ECE4391 Course Syllabus

ECE4391

Electromagnetic Compatibility (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Peterson,Andrew F.

Prerequisites
ECE 3025 [min C] and ECE 3040 [min C]

Corequisites
None

Catalog Description
To study electromagnetic interference and susceptibility of electrical systems, with application to analog and digital circuits.

Textbook(s)
Ott, *Electromagnetic Compatibility Engineering* (1st edition), John Wiley, 2009. ISBN 9780470189306 (required)

Course Outcomes
Upon successful completion of this course, students should be able to:

1. Explain the basic causes of most electromagnetic compatibility (EMC) problems and implement design techniques that minimize those problems.
2. Interpret FCC limits on radiated emissions and be able to estimate those emissions for circuit subsystems.
3. Calculate self and mutual capacitance and inductance for simple configurations of conductors.
4. Estimate the noise coupled from one circuit to another through mutual capacitance and mutual inductance.
5. Distinguish between differential-mode and common-mode currents, and be able to design devices such as common-mode chokes to suppress unwanted common mode currents.
6. Explain some of the nonidealities of standard circuit components.
7. Predict the high frequency content of digital signals based on their rise time and other characteristics.
8. Describe the differences between analog and digital circuits and the various sources of analog circuit and digital circuit noise .
9. Design decoupling capacitors to reduce switching noise in digital circuits.

10. Design shields for near and far sources of electric and magnetic fields.
11. Determine cavity resonant frequencies and circuit board resonant frequencies and explain their potential impact on EMC applications.
12. Explain the mechanisms by which materials become electrically charged, the possible effects of electrostatic discharge on electronics, and some mitigation techniques.

Student Outcomes

In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (M) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (M) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (LN) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

1. Introduction to EMC problems
2. Self and Mutual Capacitance
3. Self and Mutual Inductance
4. Capacitive & Inductive coupling
5. Signal grounding & Ground loops
6. Common-mode chokes and Balanced circuits
7. Ideal RLC circuits in the time and frequency domains
8. EM Fields in Lossy Media
9. Conductors and Non-ideal Resistors
10. Non-ideal Capacitors & Inductors
11. Ferrite beads
12. Power Supply Noise & Decoupling
13. Spectra of electrical signals
14. Reflection and Crosstalk Noise in Digital Circuits
15. Switching Noise & Decoupling in Digital Circuits
16. Common-mode and Differential-mode Radiation
17. Shield design for far-field and near field sources
18. Cavity and Circuit Board Resonances
19. Electrostatic charging mechanisms and discharge mitigation