Lecture 1

Introduction to the Course ECE 303

In this lecture you will learn:

- **The basic structure of the course**
- **Course policies**
- **Introduction to Electromagnetic Fields and Waves**
- **The cutting edge areas in related applications and research**

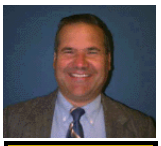
Recitation Sections

- **In order to take this class every student MUST be able to attend:**

  - One recitation section on Tuesday

  AND

  - One recitation section on Thursday



- **Recitation Instructors:**

Dr. Wesley Swartz
Paul George
Dr. Christina Manolatou

- **Recitation Schedule:**

(a) Tuesday and Thursday 1:25-2:40 PM in PH203

(b) Tuesday and Thursday 2:55-4:10 PM in PH203

Tutorial Sections

- Tutorials are offered by the TAs
- Course TAs are:

  Paul George, Felix Lee

- Tutorials are NOT mandatory
- Tutorials are meant to help you in homework
- Tutorial schedule (room PH403):

  (a) Thursday 4:30-5:30 PM (Paul George)

  (b) Thursday 6:00-7:00 PM (Felix Lee)

Office Hours

- Office hours are meant for students looking for individual help

  (a) Wednesday 3:00-4:00 PM (PH113)

  (b) Friday 3:00-4:00 PM (PH113)

Course Website

- All course documents, including:

  - Lecture notes
  - Homeworks and solutions
  - Exam solutions
  - Extra course related material

will appear on the course website:

http://instruct1.cit.cornell.edu/courses/ece303/

Homeworks

- Homeworks will be due on Fridays at 5:00 PM in the course drop box
- New homeworks and old homework solutions will appear on the course website by Friday night
- Homework 1 will be due next Friday and will be available on the course website by tonight

Course Material and Textbooks

First 3-4 weeks:

(a) Lecture Slides/Notes

and

(b) Online text book:

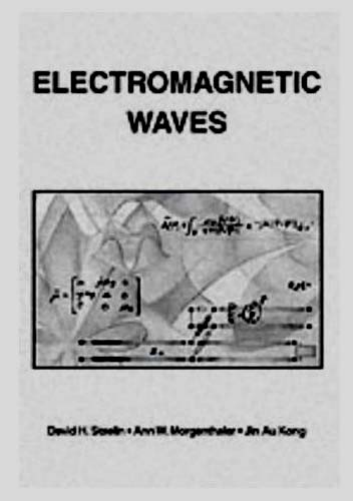
http://web.mit.edu/6.013_book/www/

Next 8-9 weeks:

(a) Lecture Slides/Notes

and

(b) →



A New Course Textbook

- **Chapters from a new course textbook (partially completed) and written by the Cornell faculty will be made available through Blackboard**

- **Students must enroll in Blackboard to access these chapters:**

http://blackboard.cornell.edu/

Course Grading

- Course grading will be done as follows:

  - Recitations (5%)
  - Homeworks (20%)
  - 3 Prelims (40%)
  - Final exam (35%)

- Final exam will be comprehensive

Maxwell's Equations in Free Space

(1) $\nabla . \varepsilon_o \vec{E} = \rho$ Gauss' Law

(2) $\nabla . \mu_o \vec{H} = 0$ Gauss' Law

(3) $\nabla \times \vec{E} = -\frac{\partial \mu_o \vec{H}}{\partial t}$ Faraday's Law

(4) $\nabla \times \vec{H} = \vec{J} + \frac{\partial \varepsilon_o \vec{E}}{\partial t}$ Ampere's Law

James Clerk Maxwell
(1831-1879)

The entire course is about these 4 equations !!

