University of Massachusetts
Department of Electrical &
Computer Engineering
Amherst, MA 01003

Course Instructor: **R. Janaswamy**
Date of Outline Preparation: **09/06/2022**
Prepared by: **R. Janaswamy**

ECE 606: Electromagnetic Field Theory (3-0), Fall 2022

I. **Catalog Data:**

Maxwell's equations, electromagnetic energy and power, constitutive parameters, Helmholtz equation, generalized plane waves, electric and magnetic currents, electromagnetic duality, equivalence principle, induction theorem, optical theorem, reciprocity theorem, Green's functions, TE/TM field decomposition, rectangular harmonics, cylindrical harmonics, spherical harmonics.

II. **Course Objective:**

The objective of the course is to give the student an understanding of the physical and mathematical techniques for solving practical electromagnetic problems encountered in antennas, propagation, scattering and microwave circuits using Maxwell's equations.

III. **Text and References:**

Text: *Electromagnetic Radiation, Scattering and Diffraction,* P. H. Pathak and R. J. Burkholder, IEEE Press, 2022, ISBN: 978-1-119-81051-3

References:

R. Janaswamy, Engineering Electrodynamics: A collection of theorems, principles and field representations, Institute of Physics, 2020.

C. A. Balanis, *Advanced Engineering Electromagnetics*, 2nd Ed., John Wiley & Sons, 2012.

R. F. Harrington,*Time Harmonic Electromagnetic Fields,* IEEE Press/John Wiley & Sons, 2001.

J.M Jin, *Theory and Computation of Electromagnetic Fields,* 2nd Ed., IEEE Press/John Wiley & Sons,
2015.

J. Van Bladel, *Electromagnetic Fields*, Hemisphere Publishing, 1985.

J. D. Jackson, *Classical Electrodynamics*, John Wiley & Sons, 1975.

W. K. H. Panofsky and M. Phillips, *Classical Electricity and Magnetism*, Addison-Wesley, 1962.

J. A. Stratton, *Electromagnetic Theory*, McGraw-Hill, 1941.

IV. **Required Background Experience**

1. Vector analysis: gradient, divergence and curl, line integral, surface integral, and volume integrals.
2. Complex analysis and partial differentiation.
3. Electromagnetic fields and waves, Maxwell's equations.
4. Plane waves, transmission lines.

V. **Detailed Description of the Course**

1. Expanded Description of the Course

    A. Introduction: Secs 1.2-1.4, 1.6-1.7, 1.10, 2.1
    10 lecs
    Maxwell's equations, constitutive relationships, material boundary conditions, scalar and vector Helmholtz equations, separation of variables, Bessel functions, Legendre functions.

    B. Electromagnetic Theorems: Secs, 6.1, 6.5-6.9, 7.1, 11.1, 10.1.3 12 lecs
    Conservation of power, principle of duality, uniqueness theorem, image theory, equivalence and induction theorem, reciprocity theorem, optical theorem.

    C. Example Problems: (Notes)
    12 lecs
    Rectangular, cylindrical and radial waveguides; discontinuities and currents in rectangular waveguides; spherical cavity; planar currents in half-space, dipole radiating in the presence of a conducting wedge, dipole radiating over a PEC-backed conducting slab, dipole radiating over material sphere.

    D. Characteristic mode theory: Ch 13
    4 lecs
    Electric-field integral equation, eigenfunctions, characteristic modes.

TOTAL 38 lecs

2. Method of Instruction and Evaluation

A lecture mode of instruction will be used. One midterm (35%, take-home, in October 12, due October 17) and one final exam (40% take-home, in December 8, due December 15) are planned for the course. Homeworks will be assigned periodically and carry 25% of grade. No late homeworks will be entertained.

VI. **Lecture:**
Elab Rm 325, 13:25-14:15 EST

VII. **Office Hours:**
M, W: 15:00-16:00 EST.

VIII. **Course Website:**
https://umass.moonami.com/course/