# AC motor drives

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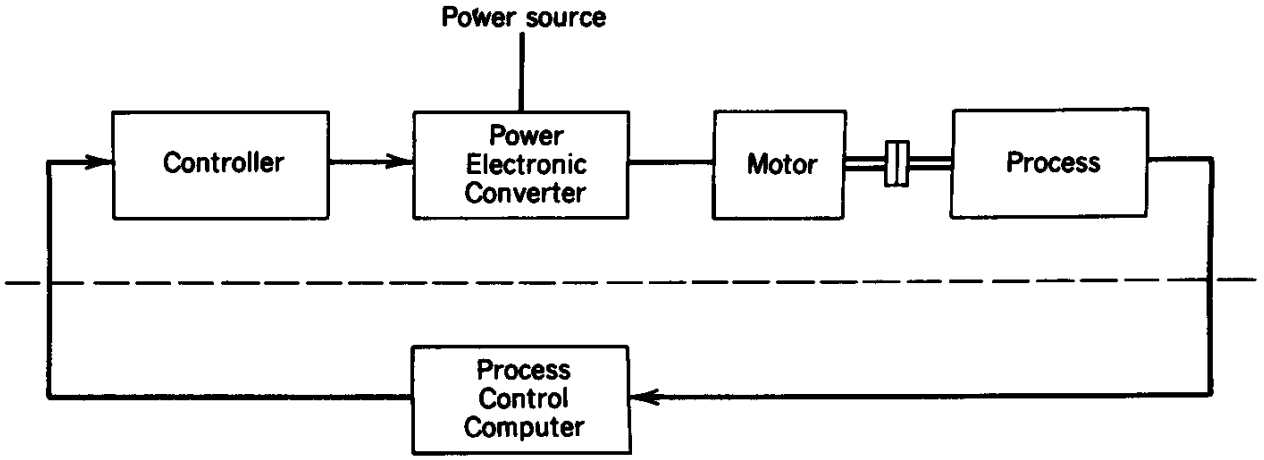
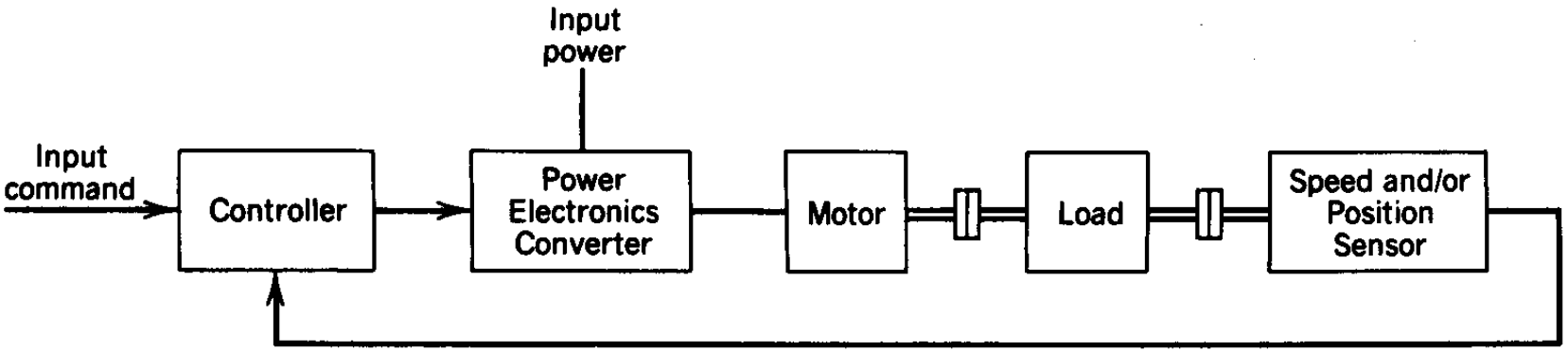
# Plan

**Motor drives are one of the most important applications of Power Electronics**

- Introduction to Motor Drives
- Induction Motor
- Synchronous Motor

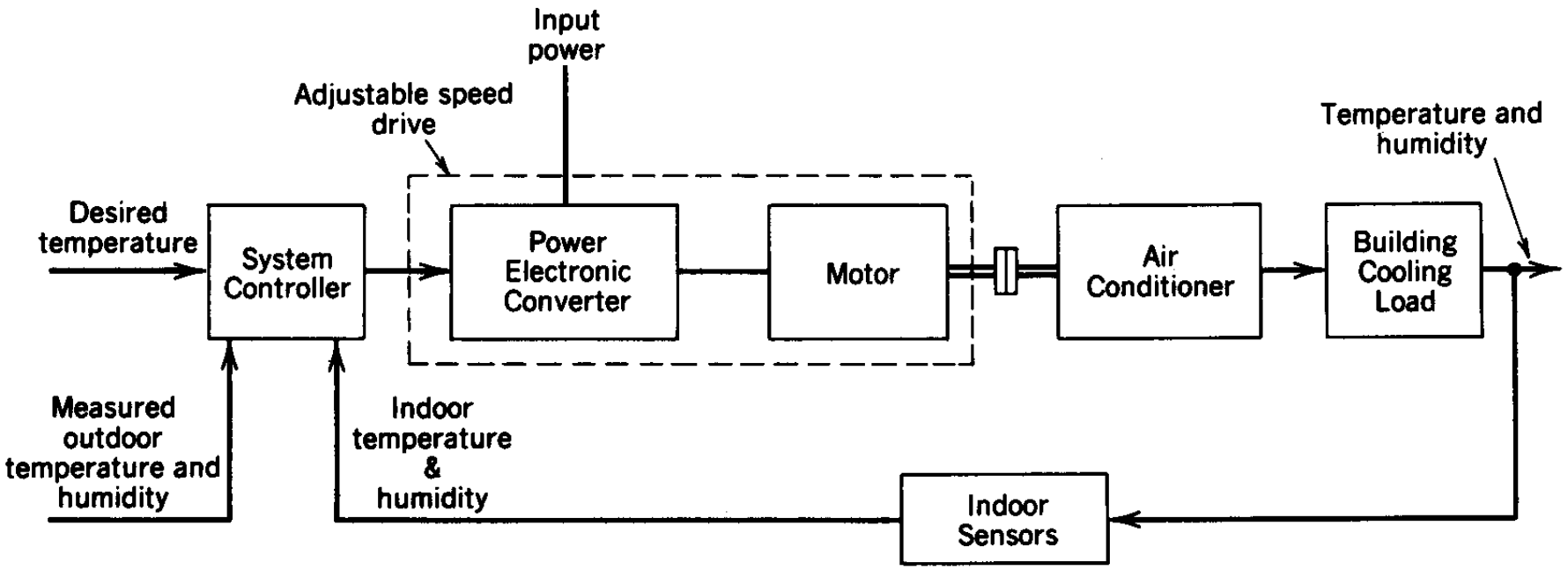
# Control Structure of Drives
# Very general description




