

Applied Electromagnetics

Dan Sievenpiper, 2018-10-29

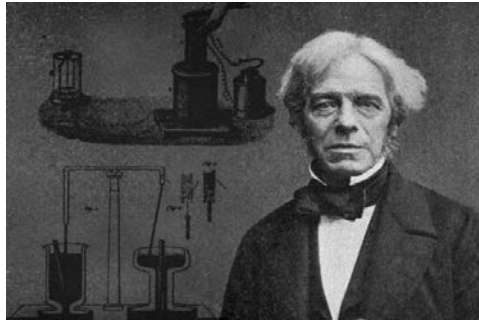
History: A Few of the Early Pioneers in Electromagnetics

Andre-Marie
Ampere



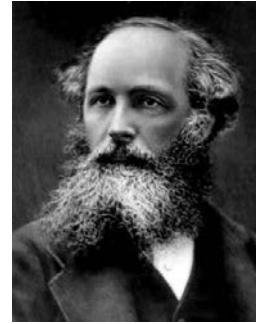
Invented telegraph
(among many other things)

Michael Faraday



Invented electric motor
(among many other things)

James C. Maxwell



Unified electricity, magnetism
and light into one theory

Heinrich Hertz



Proved existence of
electromagnetic waves

Nicola Tesla



Invented AC, wireless
power transfer

Guglielmo
Marconi



Invented radio
communication

Many, many others:

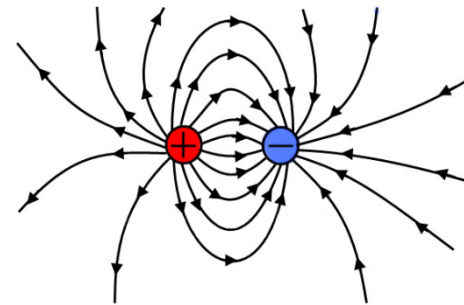
- Alessandro Volta
- James Prescott Joule
- Georg Simon Ohm
- Charles William Siemens
- Charles-Augustin Coulomb
- Joseph Henry
- Wilhelm Eduard Weber
- Hans Christian Orsted
- ...

Courses in Applied Electromagnetics

- Undergrad Courses
 - ECE107 – Electromagnetism
 - ECE123 – Antenna Systems Engineering
 - ECE166 – Microwave Systems and Circuits
 - ECE182 – Electromagnetic Optics, Guided-wave and Fiber Optics
- Graduate Courses
 - ECE221 – Magnetic Materials Principles and Applications
 - ECE222A – Antennas and their System Applications
 - ECE222B – Electromagnetic Theory
 - ECE222C – Computational Methods for Electromagnetics
 - ECE222D – Advanced Antenna Design

ECE107 Electromagnetism

- Electrostatics, magnetostatics
- Vector analysis
- Maxwell's equations
- Plane waves, reflection, refraction
- Electromagnetic properties of materials
- Transmission line theory
- Radiation

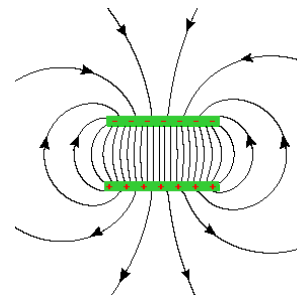
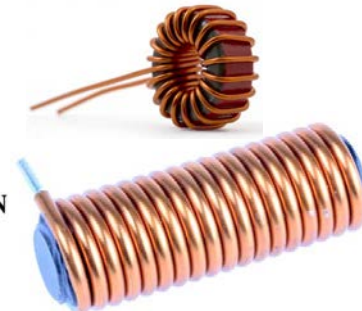
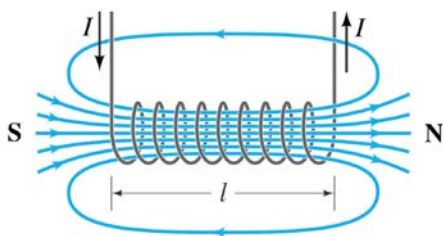
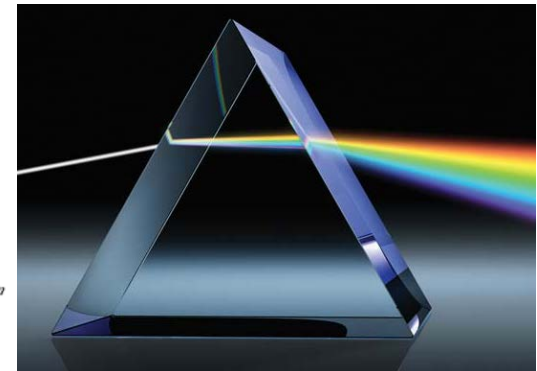
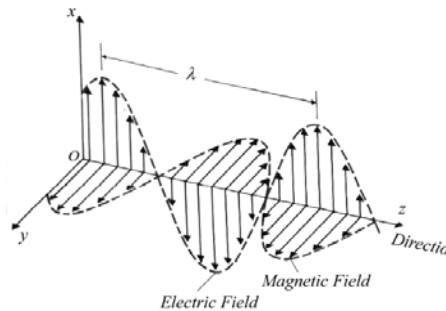
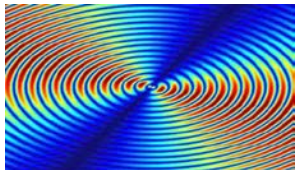


