Electrical Machines and Power Electronics
DT021/3

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Module Description and Aim

Module Description:

- This module provides a foundation course on the most important ac electrical machines and most important power electronic conversion circuits for those students who are majoring in Electric Power.

Module aim

- The aim of this module is to understand the operation and behaviour of ac machines and power electronic semiconductor devices, and explain and describe the use of power electronic machine drives.

Course Information on Machine

Learning Outcomes:

- On completion of this module, the learner will be able to
- • Derive the equivalent circuit of a **synchronous machine** from known machine tests.
- • Be able to synchronise a synchronous machine to a grid network.
- • Derive the equivalent circuit of an induction machine from known machine tests.
- • Analyse behaviour of **induction machine** under load conditions.
- • Understand the implementation of passive and static power factor correction.
- • Describe the use of inverters in variable speed induction motor drives. To explain the torque speed capability of an induction motor with a variable frequency variable voltage inverter.
- The ability to undertake laboratory experiments on the material of the course, to record and analyse the results of these experiments and to present the outcomes in technical reports.

Module content: Electrical Machines

- • Synchronous Machines
- • Construction and description of operation, salient-pole and cylindrical-rotor types. Derivation of equivalent circuit from open-circuit and short circuit tests, synchronous reactance, the phasor diagram (of cylindrical-rotor machine) and the Power Angle Curve. Synchronising to an infinite busbar. Steady state stability limit.
- • Three-Phase Induction Machines
- • Production of rotating field, and description and operation of machine. Construction. Derivation of equivalent circuit, determination of torque speed characteristic. Locked-rotor and no-load tests. Induction generator. Introduction to V/F control. Starting methods and protection.
- • Power Factor Correction
- • Need for power factor correction. Single-phase and three-phase power factor correction. Utility and consumer power factor correction. Active power factor correction and filters.
- • Variable Speed Drive: Fixed frequency induction motor torque speed characteristic, V/F operation, Torque Speed capability with v/f drive, Typical V/F drive circuit diagram

Typical Machine Laboratory

- Induction machine – development of equivalent circuit
- Torque/speed characteristics of an induction machine
- Synchronous machine characteristics-equivalent circuit of a synchronous machine
- Synchronising a synchronous machine to an infinite bus
- Sine PWM Inverter in Spice
- DC Drive Simulator
- AC Drive Simulator

Module Assessment

- Course Work including Laboratory Assignments: 40% of overall grade
- End of Module Examination: 60% of overall grade
- Note: A minimum standard of 40% in each component is required to pass the module.

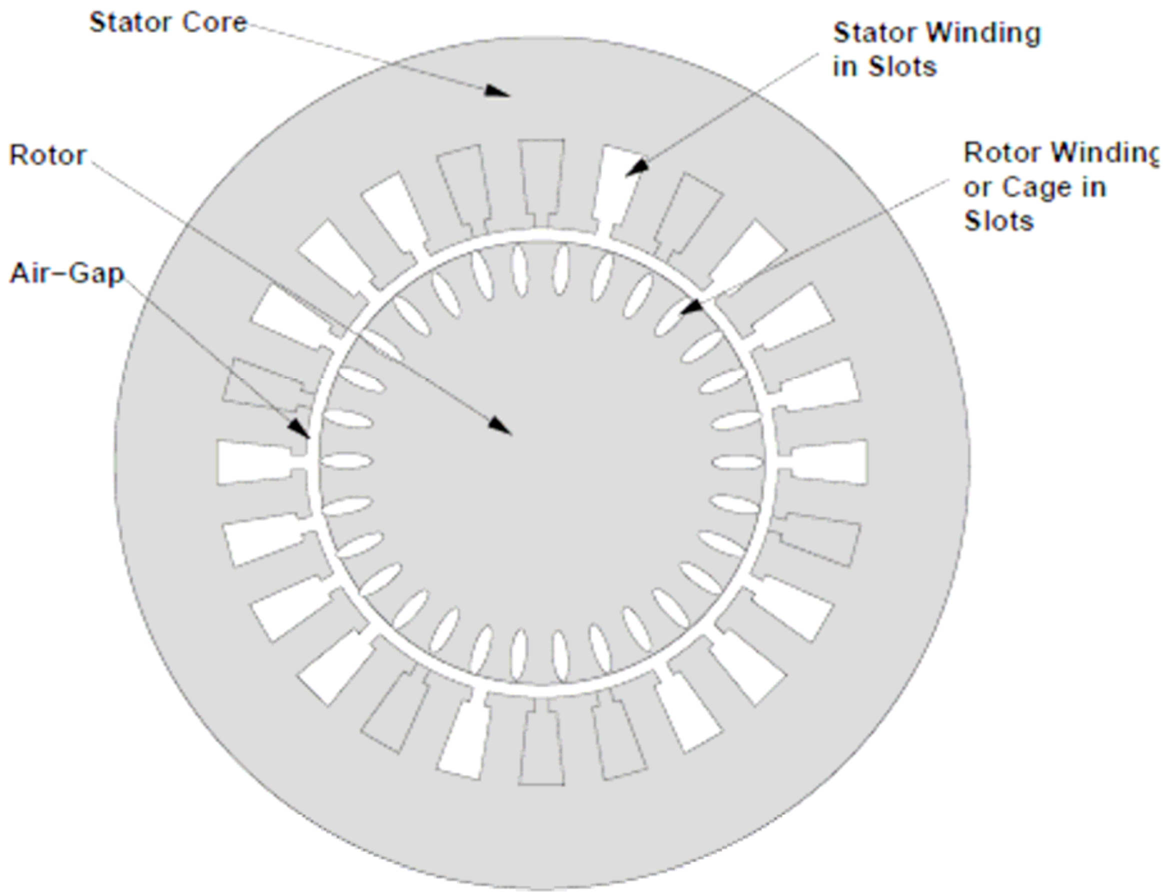
Text Book

- **P.C. Sen, 1997, Wiley, Principles of Electric Machines and Power Electronics**

Induction Machine Introduction

- Induction machines are perhaps the most widely used of all electric motors.
- simple to build and rugged, offer reasonable asynchronous performance: a manageable torque-speed curve, stable operation under load, and generally satisfactory efficiency
- Wound rotor and squirrel cage type

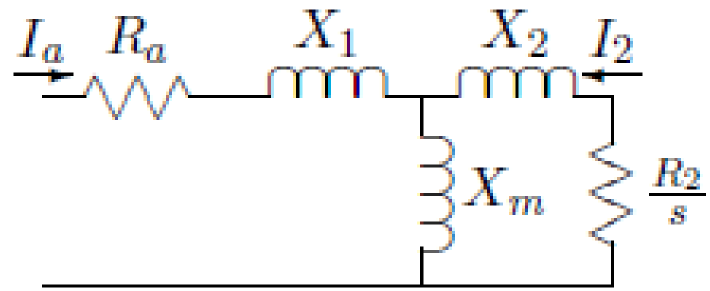
Application:



Axial view of Induction Machine

Energy Balance: Operation

- Balanced condition: Each phase has same terminal voltage, and uniform phase difference
- Power input to the stator:
- Airgap Power
- Power dissipated in the rotor
- Mechanical power
- Pm = Pag – Pd = Pag(1-s)
- Pin = Pag + Pa
- Pout = Pm – Pw = Pag – Pd - Pw



Equivalent circuit