

Fall 2020 - Syllabus

EENG 4010 and 5410 - RF and Microwave Engineering Design and Applications

Class meetings Tuesdays and Thursdays 4 – 5:20 pm (Via Zoom)

Every other Tuesday there will be hands-on lab which will be taking place at B207 and B288.

Your seat for the lab will be assigned and you need to sit in the same place throughout the semester.

Instructor Contact

Name: Ifana Mahbub, Assistant Professor, Electrical Engineering Department

Pronouns: She/her/hers

Office Location: B208

Phone Number: (940)-369-7027

Office Hours: Monday and Wednesday 3 - 4 pm or by appointment (Via Zoom)

Email: Ifana.Mahbub@unt.edu

Teaching Assistant: Pranathi Vasireddy

Office D144 (NMDL lab), Email pranathivasireddy@my.unt.edu, Office hours: Tuesday and Thursday 3 – 4 pm or by appointment. The TA will be available via Zoom during the office hour.

Communication Expectations: The primary tool that will be used to communicate directly with students would be via Canvas. You can send your personal concerns or questions via Email. You can expect to receive a response to emails by 48 hours. To schedule an appointment outside of the office hours, send an email first and we will arrange a zoom meeting.

Welcome to UNT!

As members of the UNT community, we have all made a commitment to be part of an institution that respects and values the identities of the students and employees with whom we interact.

UNT does not tolerate identity-based discrimination, harassment, and retaliation. UNT's full Non-Discrimination Policy can be found in the UNT Policies section of the syllabus.

Course Description

This course is made possible through the multi-year support received from the Office of Naval Research (ONR) for the North Texas Navy STEM Coalition (NT-NSC) awarded to the College of Engineering at UNT (PI Kaul; Co-PI Mahbub). The course is designed to provide an overview of the RF and microwave engineering design and applications with laboratory modules designed to provide hands-on experiences. The course starts with an introduction to the various uses of RF and microwave systems in our everyday lives starting from cell phones to various wireless systems and networks. Basic introduction to the mechanics of fields and wave propagation through air, water and other media with practical demonstrations are integrated in the laboratory modules. Motivation for RF electronics and RF MEMS is discussed in the context of Navy relevant areas. Design and modeling of RF passive components such as inductors, capacitors, varactors, resonators and antennas will be covered. The course evolves into the practical applications of these passive components for sensors and actuators, specifically in the context of wearable and implantable biomedical applications and flexible electronics. Through this course, students will have the opportunity to design and simulate structures using modern industry-standard tools such

as ADS and HFSS and make measurements using high-frequency measurement instrumentation such as Vector Network Analyzer and Spectrum Analyzer. The lab modules will help in cultivating interdisciplinary perspectives with hands-on exercises for undergraduate and graduate students enrolled in the course. Students enrolled in this course AND the accompanying sister course during Spring 2021 (offered by Prof. Kaul) will have the opportunity to apply and be considered for selected internships at Naval facilities in the US (US Citizenship is required) in Summer 2021 and following years which will be coordinated by Prof. Kaul. As both courses are administered in the 2020-2021 Academic Year and subsequent years, opportunities will exist for UNT students to increase their awareness of STEM related career opportunities with the US Navy through in-person guest visits, webinars, and informational videos.

Prerequisite(s): ENG 3410 or consent of instructor.

Course Structure

The theory classes of the course will be delivered remotely via zoom. There are 7 labs that would be taking place face-to-face. In case you are not able to attend the labs face-to-face due to Covid-19 risk, you have an option for attending them remotely. Please send an email to me ahead of time.

Course Topics

1. Overview of the RF and microwave engineering design and applications. Laboratory modules designed to provide hands-on experiences
2. Basic introduction to passive and active RF and microwave components and circuits for wireless communications
3. Introduction to the mechanics of fields and wave propagation through different media with laboratory experiments including practical demonstrations
4. Introduction to transmission-line theory; planar transmission-lines and S-parameters
5. RF electronics and RF MEMS discussion in the context of US Navy relevant research areas
6. Design and modeling of RF passive components such as inductors, capacitors, varactors, resonators and antennas for the applications of wearable and implantable sensors
7. Learning the simulation techniques using the industry-standard tools such as ADS and HFSS
8. Learning the measurement techniques using the high-frequency measurement instrumentation such as Vector Network Analyzer (VNA), RF signal generator and Spectrum Analyzer (SA)

Grade

Home works: 10%

Quizzes: 30%

Mid-term Exam: 20%

Lab Participation and Lab Reports: 30%

Group Project Presentation: 10%

Grade distribution

A=90-100, B=80-89, C=70-79, D=60-69, F=0-59

Schedules of exams

- Midterm Exam: October 29

Textbooks

Microwave Engineering, 4th Edition, by David M. Pozar, John Wiley and Sons Inc., 2012.

