Spring2018 Special Topics

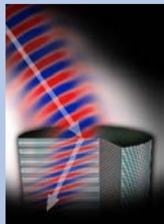
CRN	Title	Units	Instructor	Days/Time
61113	EEC 289K – Electromagnetic Metamaterials	4	Gomez-Diaz	TR 2:10-4:00 P
61114	EEC 289K - Design of RF and Microwave Filters	4	Liu	MW 4:10-6:00 P
61115	EEC 289L – Compound Semiconductor Materials and Device Presentations and Discussions	4	Woodall	MW 2:10-4:00 P
81935	EEC 289L – Wide bandgap Semiconductor Devices (WBG-Devices)	3	Chowdhury	TR 12:10-2:00 P
82194	EEC 289Q – Data Analytics for Computer Engineers	4	Ghiasi	MW 3:10-4:30 P

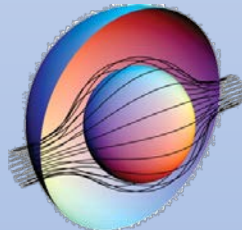
Course Offering for Spring Quarter 2018

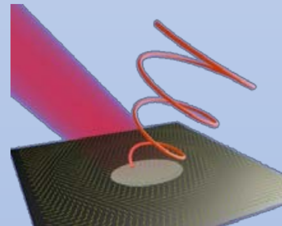
Electromagnetic Metamaterials (EEC289K)

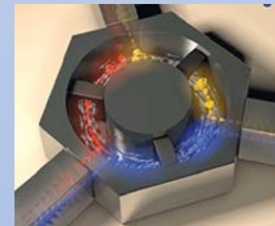
Date/Time/Location TR 2:10-4:00 pm Kemper 2112

Instructor Dr. J. Sebastian Gomez-Diaz









The purpose of the course is to build up a basic understanding in several advanced topics of electromagnetic metamaterials and metasurfaces, and to gain knowledge in cutting-edge research that covers multidisciplinary areas of electrical engineering, physics, and material science.

Tentative Course Outline

1. Review of Electromagnetic Theory

Introduction. Maxwellian framework for bulk and 2D materials. Isotropy, chirality and reciprocity. Passive, active, and non-linear materials. Examples.

2. Anisotropic and Dispersive Media

Poynting vector. Dispersion and Kramers-Kronig relations. Left-handed media. Negative refraction and the perfect lens. Indefinite and uniaxial media. Ferrites and Faraday rotation.

3. Bulk Metamaterials and Applications

Synthesis of metamaterials. Homogenization. Optical metamaterials and applications: cloaking, ε -near zero and hyperbolic materials. Metamaterials at microwaves: guided and radiative applications. Breaking time-reversal symmetry.

4. Ultrathin Metasurfaces and Applications

Generalized laws of reflection and refraction. Graphene and 2D materials. Plasmonics in metasurfaces. Hyperbolic, non-linear, and non-reciprocal responses

Prerequisites

Familiarity with electromagnetics and high level programming.

Design Project

Analyze, model, and fabricate (if possible) recent metamaterial-based devices available in the literature.

About the Instructor

J. Sebastian Gomez-Diaz is an Assistant Professor in the Electrical and Computer Engineering Department of the University of California, Davis. He received his Ph.D. degree in electrical engineering (with honors) from the Technical University of Cartagena (UPCT, Spain) in 2011. From October 2011 until March 2014 he was a postdoctoral fellow at the École Polytechnique Fédéral de Lausanne (EPFL, Switzerland). Then, from May 2014 to August 2016, he continued his postdoctoral work in the Metamaterials and Plasmonic Research Laboratory of The University of Texas at Austin (US). He has co-authored >50 journal papers, some of them published in highly selective journals such as Nature Communications, Physical Review Letters, and IEEE Transactions/Letters, and >70 conference papers. His main research interests include multidisciplinary areas of electromagnetic wave propagation and radiation, metamaterials and metasurfaces, plasmonics, novel 2D materials, antennas, and non-linear optics.

https://sites.google.com/site/jsebastiangomezdiaz/

UCDAVIS ELECTRICAL AND COMPUTER ENGINEERING

Applied Micro/Nano-Electromagnetics Research Laboratory

EEC289K - Electromagnetic metamaterials

4 units – Spring Quarter

Lecture: 3 hours

Project: 1 hour

Prerequisite: EEC230 – Electromagnetics is recommended

Grading: Letter; homework (15%), midterm (20%), design project (25%), final exam / design project II (40%)

Catalog Description:

Theory of electromagnetic metamaterials and metasurfaces. Applications at microwaves, terahertz, and optics. Graphene and 2D materials. Generalized Snell's law. Plasmonics. Cloaking. Hyperbolic, non-linear, and magnet-free non-reciprocal responses.

