ELECTRICAL MACHINES - II

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PRE-REQUISITES : Basic Electrical Technology: Circuit analysis, Principle of working of transformer and its equivalent circuit representation.
INTENDED AUDIENCE : UG Electrical Engineering as core subject. UG Mechanical and Mining Engineering as Elective subject.
INDUSTRIES APPLICABLE TO : BHEL, CESC, NTPC, WBPDCL

COURSE OUTLINE :
The course will begin with explaining basic underlying principles of working of various types of electrical rotating machines. The conditions to be fulfilled for the steady production of electromagnetic torque (Te).Motoring and generating mode of operation. Primary focus will be on the operation of 3-phase induction machine, single phase induction motor,and synchronous machines.A fair knowledge of distributed windings is essential in order to understand the working of rotating machines more effectively – few lectures will be devoted on this topic. Concept of electrical and mechanical angles will be explained.Nature of magnetic flux distribution along the air-gap of a rotating machine will be discussed.Clear concept of Rotating magnetic field is so important in understanding the operation of induction and synchronous machines.For each of this machine equivalent circuit will be derived and then used to derive expression for the torque. Starting, speed control and electrical braking of the motors will be discussed. Although main focus will be on the steady state performance analysis, few cases of important transient analysis will be discussed. Students will be motivated to solve numerical problems logically and efficiently.

ABOUT INSTRUCTOR :
Prof. Tapas Kumar Bhattacharya has over thirty years of teaching experince at IIT Kharagpur. Taught Signals & System core course at IIT Kharagpur several times.Area of research interest is in the field of electrical machines and special electrical machines and circuits..

COURSE PLAN :

Week 1 : Brief review of transformer. Rotating machine :generalconstructional features. Conditions for steady production ofelectromagnetic torque. Torque production can be explained interms of interaction of two sets of magnetic poles – one producedby stator coil current and the other by rotor coil currents.
Week 2 : MMF and flux density distribution along the air-gap of a rotatingmachine by a single coil and by multiple coils. Basic winding termsand elementary balanced 3-phase winding. Idea of electrical andmechanical angle.
Week 3 : Production of rotating field by a 3-phase winding – iits speed anddirection of rotation and its far reaching implications.
Week 4 : The expression of induced voltage in a coil when it moves relativeto a field distribution – its rms value and frequency.
Week 5 : Types and constructional features of 3-phase induction motor. Slipand its importance. Development of equivalent circuit of the motorwhen it runs with a slip. Getting expression for torque in terms ofequivalent circuit parameters and supply voltage.
Week 6 : Typical torque slip characteristic. Fixing operating point when loadtorque is present. Modification of the torque -slip characteristic byvarying rotor resistance, supply voltage and frequency.
Week 7 : Estimation of equivalent circuit parameters from no load and locked(blocked) rotor tests. Problem solving.
Week 8 : Single phase induction motor: double revolving field theory anddevelopment of equivalent circuit and expression for torque..Torque-slip characteristic. Expression for starting torque inpresence of auxiliary winding. Estimation of starting capacitance forauxiliary coil using concept of phase splitting.
Week 9 : Synchronous machine: Types and constructional features . EMFequation and concept of synchronous reactance. Synchronising anincoming generator (alternator) to the bus. Phasor diagram asgenerator. Regulation. Effect of excitation variation when generatoris connected to bus. Power-angle characteristic. Steady statestabilty limit.
Week 10 : Synchronous machine connected to bus and operating as motor .Phasor diagram under various operating conditions. Effect ofexcitation variation.
Week 11 : Salient pole synchronous machine : concept of direct axis andquadrature axis reactances. Phasor diagrams under various operating conditions both for motoring and generating mode
Week 12 : Swing equation under dynamic condition. Equal area criteria.Steady state and transient stability limits.