- Servo drive

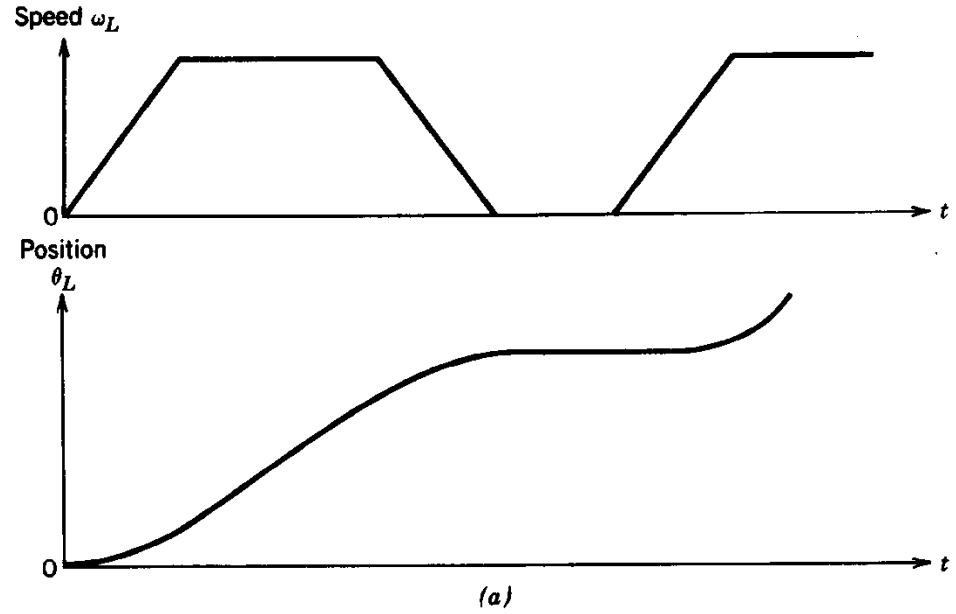
# An Example of Adjustable Speed Drives

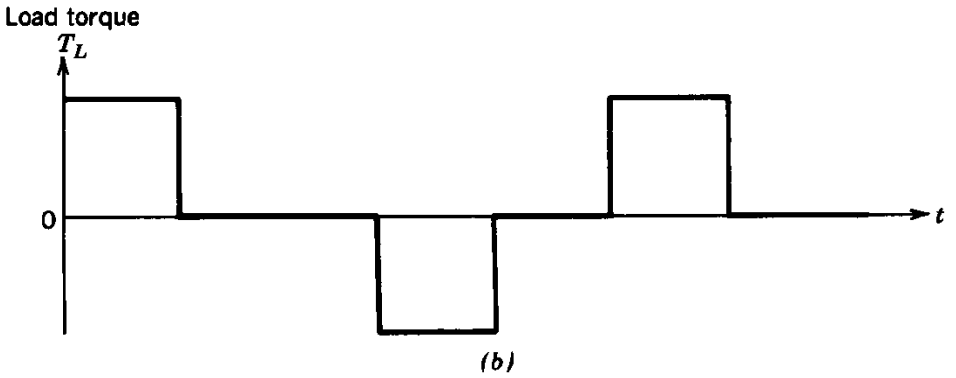



- The speed of the drive response is not important here

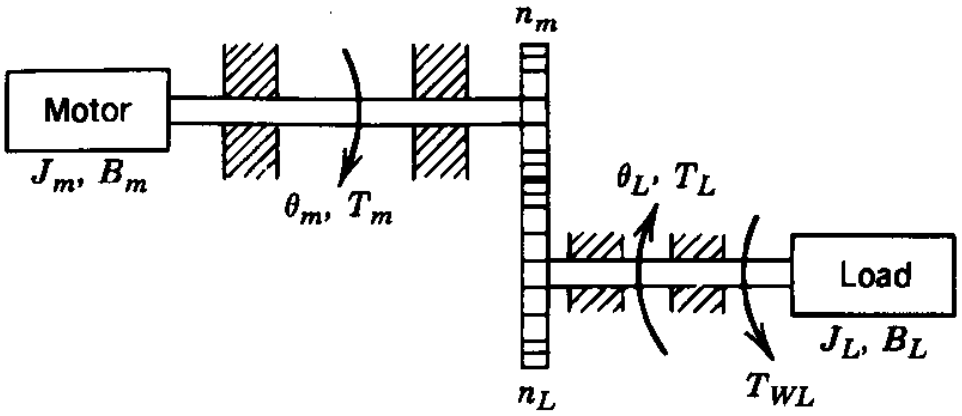
# A Representation of the Load on a Drive

