1. Course Description

Fundamental concepts of electromagnetic waves, Maxwell’s equations, propagation of plane electromagnetic waves, theory and application of transmission lines, waveguides, antennas. Prerequisite: ELE411.

2. Course Objectives

The objective of the course is to introduce students to the basics of electromagnetic waves emphasizing on the propagation of electromagnetic waves in bounded and unbounded media.

Course learning Outcomes:
A student who has successfully completed this course should be able to:
1. Understand the basics of time-varying fields and Maxwell’s equations.
2. Understand the propagation of time-harmonic plane-wave fields in an unbounded homogeneous medium.
3. Determine the major medium propagation parameters.
4. Understand the behavior of a plane wave incident on a plane boundary.
5. Understand the time-harmonic steady-state properties of transmission lines.
6. Determine the transmission line parameters.
7. Apply the transmission line equations.
8. Use the Smith chart to solve transmission line problems.
9. Solve basic line-matching problems.
10. Understand the discrete possible solutions of Maxwell’s equations along uniform guiding structures.
11. Understand the general wave behavior in parallel-plate waveguides.
12. Understand the general wave behavior in rectangular waveguides.
13. Understand the origin of wave distortions along guiding structures.
14. Understand the basics of the propagation of TEM, TE and TM waves along waveguides.
15. Understand the significance of the major antenna parameters.
16. Understand the advantages of employing antenna arrays.

3. Contribution of course to meeting the requirements of ABET Criterion 5

<table>
<thead>
<tr>
<th>Professional Component</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Mathematics and Basic Sciences</td>
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<tr>
<td>Engineering Topic</td>
<td>3</td>
</tr>
<tr>
<td>General Education</td>
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</tbody>
</table>

4. Relationship of course to program outcomes

PO (a): ability to apply knowledge of mathematics, science, and engineering
Applies knowledge of:
• electricity and magnetism

PO (c): ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
• Expresses unambiguous needs and identifies objectives and requirements
• Performs design or solve problems using knowledge and alternatives when applicable

PO (e): an ability to define, formulate, and solve engineering problems
Demonstrates an ability to formulate engineering problems, to recognize and identify the basic governing theories and principles in the following areas
• electrical circuits
5. **Course Outline**

**Plane electromagnetic waves in unbounded media** (2.5 weeks)
- Plane waves is lossless media
- Transverse electromagnetic waves
- Doppler effect
- Polarization of plane waves
- Plane waves in lossy media
- Phase velocity and group velocity
- Flow of electromagnetic power and the Poynting vector

**Incidence of plane waves on plane boundaries** (3.5 weeks)
- Normal incidence at a plane conducting boundary
- Oblique incidence at a plane conducting boundary
- Normal incidence at a plane dielectric boundary
- Oblique incidence at a plane dielectric boundary

**Transmission lines** (5 weeks)
- TEM waves along parallel-plate transmission lines
- Transmission line equations
- Wave characteristics on finite transmission lines
- Transmission lines as circuit elements
- Smith chart calculations for lossless lines
- Smith chart calculations for lossy lines
- Quarter-wave transformers
- Single-stub matching
- Double-stub matching

**Waveguides** (3 weeks)
- General Wave behavior along uniform guiding structures
- Electromagnetic modes and the cutoff frequency
- Transverse electromagnetic waves
- Transverse magnetic waves
- Transverse electric waves
- Parallel-plate waveguides
- Rectangular waveguides

**Antennas and radiating systems** (1.5 weeks)
- The elemental electric dipole
- The elemental magnetic dipole
- Linear dipole antennas
- Antenna patterns
- Beamwidth and sidelobe levels
- Directivity and directive gain
- Broadside and endfire two-element antenna arrays
- The principle of pattern multiplication

6. **Required tools / software / skills**

N.A.

7. **Textbook[s]**


8. **Additional References**


9. **Schedule of Exams & Grading Percentage**

<table>
<thead>
<tr>
<th></th>
<th>Grading Weight</th>
<th>Tentative Schedule</th>
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<tbody>
<tr>
<td><strong>Exam 1</strong></td>
<td>(25% or 30%)*</td>
<td>November 11, 2010</td>
</tr>
<tr>
<td><strong>Exam 2</strong></td>
<td>(25% or 30%)*</td>
<td>December 16, 2010</td>
</tr>
<tr>
<td><strong>Final Exam</strong></td>
<td>35%</td>
<td>As scheduled by registrar</td>
</tr>
<tr>
<td><strong>Quizzes</strong></td>
<td>10%</td>
<td>≈ 1.5/month</td>
</tr>
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</table>

* 25% on min(Exam 1, Exam 2) and 30% on max(Exam 1, Exam 2).
10. **Course Policies**

- Failure to take a test or the final exam during the assigned class period will result in a grade of zero being recorded for that test unless the student has personally contacted me and received permission to be absent from the test.
- No makeup exams will be given for the two midterms. In case a student fails to take a midterm exam, the grading percentage will be as follows: 15% on the quizzes, 35% on the other midterm and 50% on the final exam.
- Makeup exams will be given for students who fail to attend the final exam.
- The student is responsible for all business conducted announcements made during any scheduled class period. LAU attendance policies are enforced.

11. **General Comments**

Homework sets will be given on a regular basis and their solutions will be posted on the course website. Most of the homeworks will be solved in class. Even though homeworks will not be graded, they are critical to learning the material and to doing well on the midterms and final exam. Homework questions will appear regularly in quizzes and they may also appear in the tests. You are encouraged to discuss the homework with your colleagues.

In order to get the most out of the course, try to stay ahead. Before attending a lecture, make sure you have reviewed the material covered in the previous lectures. Read the assigned material, but at a minimum, make sure to review the slides posted on the course website. This way, lectures will be much more informative and meaningful. Studying on a daily basis will be very fruitful since quizzes count for 10% of the final grade.

It is intended that the overall work required be approximately six hours per week, including three hours of lecture. Students who find themselves spending substantially more than six hours any week should question whether they are stuck and might make more rapid progress if they asked the instructing staff for some hints or advice. I am available at these office hours:

Office Hours: MW 10:00 - 01:00, TH 11:00 – 01:00 or by appointment.
Office: Bassil 102.
Email: chadi.abourjeily@lau.edu.lb
Course Website: http://services.sea.lau.edu.lb/academia/courses/ele413/

12. **General Rules & Regulations**

- A student can miss no more than 4 sessions of instruction. By the 5th session, the instructor may ask the student to drop the course.
- Plagiarism: students caught cheating on an exam receive a grade of zero on the exam in the first cheating attempt and a warning. Students caught cheating for the second time in the same course receive an F grade in the course and a second warning. A grade of zero on an exam resulting from cheating must be counted in the student's course grade. The zero cannot be dropped in computing the final grade in case the instructor has a policy of allowing students to drop their worst exam grade.
- Any student who receives 3 warnings will be suspended.

13. **Person(s) who prepared this description and date of preparation**

Chadi Abou-Rjeily, September 27, 2010