NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ELECTRICAL AND ELECTRONICS ENGINEERING

ELECTRICAL ENGINEERING PROGRAM

EE521 – ELECTROMAGNETIC PROPAGATION AND RADIATION I

I. GENERAL INFORMATION

CODE	**:**	EE521 – Electromagnetic Propagation and Radiation I
SEMESTER	**:**	6
CREDITS	**:**	04
HOURS PER WEEK	**:**	05 (Theory – Practice)
PREREQUISITES	**:**	FI463
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The course prepares the student in learning and the application of the laws and concepts of electromagnetism, specifically magnetostatics, Faraday's law and Maxwell's Equations.

III. COURSE OUTCOMES

At the end of the course the student will:

- Know how to calculate the magnetic field, potential magnetic vector in engineering systems, for example transmission lines.
- Know how to calculate the inductance in electrical systems.
- Know how to calculate the induced voltage.
- Know how to calculate the reflection and transmission of electromagnetic waves.

IV. LEARNING UNITS

1. MAGNETOSTATICS IN THE VACUUM
Entrance test, Law of Ampere forces, Law of Biot and Savart. Ampere circuit law, applications. Magnetic flux. Vector potential Differential equation of the vector potential. Magnetic field due to a magnetic dipole, applications. Moment of magnetic rotation (magnetic torque). Use of computational tools for vacuum magnetostatics: Matlab Pdetool.

2. MAGNETOSTATICS IN MATERIAL MEDIA
Magnetization, Density of magnetization currents. Density of magnetic poles, applications. Classification of materials. Magnetic susceptibility. Absolute, relative permeability. Magnetic intensity field, Magnetic circuits. Use of computational tools for magnetostatics in material media: Matlab Pdetool.

3. GENERAL METHODS FOR SOLVING MAGNETOSTATIC PROBLEMS
Laplace equation for magnetic scalar potential. Solution of the Laplace equation in cylindrical and rectangular spherical. Image methods Use of computational tools for magnetostatics in material media: Matlab Pdetool.

4. **FARADAY INDUCTION LAW**
   Faraday induction law. Faraday's Law based on electromagnetic fields. Faraday Law for stationary circuits and moving circuits. Applications to the electric generator. Own inductance, mutual inductance, Neumman formula. Applications of inductance calculation for transmission lines.

5. **MAGNETOSTATIC ENERGY**
   Magnetic energy of coupled circuits. Magnetic energy as a function of magnetic fields. Magnetic force through magnetic energy. Losses from Eddy currents. Hysteresis losses.

6. **MAXWELL EQUATIONS**
   Vacuum flat electromagnetic waves. Maxwell equations. Phasorial Maxwell equations. Electromagnetic power flow, Poyting vector. Normal incidence of electromagnetic waves for two and three media. Reflection and transmission coefficient. Standing waves, standing wave ratio. Polarization of electromagnetic waves. Electromagnetic waves in dissipative media. Classification of a medium, Tangent of losses.

V. LABORATORIES AND PRACTICAL EXPERIENCES

- Magnetostatics in a vacuum.
- General methods to solve magnetostatic problems.
- Induction Law of Faraday, Magnetic Energy.
- Maxwell's equations.

VI. METHODOLOGY

The course is developed in sessions of theory, practice. In the theory sessions, the teacher presents the laws, concepts, theorems and applications of electromagnetism. In the practical sessions, various problems are solved and their solution is analyzed. In all sessions the active participation of the student is promoted.

VII. EVALUATION FORMULA

The learning will be evaluated through the "G" system.

- Partial Exam (PE): Weight 1
- Final Exam (FE): Weight 1
- Average of Practices (P): Weight 1.

$$\boldsymbol{FA} = \frac{\boldsymbol{PE + FE + P}}{\boldsymbol{3}}$$

VIII. BIBLIOGRAPHY

- David Cheng “Fundamentals of Electromagnetism for Engineering” Addison-Wesley 1998 1st reprint
- William H. Hayt "Electromagnetic Theory" McGraw-Hill 2006 Seventh Edition
- Reitz Milford C “Fundamentals of Electromagnetic Theory” Addison-Wesley Fourth Edition