Radars for Upper Atmosphere Research

49.92 MHz incoherent scatter radar at the Jicamarca Observatory
The radar has an array of 18,432 half-wave dipoles !!

Arecibo Radio Telescope in Puerto Rico

300 m

Dish Antennas for Satellite Communications

A DIRECTV dish antenna

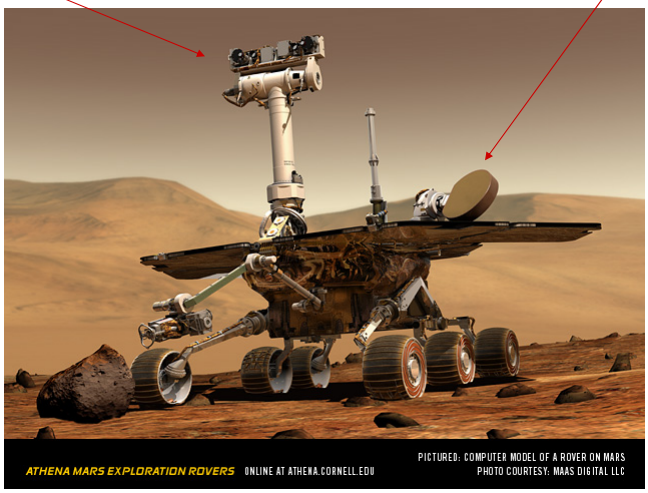
Dopler Radar of an F-16 Plane

Antennas for Deep Space Communications

PANCAM

Mars Rover

High Gain Antenna



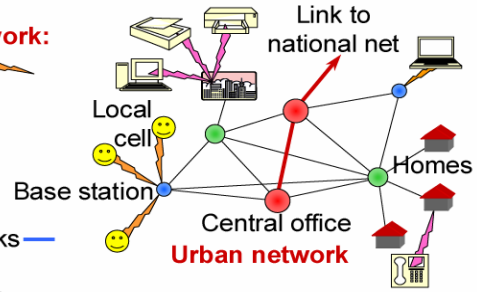
Communication Networks: Wireless and Optical

Local Telecommunications Network:

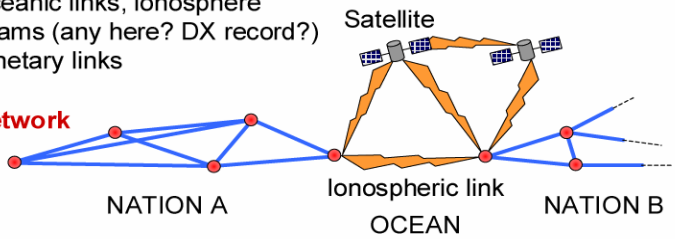
- Cell phones (who has one?)
- Wireless phones, data
- Wires, coaxial cables
- Optical fibers

Other Communications Links:

- Microwave and optical fiber links
- International satellite links
- Transoceanic links, ionosphere
- Radio hams (any here? DX record?)
- Interplanetary links



National Network

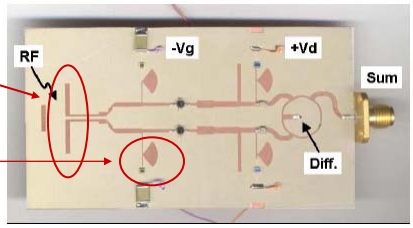


Antennas for Mobile Consumer Products

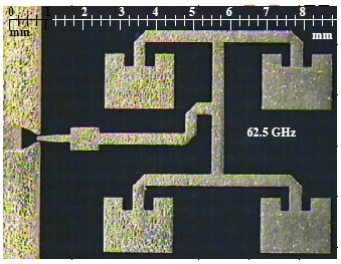
A PCMCIA card antenna – shown with the cover removed (2-5 GHz)

A dipole antenna integrated with a low noise amplifier on a PC board for mobile receivers (4-8 GHz)

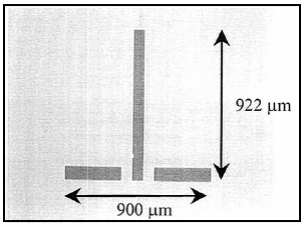
Stub tuners



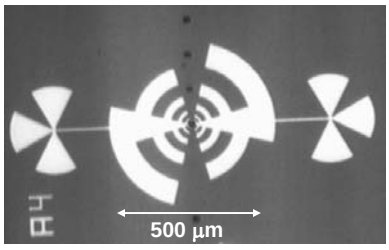
Antennas: The Next Wave in Integration



A 60 GHz patch antenna

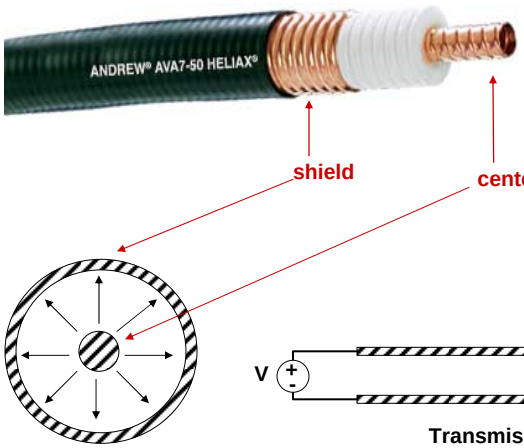


A 100 GHz integrated monopole antenna



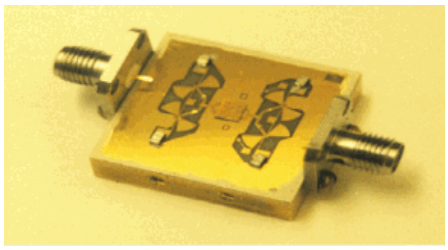
A 500-2000 GHz log-periodic integrated antenna

