

EEE 5467 Micro/Nano Machined Metamaterials Fall 2018 Section 13H7

1. **Catalog 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)
2. **Pre-requisites:** EEL 3472 Electromagnetic Fields and Applications, and EEL 3111C Circuits 1 , **Co-requisites:** None
3. **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 passive RF/microwave and optical components.
4. **Contribution of course to meeting the professional component:** N/A
5. **Relationship of course to program outcomes:** N/A
6. **Instructor:** Yong-Kyu Yoon
 - a. Office location: LAR 225
 - b. Telephone: 392-5985
 - c. E-mail address: ykyoon@ece.ufl.edu
 - d. Web site: <https://elearning.ufl.edu/> (E-Learning)
 - e. Office hours: TW 1:00 – 1:50 pm or by appointment
7. **Teaching Assistant:** None
 - a. Office location: N/A
 - b. Telephone: N/A
 - c. E-mail address: N/A
 - d. Office hours: N/A
8. **Meeting Times:** T4 (10:40-11:30am), Th4,5 (10:40am-12:35pm)
9. **Class/lab schedule:** Three 50-min. lectures per week
10. **Meeting Location:** CHE 316
11. **Material and Supply Fees:** None
12. **Textbooks and Software Required**
 - Textbook
 - a. Title: Metamaterials: Physics and Engineering Explorations
 - b. Author: Nader Engheta and Richard W. Ziolkowski, Edited by
 - c. Publication date and edition: 2006, IEEE Press and Wiley-Interscience
 - d. ISBN number: 0471761028 9780471761020
 - Software:

High Frequency Structure Simulator (HFSS, ANSYS Inc.) and Manual
COMSOL Multiphysics Simulation Tools (COMSOL, Inc.) and Manual
13. **Recommended Reading** (see 12 above)
 - 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

14. **Course Outline** (provide topics covered by week or by class period)

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. 11th)

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 (Nov. 29th and Dec. 4th)

Term Project Due (Dec. 11th)

15. **Attendance and Expectations:** Students are expected to attend class lectures and arrive on time. Please turn off cell-phones, pagers, and other electronic devices.

16. **Grading:**

Homework	10%
Midterm	30%
Final	30%
Term Project	<u>30%</u>
	100%

17. **Grading Scale**

Numeric Cutoff	Letter Grade	Grade Points
90	A	4.00
87	A-	3.67
83	B+	3.33
80	B	3.00
77	B-	2.67
73	C+	2.33
70	C	2.00
67	C-	1.67
63	D+	1.33
60	D	1.00
57	D-	0.67
<57	E	0.0

“In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:

<http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades>

18. Exam Policy:

Homeworks: **DUE AT THE BEGINNING OF CLASS PERIOD**

-10% if turned in after lecture begins

-20% if turned in after lecture ends (up to one business day late)

Exams: Take-home, presentation, and report

No make-up unless prior written documentation from Dean of Students, Physician, or Judge

19. Honesty Policy: All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

UF Honor Statement: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.

*****CHEATING, COPYING, or PLAGERISM will result in a ZERO ON THE ASSIGNMENT, and DISCIPLINARY ACTION WILL BE PURSUED** (see www.dso.ufl.edu/judicial/academic.php)

20. Accommodation for Students with Disabilities: Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services: Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student 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.