NORTHERN ARIZONA UNIVERSITY

College of Engineering, Forestry & Natural Sciences
Department of Electrical Engineering & Computer Science

EE 364: FUNDAMENTALS OF ELECTROMAGNETICS

Course Syllabus, Fall 2015

Instructor: Dr. Abolfazl Razi
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Office Hrs: M,W 10:00-12:00 a.m., Th 11:00 a.m.-1:00 p.m., or by appointment

Class Times:	Lectures (3 credit hrs):	MWF	9:10-10:00 a.m., Engineering, Room 224
	Lab (1 credit hr):	#1 - W	2:20-4:50 p.m., Engineering, Room 234
		#2 - Th	2:20-4:50 p.m., Engineering, Room 234

Classroom: 224
Prerequisite: PHY 262 with a grade of "C" or better.

Required Textbooks: one of the following

1- Fundamentals of Applied Electromagnetics by Fawwaz Tayssir Ulaby, Eric Michielssen, Umberto Ravaioli, Prentice Hall, ISBN 0132139316, 6th or 7th edition

2- Fundamentals of Engineering Electromagnetics by David Keun Cheng, Addison-Wesley Publishing Company, ISBN 0201566117

3- Electromagnetics by John Daniel Kraus, Mcgraw-Hill Publishing Company, ISBN-13: 978-0070356214, ISBN-10: 0070356211, 4th Edition

- The first text book is strongly recommended. Additional materials will be posted on BbLearn and / or distributed in class.

Catalog Description:

Introduction to vector operation, Static electric and magnetic fields. Electric and magnetic fields with boundary conditions. Time varying electromagnetic fields and Maxwell's equations. Application to traditional circuit theory, RF circuit components, transmission lines, electromagnetic interference and electromagnetic compatibility. Letter grade only. Course fee required.

Course Content: (4 credit hours – 3 lecture, 1 lab)

- 1st Quarter, review on vector operation including scalar and vector fields, (line, surface and volume) integrals, vector multiplications, orthogonal coordinates, gradient, divergence and Laplacian operations

- 2nd Quarter, Electrostatics: Electric force, electric field, electric potential, materials' electric properties, Method of images.
- 3rd Quarter, Magnetostatics and Inductance: Magnetic force, magnetic field, materials' magnetic properties, curl / circulation, induced EMF, transformers.
- 4th Quarter: Maxwell's equations, frequency domain, plane waves, polarization, transmission / reflection, antennas, decibels, pathloss, Review on Transmission lines (impedance, VSWR, Smith chart), skin depth, Smith chart.

There will be an exam after completing each quarter. The three in-class exams will be at the last week of September, October, November with advance notice. These dates are subject to minor changes. The final exam is scheduled on Dec 16, 7:30-9:30 as announced by NAU website.

Grading: Final letter grades will be assigned as follows:

A:	≥ 90%
B:	≥ 80% and < 90%
C:	≥ 70% and < 80%
D:	≥ 60% and < 70%
F:	< 60%

Course grades will be calculated as follows:

Homework:	10%
Quiz and In-Class Activity	10%
Lab Activities:	20%
Two Highest In-Class Exams:	15% each
Lowest In-Class Exam:	5%
Comprehensive Final Exam:	25%

Homework and/or in-class activities will be assigned and discussed at least biweekly. Lab activities will vary significantly in difficulty level and time required, and grading will be weighted accordingly. At least two lab activities will require a formal, professional report. There will be three in-class exams and a comprehensive final. Grades will be based not only upon technical content but also on presenting your work in a well-organized, neat, clear, and professional manner using standard technical terms and symbols.
There will be an optional final project and the students will develop a GUI in MATLAB to visualize two given electromagnetics concepts. The project grade will be up to 10% of the final grade based on correctness, creativity, reporting and ease of use. The students also are encouraged to develop a visualization tools for their choice of electromagnetics and the score for this part will be up to 10% of the final grade.

Students should inform the instructor of any significant, scheduled "life events" – such as religious ceremonies, away games for NAU athletes, weddings, etc. – as soon as possible, at least 2 weeks ahead of time. Given these conditions, exams will not be scheduled on those days, and make-up work will be assigned and due *before* the student leaves for the event.

