Basic Electrical Technology
[ELE 1051]

SINGLE PHASE AC CIRCUITS

L19 – Power in AC circuits

Topics Covered

◆ **Synchronous Motors**

　　✦ Introduction

　　✦ Construction

　　✦ Working Principle

　　✦ Applications

Synchronous Motors

Introduction

- Synchronous motors are constant speed AC motors which always run at synchronous speed irrespective of connected load.

- Its power factor of operation is controllable.

- Field system is DC excited or made up of permanent magnets

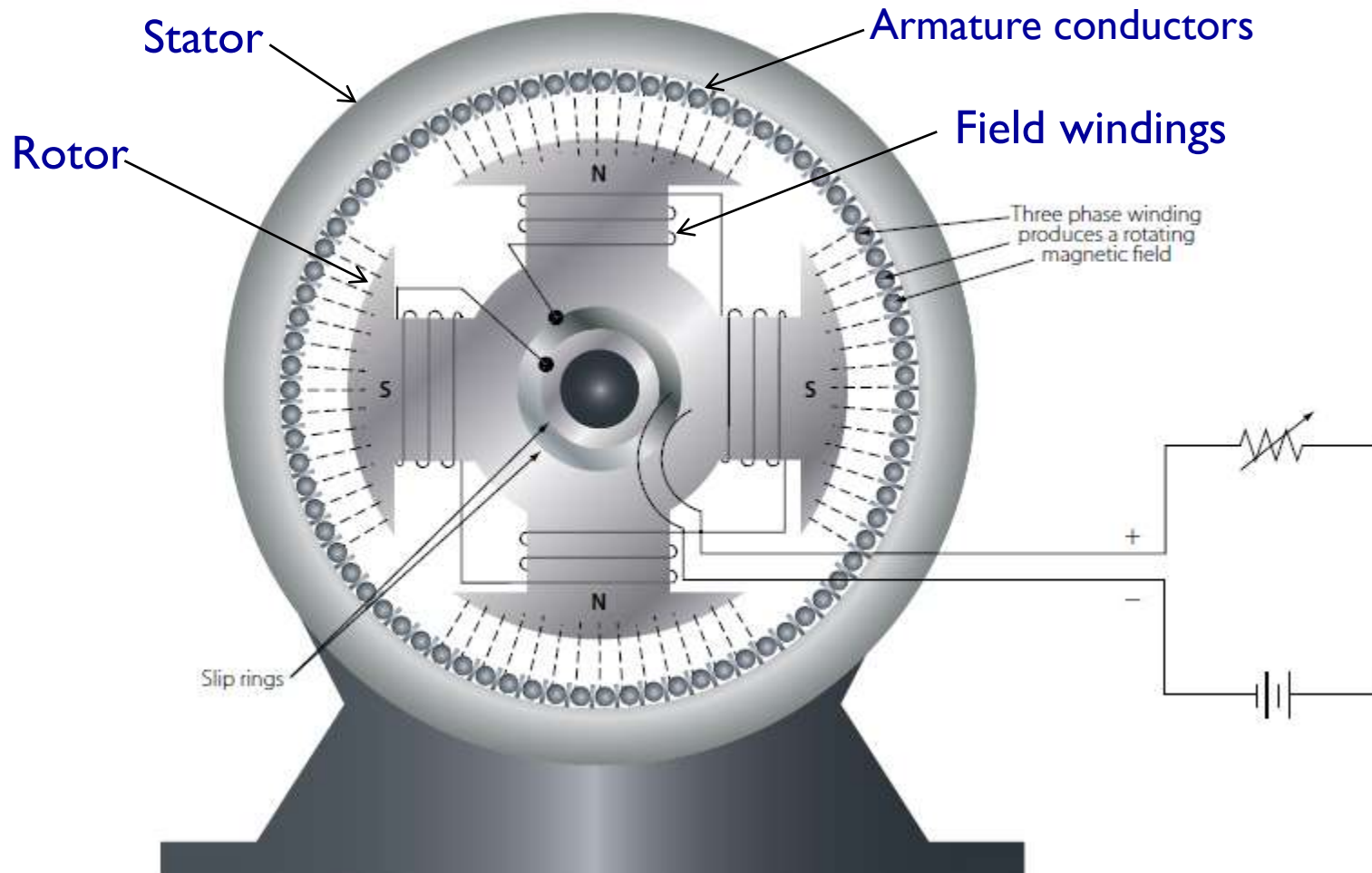- Synchronous condensers are used for power factor improvements.

