NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF SCIENCES

PHYSICS PROGRAM

CF372 – ELECTROMAGNETISM I

I. GENERAL INFORMATION

CODE	: CF372 – Electromagnetism I
SEMESTER	: 6
CREDITS	: 08
HOURS PER WEEK	: 10 (Theory – Laboratory)
PREREQUISITES	: CF222 Physics IV CF391 Mathematical Methods for Physicists II
CONDITION	: Mandatory

II. COURSE DESCRIPTION

Familiarize the student with electromagnetic theory, highlighting the mathematical description of the electrical and magnetic phenomena in vacuum and in matter. Recognize the dynamic properties of the electromagnetic field including the conservation laws.

III. LEARNING UNITS

1. Electrostatic Fields in the Void

Coulomb's law / Electric field / Gauss's law. Electrostatic potential / Conductors, insulators, semiconductors / Multipolar expansion / Electric dipole. Electric quadrupole / Dipoles and quadrupoles interaction with external electric fields.

2. Solution of electrostatic problems

Laplace and Poisson's equations / Dirichlet and Neumann's boundary conditions / Laplace equation with an independent variable / Rectangular, cylindrical and spherical coordinates. Curvilinear coordinates in general / Laplace equation with two variables / Conductive sphere in an initially uniform electric field / Method of images / Conductor system. Potential and capacity coefficients.

3. Electrostatic Fields in a Dielectric Medium

Dielectric / Polarization. Potential and electric field in a polarized dielectric / Displacement. Gauss's law / Isotropic and anisotropic dielectrics / Boundary conditions

/ Laplace equation / Dielectric sphere in an initially uniform electric field / Method of images.

4. Dielectrics' Microscopic Theory

Molecular field in a dielectric / Induced dipoles / A simple model / Polar molecules. Langevin-Debye Formula / Permanent Polarization / Ferroelectricity.

5. Electrostatic Energy

Electrostatic energy / Energy density / Energy of a loaded conductor system / Potential coefficients / Forces and torques.

6. Electric current

Current nature. Current density / Continuity equation / Ohm's law. Conductivity / Boundary conditions / Electrical resistance.

7. Magnetic field

Charges movements in magnetic fields / Reference systems / Transformation of electric and magnetic fields / Biot and Savart's Law / Ampere's Law / Magnetic vector potential / Magnetic scalar potential / Magnetic flux.

8. Electromagnetic Induction

Faraday's Law / Auto inductance. Inductance / Newmann's formula.

9. Magnetic properties of matter

Magnetization / Magnetic field of a magnetized material / Magnetic field functions. Magnetic scalar potential / Susceptibility and magnetic permeability / Hysteresis. Problems with boundary conditions / Magnetic circuits.

10. Magnetic energy

Magnetic energy / Energy density / Forces and torques.

11. Slowly varying current

Kirchoff's Laws / LCR Circuits / Power and Power Factor / Resonance.

12. Maxwell's equations

Maxwell's equations and their empirical bases / Electromagnetic energy. Wave equation / Monochromatic waves in a conductive medium / Reflection and refraction laws.

IV. BIBLIOGRAPHY

- J. R. Reitz and F. J. Milford, Foundations of Electromagnetic Theory, Addison Wesley, 1962.

- E. R. Peck, Electricity and Magnetism, McGraw Hill, 1953.
- E. M. Pugh and E. W. Pugh, Principles of Electricity and Magnetism, Addison Wesley, 1962.

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