Notes and laboratory manual would be provided during the lab and posted on Canvas. Broad audience literature articles will also be posted on Canvas.

Homework

Homework will be assigned and graded. Assignments will include analytical problems, simulation task, simple mathematical problems, and other tasks that require more time than an in-class setting allows. The primary purpose of the homework assignments is to help you master the concepts and practice applying them. Discussion of the homework problems is allowed and encouraged, but copying of homework is cheating. The work you turn in must be your own.

Projects

Project reports should be turned in every other Tuesday before the start of the new lab session.

Late Assignments

Homework assignments and project reports are due at the beginning of class/lab. Late assignments will be penalized 10% per day or fraction thereof for the first 72 hours (including weekends, holidays, etc.). After 72 hours, late assignments will not be accepted.

Class Evaluation by Students

SPOT is a requirement for all organized classes at UNT and is available for your input at the end of the semester.

Course Learning Outcomes (CLO):

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

1. Analyze passive and active components at RF and microwave frequencies
2. Analyze RF and microwave networks containing passive distributed components
3. Perform lab experiments including using bench-top instruments such as a Vector Network Analyzer, Spectrum Analyzer and RF Signal Generator
4. Perform a variety of microwave and RF measurements
5. Perform analysis of transmission-line networks, impedance matching and S-parameters
6. Learn advanced design software to perform electromagnetic simulation and characterization of microwave circuits and antenna
7. Use ADS, HFSS and CST Studio software as a tool to solve for the electric and magnetic fields from charges and currents of the designed passive components and RF MEMS
8. Organize and write technical lab reports, analyze and summarize results
9. Organize and make technical presentations

10. Opportunities to interact weekly with the instructor and the teaching assistant during regular office hours and discussion sections in order to further the students' learning experiences and the students' interest in the material

ABET Student Learning Outcomes (SO)

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

CLO	Student/ABET Criterion 3 Outcomes						
	SO-1/ 3[1]	SO-2/ 3 [2]	SO-3/ 3 [3]	SO-4/ 3 [4]	SO-5/ 3 [5]	SO-6/ 3 [6]	SO-7/ 3 [7]
1	x						
2	x						
3	x					x	
4	x					x	
5	x						x
6	x					x	
7	x					x	
8	x		x				
9	x		x				
10			x				

Policies

A. Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but

not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University. See full policy at <https://policy.unt.edu/sites/default/files/06.003.pdf>.

B. ADA Accommodation Statement. UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding one's specific course needs. Students may request accommodations at any time, however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the ODA website at disability.unt.edu.

C. Course Safety Procedures (for Laboratory Courses). Students enrolled in [insert class name] are required to use proper safety procedures and guidelines as outlined in UNT Policy 06.038 Safety in Instructional Activities. While working in laboratory sessions, students are expected and required to identify and use proper safety guidelines in all activities requiring lifting, climbing, walking on slippery surfaces, using equipment and tools, handling chemical solutions and hot and cold products. Students should be aware that the UNT is not liable for injuries incurred while students are participating in class activities. All students are encouraged to secure adequate insurance coverage in the event of accidental injury. Students who do not have insurance coverage should consider Standard Syllabus Statements Related Policy 06.049 Course Syllabi Requirements obtaining Student Health Insurance. Brochures for student insurance are available in the UNT Student Health and Wellness Center. Students who are injured during class activities may seek medical attention at the Student Health and Wellness Center at rates that are reduced compared to other medical facilities. If students have an insurance plan other than Student Health Insurance at UNT, they should be sure that the plan covers treatment at this facility. If students choose not to go to the UNT Student Health and Wellness Center, they may be transported to an emergency room at a local hospital. Students are responsible for expenses incurred there.

D. Emergency Notification & Procedures. UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Blackboard for contingency plans for covering course materials.