Construction

Stator

▶ Has slots on the inner periphery to accommodate the armature windings

Rotor

▶ Carries the field windings that produces the required flux.
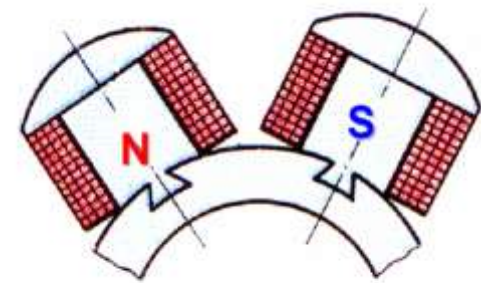
Construction

Stator

Rotor

Armature conductors

Field windings

Three phase winding produces a rotating magnetic field

N

S

S

N

Slip rings

+

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Construction

Synchronous machines are of two types based on the rotor structure

➢**Salient pole type**

Salient-Pole

▶Low speed applications

➢**Cylindrical Rotor Type**

Non-Salient-Pole

▶ Robust and used for high speed applications
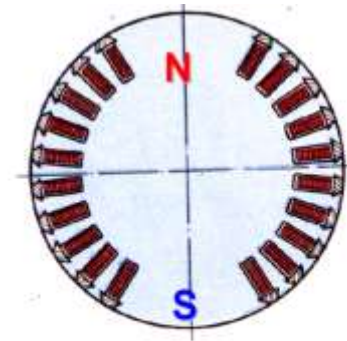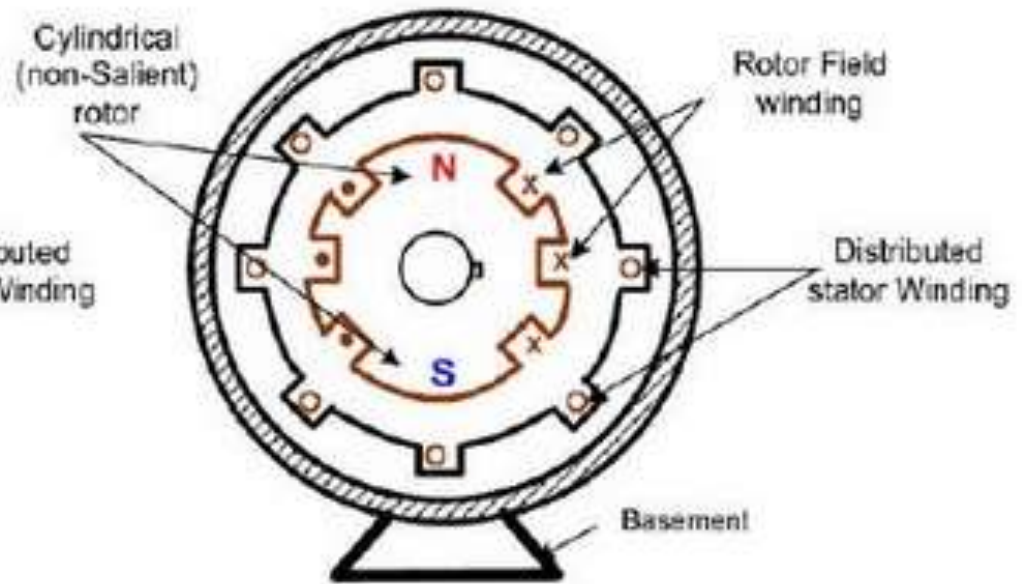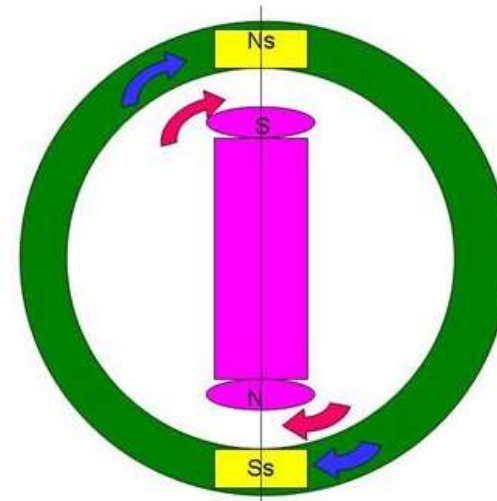
Construction
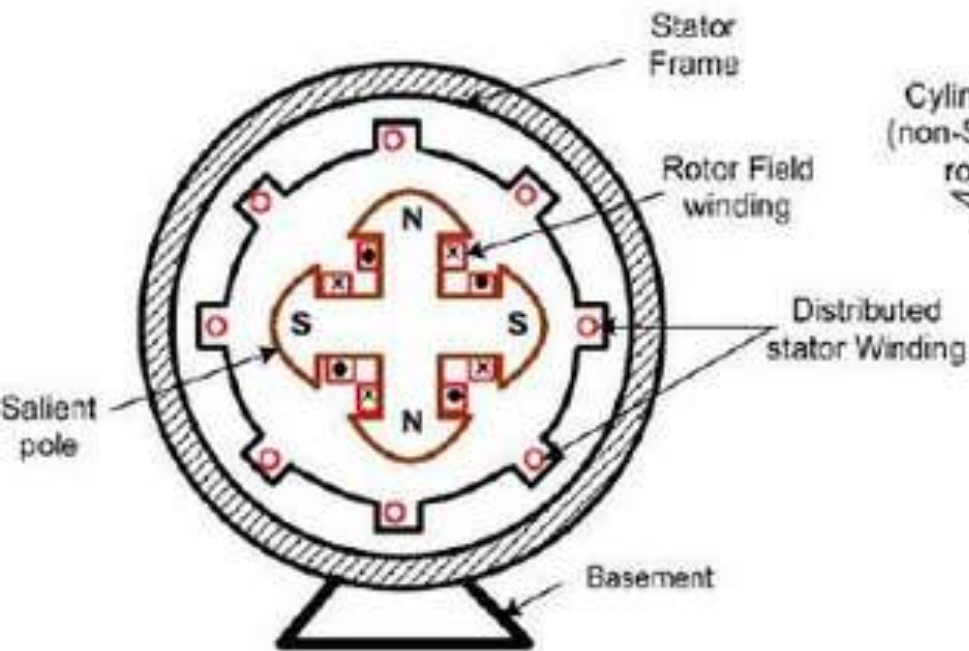
Salient Pole   Non Salient Pole

