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

Course Instructor: **R. Janaswamy**
Date of Outline Preparation: **09/06/2016**
Prepared by: **R. Janaswamy**

ECE 606: Electromagnetic Field Theory (3-0), Fall 2016

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: C. A. Balanis, *Advanced Engineering Electromagnetics*, John Wiley Sons, 1989.

References:

Time Harmonic Electromagnetic Fields, R. F. Harrington, IEEE Press/John Wiley & Sons, 2001, ISBN 0-471-20806-X.

Theory and Computation of Eelectromagnetic Fields, IEEE Press/John Wiley & Sons, 2010, ISBN 978-0-470-53359-8

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 Maxwell's equations.
4. Plane waves, transmission lines

V. Detailed Description of the Course

1. Expanded Description of the Course

   A. Introduction: Ch 1 & 2 — 4 lecs
   Maxwell's equations, Helmholtz's theorem, time-harmonic fields, electromagnetic energy and power, constitutive relationships, material boundary conditions, and radiation condition.

   B. Construction of Solutions: Ch 6 — 2 lecs
   Scalar and vector potentials, TE/TM decomposition of Fields, construction of solutions.

   C. Electromagnetic Theorems: Ch 7 — 8 lecs
   Electric and magnetic sources, principle of duality, uniqueness theorem, equivalence and induction theorem, reciprocity theorem, optical theorem.

   D. Plane Wave Functions: Ch 8 — 8 lecs
   Parallel plate and rectangular waveguides, sources inside waveguides, waveguide discontinuities, plane current sheets, plane wave spectrum approach.

   E. Cylindrical Wave Functions: Ch 9 — 8 lecs
   Bessel functions, circular and radial waveguides, line source, scattering and radiation by circular cylinders, plane wave spectrum representation, scattering and radiation due to discontinuities in cylindrical structures.

   F. Spherical Wave Functions: Ch 10 — 8 lecs
   Spherical Bessel functions, Legendre functions, spherical cavity, field representation in 3D, Debye potentials and multipole expansions, wave transformations, radiation and scattering from apertures in spheres and cones, physical limitations on antennas.

   G. No Classes [10/11, (Mon Schedule on 10/12), 11/11, 11/21-11/25]

   TOTAL — 39 lecs

2. Method of Instruction and Evaluation

A lecture mode of instruction will be used. One midterm (40%, 10/19: 7:00-9:00 pm) and one final exam (40%) are planned for the course. Homeworks will be assigned periodically and carry 20% of grade. No late homeworks will be entertained.

VI. **Lecture:**
Elab 325: 10:10-11:00 am

VII. **Office Hours:**
MW: 11:00-12:00 noon, Marcus 215 Conference Room.

VIII. **Course Website:**
http://www.ecs.umass.edu/ece/janaswamy/ECE_606/