given below.</p> <p><u>Lab 1: S-parameter Measurements with a Network Analyzer</u> The lab will teach how to calibrate a network analyzer using Short-Open-Load-Thru (SOLT) standards. S-parameter measurements of some basic passive components like microstrip line, filter and inductor will be taught. Finally, a de-embedding technique will be taught to extract the data of the device under test from the measured S-parameters.</p> <p><u>Lab 2: Material Characterization through Microwave Measurements</u> The lab focuses on extracting material parameters (relative permittivity and loss tangent) from microwave measurements of T, ring and cavity resonators. The students will be taught to measure the material properties through an impedance analyzer as well. The results of the two methods will be compared.</p> <p><u>Lab 3: Microwave Measurements of Active Components</u> In this lab, students will learn microwave measurements of active components. Amplifier characterization will be taught through S-parameter measurements. Power spectrum, noise and non-linearity measurements will also be taught.</p> <p><u>Lab 4: Antenna Measurements</u> The lab teaches antenna measurements in a near-field anechoic chamber, namely Star Lab. In addition to return loss measurements for antennas, radiation pattern, gain, co-pole and cross pole levels and axial ratio measurements will be taught.</p> <p>In addition to the labs, students will be trained on PCB manufacturing through LPKF tool, characterization of circuits through RF probes on Cascade Probing station, and high frequency antenna characterization in Micro Lab anechoic chamber.</p>
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Course Description from Program Guide	Advanced topics in microwave measurements: introduction to state-of-the-art microwave test equipment (Vector Network analyzer, spectrum analyzer), power spectrum and noise measurements, calibration, S-parameter and impedance measurements, methods for measuring the dielectric constant of materials, Low Noise and Power amplifier measurements, Non-linearity measurements, near-field and far-field antenna pattern measurements, Printed Circuit Board (PCB) design and fabrication, Introduction to Microwave and Antenna CAD tools. Followed by a project that includes design, analysis, fabrication and testing of a microwave subsystem.
Goals and Objectives	By the end of the course students will have expertise in the following. 1. Deep knowledge of Vector Network Analyzer operation 2. Calibration and S-parameter measurements 3. De-embedding 4. Material characterization through microwave measurements 5. Microwave Amplifier Design and Characterization 6. Antenna Design and Measurements 7. PCB Design and Manufacturing
Required Knowledge	Fundamental knowledge of Electromagnetics Fundamental knowledge of Microwaves (EE223 course will suffice) Basic knowledge of Antennas
Reference Texts	Texts: Joel P. Dunsmore, Microwave Component Measurements (with Advanced VNA Techniques) Course Slides/Lab Handouts Reference Books: - R.J. Collier, A.D. Skinner, Microwave Measurements (3rd Edition) Scott A. Wartenberg, RF Measurements of Die and Packages Gary E. Evans, Antenna Measurement Techniques
Method of evaluation	40.00% - Research Project 60.00% - Homework /Assignments
Nature of the assignments	Labs (4), 15% each and total of 60% (<i>Experiments in Lab and Report</i>) Design Project 40% (<i>Simulations, Fabrication, Characterization, Report and Presentation</i>)
Course Policies	Late submissions will have negative grading.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 01/28/2019 Wed 01/30/2019	S-parameters and Microwave Measurements Fundamentals
2	Mon 02/04/2019 Wed 02/06/2019	VNA Fundamentals
3	Mon 02/11/2019 Wed 02/13/2019	<u>Lab 1: S-parameter Measurements with a Network Analyzer</u>
4	Mon 02/18/2019 Wed 02/20/2019	Microwave Materials Characterization through Resonators
5	Mon 02/25/2019 Wed 02/27/2019	<u>Lab 2:Material Characterization through Microwave Measurements</u>
6	Mon 03/04/2019 Wed 03/06/2019	Microwave Amplifier Design and Characterization Basics
7	Mon 03/11/2019 Wed 03/13/2019	<u>Lab 3: Microwave Measurements of Active Components</u>
8	Mon 03/18/2019 Wed 03/20/2019	PCB Manufacturing Training Through LPKF
9	Mon 03/25/2019 Wed 03/27/2019	Spring Break
10	Mon 04/01/2019 Wed 04/03/2019	Characterization of Microwave circuits through probes on Cascade Probing station
11	Mon 04/08/2019 Wed 04/10/2019	Antenna Design Fundamentals
12	Mon 04/15/2019 Wed 04/17/2019	<u>Lab 4:Antenna Measurements</u>
13	Mon 04/22/2019 Wed 04/24/2019	High frequency antenna characterization Demo in Mini SNF anechoic chamber.
14	Mon 04/29/2019 Wed 05/01/2019	Research Project
15	Mon 05/06/2019 Wed 05/08/2019	Research Project
16	Mon 05/13/2019 Wed 05/15/2019	Research Project Presentations
17	Mon 05/20/2019 Wed 05/22/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.