Course Name	**DC Machines**
Course Code	EE-223
Credit Hours	3 (Theory) + 1 (Lab)
Marks	Theory (100) / Practical (50)
Semester	4th
Pre-requisites	Circuit Analysis
Course Instructor	Engr. Zeeshan Ahmad Arfeen *Assistant Professor*
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COURSE OBJECTIVES:

To understand the magnetic field and the reluctance of magnetic materials and air. Voltage-current characteristics and voltage regulation of generator. Torque speed characteristics and speed regulation of DC motors. Various techniques for starting, speed control, reversing and braking. Remedial measures of main problems occurring in DC machines. Generalized concepts of electromechanical energy conversion.

COURSE DESCRIPTION:

Basic principles governing the working of DC machines. Magnetic field, induced emf due to relative cutting of flux and conductor. Induced torque in current carrying conductor lying in magnetic field. Construction, working, characteristics and equivalent circuits of different types of DC generators and motors. Starting, speed control, braking and reversing of motors. Principles of electromechanical energy conversion

Recommended Text(s):

[1].Electric Machinery Fundamentals, Stephen J. Chapman McGraw –Hill international edition.

[2] Electric Machines, Charles I Hubert, Pearson Edition

Reference Book(s):

[1]. Principles of Electrical Machines,V.k Mehta
[2]. Electric Machines, D P Kothari ,Third edition
[3]. Principles of Electric Machines, P.C Sen, Second Edition

Course Plan:

Session #	Lectures [L]	Topics
Week 01	Lecture- 01	Introduction of Machinery principle, magnetic field.
	L- 02	Production of magnetic field, Reluctance , mmf , Magnetic field Intensity, permeability, relative permeability, numerical
	L- 03	Magnetic Circuits, Magnetic behavior of a ferromagnetic Materials, Energy losses in a ferromagnetic Core, Faraday's law, Production of induced force on a wire, induced voltage on a conductor moving in a magnetic field.
Week 02	Lecture 04	A simple –Rotating Loop between Curved poles faces .The voltage induced in a rotating loop, Getting DC Voltage out of the rotating loop the induced torque in the rotating loop.
	L-05	Commutation in a Simple Four Loop DC machine
	L- 06	Commutation and armature. Connection in Real DC machine
Week 03	Lecture 07	The Rotor coils/Connection to the commutator segments. Lap winding wave winding ,Frog leg winding
	L- 08	Commutator pitch, slot pitch, pole pitch, Back pitch, Front pitch, resultant pitch, Pitch factor. Chorded winding.
	L- 09	Problems with Commutation in Real Machines
Week 04	Lecture- 10	Armature Reaction , L di/dt Voltages , Solution to the Problems with Commutation .Equalizer winding
	L- 11	The Internal Generated voltage and Induced Torque Equations of Real DC machine.
	L- 12	The construction of DC machines, Pole, stator ,rotor, Brushes
Week 05	Lecture 13	Power flow and Losses in DC machines
	Lecture 14	Numerical of DC machines
	Lecture 15	Test-01
Week 06	Lecture 16	Different types of armature windings, their difference
	Lecture 17	Introduction to DC generators. Types of DC generator. Separately excited DC generators.Voltage regulation
	Lecture 18	Graphical analysis of a separately excited DC generator
Week 07	Lecture 19	The terminal characteristic of a separately excited DC generator. Control of Terminal Voltage
	Lecture 20	Non-linear analysis of a separately excited DC generator
	Lecture 21	The shunt DC generators. Voltage build up a shunt DC generator
Week 08	Lecture 22	The terminal Characteristic of a shunt DC generator, Voltage Control of a shunt DC generator, .the graphical analysis of a shunt dc generator
	Lecture 23	The series DC generator, The terminal characteristics of a series generator, The cumulatively compound DC generator and its terminal characteristics