$$\nabla \cdot \mathbf{D} = \rho_v$$

$$\nabla \cdot \mathbf{B} = 0$$

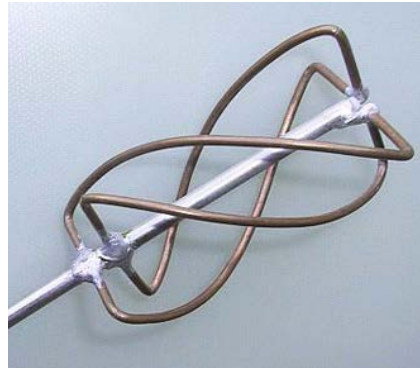
$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J}$$



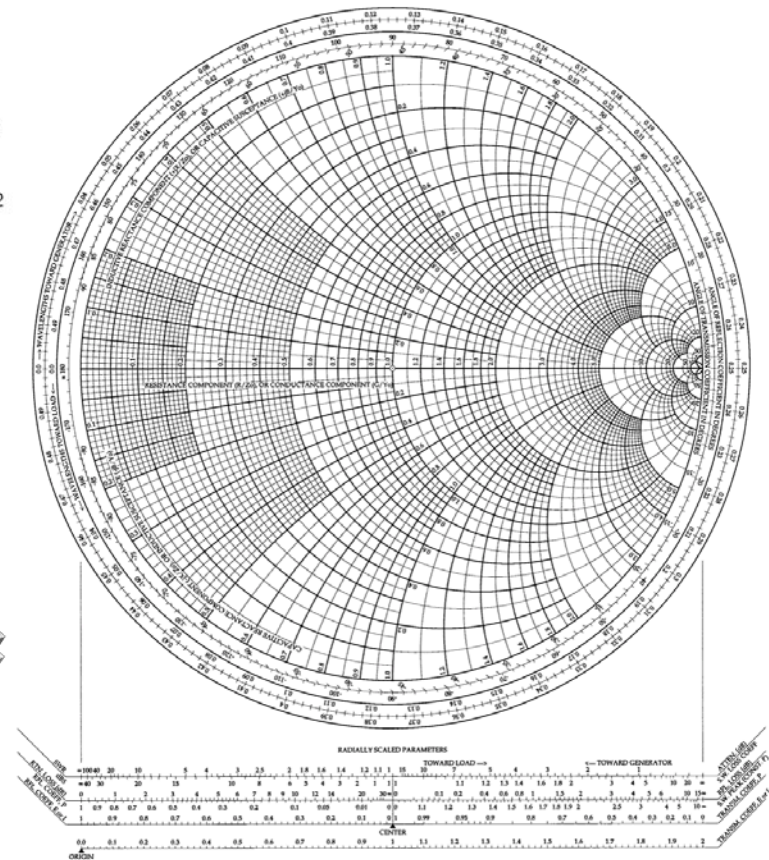
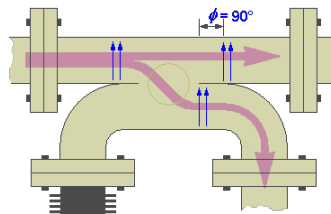
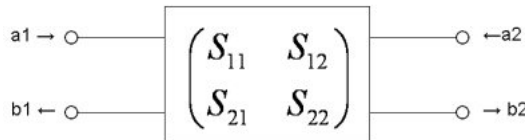
ECE123 – Antenna Systems Engineering