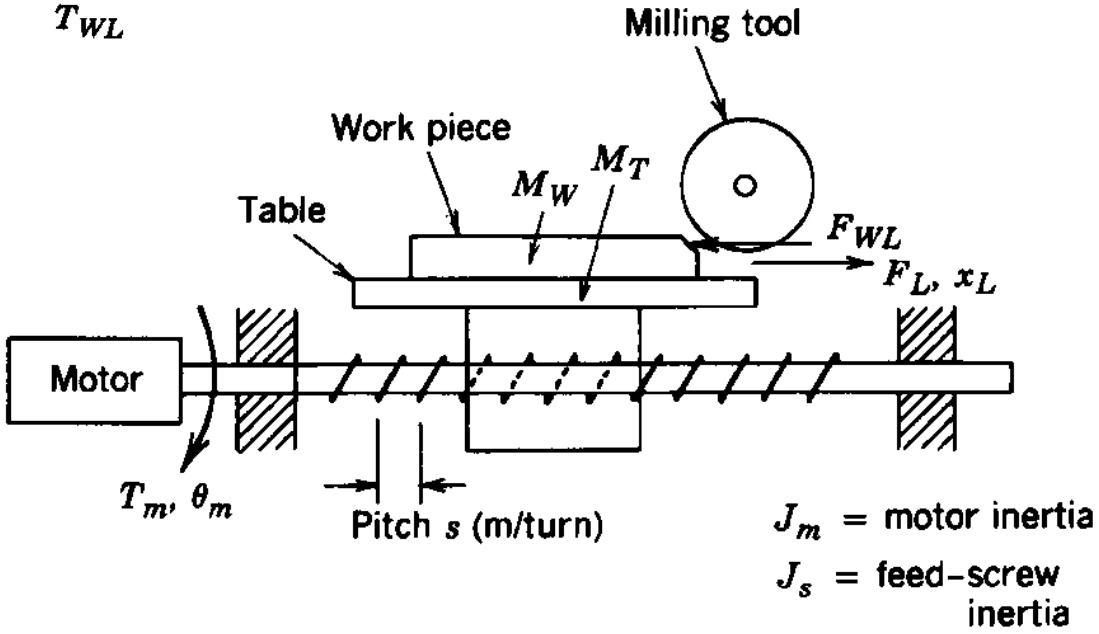
- This cycle may repeat continuously



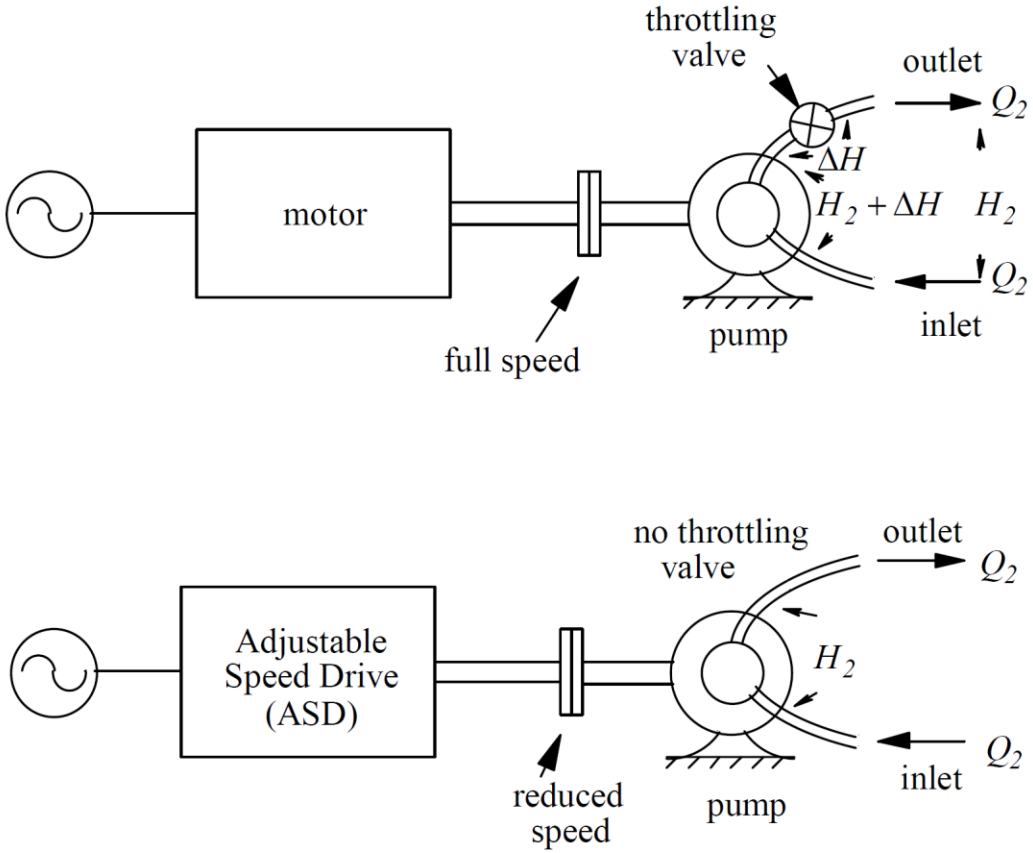
# Two Coupling Mechanisms Commonly used

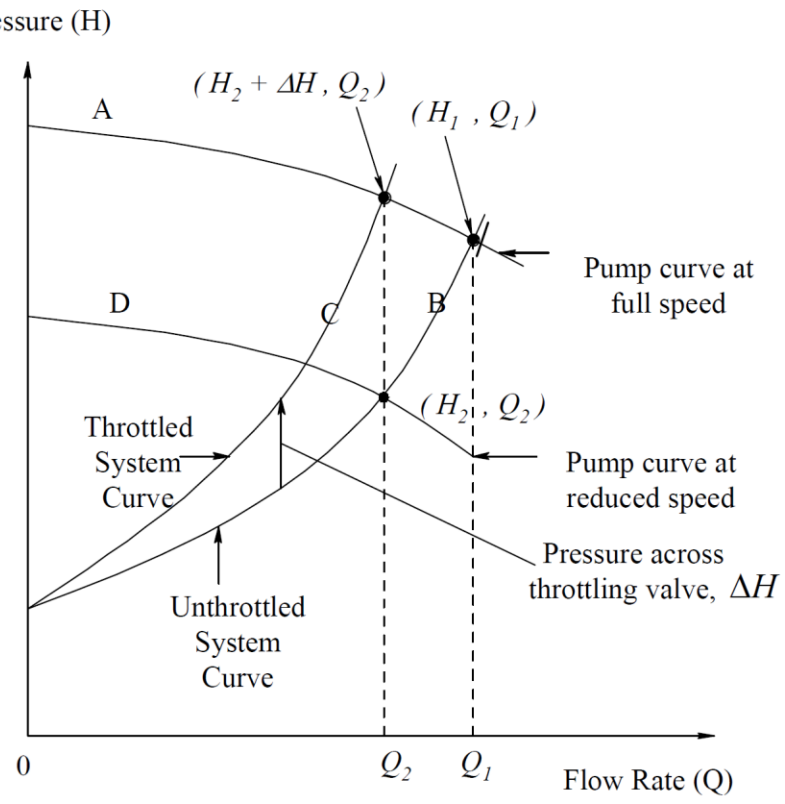


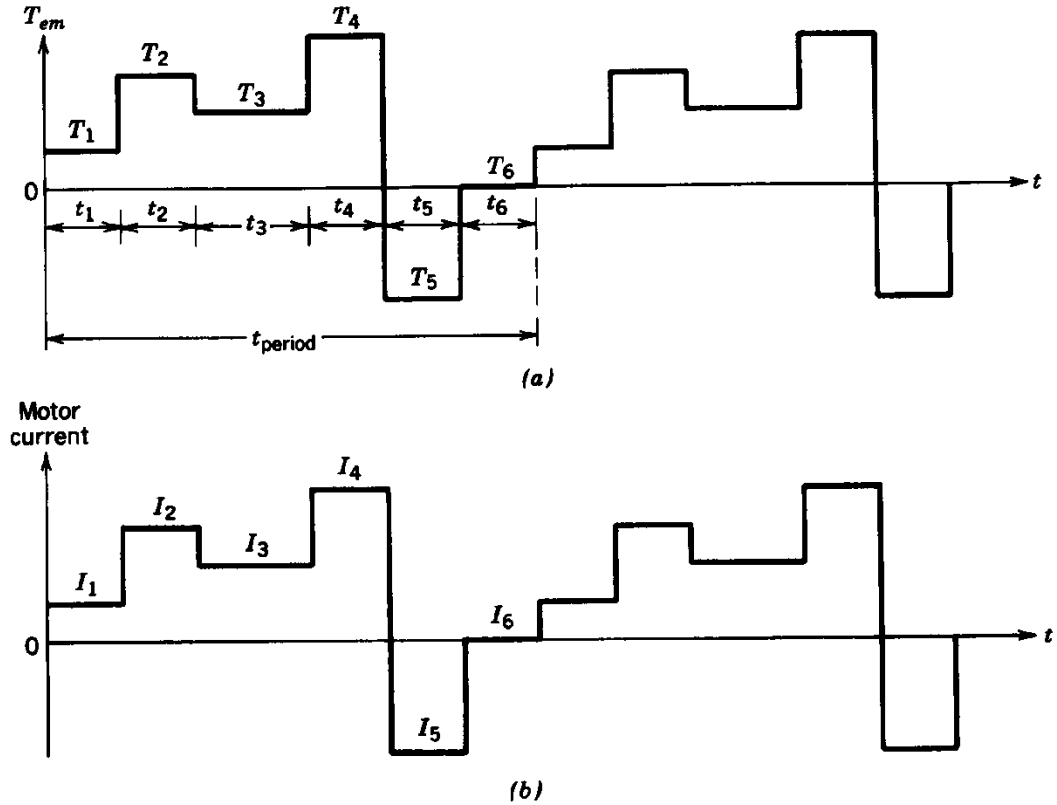
# Pump Application: Adjustable Flow rate