	Lecture 24	The series DC generator, The terminal characteristics of a series generator, The cumulatively compound DC generator and its terminal characteristics
	Midterm	
Week-09		
Week 10	Lecture 25	Introduction to DC motors, speed regulation, positive SR, negative SR
	Lecture 26	Application of DC motors. the equivalent circuit of a dc motors.
	Lecture 27	The magnetization curve of a DC machine.
Week 11	Lecture 28	Separately excited and shunt DC motor.
	Lecture 29	Open circuit characteristic curve, external and internal characteristic curve of dc motor.
	Lecture 30	The terminal characteristic of shunt DC motor
Week 12	Lecture 31	Nonlinear analysis of shunt DC motor
	Lecture 32	Speed control of shunt DC motor, the effect of an open field circuit.
	Lecture 33	The permanent magnet Dc motor
Week 13	Lecture 34	The series DC motor. Induced torque in a series DC motor
	Lecture 35	The terminal characteristics of a series DC motor
	Lecture 36	Speed Control of DC series Motor
Week 14	Lecture 37	The DC Compound motor
	Lecture 38	The torque speed characteristic of a cumulatively compounded DC motor
	Lecture 39	The torque speed characteristic of a differentially compounded DC motor.
Week 15	Lecture 40	The Nonlinear analysis of a compounded DC motor
	Lecture 41	Speed Control in the cumulatively compounded DC motor
	Lecture 42	DC motor starters
Week 16	Lecture 43	Problems in Starting
	Lecture 44	Starting circuits
	Lecture 45	The ward Leonard system and solid state speed controllers
Week 17	Lecture 46	Protection circuit section, start/stop circuit section
	Lecture 47	HP/LP Electronics section
	Lecture 48	DC motor efficiency calculation.
Week 18	**FINAL TERM EXAMINATION**	

Grading Policy

Theory (100)	Mid-Term Exam		**30**
	Final Exam		**50**
	Sessional	Attendance	5
		Assignments	5
		Quizzes	5
		Presentation	5
		Total	**20**
Practical (50)	Mid-Term Exam		**15**
	Final Exam		**25**
	Sessional / Project		**10**

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Course Instructor

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Head of Department

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Principal

HEC Course Discription

Magnets, Electromagnetic Forces, Generated Volltage and Energy Conversion

Introduction, Magnetic Field, Magnetic circuit defined, Reluctance and the magnetic Circuit Equation, Relative Permeability and magnetization curves, Analogies between Electric and magnetic circuits, Magnet Hysteresis and Hysteresis Loss, Interaction of magnetic Fields (Motor Action), Elementary two pole motor, BLI rule, Electromagnetically Induced voltage (Generator Action), Elementary two pole generator, Energy conversion in rotating Electrical Machines, Eddy currents and Eddy Current Losses.

Principles of Direct –Current Machines

Introduction, Flux Distribution and Generated Voltage in an elementary DC Machine, Commutation, Construction, Layout of simple Armature winding, Brush position, Basic DC Generator, Voltage regulation, Generator to motor transition and vice versa, Developed Torque, Basic DC motor, Dynamic behavior when loading and unloading a dc motor, speed regulation, Effect of Armature inductance in commutation when a DC machine is supplying a load, Interpoles, Armature reaction, Compensating windings, Equivalent circuit of a Separately Excited Shunt Generator and shunt motor, Dynamic behavior During speed Adjustment, Mechanical power and developed Torque, Losses and Efficiency.

DC Generator Characteristics

DC Generator Characteristics, open circuit characteristic of a DC Generator, Characteristics of a separately Excited D.C Generator-voltage build up in a self excited Generator, Critical field resistance for a shunt and series generator, Characteristics of a shunt generator, Drawing O.C.C at different speeds, Compound generator Characteristics.

Speed Control of DC motors

Speed Control of DC motors, Speed Control of DC shunt Motors, Speed Control of DC series Motor, Speed Control of DC Compound motor