- How radiation occurs, ideal dipole, radiation patterns
- Gain, directivity, impedance, polarization, etc.
- Antenna arrays, effective aperture, noise temperature
- Friis transmission equation, communication and radar
- Matching, baluns, ground effects
- Traveling wave antennas, reflector antennas, etc.
- Antennas for mobile communications



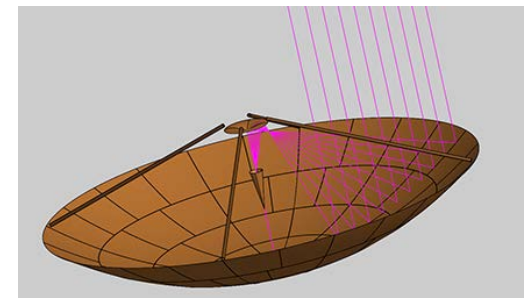
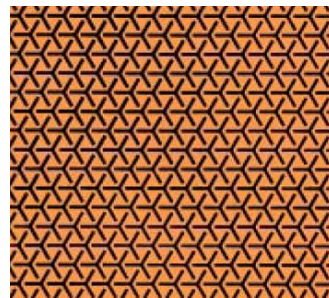
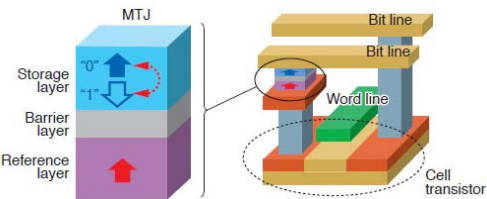
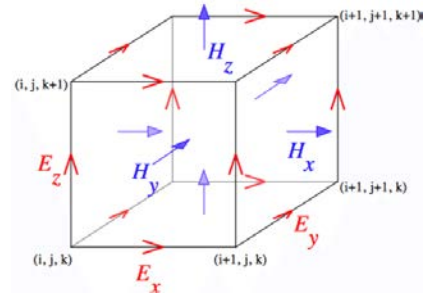
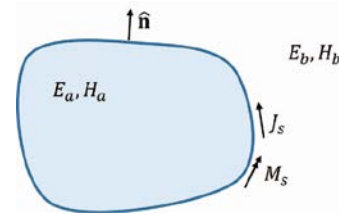
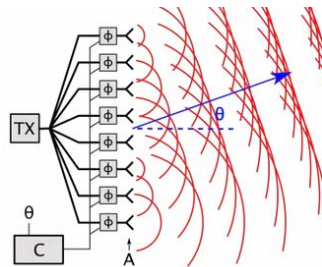
ECE166 – Microwave Systems and Circuits

- Transmission lines, microwave circuit analysis
- Matching circuits and structures
- Smith chart
- S-parameters
- Couplers
- Microwave amplifiers
- Noise, linearity



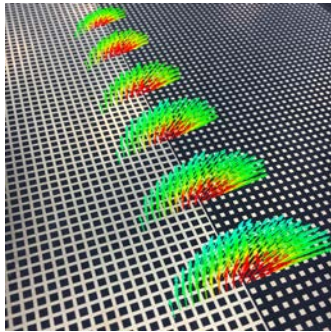
Graduate Courses

- ECE221 – Magnetic Materials Principles and Applications
- ECE222A – Antennas and their System Applications
- ECE222B – Electromagnetic Theory
- ECE222C – Computational Methods for Electromagnetics
- ECE222D – Advanced Antenna Design

