NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF ELECTRICAL AND ELECTRONICS ENGINEERING

ELECTRICAL ENGINEERING PROGRAM

EE225 – ELECTRICAL MACHINES III

I. GENERAL INFORMATION

CODE	**:**	EE225 – Electrical Machines III
SEMESTER	**:**	8
CREDITS	**:**	03
HOURS PER WEEK	**:**	04 (Theory – Practice – Laboratory)
PREREQUISITES	**:**	EE214 – Electrical Machines II
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The course prepares the student in theoretical concepts, which allow the modeling of electric machines for transient analysis and control. In the case of alternating current machines, an orientation is given to obtain the models, used in the control, fault analysis and stability in power systems. Likewise, the induction machine model and the Vector Control are presented.

III. COURSE OUTCOMES

At the end of the course the student will:

- Explain Maxwell's equations for the magnetic field generated in electric machines.
- Be able to model all types of electric machines by formulating the electrical and mechanical equations with the corresponding binding equations to analyze the particular case of operation of the electric machine.
- Be able to describe the transitory state at the time of operating an electric machine.
- Acquire solid knowledge about the transients in the speed and the armature current in the DC machine.
- Be trained to understand the vector control applied to induction models.

IV. LEARNING UNITS

1. **GENERALIZED MACHINE**
   Model d-q machine modeling / Determination of own and mutual inductance parameters / Rotational inductance.

2. **THE GENERALIZED SWITCHING MACHINE**
   Electrical and mechanical equilibrium equations of the generalized machine model d-q / Electromagnetic torque, for transient analysis / Obtaining the equations of DC machines / Operation as motor and generator / Transient processes in DC machines / Start of DC motors and transitory.

3. **CONTINUOUS CURRENT MACHINES**
   Shunt generator self-excitation / Short-circuit in terminals of direct current generators / Equilibrium equations for amplidine.

4. **THE GENERALIZED MACHINE OF RUBBER RINGS**
   Transformation of the equations of the generalized brush ring machine into the form of the equations of the generalized switch machine (d-q axes fixed to the rotor) / Equations for an orthogonal system of d-q axes traveling at an arbitrary speed / Machine application Generalized friction ring to obtain the equations of: reluctance motor, synchronous machine and asynchronous biphasic machine.

5. **THE SYNCHRONOUS MACHINE, MODELING AND TRANSITIONAL PROCESSES**
   Electrical parameters and equations of the outgoing pole synchronous machine / Transformation of the equations into the form of the equations of the generalized switching machine / Electromagnetic torque, equivalent circuits in direct and quadrature axes / Equations of the synchronous machine in relative units, state stationary / Equation of rotor movement in relative units, oscillation equation of the synchronous generator / Transients caused by variations in the excitation current, effect of the damping winding / Reactances and operational equivalent circuits, reactances and transient and subtransory time constants / Transient during symmetrical short circuit in synchronous generator terminals, damping winding effect / Static and dynamic stability / Area Method.

6. **DYNAMIC EQUATIONS OF THE JAULA DE ARDILLA MACHINE**
   Electrical parameters and equations of the asynchronous machine / Transformation to the friction ring machine / Transformation to the equations of the generalized switch machine / Total variance decomposition / Determination coefficient / Estimation errors / Correlation coefficient / Prediction intervals / Hypothesis tests of regression coefficients.

7. **VECTOR CONTROL OF THE "SQUIRREL BOX" MACHINE**
   Electromagnetic torque and equivalent circuits in both axes / Equations of movement in relative units / Transients of connection of the machine to the network / Reactance and operational equivalent circuit, reactance and transient time constant / Sub-transient effect in asynchronous motors / Transient during symmetrical short circuit in terminals of the asynchronous machine / Transforming the dynamics of the induction machine from coordinates a-b-c to d-q / Orientation in the rotor flow / Torque calculation in the squirrel cage machine / Direct vector control scheme / Control scheme indirect vector.

V. METHODOLOGY

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

VI. 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.

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

VII. BIBLIOGRAPHY

- M. JEROME MEISEL, "Principles of Electromechanical Energy Conversion", MCGRAW.HILL, 1969.
- P.C. SEN, "Principles of Electric Machines and Power Electronics", JHON WILEY & SONS, 1997.
- SYED A. NASAR- ION BOLDEA, Electrical, Dynamic and Control Machines, 1995.
- JONES C. V., "THE UNIFIED THEORY OF ELECTRICAL MACHINES" BUTTERWORTHS, 1967.
- ADKINS B., "THE GENERAL THEORY OF ELECTRICAL MACHINES", CHAPMAN AND HALL, 1957.
- ADKINS, B., HARLEY; "THE GENERAL THEORY OF ALTERNATING CURRENT MACHINES", CHAPMAN AND HALL, 1975.
- CHEE-MUN ONG, “DYNAMIC SIMULATION OF ELECTRIC MACHINERY”, PRENTICE HALL PTR, 1998.
- LEONARD WERNER "CONTROL OF ELECTRICAL DRIVES" HEIDELBERG. - 1996. 2nd.