1 Course Information

Instructor
J. W. McDaniel
Office: 112 Radar Innovations Lab
e-mail: jmcdaniel@ou.edu
Office Hours:
T 12:00-2:00 pm (RIL 112),
and by appointment

Prerequisites
ECE 4703/5703:
Electromagnetic Fields and Wave Propagation

Course Website
https://canvas.ou.edu

Credit
3 undergraduate/graduate hours

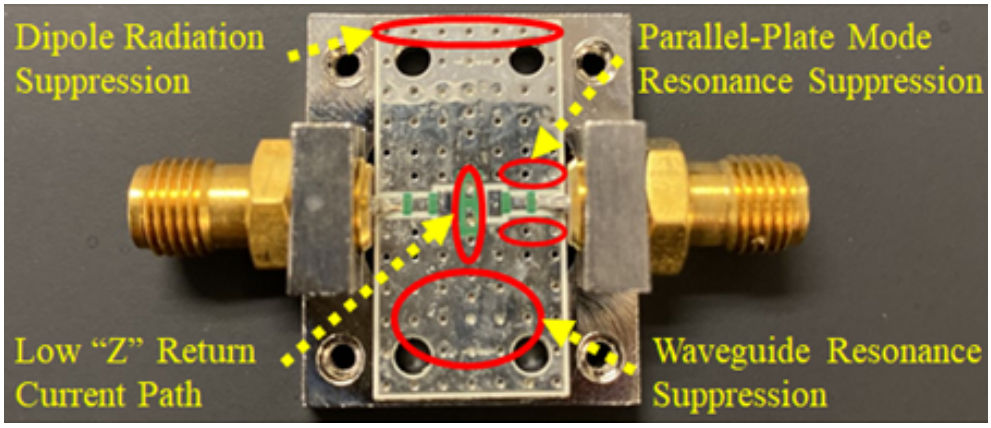
Class Times
T & Th 3:00-4:15 p.m.

Textbook References
High Speed Digital Design
Johnson 1st ed.
Advanced Engineering Electromagnetics
Balanis 2nd ed.
Intro. to Electromagnetic Compatibility
Paul 2nd ed.
RF Circuit Design
Ludwig 2nd ed.

Class Format
This class will not be pure lecture. There will be class discussion and activities. Participation is expected.

1.1 Course Description

This class will focus on the art of integrated microwave electronics and offer fundamental electromagnetic analysis techniques to de-bunk the so called black-magic of RF/Microwave circuits. The class will have an emphasis on board-level concepts that require looking through a pair of electromagnetic goggles to truly understand the phenomena that can either result in a successful or un-successful board spin. For example, have you ever wanted to know what all those vias do on an evaluation board? Do they serve a purpose? How would I know where and how many vias to place? The example below shows that each and every via on the board serves a very important purpose. This is one example of many topics to be covered in this class where we will evaluate the problem, understand the electromagnetic phenomena, model its effective behavior, and derive a solution using core electromagnetic understanding. The outcome of this class is for students to have a series of design guidelines, both from the notes and project reports, that can be referenced for future RF/microwave designs.



2 Class Policies

1. Maintain collegial atmosphere in classroom
   - Participate in discussion
   - Be respectful of other students
   - Put cell phones on silent
   - Do not use cell phones or laptops in class (unless taking notes)
   - Ask questions
2. Contact with the instructor
   - E-mail is the best way to contact me for a quick question
   - For long questions please come to office hours
   - If you can't come to office hours e-mail me for an appointment
3. Extra Credit
   - No extra credit will be given in this course.
4. Attendance
   - Class attendance is expected
   - Make every attempt to be on-time to class
   - If late to class please try to minimize the distraction that you create
5. Academic Integrity
   - It is your responsibility to read and understand the Academic Integrity Policy (http://www.ou.edu/provost/integrity/).
   - Plagiarism and copying will not be tolerated. If caught, all parties involved will receive a zero for the assignment. If caught multiple times, then the repeat offenders will receive a failing grade for the course. There will be a report due for this course, please educate yourself on the proper use of citations and what constitutes plagiarism.
6. Reasonable Accommodation
   - Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.
7. Late Assignments
   - Late projects will be accepted for this course as explained Section 3.2.
   - If you will not be in town when a project is due, please turn in the assignment (either physically or electronically) before you leave town.
8. Religious Holidays
   - It is the policy of the University to excuse the absences of students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required classwork that may fall on religious holidays.

