Course Name:Electric Machine-I
Course Code:EE401
Credit:4

Prerequisites:

Sl. No.	Subject	Description	Level of Study
01	Mathematics	General Mathematics	Class XII, 1st Sem
02	Physics	Electrostatics, Electromagnetism and AC Fundamentals	Class XII, 2nd Sem

CourseObjective:

- Tomakestudentsconversantabouttheunderlyingenergyconversiontheory betweenelectrical andmechanicalsystemsbyintroducingelectromechanicalenergyconversionprinciples.
- Toexposethestudentstotheconceptsofvarioustypesofelectricalmachinesandapplicatio ns ofelectricalmachines.

CourseOutcomes:

Attheendof thecourse,astudentwillbeableto:

1. **Use** concepts in trigonometry, complex algebra, phasor operations andprinciples of electromagnetismtofindcorrectsolutionstoelectricalmachineperformancequestions.
2. **Select**propermaterialsandmethodsfordesignandconstruction ofelectricalmachineswithin therealmofmanufacturing,economic,performance,efficiencyandenvironmentalconstr aints.
3. Use modeling/simulation parameters with standard equivalent circuit models to **predict** correctly the expected performance of various general-purpose electrical machines andtransformers.
4. **Compare**acceptedstandardsandguidelinesto**select**appropriate electricalmachinestomeet specifiedperformancerequirements and **choose** the scope of applicability of various types of AC and DC machines in real-life multi-

disciplinary usages.

5. **Demonstrate**anunderstandingofthefundamentalcontrolpracticesassociatedwithACand DCrotatingmachines(starting,reversing,braking,speedcontroletc.)andtransformers.

6. **Setup**testingstrategiestoevaluateperformancecharacteristicsofelectricalmachines.

CO- PO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1	2	1	-	-	-	-	-	-	-	-
2	1	1	2	1	-	1	1	1	-	-	1	1
3	1	2	2	1	2	-	-	-	1	-	1	1
4	-	1	2	1	-	-	-	1	-	1	-	1
5	-	2	1	1	-	1	1	-	1	-	1	1
6	-	2	1	1	-	1	1	-	-	1	-	1

Correlation levels 1, 2 or 3 as defined above: 1: Slight (Low) 2: Moderate (Medium)3: Substantial (High) and "-" if there is no correlation.

Syllabus Indicating CO:

Module No.	Content	Relevant CO's
1	Electromechanical Energy Conversion Principle, Singly Excited Magnetic System, Doubly Excited Magnetic system. Physical concept of torque production, Electromagnetic torque and Reluctance torque.	**CO1, CO5**
2	Concept of General terms pertaining to Rotating Machines: Electrical & Mechanical degree, Pole pitch, Coil, Generated EMF in full pitched coil, Generated EMF in a short pitched coil,	**CO1, CO4, CO5**
3	EMF polygon, Distribution factor, Pitch factor. MMF produced by Distributed Windings, MMF of a coil, MMF of single phase distributed Winding, MMF waveform of commutator machines.	**CO1, CO5, CO6**
	EMF generated in the armature. Methods of Excitation, Armature reaction & its effect in the performance, Methods of decreasing the effects of Armature reaction, Effect of Brush	**CO1, CO5, CO6**

4	shift. Commutation process, Resistance commutation, Delayed commutation, Voltage commutation, Improvement of Commutation.	
5	Operating Characteristics of DC Generators: Separately Excited generators, Shunt Generators, Series Generators and Compound Generators.	**CO3, CO4, CO5**
6	Torque equation of D.C motor, Operating Characteristics of Shunt, Series & Compound motors. Losses and efficiency of DC machines, Hopkinson's and Swinburne's test. D.C Machine application: Generator application, Motor application	**CO3, CO2,CO4, CO5**
7	Induction motor as a Transformer, Flux and MMF phasors in Induction motors, Equivalent circuit, Performance equations, Induction motor phasor diagram, Toque-slip characteristic, Power slip characteristic, Determination of equivalent circuit parameters.	**CO3, CO2, CO4, CO5**
8	Methods of starting of squirrel Cage and Wound rotor Motors. Speed control of Induction motorPolarity Test, Application of Polyphase Induction motor.	**CO3, CO5**
9	Determination of polarity and connections (star/star, star/delta, delta/star, star/zigzag, delta/zigzag, open delta), Phasor groups. Effect of unbalanced loading, Production of Harmonics in Transformer and its suppression,3 phase to 2 phase transformation, Scott connection, 3 phase to 6 phase connections, Double star and Double delta,	**CO1, CO3, CO5, CO6**
10	3 winding transformer: Parameter estimation, application, Parallel operation of Transformers, Introduction to Tap changing transformer andits function.	**CO1, CO3, CO5, CO6**
11	Potential transformer, Current transformer, Pulse transformer, Audio frequency transformer, Grounding transformer, Pulse transformer.	**CO1, CO3, CO5, CO6**