Principle of Operation

▶ Armature energized from a 3 phase ac source , and the machine is started as induction motor with damper windings.

▶ After achieving the full speed, field winding is excited and the stator and rotor field gets magnetically locked.

Rotor with damper windings

Rotor poles get locked to the unlike poles in the stator .Torque is now unidirectional

Power Factor Control

▶ By varying excitation current one can change the operating power factor.

▶ With normal excitation unity power factor can be achieved.

▶ Under excited synchronous motor operates with lagging power factor.

▶ Over excited synchronous motor operates with leading power factor - Synchronous Condenser

Applications

▶Constant speed applications

▶Used for power factor improvement

Energy Meters

Topics Covered

- *Working Principle of Energy Meters*

- *Introduction to Digital Energy Measurement*

- *Electricity Tariff*

Working Principle

Energy is the total power delivered or consumed over a time interval,

Energy = Power x Time

Electrical energy developed as work or dissipated as heat over an interval of time 't' may be expressed as:
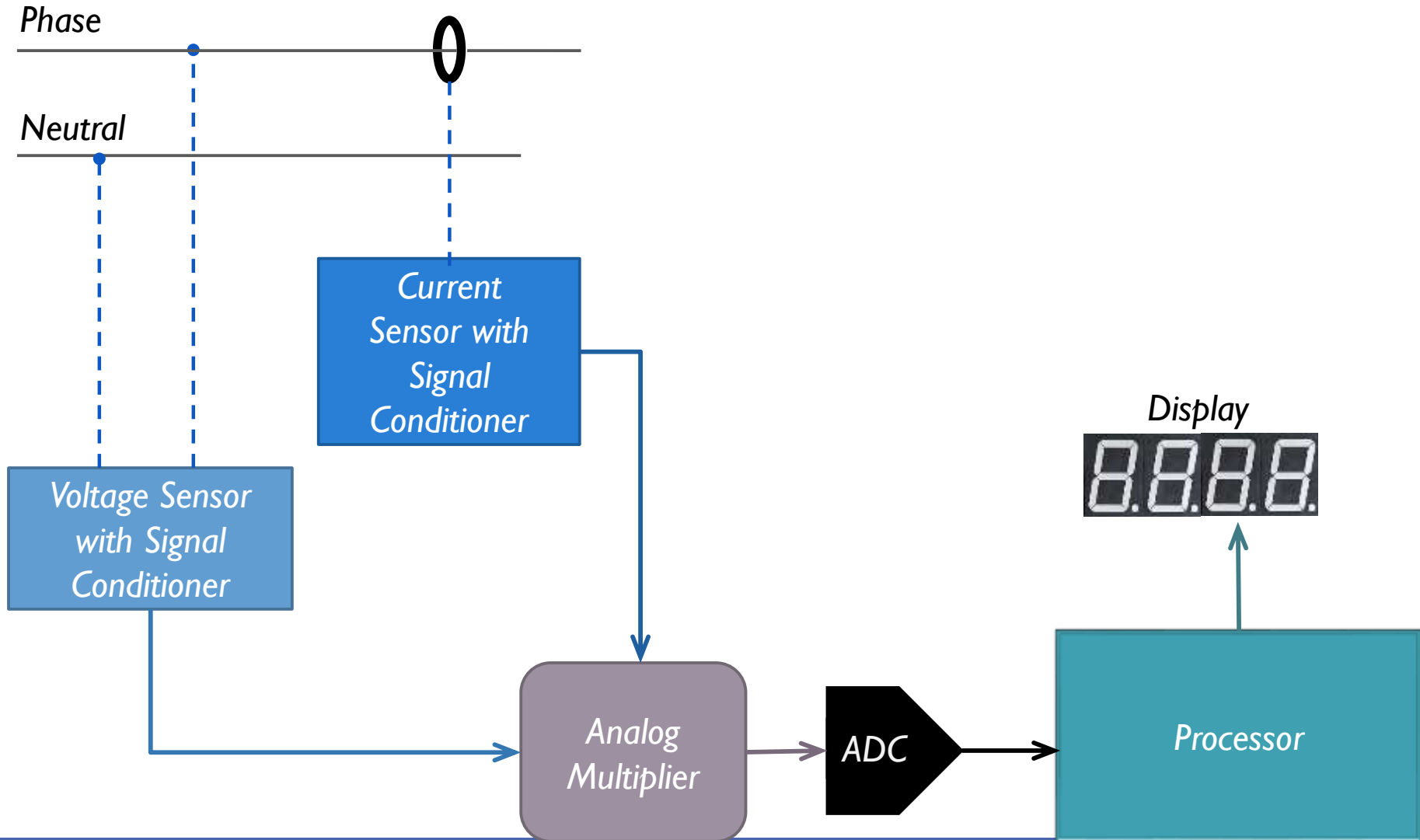
$$Energy = \int_0^t v\, i\ dt$$

v – Applied voltage in (volts)

i – current (A)