3 Assignments

3.1 Grading

Projects: 100%

The grading scheme is shown below:

90-100	A
80-89	B
70-79	C
60-69	D
59 and below	F

3.2 Projects:

- Projects will be posted in canvas under the assignment tab.
- Projects should be turned in at the beginning of class on the due date listed at the top of the assignment.
- You may collaborate with other students on projects (I in fact encourage you to do so!); however, there is a line between collaboration and copying (cheating!!!). If students are caught copying, then both students will receive a zero on the assignment. If caught twice, I will report you both to the disciplinary committee.
- Late Policy: After the due date, projects will be accepted until the end of the following class at 15% off. It will not be accepted after that unless the student has a University accepted excuse.
- Projects are expected to be turned in before a student leaves town if a student must miss class the day the assignment is due. In this case, the assignment can also be scanned and emailed to me.
- All project reports should be written up in a neatly, professionally, and organized summary report that includes detailed analysis, screen-shots, simulated results, and answers to questions.
- Below is the tentative list projects (subject to change):

    1. LC lowpass filter walk-through:
        - The intent of this project is not to emphasize filter design rather illustrate the complexity of design with non-ideal component characteristics. This project will help students learn or continue developing their skills with RF/microwave circuit simulator software (i.e. Keysight Advanced Design System [ADS] and/or NI Microwave Office [MO]) and finite-element-method (FEM) electromagnetic solvers (i.e. ANSYS HFSS). This project will walk you through the design process including the design and simulation of a lowpass filter (LPF) using ideal LC components, non-ideal components (with ideal traces), and non-ideal components (with transmission line affects) in ADS/MO and full filter co-simulation in HFSS.
    2. Via transitions and ground plane cut-out affects on signal integrity:
        - The intent of this project is to illustrate several analog/digital design issues that many hardware designers either don't think about or miss during the design phase due to a lack of electromagnetic understanding. All three of these issues are associated with maintaining signal propagation integrity. This project will walk you through how via transitions act like lowpass filters and why they are detrimental to both high-frequency analog and fast-clocking digital circuits. This

project will also walk you through how ground plane cut-outs can act as bandstop filters and affect signal propagation.

3. CPWG trace and PCB design consideration
   - The intent of this project is to expose you to a new and commonly used transmission line topology called the ground-backed coplanar waveguide (CPWG). In addition to just the geometry design, this project will walk you through how to realize this structure for wideband (large frequency) applications without exciting undesired higher order resonance modes. Furthermore, CPWG traces can cause other issues throughout PCBs so this project will also walk you through how to handle those issues as well. In the end, you will understand why evaluation boards, similar to shown above, has all of those vias through the PCB.

4 Additional Policies

4.1 Disability Accommodation

The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in the University Community Center, 730 College Ave., (405) 325-3852 (Voice), (405) 325-4173 (TDD), (405) 325-4491 (Fax), and Email: drc@ou.edu.

4.2 Academic Integrity

The Provost's web pages include information on expectations for academic integrity. Please review the material at http://integrity.ou.edu/students_guide.html. It is the aim of the faculty of the University of Oklahoma to foster a spirit of complete honesty and a high standard of integrity as well as academic excellence. Any attempt by students to present as their own any work that they have not honestly performed is regarded by the faculty and administration as a serious offense and renders the offenders liable to serious consequences, possibly suspension.

4.3 Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact me as soon as possible to discuss. Generally, modifications will be made where medically necessary and similar in scope to accommodations based on temporary disability. Please see www.ou.edu/content/eoo/pregnancyfaqs.html for commonly asked questions.

4.4 Title IX Resources

For any concerns regarding gender-based discrimination, sexual harassment, sexual misconduct, stalking, or intimate partner violence, the University offers a variety of resources, including advocates on-call 24.7, counseling services, mutual no contact orders, scheduling adjustments and disciplinary sanctions against the perpetrator. Please contact the Sexual Misconduct Office 405-325-2215 (8-5) or the Sexual Assault Response Team 405-615-0013 (24.7) to learn more or to report an incident.

5 Topics:

1. Overview of Microwave Engineering (3 weeks)
2. Non-Ideal Component Characteristics (2 weeks)
3. Noise Suppression with Non-Ideal Components (1.0 week)
4. EMC Regulations (0.5 weeks)
5. Common-mode Currents, Differential Mode Currents, and Radiated Emissions (1.5 weeks)
6. Signal Vias and Return Current Paths (1.5 weeks)
7. Inductive and Capacitive Coupling (Crosstalk) (1.0 week)
8. Shielding and Cabling (1.0 week)
9. Printed Circuit Board (PCB) Design and Layout Considerations (2.0 weeks)
    - CPWG traces (1.0 week)
    - Ground and Power Planes (1.0 week)
10. Digital Waveforms and Circuit Noise (1.0 week)
11. Electrostatic Discharge (0.5 weeks)