Expanded course description:

The purpose of this course is to build up a basic understanding in the analysis, design, and practical applications of electromagnetic metamaterials and metasurfaces from microwaves to optics.

I. Review of electromagnetic theory
   A. Introduction
   B. The Maxwellian framework for bulk and 2D materials
   C. Isotropy, chirality, and reciprocity
   D. Passive, active, and non-linear materials
   E. Examples of wave propagation

II. Electrodynamics of anisotropic and dispersive media
   A. Poynting vector
   B. Dispersion and Kramer-Kronig relations
   C. Wave propagation in left-handed media
   D. Waves through NRI slabs: Negative refraction and the perfect lens
   E. Indefinite and uniaxial media
   F. Ferrites and Faraday rotation

III. Bulk metamaterials and applications
   A. Synthesis of metamaterials
   B. Homogenization
   C. Optical metamaterials and applications: Cloaking, ENZ, and HMTMs
   D. Metamaterials at microwaves: guided and radiative applications
   E. Breaking time-reversal symmetry

IV. Ultrathin metasurfaces and applications
   A. Generalized laws of reflection and refraction

B. Graphene and 2D materials
C. Plasmonics in metasurfaces
D. Hyperbolic, non-linear, and non-reciprocal responses

The design project aims to analyze and model metamaterial-based devices taken from recent literature. To this purpose, full-wave software will be employed. Potential examples include cloaking (invisibility) devices, non-linear metasurfaces, non-reciprocal antennas, plasmonics using graphene, hyperbolic lenses, etc. Project II (optional) aims to either fabricate such devices or to modify their design to significantly improve their performance.

Textbook/reading:

Most material will be from class and recent research papers on electromagnetic metamaterials and metasurfaces. Recommended textbooks

1. C. A. Balanis, Advanced engineering electromagnetics
2. D. Jackson, Classical electrodynamics
3. P. Yeh, Optical waves in layered media
4. S. A. Tretyakov, Analytical modeling in applied electromagnetics
5. R. Marques et al, Metamaterials with negative parameters
6. N. Engheta et al, Metamaterials: physics and engineering explorations
7. C. Caloz et al, Electromagnetic Metamaterials: Transmission line theory and microwave applications

Instructor: J. S. Gomez-Diaz

EEC 289K: Design of RF and Microwave Filters

Instructor: Xiaoguang “Leo” Liu

Spring, 2018

Lecture Time: TBD

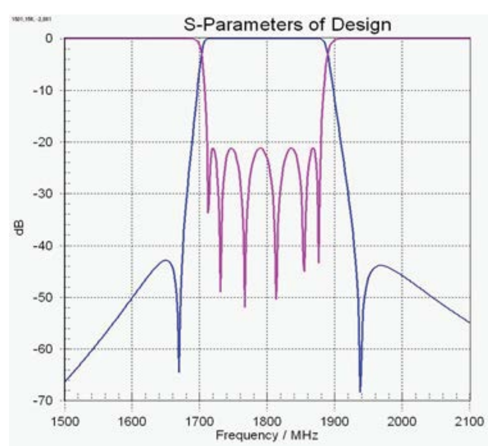
Location: TBD

Pre-requisite: EEC 132A or equivalent

Filters are ubiquitous components in high frequency electronic systems. Jokingly known as the “RF engineers’ bandage”, RF and microwave filters find use in band/channel selection, image rejection, anti-aliasing, and pretty much anywhere undesired signals need to be eliminated. This course intends to provide a thorough and up-to-date overview of the design theories and implementation techniques for RF and microwave filters. The targeted audience is senior undergraduate students and graduate students with a basic background in circuit analysis and RF engineering.