The following policies were designed to account for unexpected, emergency life events that may happen to some students, while maintaining fairness for all students. The lowest homework grade will be dropped and one missed in-class activity will be dropped. If you attend all class sessions, your second-lowest homework grade will be dropped. A "standard" lab that is missed can be made up during reading week; the Junkyard Generator and Emag Buffet labs extend across several weeks and are therefore not replaceable. No late assignments (including lab reports) will be awarded points, and no extra credit assignments will be given. Definition of Late: Electronic submissions received even one minute after a deadline will not receive credit, and paper homework submitted more than 5 minutes after class starts will not receive credit. Students are strongly encouraged to complete all assignments to prepare for the examinations, and the instructor will be available to review late assignments or extra problems with a student.

No other grading accommodations will be made, with the exception of extreme cases where the university administration becomes involved, such as extended hospitalization.

University and College Policies: This course is conducted in accordance with all applicable university policies. For example, students should be familiar with and must conduct themselves in accordance with the following policies:

- NAU Student Code of Conduct:
  http://www4.nau.edu/stulife/handbookcode.htm
- Disciplinary Action:
  http://www4.nau.edu/stulife/handbookdisciplinary.htm
- NAU Class Management Policy
  http://www4.nau.edu/stulife/handbookmanagement.htm
- NAU Academic Integrity Policy
  http://jan.ucc.nau.edu/academicadmin/policy1.html
- NAU Code of Ethics
  http://jan.ucc.nau.edu/~blutz/academic_affairs/Professional_Ethics-Code_of_Conduct.doc
- Safe Working and Learning Environment:
  http://oak.ucc.nau.edu/dam1/Safe%20Policy.htm
- Students with Disabilities:
  http://www2.nau.edu/dss/
- Institutional Review Board:
  http://www.research.nau.edu/vpr/IRB/index.htm
- Plagiarism Guidance:
  http://www.nau.edu/library/information/guides/plagiarism.html

In addition, laptop computers may only be used for class activities during class time, texting during class is not allowed, and cell phone ringtones should be muted. Students should make every effort to be in their seats and ready when class begins. In the rare cases where being tardy is unavoidable, the student should enter the class as quietly as possible so that other students are not disturbed. Students who are late more than twice in a semester will have points deducted from their participation grade and might not be allowed to join the class in progress.

Student Learning Outcomes:

After participating in this course, a student will be able to:

- Mathematically compute and describe the physical interpretation of vector calculus operations including gradient, divergence, and curl.
- Interpret visualizations of electric fields, electric scalar potentials, and magnetic fields in terms of the forces that charged particles or currents would experience.
- Sketch the electric fields, electric scalar potentials, and magnetic fields associated with a given set of charges and currents.
- Discuss the superposition principle and describe its physical interpretation.
- Describe the parameters used to characterize a material's response to electromagnetic fields and how these parameters are affected by variables such as temperature, frequency, and field strength.
- Discuss the primary categories of materials, in electromagnetic terms, and how those materials respond to electric and magnetic fields. Sketch the deformation of external fields near different types of materials.
- Describe the theory of magnetic induction and what variables could be altered to increase the electromotive force (EMF) produced by an electric generator.
- Utilize image theory to simplify an electromagnetics problem, and describe the physical processes that image theory represents.
- Mathematically describe plane waves of various polarizations and propagation directions, in the frequency domain. Interpret the ideal plane wave model in physical terms.
- Calculate the reflected and transmitted power and propagation directions when a plane wave propagates between two dissimilar materials.
- Calculate the decay in signal strength as a plane wave propagates through various materials.
- Calculate the reflection coefficient, VSWR, reflected and transmitted power in a transmission line with various loads. Determine these values mathematically and using a Smith chart.
- Describe the characteristics of several standard antennas, including the benefits and drawbacks of each type.
- Select an appropriate polarization, frequency, and antenna type for a given transmission application. Calculate polarization loss and path loss.
- Convert between linear and logarithmic power values. Convert between common values without a calculator. Describe the expected accuracies in various power measurements.

- Apply the knowledge and understanding described above to explain how electromagnetic phenomena are utilized in various technical devices.
- Build upon the knowledge and understanding described above to utilize electromagnetic phenomena in novel designs.