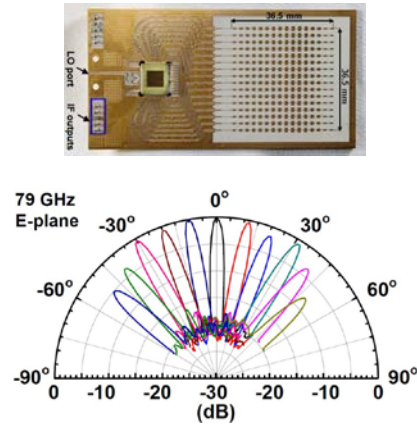


Current Applied Electromagnetics Research at UCSD

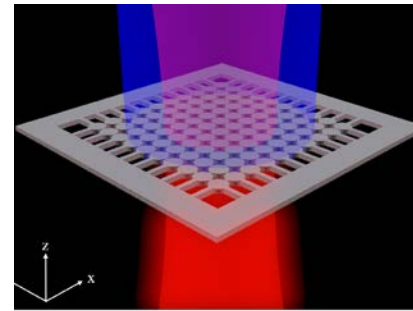
Edge wave at interface between complementary metasurfaces (Dan Sievenpiper)



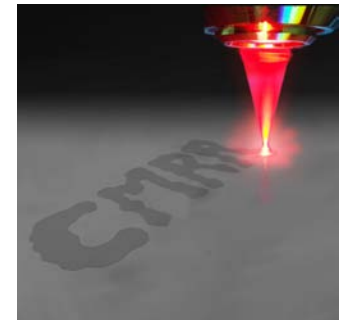
Automotive phased array radar (Gabriel Rebeiz)



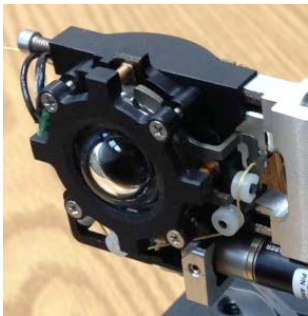
Bound State in the Continuum Laser (Boubacar Kante)



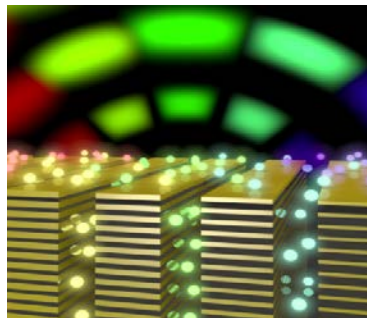
Magneto-optical image written in magnetic film, (Eric Fullerton)



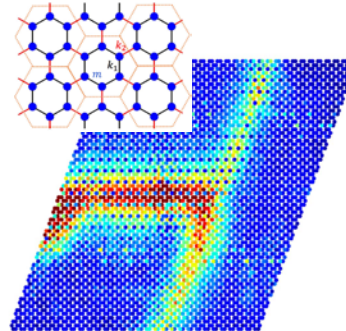
Monocentric Custom Lens 12 mm, f/1.35, (Joe Ford)



Plasmonically Enhanced LED (Zhaowei Liu)



Phononic Topological Insulator (Prab Bandaru)



Also:
Vitaliy Lomakin
Shayan Mookherjea
Stojan Radic

Careers in Electromagnetics

- **Communications and radar systems**
 - Cellphone systems, radar systems, base stations, handsets, etc.
 - Antennas, RF circuits, system level design, EM propagation
 - Emerging: Automotive radar, 5G cellular systems
- **Antennas and electromagnetic structures**
 - Direction finding, signal intelligence, electronic warfare, DEW
 - Radomes, system integration, mutual coupling, interference
 - High frequency circuits and components
- **Optical and imaging systems**
 - Lidar, mmW imaging, infrared and optical imaging
- **Instrumentation**
 - Measurement equipment, FCC certification, EMC/EMI testing
 - SAR testing, human effects – simulation and measurement
- **A few of the companies or institutions where our students now work:**
 - Apple, Google, Qualcomm, Huawei, Keysight, Skyworks, Bell Labs China, Northrop Grumman, General Atomics, HRL Laboratories, Anokiwave, SpaceX, Intel, Samsung, MediaTek, AMD, Facebook, Amazon, Microchip, Maxlinear, ADI, Broadcom, Maxim, Motorola, Nokia, Cavendish Kinetics, Continental, Hitachi, Lockheed Martin, Boeing, MIT Lincoln Labs, Sandia, Thales, various other national labs, universities, and small companies