The topics covered in this course include:

- Review of network analysis and synthesis techniques
- Filter approximations and prototype synthesis
- Frequency and impedance transformations
- Coupled resonator filters and the coupling matrix
- Design of microstrip and waveguide filters
- Mechanical and micro-mechanical filters
- Tunable filters and wide-band filters



2018 SQ 289L SYLLABUS

289L: Compound Semiconductor Materials and Device Presentations and Discussions
Location: OLSON 244
Time: MW 2:10 – 4: 00 p.m.
Format: Lectures given by students: MW 2:10-3:30 p.m.
Student discussions W 3:40-4:00 p.m.
Course Credit: 4 units for each student.
Instr: Jerry Woodall: Distinguished Professor of ECE
jwoodall@ucdavis.edu
Office: 2001 Kemper Hall
Hours: Tues. 1:30-4:30

Course purpose and goals:

The purpose and goals of this course are to provide a detailed knowledge of all aspects of compound semiconductor materials and devices. **The students who are enrolled in the course will teach the course.** The goal of this method is to give each and every student the practice and experience of both learning and teaching a course and improving public speaking skills, and team skills in organizing lectures.

How the course will operate:

1. Each student in alphabetical order of last name be assigned a topic in order from the list in the syllabus (see next page).
2. Each student will present a comprehensive lecture derived from research from textbooks, journals, and the web to prepare the lecture on the topic assigned to the partnership. The presentation format will be a classroom projected ppt or pdf file.
3. For each Monday class part I a 1 hour 20 minute of a formal presentation will be given from 2:10 to 3:30 p.m.
4. For each follow-on Wednesday class, part II continuation of the part I lecture will be presented from 2:10 p.m. to 3:30 p.m. This will be followed by a 10 minute break and then a Q/A session will occur from 3:40-4:00 p.m. Any registered student who has an unexcused miss of any lecture or discussion will receive a maximum letter grade of a B.
5. At the time of the writing of this revision, there are 0 students registered for 289L. Depending on the final number of registered either all some of the topics will be shared by more than 1 student. For these lectures there will be a discussion session following the lectures. The student assignments will be listed in red font on the next page.
6. All students must turn into the instructor an e-file of the lecture within 24 hours immediately following the class.

Grading:

Lecture 85%: grade metrics include: comprehensiveness, clarity, grammar, style, staying on target of teaching the assigned topic, etc.
Discussion 15%: Participation in discussion of other student lectures, e.g. asking important questions, adding comments for completeness or clarity, etc. (All students

taking the SQ 2016 course got at least an A-). **Class attendance is mandatory. Any unexcused absence will result in a reduction of one letter grade for the course.**

Note: Enrollment is capped at 20 students.

Drop Outs: all drop-outs must notify Prof. Woodall of this intention by the end of the Wednesday class of the first week. There will be no drop-outs allowed after that date.

Swapping team members or topics: All students may swap pair wise topics and/or pair wise individual partners in advance of the scheduled presentation of the swapped topics. The date or order of topic presentation cannot be changed.

Weekly Compound Semiconductor Topics:

1. First class
1.1 Introductory remarks Prof. Woodall
1.2 Review and current status of solar cells.
2. Overview of current and past use/applications of compound semiconductor materials and devices
3. Review and current status of LEDs
4. Review and current status of injection lasers
5. Review and current status of BJTs and HBTs
6. Review and current status of MESFETs and MOSFETS
7. Review and current status of photodetectors (excluding PVs)
8. Review and current status of specialty devices, including, RTD, cascade lasers, superlattice devices, etc.
9. Review and current status of special device and materials processing considerations including doping, selective etching, surface and interface Fermi level pinning, MOS-C, lift off, device isolation, LED, laser, photodetector, solar sell, HEMT and HBT fabrication
10. Review and current status of 2-D materials and devices

EEC 289L Spring 2018

Course title: Wide bandgap Semiconductor Devices (WBG-Devices)

Instructor: Srabanti Chowdhury (http://faculty.engineering.ucdavis.edu/chowdhury/)

Are we prepared for the Next generation electronics?

When we say "Next Gen"- we are talking "Beyond Si"

Widebandgap (WBG) semiconductors present a pathway to push the limits of efficiency in electronics beyond that available from Silicon or other commercially used semiconductors, enabling significant energy savings.. Increasing efficiency is not only critical for minimizing consumption of limited resources; it simultaneously enables new compact architectures, the basis for a new industry offering more functionality at a reduced system cost. This coursework attempts to answer the rhetorical question that the electronics industry is asking today- what is the path beyond Silicon by providing a clear picture on the limitations of Silicon and advantages of semiconductor devices those are built with wide bandgap semiconductor. We will thoroughly discuss the operation principle of these WBG enabled devices, their performance, their current and potential application space, and their demands in the market. We will discuss semiconductor materials to the extent required to understand these devices. The course work will discuss devices based on Gallium Nitride and other III-Nitrides, Diamond and Oxide. The term papers will include two short projects that will require simulation to conduct device design and analysis.