Gaps in Syllabus:

S. No.	Gap	Action taken	Resource Person	No. of students	Relevance to POs, PSOs
1	**Magnetic circuit calculation:** *This technique is very useful to deal with flow Electrical machines, but missing in the syllabus.* **Topics covered:** Laws of Magnetic circuits, Calculation of Magnetic circuit of DC Machine, Three-phase Induction Machine, Transformer etc.	The various topics are addressed by **lecture classes, providing notes, and by solving numerical problems.**	**G. Das**	**140**	**PO 1, PO 2**
2	**Electrical Materials:** *This topic is very much relevant for Machine manufacturing industries, but missing in the syllabus.* **Topics covered:**Conducting material, Insulating material, properties of insulating material, Insulation for conductor covering, Insulating varnish, Causes of Insulation Failure.	The various topics are addressed by **lecture classes, providing notes, and by solving numerical problems. Research literatures are provided for different techniques**.	**G. Das**	**140**	**PO 1, PO 3, PO 5**
3	**Design of armature winding:** *This topic is very much relevant for Machine manufacturing industries, but missing in the syllabus.* **Topics covered:** Important terms related to armature winding, single layer and double layer winding, Types of armature winding, winding pitch and their relationship, Dummy coil, circulating current, Equilizer connection.	These are emergent topics under scheduling and therefore are covered in continuation with the static scheduling by **lectures and providing research papers**.	**G. Das**	**140**	**PO 1, PO 3, PO 5**

Lecture Plan:

SL NO	DAYS	TOPIC	REMARKS
		MODULE 1	
1	DAY 1	Electromechanical Energy Conversion Principle	
2	DAY 2	Singly Excited Magnetic System	
3	DAY 3	Doubly Excited Magnetic system.	
4	DAY 4-5	Physical concept of torque production Electromagnetic torque and Reluctance torque.	
5	DAY 6-7	Concept of General terms pertaining to Rotating Machines: Electrical & Mechanical degree, Pole pitch, Coil, Generated EMF in full pitched coil,	
6	DAY 7-8	Generated EMF in a short pitched coil, EMF polygon, Distribution factor, Pitch factor.	
7	DAY 9	MMF produced by Distributed Windings	
8	DAY	MMF of a coil, MMF of single phase distributed Winding,	

	10-11		
9	DAY 12	MMF waveform of commutator machines.	
MODULE 2 DC MACHINE			
10	DAY 13-16	EMF generated in the armature. Methods of Excitation, Armature reaction & its effect in the performance, Methods of decreasing the effects of Armature reaction, Effect of Brush shift.	
11	DAY 17-19	Commutation process, Resistance commutation, Delayed commutation, Voltage commutation, Improvement of Commutation.	
12	DAY 20-23	Operating Characteristics of DC Generators: Separately Excited generators, Shunt Generators, Series Generators and Compound Generators.	
13	DAY 24-225	Torque equation of D.C motor, Operating Characteristics of Shunt, Series & Compound motors.	
14	DAY 26-27	Losses and efficiency of DC machines, Hopkinson's and Swinburne's test.	
15	DAY 28	D.C Machine application: Generator application, Motor application	

REFERENCE BOOK

1. Generalised theory of Electric Machine, P.S. Bhimbra, Khanna Publisher
2. Electri Machine , S K Bhattachraya, Mcgraw Hill
3. Electric Machinery, S K Sen, Khanna Publisher
4. Electric Machines, M.G. Say