E. Student Evaluation Administration Dates. Student feedback is important and an essential part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT. The survey will be made available during weeks 13, 14 and 15 of the long semesters to provide students with an opportunity to evaluate how this course is taught. Students will receive an email from "UNT SPOT Course Evaluations via IASystem Notification" (no-reply@iasystem.org) with the survey link. Students should look for the email in their UNT

email inbox. Simply click on the link and complete the survey. Once students complete the survey they will receive a confirmation email that the survey has been submitted. For additional information, please visit the SPOT website at www.spot.unt.edu or email spot@unt.edu.

Tentative Course Calendar

Week	Date		
1	08/25	Introduction, review of TL	
	08/27	Field Analysis of TL	
2	09/01	Lab 1: Introduction to ADS and HFSS	
	09/03	Reflections, standing waves, quarter wave transformer	HW 1 posted
3	09/08	Angus McColl's lecture "My Amazing Adventure as an Engineer in the US Navy", Transients on TL	
	09/10	Smith Charts, single stub matching, single stub matching with equal or unequal impedances	
4	09/15	Lab 2: Bow-tie Antenna simulation in ADS	HW 1 due
	09/17	Double stub matching	
5	09/22	Lossy TL, Lossy line example with Smith chart, coaxial lines and connectors	Quiz 1
	09/24	Impedance and multi-port network	
6	09/29	Lab 3: Spiral based coil simulation in HFSS	HW 2 posted
	10/01	Z and S matrices	
7	10/06	S Parameters, ABCD Parameters and TRL Calibration	
	10/08	Broad band tuning	HW 2 due
8	10/13	Lab 4: RF MEMS simulation with etched substrate	
	10/15	Lumped Element Networks	
9	10/20	3- Element Lumped Element Networks	Quiz 2
	10/22	Mid-term exam review	HW 3 posted
10	10/27	Lab 5: Measurement with Vector Network Analyzer	

	10/29	Mid-term Exam	
11	11/03	Power Dividers and couplers, Wilkinson Power Divider	HW 3 due
	11/05	Quadrature coupler, coupling and cross talk, coupled line analysis	
12	11/10	Lab 6: Measurement with Spectrum Analyzer	
	11/12	Navy officer talk/Lumped element filter design, coupled line filter	Quiz 3
13	11/17	Stub filter design, transparencies, Stepped impedance filter design	HW 4 posted
	11/19	TEM/ TE/ TM waves, rectangular waveguides	
14	11/24	Lab 7: Propagation loss in tissue mimicking solution	
	11/26	Thanksgiving break	
15	12/01	Circular waveguides, field patterns, Bessel functions, Waveguide Feeds/Aperture Coupling	HW 4 due Quiz 4
	12/03	Group Project Presentation	

ADS and HFSS Software Access:

Instructions for accessing the software will be posted via zoom.

COVID-19 Impact on Attendance

While attendance is expected as outlined above, it is important for all of us to be mindful of the health and safety of everyone in our community, especially given concerns about COVID-19. Please contact me if you are unable to attend class because you are ill, or unable to attend class due to a related issue regarding COVID-19. It is important that you communicate with me prior to being absent so I may make a decision about accommodating your request to be excused from class.

If you are experiencing any symptoms of COVID-19 (<https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>) please seek medical attention from the Student Health and Wellness Center (940-565-2333 or askSHWC@unt.edu) or your health care provider PRIOR to coming to campus. UNT also requires you to contact the UNT COVID Hotline at 844-366-5892 or COVID@unt.edu for guidance on actions to take due to symptoms, pending or positive test results, or potential exposure. While attendance is an important part of succeeding in this class, your own health, and those of others in the community, is more important.

Class Materials for Remote Instruction

The UNT fall schedule requires this course to have fully remote instruction beginning November 28th. Additional remote instruction may be necessary if community health conditions change or you need to self-isolate or quarantine due to COVID-19. Students will need access to a [webcam and microphone – faculty member to include what other basic equipment is needed] to participate in fully remote portions of the class. Additional required classroom materials for remote learning include: [list specific software, supplies, equipment or system requirements needed for the course]. Information on how to be successful in a remote learning environment can be found at <https://online.unt.edu/learn>.

Statement on Face Covering

Face coverings are required in all UNT facilities. Students are expected to wear face coverings during this class. If you are unable to wear a face covering due to a disability, please contact the Office of Disability Access to request an accommodation. UNT face covering requirements are subject to change due to community health guidelines. Any changes will be communicated via the instructor.