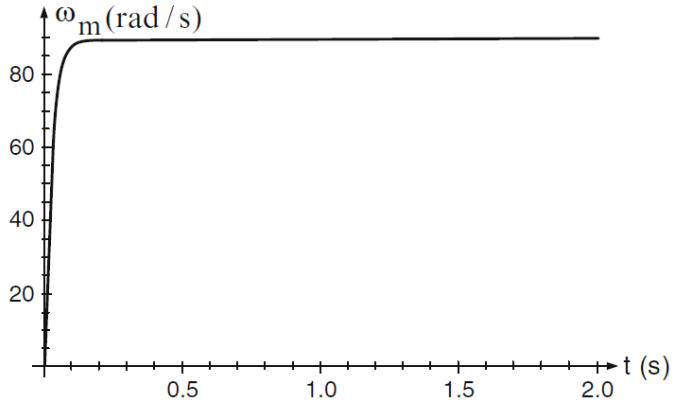
- Fixed versus adjustable speed drive

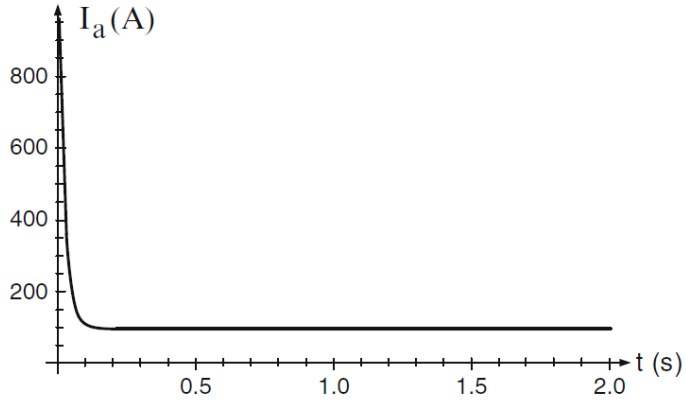


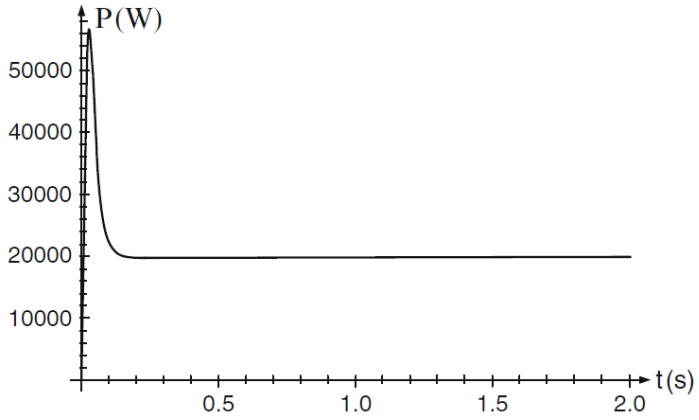



# Instantaneous Waveforms of Torque, Current and Power



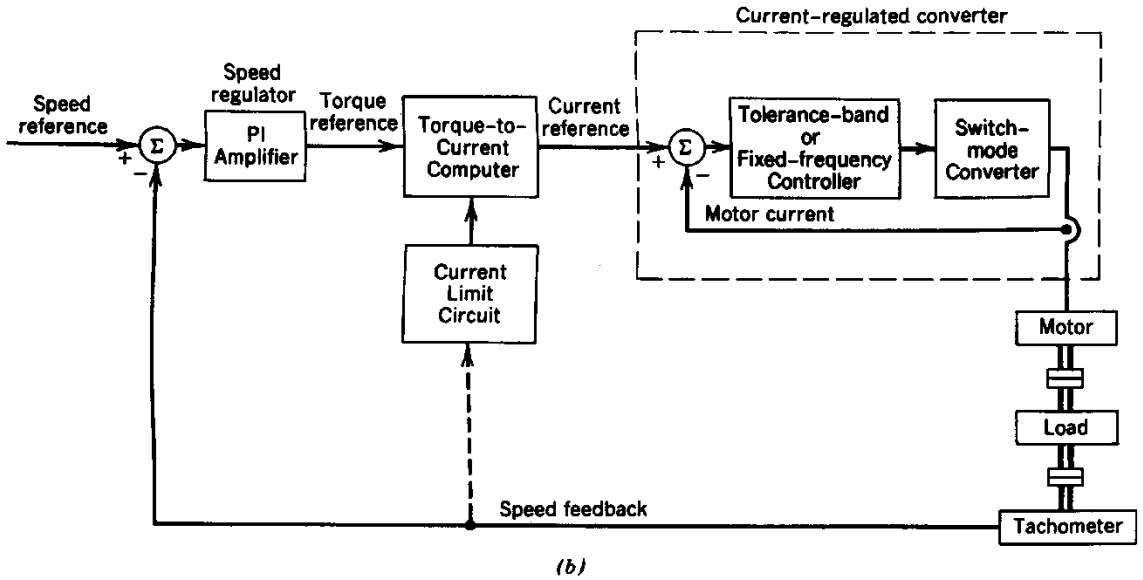



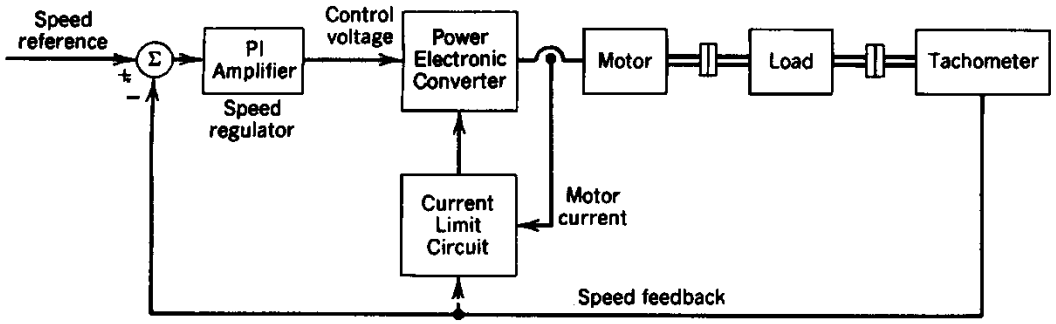




- Their RMS values may determine the limit

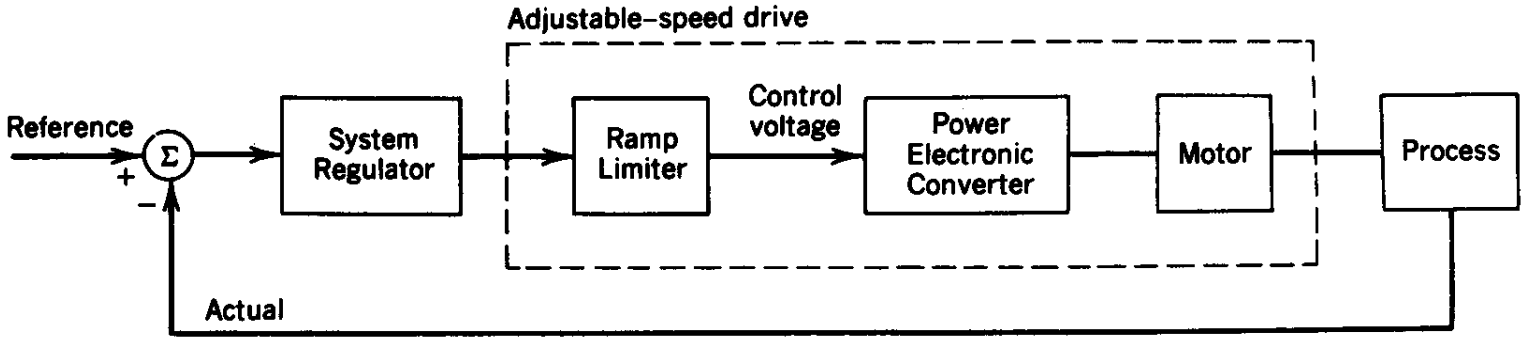
# Control of Servo Drives

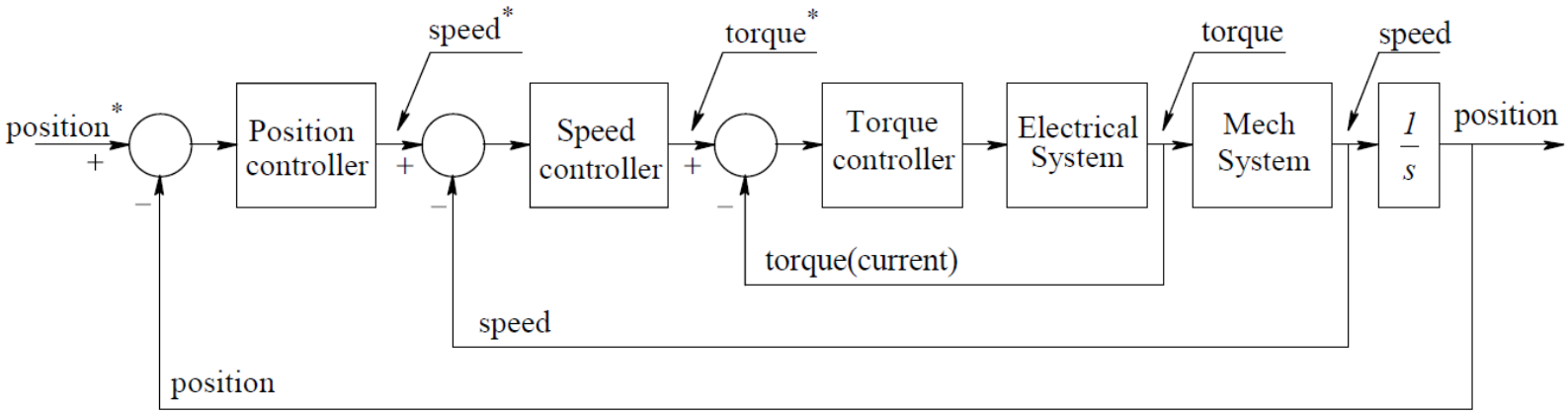



- The structure is application dependent

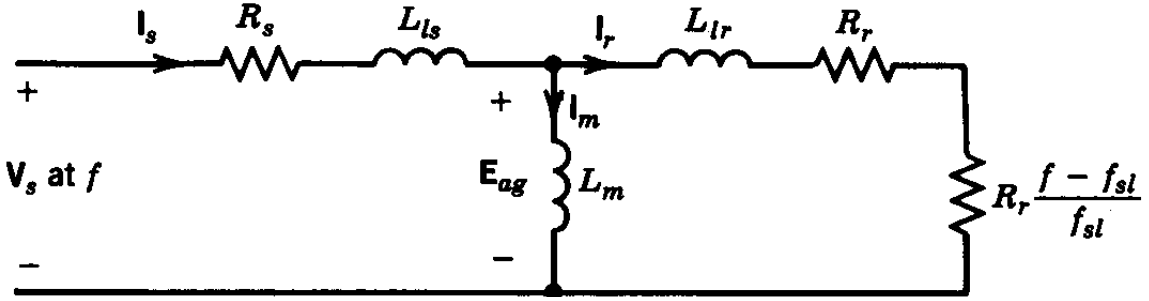
# Limiters in the Control Structure

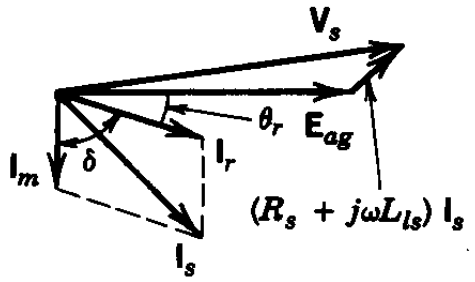


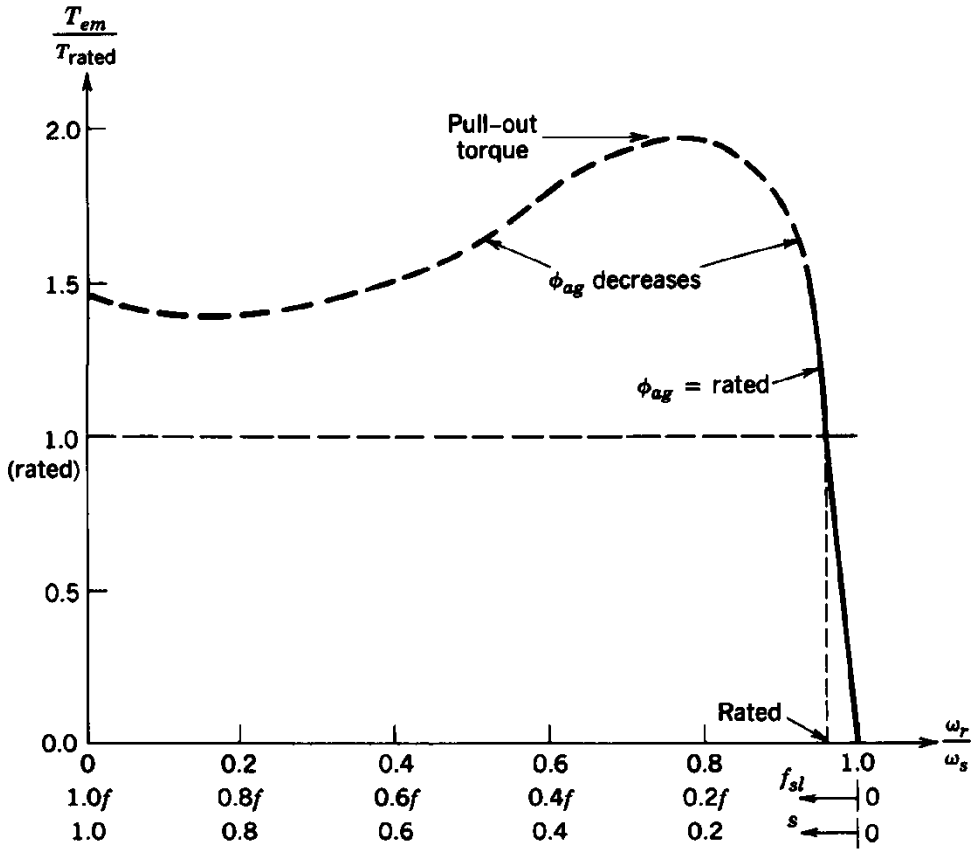




- By providing ramp limiters, for example, drive can be prevented from “tripping” under sudden changes

