

Introduction to RF Circuits

EEL 4930 Section XXXX

Class Periods: Tuesday 2-3 periods (8:30 am – 10:25 am), Thursday 3 period (9:35 am – 10:25 am)

Location: Classroom location (TBA)

Academic Term: Fall 2021

Instructor:

Name: Yong-Kyu “YK” Yoon

Email Address: ykyoon@ece.ufl.edu or yongkyu.yoon@ufl.edu

Office Phone Number: (352) 392-5985

Office Hours: Tue and Wed 1 – 2 pm, Larsen Hall 225 (or Zoom: ufl.zoom.us/j/3523925985)

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- Name, email address, office location, office hours

Course Description

Introductory course on the radio frequency (RF) fundamentals and related circuits with topics of impedance matching, Smith Chart, s-parameters, waveguides, resonators, filters, active devices and amplifiers (3 credit hours)

Course Pre-Requisites / Co-Requisites

EEL 3112 Circuits 2 and EEE 3308C Electronic Circuits 1 or their equivalent

Course Objectives

To let students understand the basic concepts of RF/microwave parameters, components and circuits, and enable them to design and analyze RF/microwave components and circuits using analytical and numerical means.

Materials and Supply Fees

N/A

Professional Component (ABET):

State the contribution of the course to meeting the professional components of the ABET-accredited degree.

This course consists of 3 credits of Engineering Design;

Relation to Program Outcomes (ABET):

The table below is an example. Please consult with your department’s ABET coordinator when filling this out.

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Medium
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	High
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	Medium

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	Medium
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	Medium

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Title: Microwave Engineering
- Author: David M. Pozar
- Publication date and edition: 2013, Wiley, 4th Edition
- ISBN number: **0470631554**

Recommended Materials

- Title: Microwave and RF Design
- Author: Michael Steer
- Publication date and edition: 2010, Scitech
- ISBN number

Software:

- High Frequency Structure Simulator (HFSS, ANSYS Inc.)
- HFSS 3D Layout (planar 3D EM simulation engine)
- ADS (Agilent Inc.)

Course Schedule

Tentative Schedule

	Impedance Matching	Read	Skim
8/24	1. Course Introduction	1.1,	1.2-1.9
8/24	2. Review of Transmission Lines	2.1-2.3	
8/26	3. Smith Chart	2.4-2.7	
8/31	4. Impedance Matching with Lumped Elements	5.1-5.2	
8/31	5. Impedance Matching with Stubs	5.1-5.2	5.3
9/2	6. Single-section and Multi-section $\lambda/4$ Matching	5.4-5.5	
9/7	7. Binomial Broadband Matching (Butterworth)	5.6	
9/7	8. Chebyshev Broadband Matching	5.7	
9/9	9. Tapered Lines	5.8	5.9
	Transmission Lines and Waveguides		
9/14	10. Rectangular Waveguide	3.3	3.1-3.2
9/14	11. Modes and Propagation Behavior	3.10	
9/16	12. Wall Loss in Rectangular Waveguide		
9/21	13. Circular and Ridged Waveguide	3.4	
9/21	14. Coaxial Cables and Microwave Connectors	3.5	
9/24	15. Planar Waveguides (Microstrip, CPW) T-line calculator	3.7-3.8, 3.11	3.6
9/28	Exam #1	Closed book	Formula sheet

	<u>S-parameters and S-matrix</u>		
9/30	16. Impedance Concepts	4.1-4.2	
10/5	17. Scattering Parameters	4.3	
10/5	18. Scattering Matrices and Properties of S-Matrices		
10/7	19. Transmission (ABCD) Matrices	4.4	
10/12	20. Examples of S-Matrices	7.1-7.2	
10/12	21. Examples of S-Matrices	7.3	
	<u>Couplers</u>		
10/14	22. Branch Line Coupler (90° hybrid)	7.5	7.4
10/19	23. Coupled Line Couplers	7.6	7.7
10/19	24. The 180° Hybrid	7.8	7.9
10/21	25. Other Couplers	Handout	
	<u>Resonators</u>		
10/26	26. Series Prototype Resonators	6.1	
10/26	27. Term project discussion		
10/28	28. Parallel Prototype Resonators, T-line Resonator	6.2	
11/2	29. Coupling to Resonators	6.7	
11/2	30. Waveguide Cavity Resonators	6.3-6.4	
11/4	31. Nonmetallic Resonators	6.5-6.6	
11/9	Exam #2	Closed book	Formula sheet
	<u>Filters</u>		
11/11	32. Filter Design Using Insertion Loss Method	8.3	8.1-8.2
11/16	33. Filter transformations	8.4	
11/16	34. Filter implementations	8.5	
11/18	35. Filter implementations	8.6	
	<u>Active Devices and Amplifiers</u>		
11/23	36. Microwave Transistors	11.1	
11/23	37. Power Gain Definitions	11.2	
11/30	38. Unconditional Stability	11.3	
11/30	39. Conditional Stability	11.3	
12/2	40. Noise in Microwave Systems		
12/7	41. Low Noise Amplifier Design		
12/7	42. Power Amplifier Design		
Final	Final (Follow school schedule)	Open book Open note	TBA

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy, Class Expectations, and Make-Up Policy

This class may be presented online using Zoom and requires access to a working webcam and stable internet connection. I prefer that students keep their camera on during the class so that I can see you as I would during
Course Title, Prefix, and Number
Course Instructor and Academic Term

normal face-to-face classes. Studies show that if we can see each other's faces then we will have more engagement, more student success, and more faculty success. However, this is not a requirement. I understand if on certain days you can't have your camera on due to internet bandwidth limitations, other family members, health issues, or any other reasons.

Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Evaluation of Grades

Students are expected to attend class lectures and arrive on time. Please turn off cell-phones, pagers, and other electronic devices during the class unless you are asked to use them.

Assignment	Total Points	Percentage of Final Grade
Homework Sets	100 each	10%
Design Project	100 each	20%
Exam1	100	25%
Exam2	100	25%
Final Exam	100	20%
		100%

This course is co-listed with the graduate class. The homework portion of the graduate section will involve additional work with respect to the undergraduate section. The exams will also involve additional questions or take home questions for the graduate section with respect to the undergraduate section. Grading for the homework and projects are different from the undergraduate course. The graduate and undergraduate sections will be graded separately, for which the graduate section has additional problems and different weights for all problems.

EEL 4930 has computer software based simulation and design homework and a group term project. Term project reports are required.

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.a.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.a.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another

and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Connections Center, <https://career.ufl.edu/>, 392-1601. **Reitz Union. Career development assistance and counseling.**

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.