Guiding Electromagnetic Energy: Transmission Lines

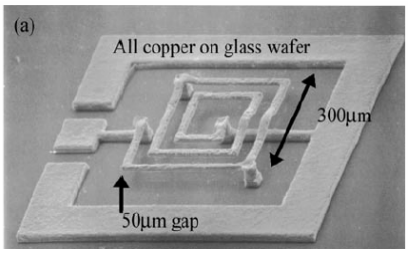


Transmission Lines

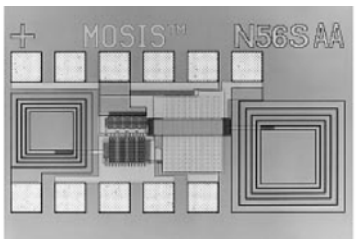
Microwave Circuits



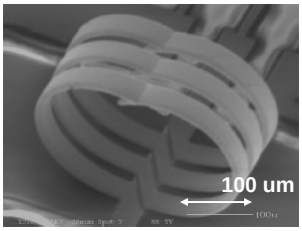
A GaN amplifier chip with stub tuners for 10 GHz operation



A planar on-chip inductor

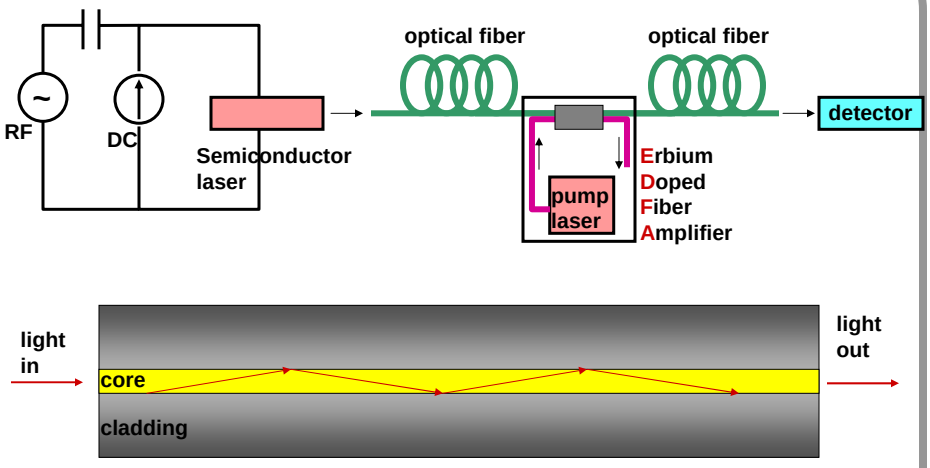


A Silicon 1 GHz amplifier chip



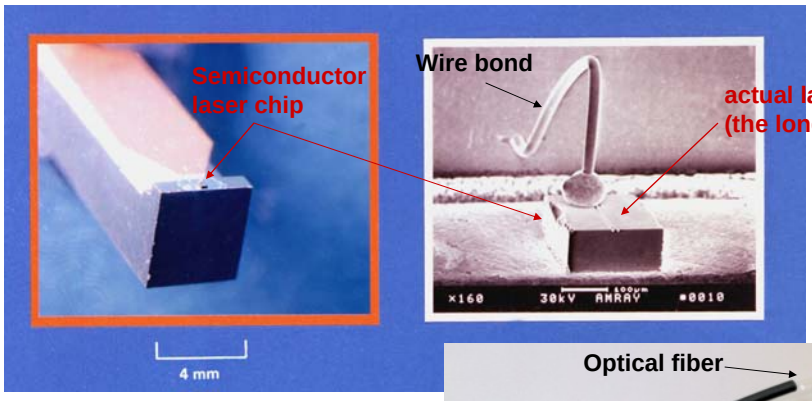
A 3-D on-chip inductor

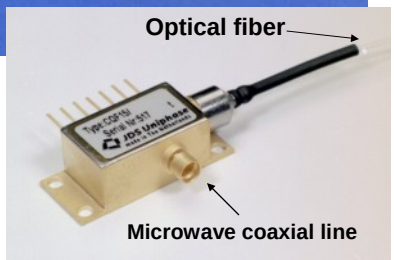
Optical Fiber Communication Links



Light guiding in an optical fiber

Semiconductor Lasers: Powering Up the Information Age

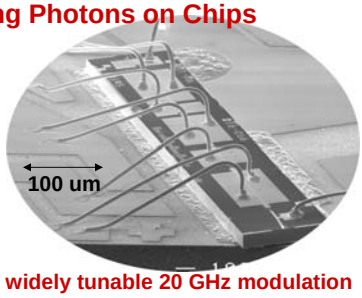




A commercial packaged diode laser

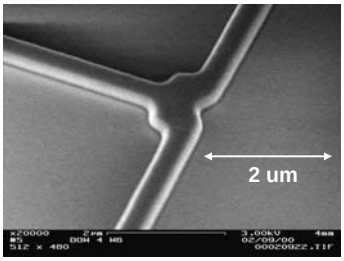
Micro-Photonics: Processing Photons on Chips

A semiconductor laser that produces femtosecond long pulses of light



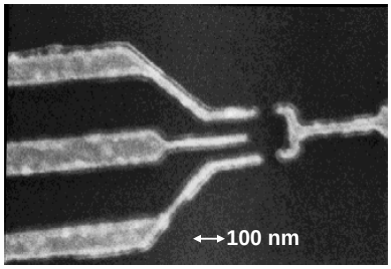
A widely tunable 20 GHz modulation speed semiconductor laser

An optical micro-ring filter (separates out light of a particular color)

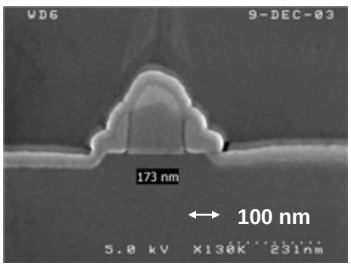