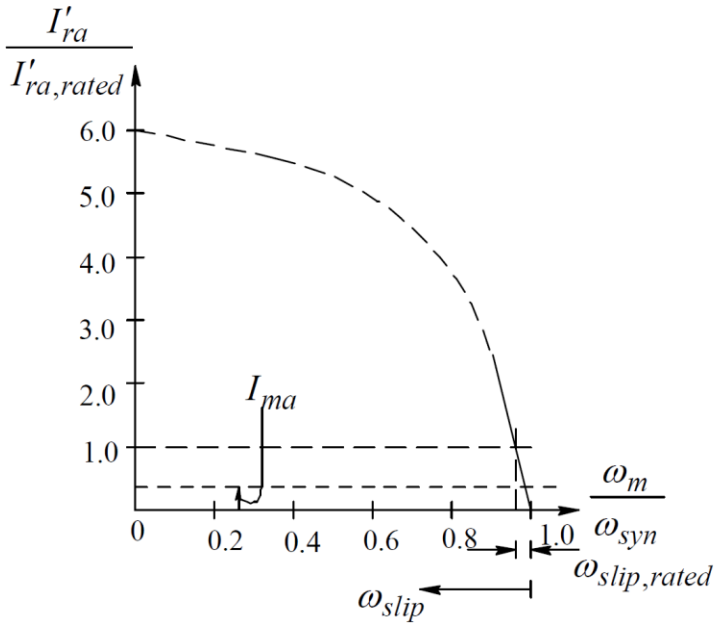
# Induction Motor Drives

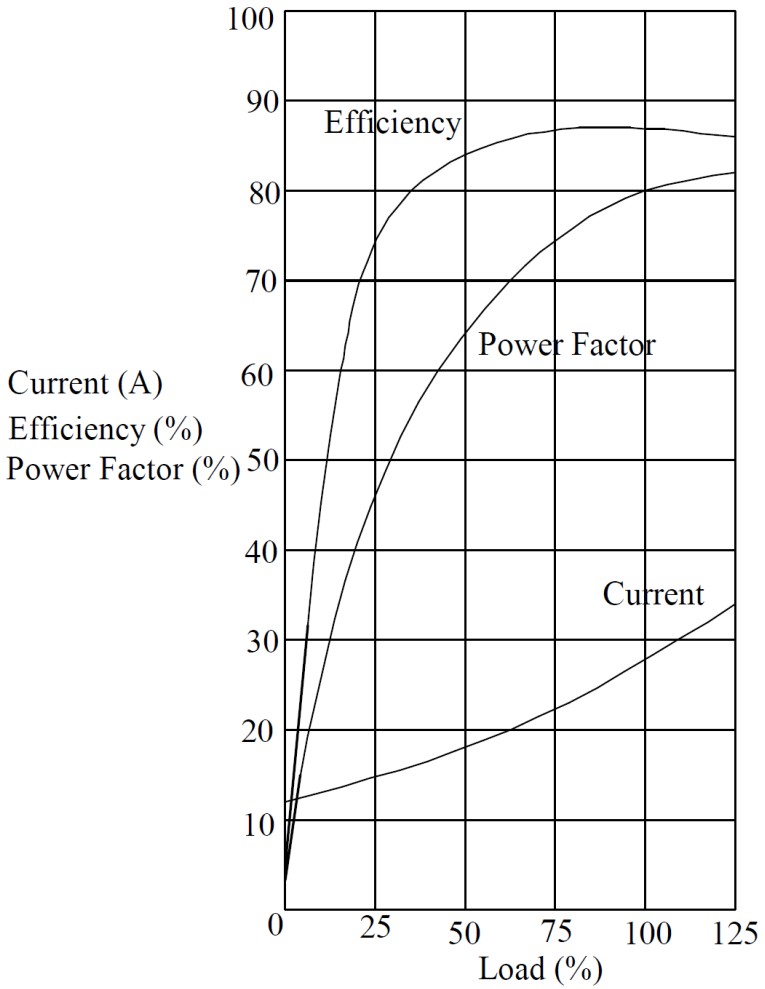


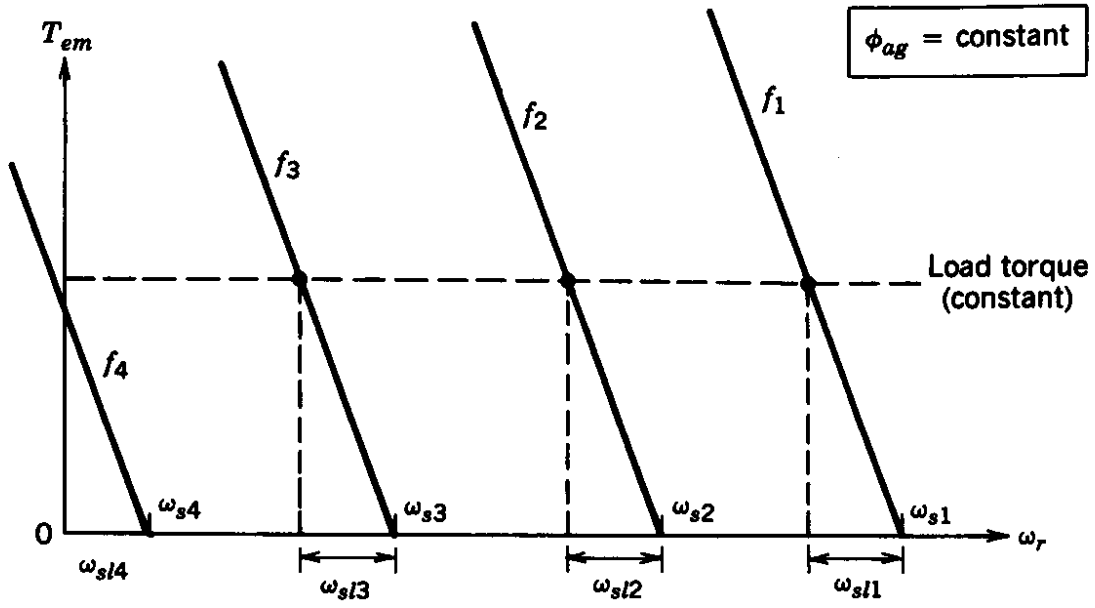
# Motor Currents, Efficiency, Power Factor as a function of Load



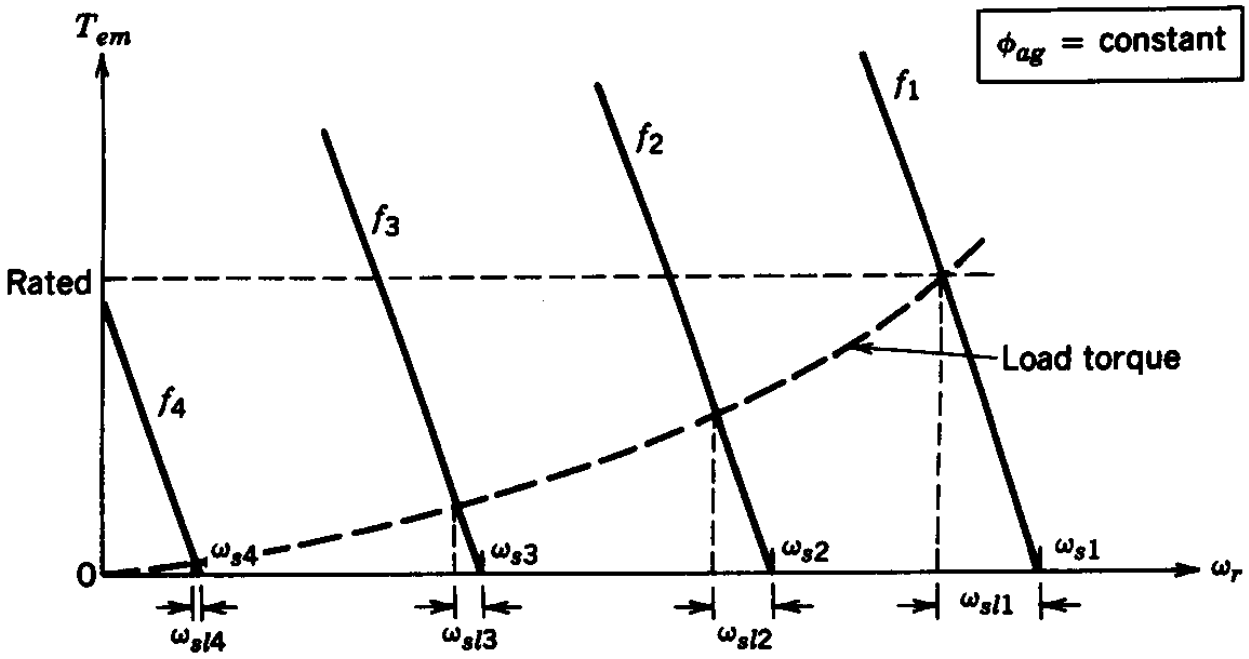
# Torque Speed Characteristics at various Frequencies of Applied Voltage

