### CMPE 330 (WAVES AND TRANSMISSION) SYLLABUS

- I. Introduction (4 lectures)
  - 1. Why study waves and electromagnetics?
    - Why circuit analysis is not enough (wireless transmissions, delays)
    - Applications (Taflove): military, computer interconnects, communications, photonics, medicine
    - WRITING ASSIGNMENT: Applications of waves and electromagnets to future careers (two page essay)
  - 2. Course philosophy and background
    - The professor
    - Courses it uses: ENEE 206, MATH 225, MATH 251
    - Courses it complements: PHYS 122, CMPE 314, CMPE 323
    - Courses that require it: All communications track electives
    - ABET, IEEE Required outcomes
  - 3. Textbook:
    - F. T. Ulaby, FUNDAMENTALS OF APPLIED ELECTROMAGNETICS [required]
      - o Advantages: begins with transmission lines, useful software, simple mathematics
      - o NOTE: 2010 Media Edition preferred; CD is required
  - 4. Waves and complex numbers
    - Basic wave parameters
      - o Amplitude, wavelength, frequency, wavenumber, phase offset
    - Dispersion relations: Relations between wavelength, loss, and frequency
    - Electromagnetic spectrum
    - Spectral analysis
    - Review of complex numbers
    - Phasors
  - 5. ASSIGNMENT: Problem Set
- II. Transmission Lines (6 lectures)
  - 1. Basics
    - Lumped Model
    - Types of lines
    - Propagation equations
  - 2. Time Domain
    - Current and voltage evolution
    - SPICE calculations
  - 3. Frequency Domain (Phasors)
    - Current and voltage transmission
    - Voltage standing wave ratio
    - Power flow
  - 4. Smith Chart
    - Parametric equations
    - Impedance matching
  - 5. Lossy Lines
  - 6. Applications
  - 7. ASSIGNMENT: Problem Set
  - 8. MID-TERM 1
- III. Vector Analysis (3 lectures)
  - 1. Motivation
    - Charges + currents  $\rightarrow$  Fields  $\rightarrow$  Forces + measurable effects
    - Electric and magnetic fields are described by vectors

- 2. Laws of vector algebra
  - Addition, subtraction, dot product, cross product
  - Position vectors
- 3. Coordinate systems
  - rectangular, cylindrical, spherical
- 4. Line and surface integrals
- 5. ASSIGNMENT: Problem Set

## IV. Classic E&M Experiments (1 lecture)

- 1. Historical Perspectives
  - Electrostatics: Franklin, Coulomb, Galvani, Volta
  - Magnetostatics: Oersted, Ampere
  - Dynamics: Faraday, Henry, Lenz
  - Maxwell's Equations: MAXWELL
  - Waves: Hertz, Marconi
- 2. Historical Electronics Museum Experiments
  - Oersted's Experiment
  - Faraday's Experiment
  - A motor: (a) a moving wire, (b) a complete motor
  - A generator
- 3. Experimental demonstrations
- 4. PROJECT/WRITING ASSIGNMENT: Build an electrical motor-generator set; Write a 5–10 page description

### V. Static Fields (6 lectures)

- 1. Electrostatics
  - Charge and Coulomb's law
  - Electric field
  - Dielectric materials
  - Gauss's law
- 2. Voltage and capacitance
  - Charge distributions
  - Capacitance calculations
- 3. Magnetostatics
  - Current and Biot-Savart law
  - Magnetic field
  - Magnetic materials
  - Ampere's law
  - Gauss's law
- 4. Applications
- 5. ASSIGNMENT: Problem Set
- 6. MID-TERM 2

### VI. Time-Varying Fields (4 lectures)

- 1. Faraday's Law
  - Physical expression
  - Differential form
- 2. Ampere's Law
  - Physical Expression
  - Differential Form
- 3. Gauss's Law: Differential Form
- 4. MAXWELL'S EQUATIONS
  - Comparison of integral and differential forms

- Power Density: Poynting Vector
- Boundary conditions
- Phasor form: sinusoidally varying fields
- 5. ASSIGNMENT: Problem Set

# VII. Wave Propagation (5 lectures)

- 1. Uniform plane waves
  - Lossless and lossy media
  - Power flow
  - Skin Depth
- 2. Reflection and transmission
  - Normal incidence
  - Snell's laws
- 3. Applications
- 4. ASSIGNMENT: Problem Set
- 5. COURSE REVIEW

#### **COURSE ASSESSMENTS:**

- 2 writing/project assignments 20%
- 8 problems sets + 10 math/physics quizzes 40%
- 2 mid-term exams + 7 review quizzes 20%
- 1 final exam 20%

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