Picture sources: http://www.cpp.edu/~discovery/robotics.html , https://techcrunch.com/2016/01/31/marketing-in-the-fast-lane-with-self-driving-cars/ http://www.recode.net/2015/3/13/11560156/what-is-5g-and-what-does-it-mean-for-consumers, http://www.renewablechoice.com/blog-2015-record-setting-year-for-renewables/

1 Roadmap and market of wide bandgap semiconductor Applications (present and future)

2 Substrates and materials

- Various methods of growth (MOCVD, HPVE, MBE, Na-flux, CVD

3 WBG- based High Power High voltage devices

- Material properties and its advantages
- Substrates and growth methods
- Lateral devices (RF and High power)
- Vertical Device (RF and High power)
- CMOS- compatible process
- Characterization and Reliability
- Thermal management

4 GaN based LEDs and Lasers

- Growth
- p-Type GaN and its challenges
- n-Type GaN
- Blue and Blue-Green LEDs
- Room-Temperature Pulsed Operation of Laser Diodes
- Emission Mechanisms of LEDs and LDs
- Current Status: Lasers with Self-Organized InGaN Quantum Dots.

5 III-Nitride UV detectors

- UV Metal Semiconductor Metal Detectors
- Characterization of Advanced Materials for Optoelectronics by Using UV Lasers
- Novel III-Nitride Heterostructures for UV Sensors and LEDs
- Nitride Photodetectors in UV Biological Effects Studies

6 WBG- Photovoltaics for high temperature operation

Evaluation : based on project and discussions

Picture sources: http://www.cpp.edu/~discovery/robotics.html , https://techcrunch.com/2016/01/31/marketing-in-the-fast-lane-with-self-driving-cars/ http://www.recode.net/2015/3/13/11560156/what-is-5g-and-what-does-it-mean-for-consumers, http://www.renewablechoice.com/blog-2015-record-setting-year-for-renewables/

EEC 289Q – Data Analytics for Computer Engineers

Instructor: Soheil Ghiasi
Spring 2018

Lecture: 4 hours
Prerequisites: EEC172, "EEC180B or ECS122A"

Description:
Advances in computing, and the ability to accumulate, process and extract application-dependent information from massive amounts of data have revolutionized scientific and engineering disciplines. Just as one example, large-scale deep convolutional neural networks have led to remarkable advances in image and speech recognition, problems that have been under active research for about half a century.
The goal of this special topics course is to provide an overview of machine learning techniques for students with computer engineering background. The course will introduce some theoretical concepts as well as algorithms from statistical data analysis and predictive modeling, with an emphasis on topics that are most relevant to computer engineering researcher and practitioners, such as integration of algorithms within a complete system (the interplay between data acquisition, processing, visualization, etc.), implementation tradeoffs and scaling considerations. Examples from different application domains, such as healthcare, e-commerce and finance will be discussed. An integral part of the course is a student-led seminar series (discussion of several key papers), and a course project on either collection or analysis of interesting data.

Grading: Letter based on homework %30, class participation 20%, and course project 60%

Textbook:

Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin, 'Learning from Data (a short course)', AMLbooks.com, 2012
Yoshua Bengio, Ian Goodfellow and Aaron Courville, "Deep Learning", MIT Press, 2016

Expanded Course Outline

1. Introduction
    a. How can we automatically learn from data?
        i. Example applications
        ii. Supervised learning vs. other machine learning paradigms
        iii. Classification vs. regression vs. logistic regression
        iv. Data analytics pipeline (acquisition, preprocessing, segmentation, feature extraction, classification and visualization)
    b. Overview of linear algebra
    c. Software environment and setup (Matlab, R, Caffe/TensorFlow)

2. Linear Models
    a. Multi-variate linear regression
    b. Linear classification
    c. Space transformation

3. Logistic Regression
    a. Model and learning algorithm
    b. Multiclass classification
    c. Overfitting and regularization

4. Neural Networks
    a. Model and applications
    b. Cost function and backpropagation algorithm
    c. Regularization for neural networks
    d. Practical considerations for backpropagation

5. Convolutional Neural Networks and Deep learning
    a. Model and applications
    b. Auto-encoders
    c. Fine-tuning of deep neural networks

6. Large scale machine learning
    a. Gradient decent for large models and/or large datasets
    b. GPU vs. FPGA implementation