- The air gap flux is kept constant

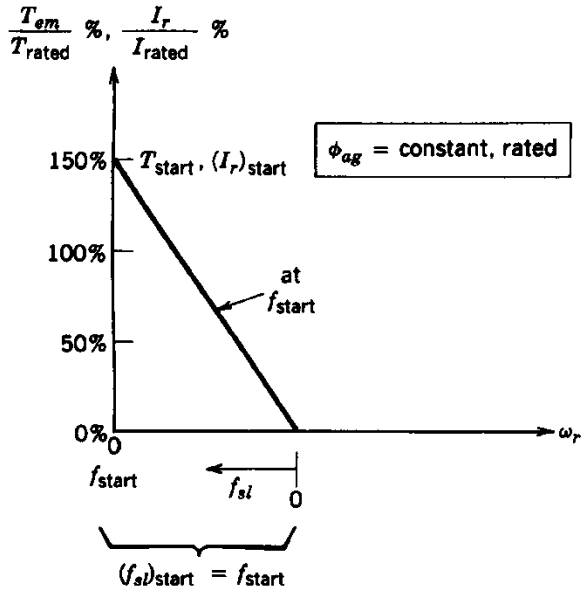


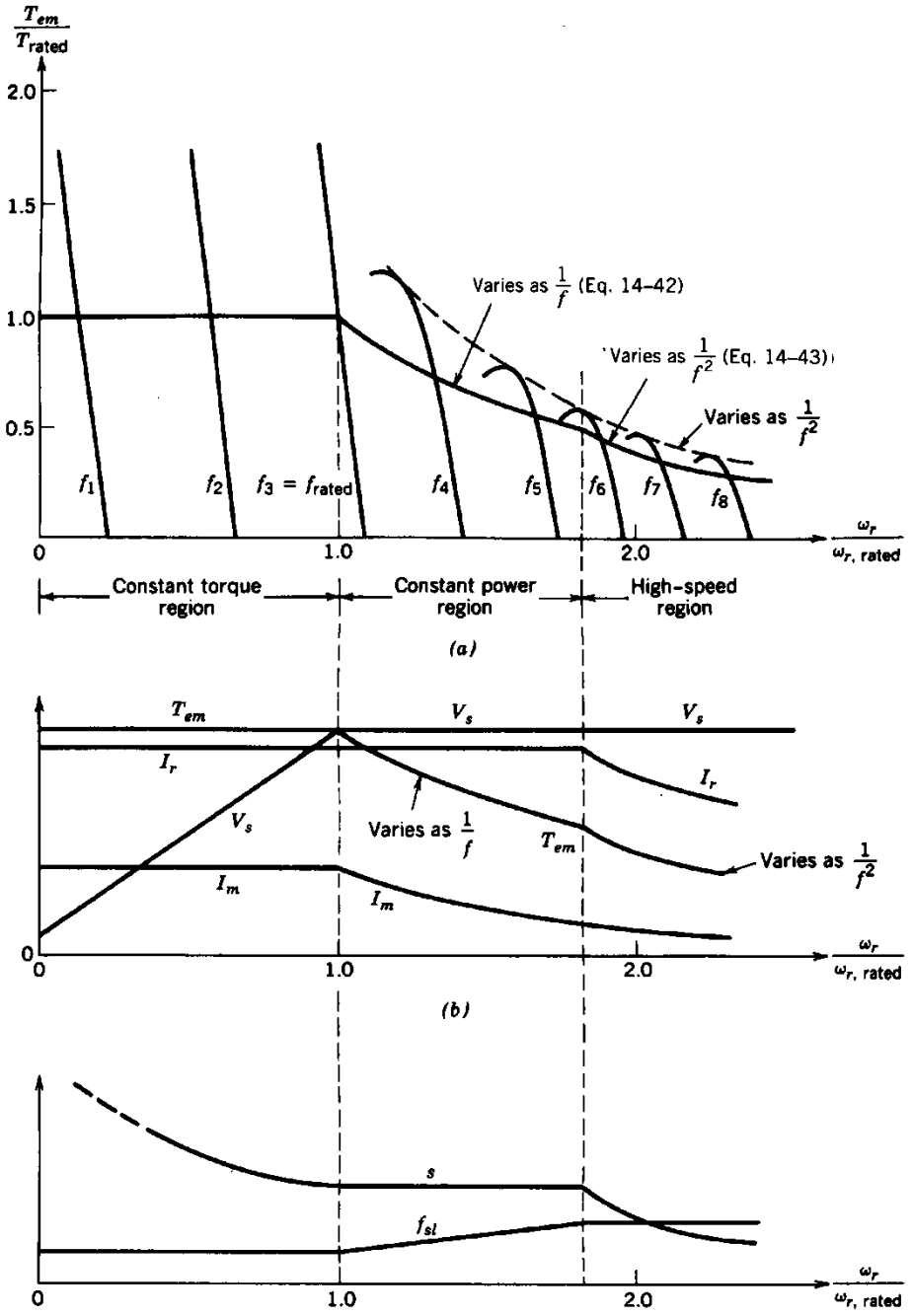
# Adjusting Speed of a Centrifugal Load

- The load torque is proportional to speed squared

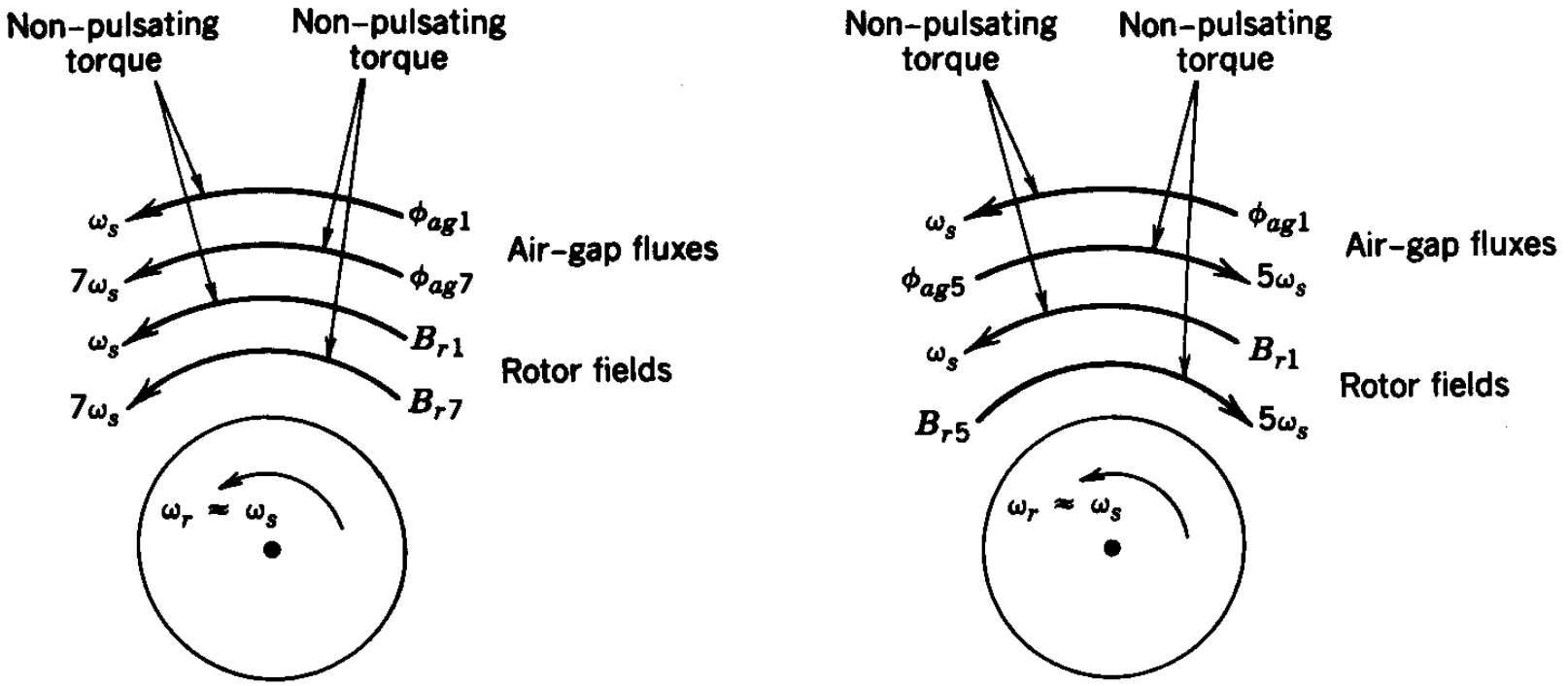


# Induction Motor Drive Capability Curves



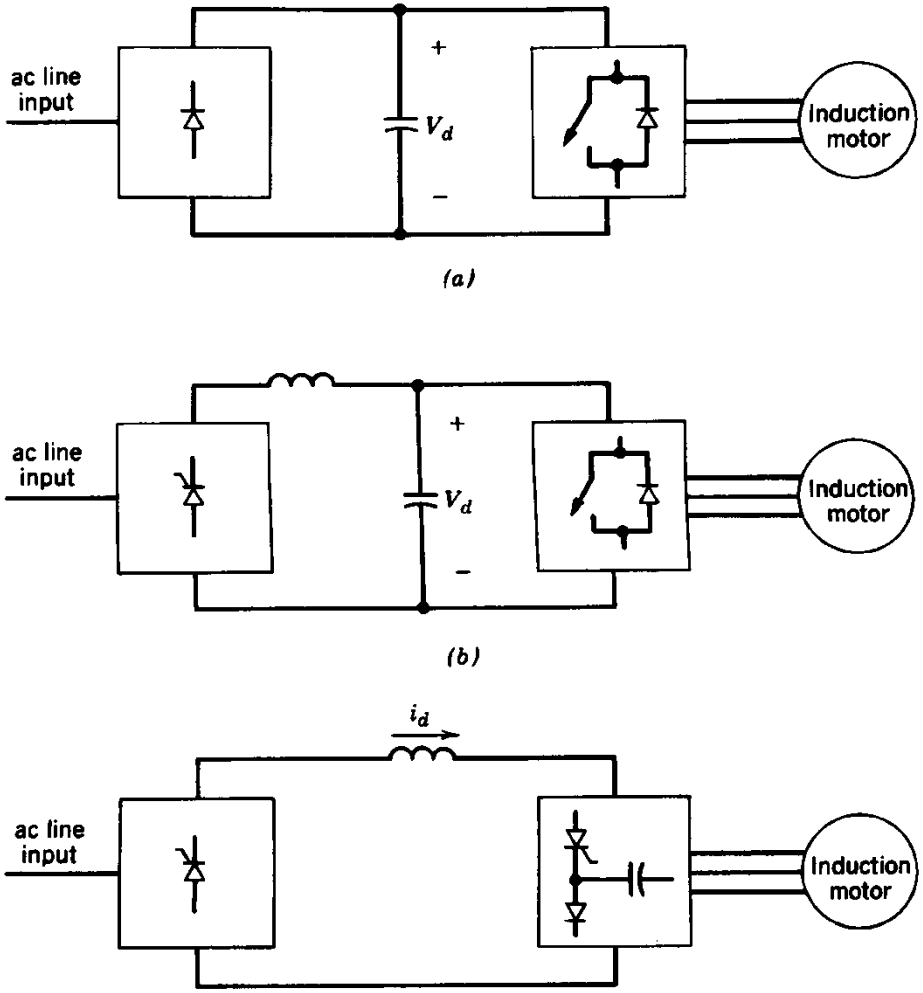



# Torque Pulsations due to Harmonics

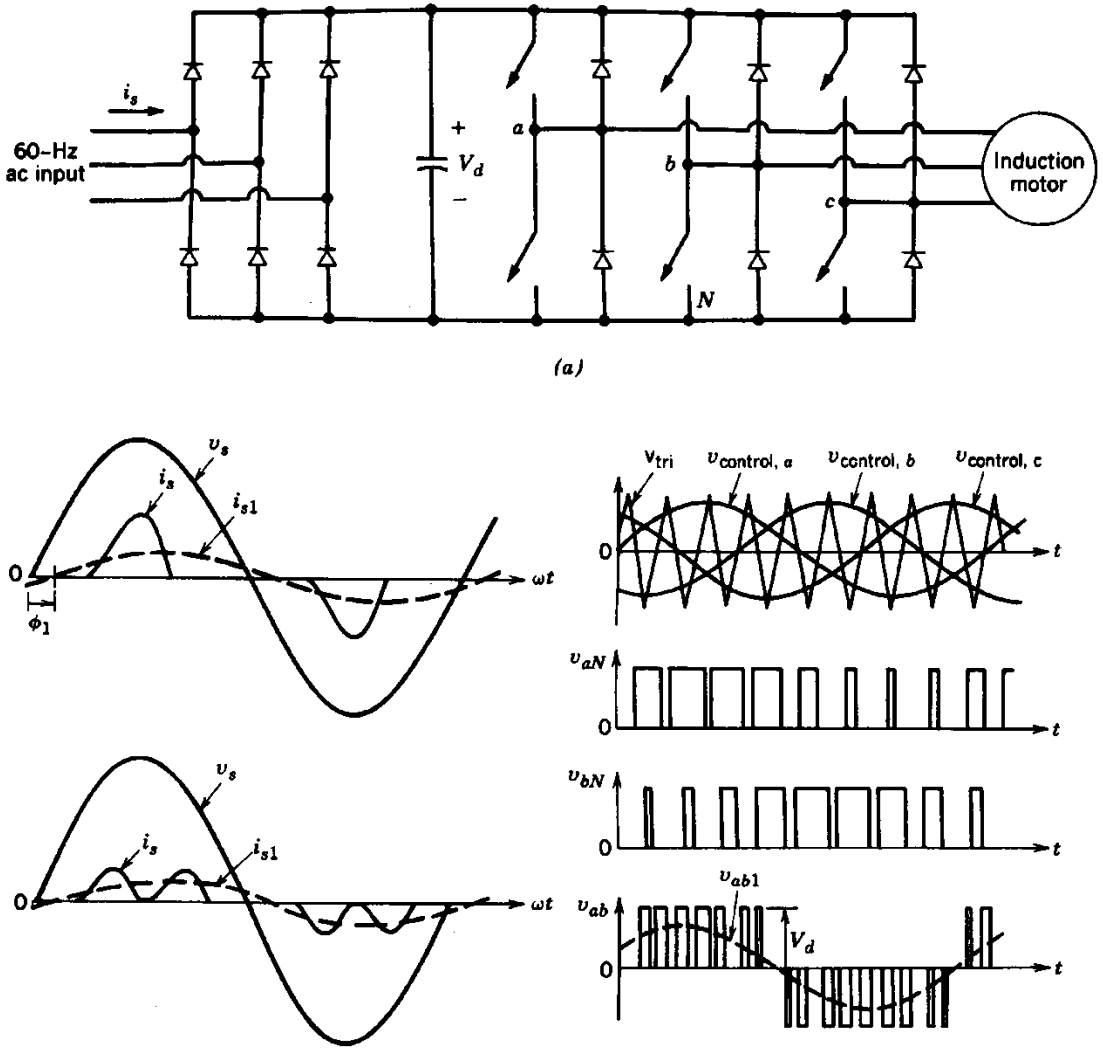



- Rotations of fields due to the fifth and the seventh harmonics are in opposite directions

