Electrical Machines

Code	Credit Hours
EE-260	3-1

Course Description

It is a compulsory course on Electrical Machines (AC and DC). It starts by building a strong foundation of Electrical Machines employing Electromechanical and Electromagnetic principles. From there on a thorough understanding of Construction and Working Principles are achieved and techniques are developed that help in Analysis of Electric Machinery. Finally, a comprehensive knowledge of the application of each type of equipment and its "Terminal Characteristics" is given that combines theory with practice. Equipment covered includes DC and AC Machines (Motors and Generators) and Transformers. The course also includes Single Phase AC and Special Purpose motors. Comprehensive laboratory exercises are an integral part.

Text Book:

1. Stephen J. Chapman, Electric Machinery Fundamentals, 4th Ed., McGraw Hill, 2005

Reference Book:

1. An Introduction to Electrical Machines and Transformers, John Wiley and Sons, 1981
2. A. E. Fitzgerald, Electric Machinery, 6th Ed., McGraw Hill, 2003

Prerequisites

EE-211 (Electric Network Analysis)

ASSESSMENT SYSTEM FOR THEORY

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

ASSESSMENT SYSTEM FOR LAB

Lab Work and Report	70-80%
Lab ESE/Viva	20-30%
Project	10-15%

Teaching Plan

Week No	Topics	Learning Outcomes
1	Introduction	Course Outline, objectives, teaching plan, assessment method, concepts review
2-6	Electro mechanical Systems, Transformers	1. Basic principles of Electromagnetism and Electromechanical systems a. Introduction to course – course objectives, outline and creation of interest b. Basics of Rotational Motion c. Basics of Electromagnetism d. Magnetic Circuit Analysis e. Faraday's Law and Lenz's Law f. Core Losses: Hysteresis Loss and Eddy Current Loss g. Real, Reactive, Apparent and Complex Power in AC Circuits 2. Theory, Construction, and Operation of Single-Phase and Three-Phase Transformers a. Types and Construction b. The Ideal Transformer c. The Real Transformer and its Equivalent Circuit d. No Load and Short Circuit Testing e. Transformer Voltage Regulation and Phasor Diagrams
7-8	The Principle of Operation of DC Machines. DC Motors	The Principle of Operation of DC Machines a. A simple Rotating Loop between Curved Pole Faces b. Commutation and Armature Construction c. Armature Reaction d. Construction of Real DC Machines e. Power Flow and Losses in DC Machines DC Motors a. The Equivalent Circuit of a DC Motor b. The Magnetization Curve of a DC Machine c. Separately Exited and Shunt DC Motors, their Terminal Characteristic and Speed Control d. The Permanent Magnet DC Motor e. The Series DC Motor and its Terminal Characteristic and Speed Control f. The Compounded DC Motor, its Terminal Characteristic and Speed Control
9	**MID TERM EXAM**	

10-12	DC Generators, AC machinery, Synchronous Generators	DC generators a. Introduction to DC Generators b. The Separately Excited DC Generator, its Terminal Characteristic and Terminal Voltage Control c. The Shunt DC Generator, its Terminal Characteristic and Terminal Voltage Fundamentals of AC machinery a. A simple loop in a uniform magnetic field b. The Rotating Magnetic Field c. Induced Voltage and Torques in AC Machines d. AC Machines Power Flows and Losses, Voltage and Speed Regulation 6. The Construction, Working Principles and Operation of the Three-Phase Synchronous Generator a. Construction b. Speed of Rotation c. Equivalent Circuit d. Phasor Diagrams e. Power and Torque f. Synchronous Generator Operating Alone g. Parallel Operation of AC Generators
13-17	Synchronous Motor, Three-Phase Induction Motor, Special Purpose Motors	The Working Principles and Operation of the Three-Phase Synchronous Motor a. Equivalent Circuit and Phasor Diagrams b. Torque-Speed Characteristic Curve c. Effect of Load Changes d. Effect of Field Current Changes (V-Curves) e. Using the Synchronous Motor for Power Factor Correction f. Starting Synchronous Motors and Amortisseur Windings The Construction, Working principles and Operation of the Three-Phase Induction Motor a. Construction b. Concept of Rotor Slip c. Electrical Frequency on the Rotor d. Equivalent Circuit e. Power and Torque f. Torque-Speed Characteristic The working principle and operation of AC Single Phase and Special Purpose Motors a. The Universal Motor b. Introduction to Single-Phase Induction Motors and Theory of Operation c. Starting Single-Phase Induction Motors d. Stepper Motors e. Brushless DC Motors
18	**End Semester Exams**	

Practical:

Experiment No	Description
Lab 01	Safety rules, Introduction to Laboratory Equipment and Work Benches
Lab 02	Measurement of Real, Reactive, Apparent Power in AC Circuits and Power Factor Calculation
Lab 03	Step-up and Step-down Operation of Transformers and its Power Ratings
Lab 04	No-Load Test of a Transformer and plugging values into the Equivalent Circuit
Lab 05	Short-Circuit Test of a Transformer and plugging values into the Equivalent Circuit
Lab 06	Torque-Speed Characteristic of the DC Shunt Motor
Lab 07	Torque-Speed Characteristic of the DC Series Motor
Lab 08	Torque-Speed Characteristic of the DC Compound Motor
Lab 09	Terminal Characteristic of the DC Shunt Generator
Lab 10	Open-Circuit Characteristic, Short-Circuit Characteristic of the Synchronous Generator
Lab 11	V-Curves of the Synchronous Motor
Lab 12	Torque-Speed Characteristic of the Squirrel Cage Induction Motor (SCIM)
Lab 13	Torque-Speed Characteristic of the Universal Motor on both AC and DC Supplies
Lab 14	Torque-Speed Characteristic of the Single-Phase AC Capacitor Start Induction Motor