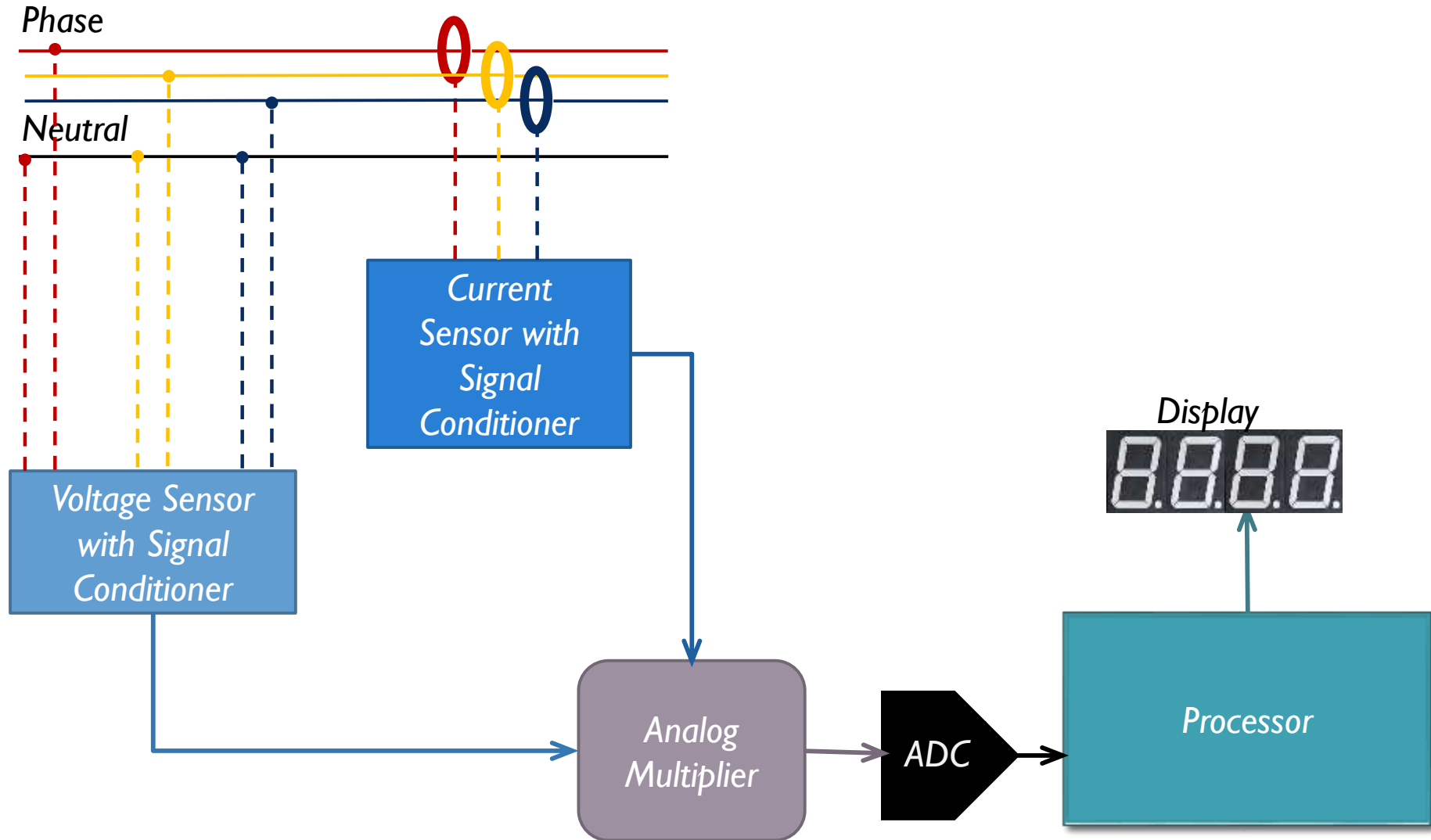t – time (hr)

Unit of Energy: **kWh**

Digital Energy Meter

Three Phase Digital Energy Meter

Electricity Tariff

Installation	Power Supply	Tariff
Industries	11kV and above	Demand Charges (per kVA) Power Factor Surcharge (per unit) Energy Charges (per kWh)
Hotels/Restaurant/ Cinemas/Petrol Bunks/Banks/ Commercial Complexes	400V Three Phase 230V Single Phase	Sanctioned Load (per kW) Power Factor Surcharge (per unit) Energy Charges (per kWh)
Residential	400V Three Phase 230V Single Phase	Sanctioned Load (per kW) Energy Charges (per kWh) Rebate for Solar Installations

Reference: MESCOM 'Electricity Tariff-2014' dated 06/05/2014

Summary

➢ Synchronous motors are constant speed AC motors which always run at synchronous speed. Synchronous condensers are used for power factor improvements.

➢ Energy can be measured by integrating power over an interval of time.

➢ Electricity Tariff depend on the type of consumer.