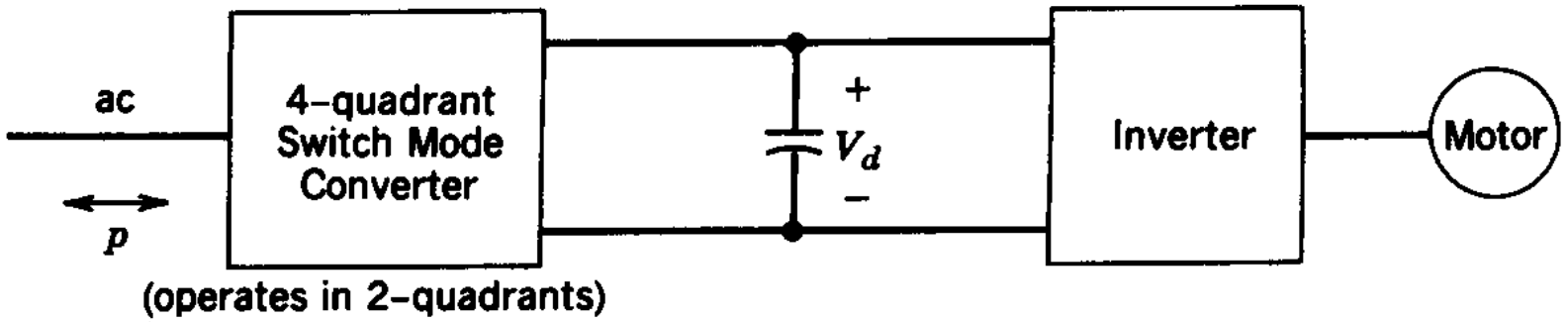
# Clasification of Converters for IM

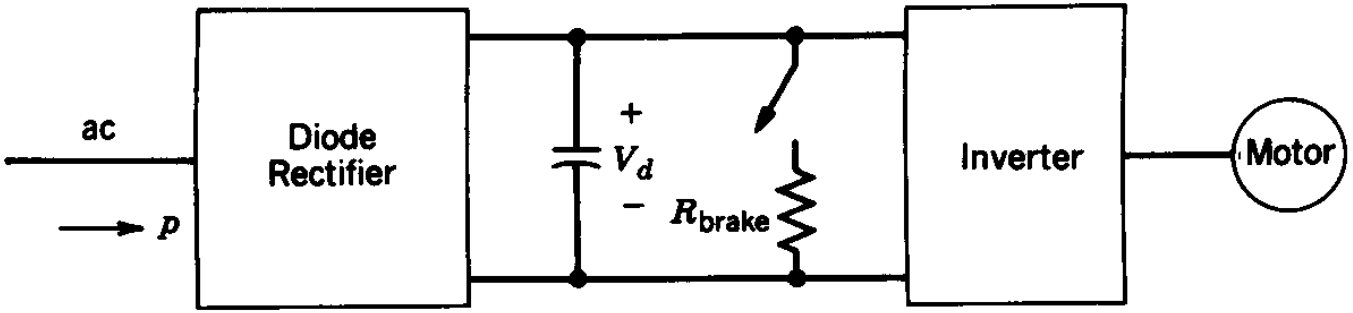


# PWM-VSI System

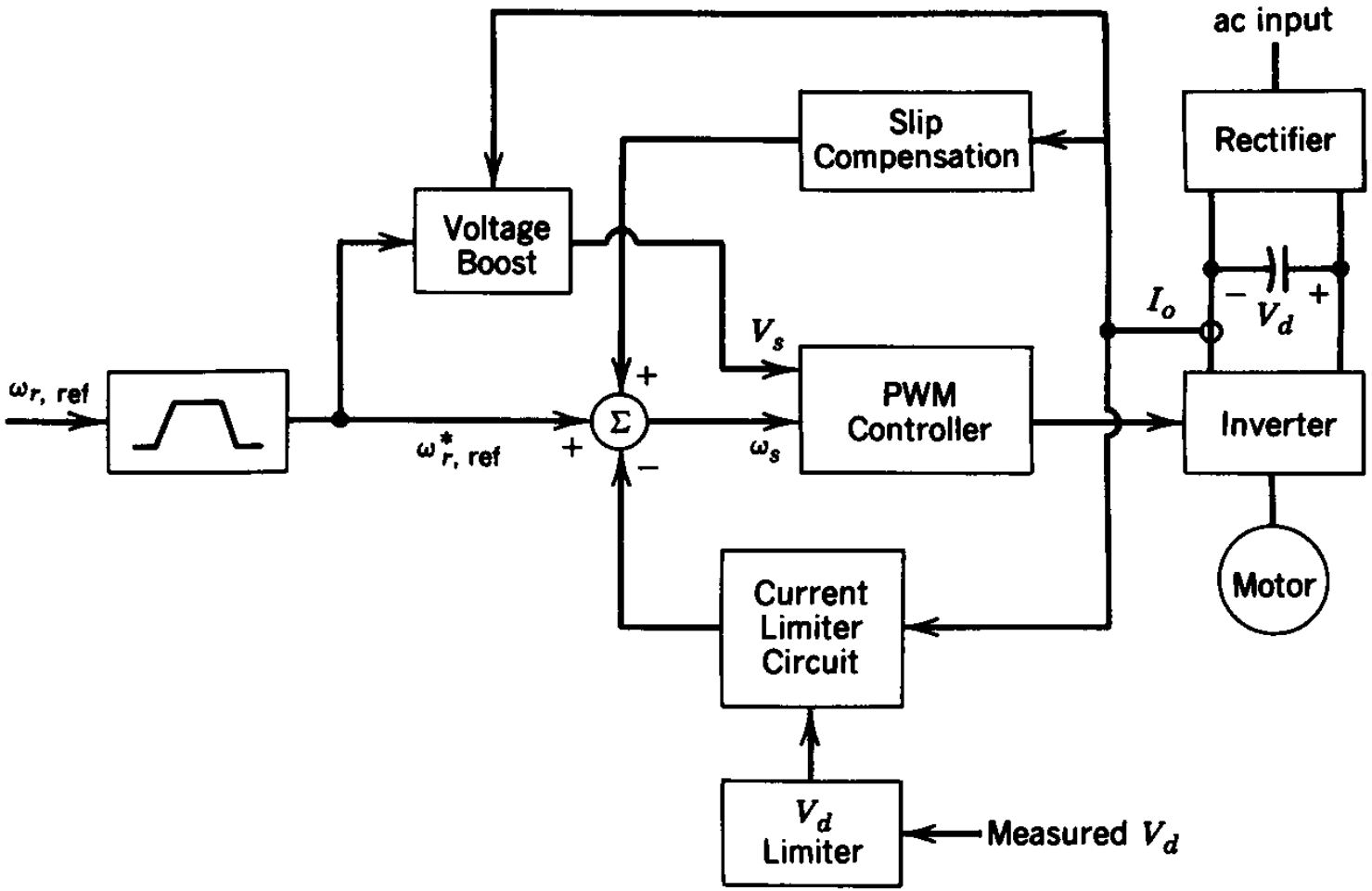


# Options for recovered energy during regenerative braking

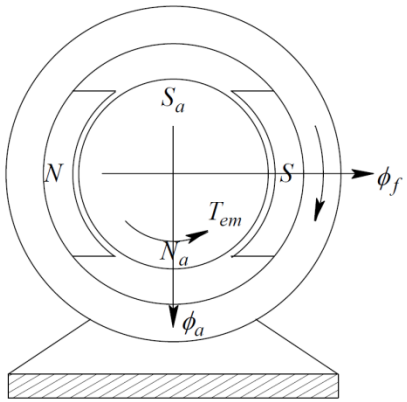


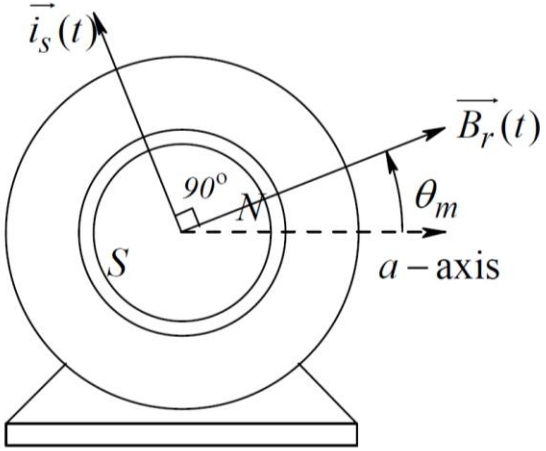



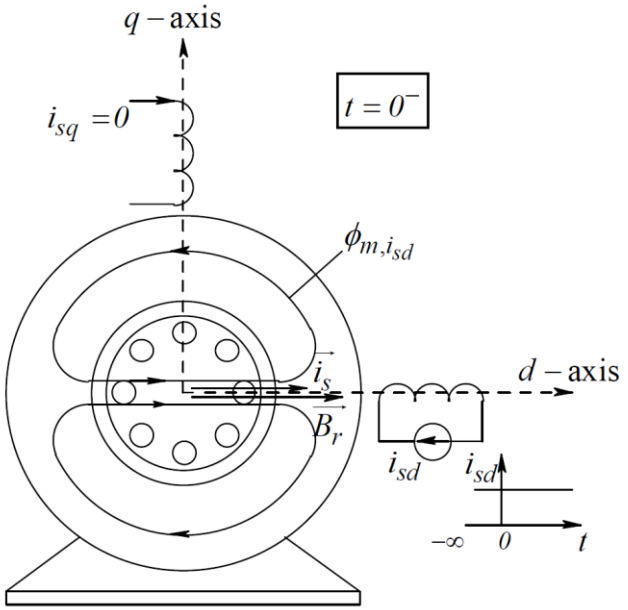
# General-Purpose Speed Controller
*no high dynamics*

