## Fields and Waves 25762 Fall 2014

INSTRUCTOR: Amir Borji, Room 211 (Ext. 4381, aborji@sharif.ir)

#### LECTURES SCHEDULE: Sat/Mon 7:30-9:00 in Alef 13

#### TUTORIALS SCHEDULE: Sat 12:00-13:30

#### CLASS WEBSITE: http://sharif.edu/~aborji/25762/

#### TEXT and REFERENCES:

- Field and Wave Electromagnetics, by D. K. Cheng, 2<sup>nd</sup> edition, 1989 Addison-Wesley Publishing Co. (Chapters: 7,8,9,10)
- 2. *Fields and Waves in Communication Electronics*, by S. Ramo, J. R. Whinnery, and T. van Duzer, 2<sup>nd</sup> edition, 1984 John Wiley & Sons Inc. (chapters: 3,4,5,6,8)
- Electromagnetic Waves, D. H. Staelin, A. W. Morgenthaler, J. A. King, 1994, Prentice Hall Inc (Chapters: 1,3,4,5,6,7)

In addition, the following books are **strongly** recommended:

- 4. *Electromagnetic Waves and Antennas*, by S. J. Orfanidis, an excellent <u>online textbook</u> at http://www.ece.rutgers.edu/~orfanidi/ewa, 2008, (Chapters: 1,2,3,5,6,7,9,10,12)
- 5. *Microwave Engineering*, by D. M. Pozar, 3<sup>rd</sup> Ed., 2005, John Wiley & Sons
- 6. Engineering Electromagnetics, by U. S. Inan and A. S. Inan, 1999 Addison Wesley Inc.
- 7. Electromagnetic Waves, by U. S. Inan and A. S. Inan, 2000 Prentice-Hall Inc

#### **EVALUATION:**

**Mid-term exam:** there will be two mid-term exams (40-50% total) **Final exam:** 40-50% **Homeworks, quizzes, and attendance:** 10-15%

Quizzes: There will be a short quiz at the end of each lecture

Attendance: If you are absent in 6 lectures, you fail the course with no exceptions. Students are not allowed in class 15 minutes after the lecture starts

## *"TENTATIVE"* COURSE OUTLINE:

#### Introduction to Electromagnetic Waves and Their Applications

#### <u>Maxwell's Equations</u>

- ♦ Maxwell's equations, Faraday's and Ampere's law
- ♦ Phasor notation and Maxwell's equations in frequency domain
- ♦ Constitutive relations and media parameters, lossy medium
- ♦ Boundary conditions
- ♦ Wave equation, simple electromagnetic wave
- ◊ Conservation of power and Poynting theorem

- ♦ Lorentz gauge, retarded potentials, radiation field of a short dipole
- (\*) Relationship between field and circuit theory (KVL and KCL laws, inductors, capacitors, resistors)

# Midterm exam 1: Wed 93/07/30

#### <u>Transmission Lines</u>

- ◊ Transmission line equations in time and frequency domain
- ◊ Transmission line equations from field theory, TEM waves
- ♦ Lossy transmission lines
- ◊ Voltages, currents, input impedance, reflection, transmission, characteristic impedance
- ♦ Impedance transformations, impedance matching, and Smith Chart
- ◊ Propagation of pulses on dispersionless transmission lines, zigzag diagrams
- ♦ Microstrip lines, coaxial lines, two wire lines: design equations
- ◊ Introduction to S-parameters, two-port microwave networks

# Midterm exam 2: Wed 93/09/05

#### <u>Plane Electromagnetic Waves</u>

- ◊ Plane waves in unbounded medium
- ◊ Plane waves in lossy medium
- ♦ Polarization of plane waves
- ♦ Dispersion and wave velocities, pulse broadening
- $\diamond$  What happens if  $\varepsilon$  and/or  $\mu$  is negative? Metamaterials and DNG
- ◊ Propagation in dispersive media, Drude model, Lorentz model
- ◊ Simple cases of propagation in a uniaxial medium, Faraday rotation

## **Reflection and Refraction of Plane Waves**

- ♦ Normal incidence on conductors and dielectrics
- ♦ Oblique incidence on conductors and dielectrics
- ♦ Total reflection and critical angle, total transmission and Brewster angle
- ♦ Transmission line formalism, anti-reflection coating

#### Introduction to Waveguides

- ♦ Simplifying Maxwell's equations for propagating modes in one direction
- ◊ General properties of electromagnetic modes: TEM waves, TM waves, TE waves
- ◊ Parallel plate waveguide: mode charts, losses, field distributions, dispersion relation
- ◊ Rectangular waveguide: mode charts, losses, field distributions, dispersion relation
- ♦ Circular waveguide: mode charts, losses, field distributions, dispersion relation
- (\*) Dielectric waveguides: propagation in lossless dielectric slabs and *optical fibers*

# (\*) If time permits (\*)