

Micro/Nano Machined Metamaterials

EEE 5467 Section 0001

Class Periods: MWF, period 9, and 4:05 – 4:55 pm

Location: 225 Larsen Hall (Zoom)

Academic Term: Fall 2020

Instructor:

Name: Yong-Kyu Yoon

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Office Phone Number: (352) 392 - 5985

Office Hours: TW 1:00 – 1:50 pm or by appointment, LAR 225 (or Zoom)

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- N/A

Course Description

Course on the advanced micro-/nano machined metamaterials and their applications for radio frequency (RF)/microwave and optical devices such as waveguides, filters, and antennas (3 credit hours)

Course Pre-Requisites / Co-Requisites

EEL 3472 Electromagnetic Fields and Applications, and EEL 3111C Circuits 1 , **Co-requisites:** None

Course Objectives

To understand the metamaterial concept and the advanced microfabrication processes, and apply them for the design and implementation of compact and power efficient RF/microwave and optical devices.

Materials and Supply Fees

N/A

Required Textbooks and Software

Recommended book:

- Title: Metamaterials: Physics and Engineering Explorations
- Author: Nader Engheta and Richard W. Ziolkowski, Edited by
- Publication date and edition: 2006, IEEE Press and Wiley-Interscience
- ISBN number: 0471761028 9780471761020

Software:

High Frequency Structure Simulator (HFSS, ANSYS Inc.) and Manual

COMSOL Multiphysics Simulation Tools (COMSOL, Inc.) and Manual

Recommended Materials

Books:

David M. Pozar, Microwave Engineering, 3rd edition, Wiley, 2005

Ricardo Marques, Ferran Martin, and Mario Sorolla, Metamaterials with Negative Parameters: Theory, Design and Microwave Applications, 2008, Wiley

Christophe Caloz and Tatsuo Itoh, Electromagnetic Metamaterials, Wiley-Interscience, 2006

Course Schedule (Tentative) – This will be updated when the semester starts.

Introduction (w1)

Metamaterial architectures (w2,3,4,5,6)

-Basic RF concepts: Transmission line theory, Waveguide, Resonators

- Composite right/left handed (CRLH) transmission line approach
- Split ring resonator (SRR) and complementary split ring resonator (CSRR) approach
- Applications: Waveguide, Filter, Antenna etc.
- HFSS Demo

Midterm Exam (Oct. 16th)

Micro-/nanofabrication processes (w8,9)

- Lithography: UV lithography, E-beam lithography
- Metallization: Electroplating, Sputtering, Evaporation
- 3-D printing

Microwave engineering (w10,11, 12)

- Micromachined metamaterial components
- Multilayer resonator/filter design
- Multiband metamaterial antennas

Final Presentation (Dec. 7th and Dec. 9th)

Term Project Due (Dec. 11th)

Attendance Policy, Class Expectations, and Make-Up Policy

This class will 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 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 in compliance with university policies in the Graduate Catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (5)	100 each	10%
Midterm Exam	100	30%
Final Exam	100	30%
Term Project	100	30%
		100%

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
83.0 - 86.9	B+	3.33
80.0 - 82.9	B	3.00
77.0 - 79.9	B-	2.67
73.0 - 76.9	C+	2.33

70.0 – 72.9	C	2.00
67.0 - 69.9	C-	1.67
63.0 - 66.9	D+	1.33
60.0 - 62.9	D	1.00
57.0 - 56.9	D-	0.67
0 - 56.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/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 Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

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