COURSE OUTLINE

PHYS 340 – ELECTROMAGNETISM

Prepared By: Dr. Lawretta Ononye

CANINO SCHOOL OF ENGINEERING TECHNOLOGY
PHYSICS
MAY 2015
A. **TITLE:** ELECTROMAGNETISM

B. **COURSE NUMBER:** PHYS 340

C. **CREDIT HOURS:** 3

D. **WRITING INTENSIVE COURSE:** No

E. **COURSE LENGTH:** 15 weeks

F. **SEMESTER(S) OFFERED:** Fall/Spring

G. **HOURS OF LECTURE, LABORATORY, RECITATION, TUTORIAL, ACTIVITY:**  
3 lecture hours per week

H. **CATALOG DESCRIPTION:**  
This course is an intermediate level presentation of the physics of the electromagnetic field. The course will explore the applications of electromagnetism in medicine (magnetic resonance imaging), and the interdependencies between electric and magnetic fields which are the essence of the theories of circuits, lines, antennas and guided waves. Topics include Electric and magnetic fields using vector methods, Gauss’s law, theory of dielectrics, Ampere’s law, Faraday’s law, vector potential, displacement current, Maxwell’s equations, wave propagation in dielectrics and conductors, and production and propagation of radiation.

I. **PRE-REQUISITES/CO-REQUISITES:**  
a. Pre-requisite(s): University Physics II or College Physics II; Calculus II; or permission of the instructor.  
b. Co-requisite(s): None

J. **GOALS (STUDENT LEARNING OUTCOMES):**  
By the end of this course, the student will be able to:

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<th>Course Objective</th>
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| a. State the laws of electromagnetism, examine the sources of electromagnetic radiation and relate its importance in terms of practical applications. | 1. Communication  
2. Crit. Thinking  
3. Prof. Competence |
| b. Integrate how the interdependencies between electric and magnetic fields are the essence of the theories of circuits, lines, antennas, propagation, and guided waves. | 2. Crit. Thinking  
3. Prof. Competence |
| c. Examine the reflection and refraction of waves at boundaries; and the scattering of waves by free and bound electrons. | 2. Crit. Thinking  
3. Prof. Competence |
| d. Analyze how accelerated charges produce electromagnetic radiation. | 2. Crit. Thinking  
3. Prof. Competence |
| e. Apply Maxwell's equations to describe the propagation of electromagnetic waves in vacuum. | 1. Communication  
2. Crit. Thinking  
3. Prof. Competence |
f. Compare and contrast the propagation of waves in dielectrics and conductors.


L. **REFERENCES:** None

M. **EQUIPMENT:** Technology enhanced classroom

N. **GRADING METHOD:** A-F

O. **MEASUREMENT CRITERIA/METHODS:**
   - Exams
   - Quizzes
   - Homework
   - Participation
   - Project/Presentation

P. **DETAILED COURSE OUTLINE:**

I. Electrostatics
   A. Introduction
   B. Electrostatic energy
   C. Ohm's law
   D. Conductors
   E. Boundary conditions on the electric field
   F. Capacitors
   G. Poisson's equation
   H. The uniqueness theorem
   I. One-dimensional solution of Poisson's equation
   J. The method of images
   K. Complex analysis
   L. Separation of variables

II. Time-independent Maxwell equations
   A. Introduction
   B. Coulomb's law
   C. The electric scalar potential
   D. Gauss' law
   E. Poisson's equation
   F. Ampère's experiments
   G. The Lorentz force
   H. Ampère's law
   I. Magnetic monopoles?
   J. Ampère's circuital law
   K. Helmholtz's theorem
   L. The magnetic vector potential
   M. The Biot-Savart law
   N. Electrostatics and magnetostatics

III. Time-dependent Maxwell's equations
   A. Introduction
B. Faraday's law
C. Electric scalar potential?
D. Gauge transformations
E. The displacement current
F. Potential formulation
G. Electromagnetic waves
H. Green's functions
I. Retarded potentials
J. Advanced potentials?
K. Retarded fields

IV. Dielectric and magnetic media
   A. Introduction
   B. Polarization
   C. Boundary conditions for \( \mathbf{E} \) and \( \mathbf{D} \)
   D. Boundary value problems with dielectrics
   E. Energy density within a dielectric medium
   F. Magnetization
   G. Magnetic susceptibility and permeability
   H. Ferromagnetism
   I. Boundary conditions for \( \mathbf{B} \) and \( \mathbf{H} \)
   J. Boundary value problems with ferromagnets
   K. Magnetic energy

V. Magnetic induction
   A. Introduction
   B. Inductance
   C. Self-inductance
   D. Mutual inductance
   E. Magnetic energy
   F. Alternating current circuits
   G. Transmission lines

VI. Electromagnetic energy and momentum
   A. Introduction
   B. Energy conservation
   C. Electromagnetic momentum
   D. Momentum conservation

VII. Electromagnetic radiation
   A. Introduction
   B. The Hertzian dipole
   C. Electric dipole radiation
   D. Thompson scattering
   E. Rayleigh scattering
   F. Propagation in a dielectric medium
   G. Dielectric constant of a gaseous medium
   H. Dielectric constant of a plasma
   I. Faraday rotation
   J. Propagation in a conductor
   K. Dielectric constant of a collisional plasma
   L. Reflection at a dielectric boundary
   M. Wave-guides
Q. LABORATORY OUTLINE: N/A