Electrical Machines -I - Video course

COURSE OUTLINE

Synchronous machines: types, windings, emf equation, generator and motor operations, phasor diagrams; testing, power angle characteristic, v-curves, stability; starting of synchronous motor.Analysis of salient pole synchronous machines.

Single phase induction motor: Rotating and pulsating field, development of equivalent circuit based on double revolving field theory, torque-slip characteristic, performance analysis; Starting by phase spliting; selection of capacitor value for starting and running condtions.

D.C machines: Construction, armature windings; emf and torque equations; generator and motor mode of operations; armature reaction, commutation; characteristics of D.C motors; starting, speed control and braking of D.C motor.

COURSE DETAIL

MODULE - 1 General Concepts of Conventional Rotating Machines.

Module	Lec no.	Topics
I : Fundamentals of single phase transformers.	1	Introduction; Basics of magnetic circuits, Ampere's law, linear and nonlinear magnetic circuits; Faraday's law of electromagnet induction.
	2	Concept of an ideal transformer, assumptions; ideal transformer at no load and on load, phasor diagram, voltage current and power relations; basic construction of a practical single phase transformer, conceptual differences with an ideal transformer.
	3	Constructional details of a practical single phase transformer, core, winding,insulation and cooling methods; circuit model of a practical transformer incorporating an ideal transformer.
	4	Analysis of a practical single phase transformer, exact and approximate equivalent circuits, phasor diagram, relation between referred variables and parameters, per unit system of representation.
	5	Worked out examples, question - answer session.
II: Testing and performance of single phase transformers.	6	Experimental determination of single phase transformer equivalent circuit parameters, Open circuit and short circuit tests, per unit parameters; worked out example.

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Electrical Engineering

Pre-requisites:

1. Electrical Technology.

Additional Reading:

1. Research Papers.

Coordinators:

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	7	Percentage regulation of a single phase transformer, phasor diagram, derivation, per unit representation; worked out example.
	8	Efficiency of a single phase transformer, maximum efficiency, all day efficiency; Sumpner's test for experimental determination of a single phase transformer efficiency.
	9	Worked out examples, question - answer session.
III : Fundamentals of three phase transformers.	10	Bank of three single phase transformers, voltage, current and kVA rating with different connections, open . connection; worked out example.
	11	Three phase transformer as a single unit; constructional features, three limb,five limb, core type and shell type constructions; comparison with bank of three single phase transformers.
	12	Three phase transformer connections, polarity and terminal convention,vector groups; Y/Y and ./. connections, connection and phasor diagram,per phase equivalent circuit based analysis.
	13	Y/.and ./Y connections. Connection and phasor diagrams, per phaseequivalent circuit based analysis; worked out examples.
	14	Y/Z and ./Z connections. Connection and phasor diagrams, voltage,current relations.
IV: Operation and performance of three phase transformers.	15	Tap changing transformer.
	16	Parallel operation of single and three phase transformers, conditions and connection diagrams, per phase equivalent circuit based analysis with equal and unequal no load voltages, load sharing.
	17	Harmonics and switching transients in transformers, effect of transformer connections, inrush current.
	18	Worked out examples, question - answer session.
V: Special purpose transformers.	19	Single and three phase three winding transformer, equivalent circuit, phasor diagram, tests.
	20	Single and three phase autotransformers, advantages, equivalent circuit and phasor diagram.

	21	Three phase to two phase conversion using Scott connection, connection and phasor diagram, analysis with balanced and unbalanced loads.
	22	Worked out examples, question - answer session.
VI: Construction and operating principle of three phase induction machines.	23	Basic constructional features of round rotor polyphase ac machines. Airgap mmf and flux waveforms due to single phase distributed winding.
	24	Airgap mmf and flux waveform in round rotor machines due to balanced three phase distributed winding excited by balanced three phase alternating current, rotating magnetic field.
	25	Generated voltage and torque expression in three phase round rotor ac machine with distributed winding.
	26	Construction and types of three phase induction machines, wound rotor and squirrel cage induction machines; representation of the squirrel cage by a balanced three phase winding.
	27	Basic operating principle, motoring and generating mode of operation, generated rotor voltage, synchronous speed, slip speed, per unit slip.
VII: Analysis of three phase induction machines.	28	Exact and approximate per phase equivalent circuit; phasor diagram under no load and loaded condition.
	29	Power flow diagram in a three phase induction machine, airgap power, slip power, mechanical power; torque-slip and current-slip characteristics.
	30	Starting torque, breakdown slip, breakdown torque, maximum mechanical power, effect of equivalent circuit parameters.
	31	Worked out examples, question - answer session.
VIII: Testing of three phase induction machines.	32	No load and blocked rotor tests for determining equivalent circuit parameters; losses and efficiency.
	33	Induction machine performance computation from circle diagram.
	34	Cogging torque and crawling; induction machines with deep bar and double cage rotors.

	35	Worked out examples, question - answer session.
IX: Starting and speed control of three phase induction machines.	36	Direct on line starting, stator resistance and reactance based starting, rotor resistance based starting.
	37	Y/. and auto transformer based starting; worked out examples.
	38	Speed control of induction motors by stator voltage variation and pole changing techniques.
	39	Variable frequency speed control of induction machines, v/f control method, slip power control method.
	40	Worked out examples, question - answer session.

References:

1. Alexander S. Langsdorf, “Theory of Alternating current Machinery” Second Edition, TATA McGRAW-HILL, 1983.
2. D. P. Kothari, I, J. Nagrath, “Electric Machines”, Third Edition, TATA McGRAW-HILL, 2004.
3. M. G. Say, “Alternating Current Machines”, Fifth Edition, ELBS with Longman Singapore Publishers. 1994.