I. GENERAL INFORMATION

CODE : ML244 Rotating Electrical Machines
SEMESTER : 7
CREDITS : 4
HOURS PER WEEK : 6 (Theory–Practice-Laboratory)
PREREQUISITES : ML214 Static Electrical Machines,
CONDITION : Compulsory
DEPARTMENT : Mechanical - Electrical Engineering

II. COURSE DESCRIPTION

The course prepares students in the analysis and operation of DC and AC machines. Students understand the principles of operation, constructive and physical aspects, generator and motor behavior at stable regimen, efficiency and power losses. Students also analyze and apply the synchronous machine, understand its physical and constructive aspects, analyze the multi-phase asynchronous machine in stable regime, single-phase machines, as well as the physical and constructive aspects of AC motors.

III. COURSE OUTCOMES

At the end of the course, students:
1. Understand the principles of operation of DC and AC rotating machines.
2. Apply concepts of magnetic circuits with ferromagnetic cores to solve problems of rotating machines.
3. Solve circuitual models of AC and DC generators and machines to determine the electrical parameters.
4. Describe the constitution and components of AC and DC machines and generators, and explain their functioning principles.
5. Understand and apply safety regulations to prevent accidents at working with electricity.

IV. LEARNING UNITS

1. PRINCIPLE OF OPERATION OF DC MACHINES
   Principles of operation / Magnetic field produced by the stator / Determination of generated EMF / Function of the switch / Magnetic field produced by the rotor / Switching and interpoles Compensation windings / Electromagnetic torque / Problems.

2. PHYSICAL APPEARANCE AND CONSTRUCTION OF DC MACHINES
   General information / The poles / Field coils / Interpoles / Compensation windings / The yoke of stator / Brushes and brush holders / Armature core / Switching / Armature windings / Problems.

3. DC GENERATOR AT STABLE REGIMEN
   Generator equivalent circuit / Generator equations at stable regimen / Types of generators / Curves of generators / DC generators in parallel connection / Problems.

4. DC MOTOR AT STABLE REGIMEN
   Motor equivalent circuit / Motor equations at stable regimen / Types of motors / Power regulation of DC motors / Curves of the motor / Starting current and torque / Comparison of the characteristics of shunt, series and compound motors / DC motor speed control methods / Reverse direction of rotation of DC motors / Electric braking / Manual and automatic devices for starting DC motors / Electronic control of DC motors / Problems.
5. EFFICIENCY AND POWER LOSSES IN DC MACHINES
   Efficiency / Losses / Power balance of DC machines / Conventional efficiency / Problems.

6. PRINCIPLES OF OPERATION OF THE SYNCHRONOUS MACHINE
   General considerations / Magnetic fields of rotor and stator / Electromagnetic torque / Generation of EMF / Distribution and step factors / Equations to determine the EMF / Considerations in the operation of synchronous machines / Problems.

7. THE SYNCHRONOUS MACHINE AT STABLE REGIMEN

8. PHYSICAL ASPECTS AND CONSTRUCTION OF THE SYNCHRONOUS MACHINE
   General considerations / The rotor / The stator / Winding of armor / Forms of excitation / Ventilation and cooling of the alternators / Problems.

9. THE MULTI-PHASE ASYNCHRONOUS MACHINE AT STABLE REGIMEN

10. SINGLE-PHASE ENGINE

V. PRACTICAL EXPERIENCE
   Practice 1: DC machines.
   Practice 2: Synchronous machines.
   Practice 3: Asynchronous machines.
   Practice 4: Single-phase engines.

VI. METHODOLOGY
    The course takes place in theory and practice sessions. In theory sessions faculty presents the theory, concepts and methods. In practice sessions, students apply theory to solve diverse problems related to DC and AC generators and motors. At the end of the course, students submit and defend a final report. Student active participation is promoted throughout the course.

VII. GRADING FORMULA
    The Final Grade PF is calculated as follow:

    \[ PF = \frac{EP + 2*EF + PP}{4} \]

    EP: Mid-term Exam       EF: Final Exam
    PP: Average of practice grades.

VIII. BIBLIOGRAPHY
    1. FITZGERALD.
       Electrical Machinery.
    2. SISKIND
       Direct Current Machinery.
    3. KIMBARK