An optical micro-splitter (splits light two ways)

Nano-Electronics

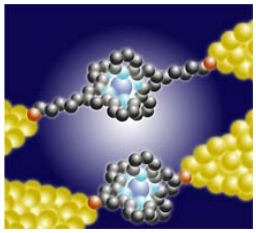


A single electron transistor (works on the principle of strong electrostatic repulsion between electrons in nanostructures)

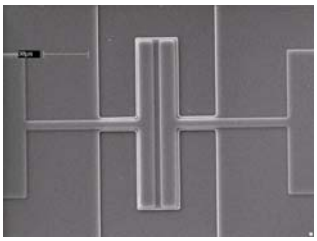


A 50 nm gate MOS transistor (electrostatics become more important as device dimensions shrink)

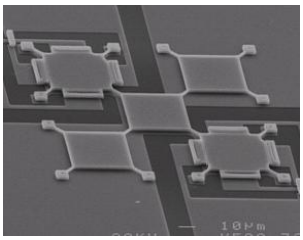
A single atom transistor



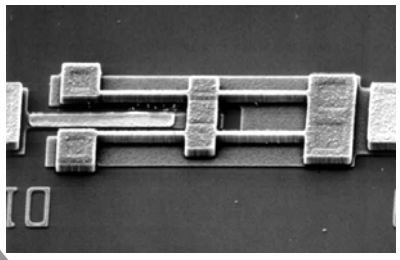
MEMs: Micro-Electro-Mechanical Devices



Bar Resonator



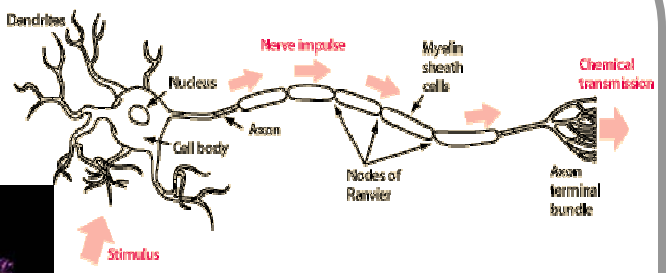
Checkerboard Filter



VHF Beam

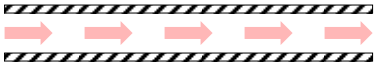
Electrostatically actuated MEMs resonators could be components of future integrated wireless systems

Nano-Biology and Electromagnetics



Protein folding is determined by the complex electrostatic interactions among the atoms

The generation and propagation of action potentials in nerve cells are modeled as electrical signals in (non-linear) transmission lines



A transmission line model of a nerve cell