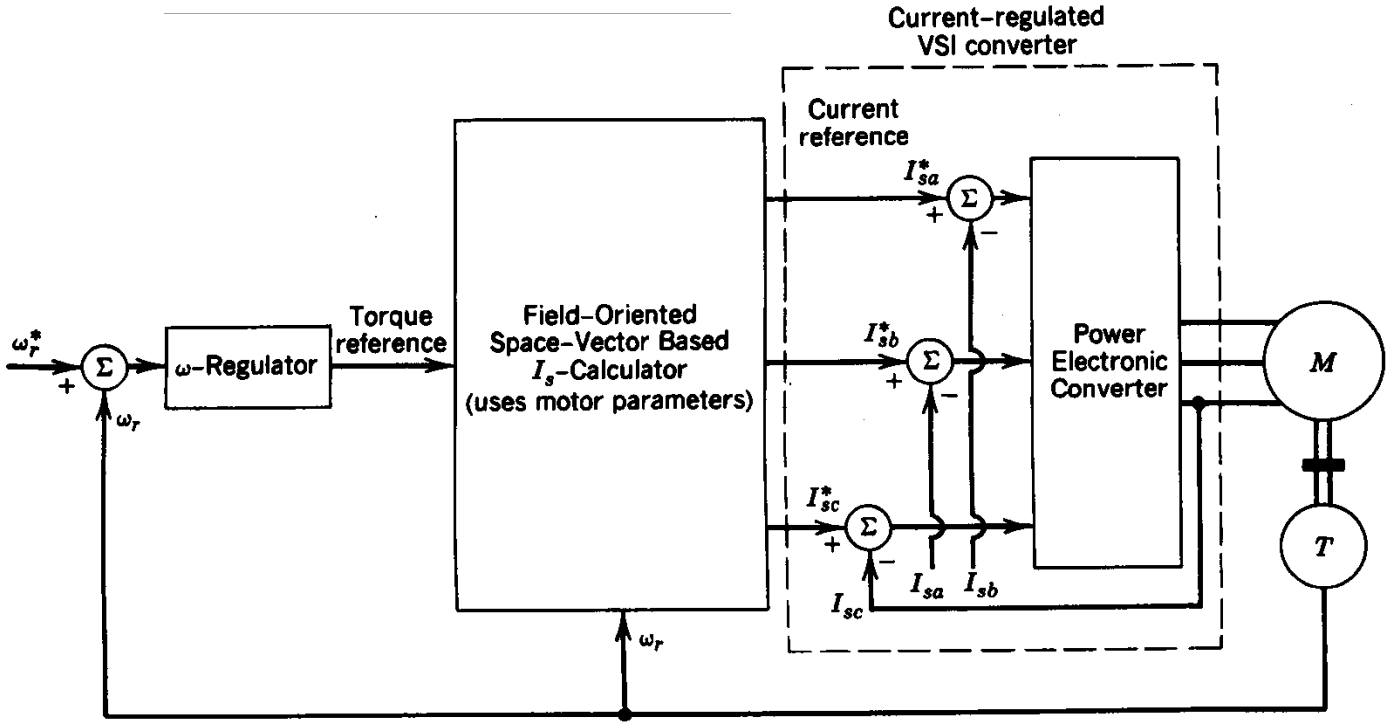


# Field-Oriented Control

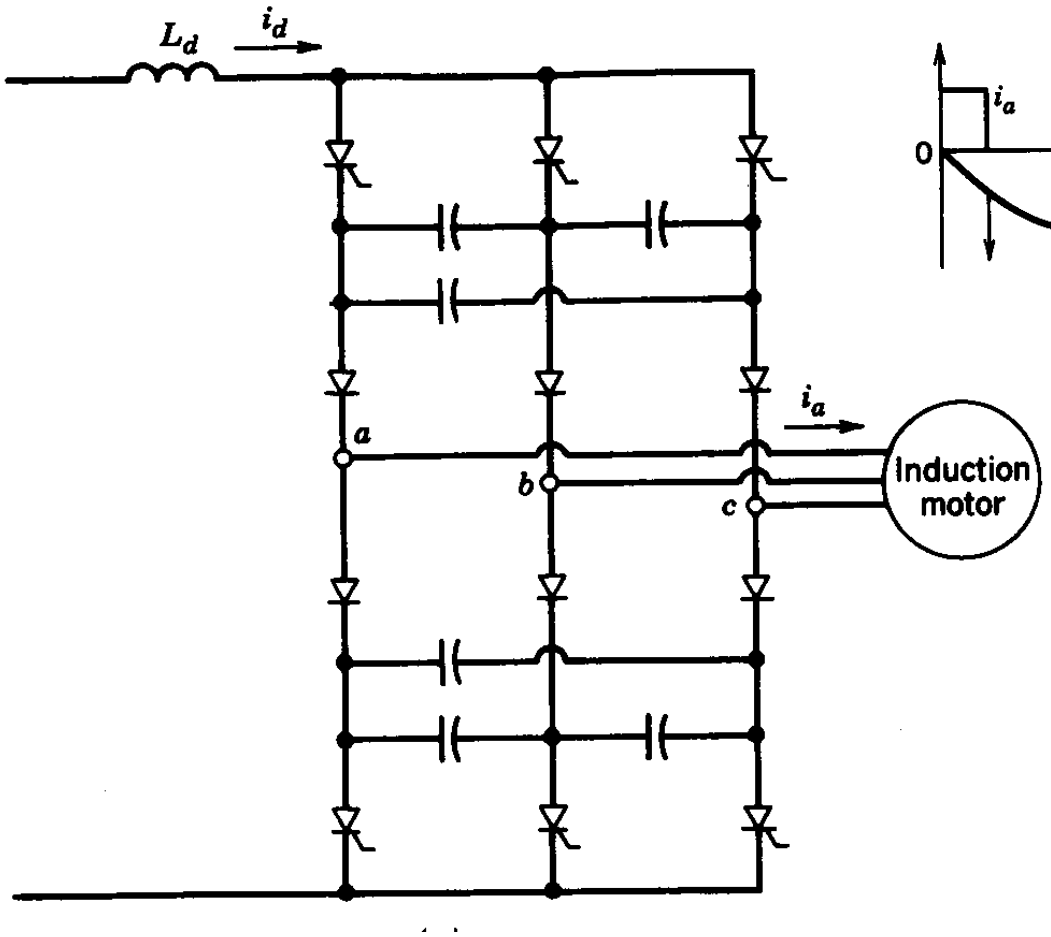


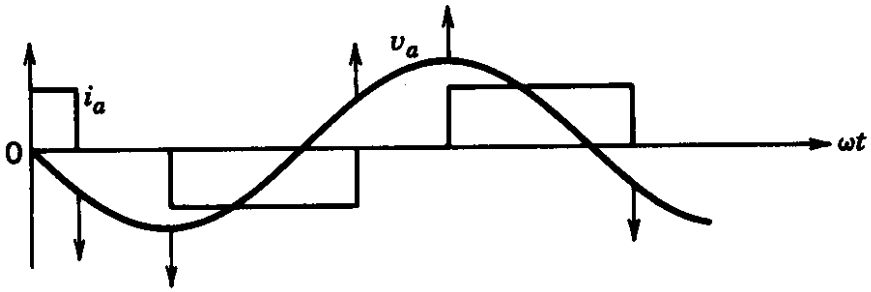



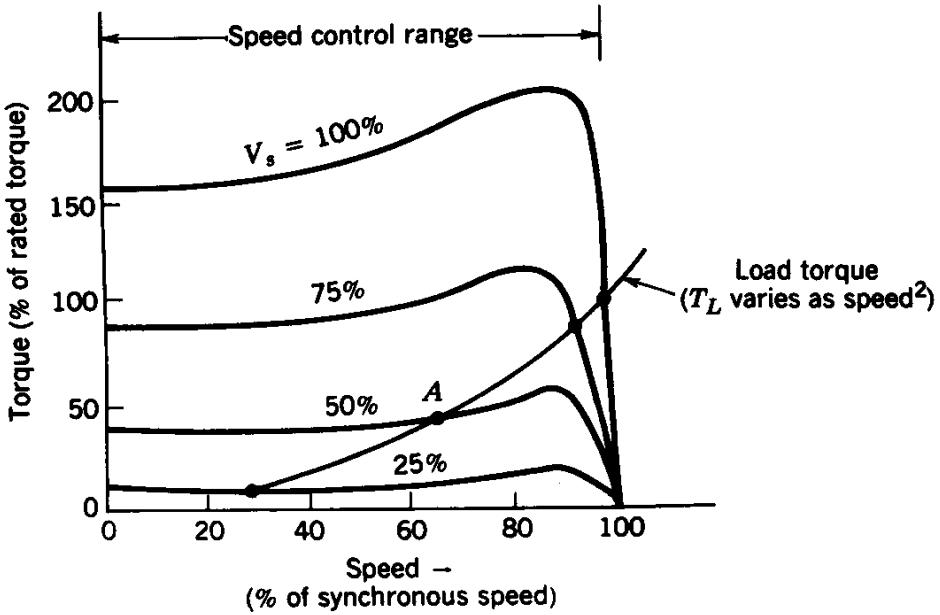



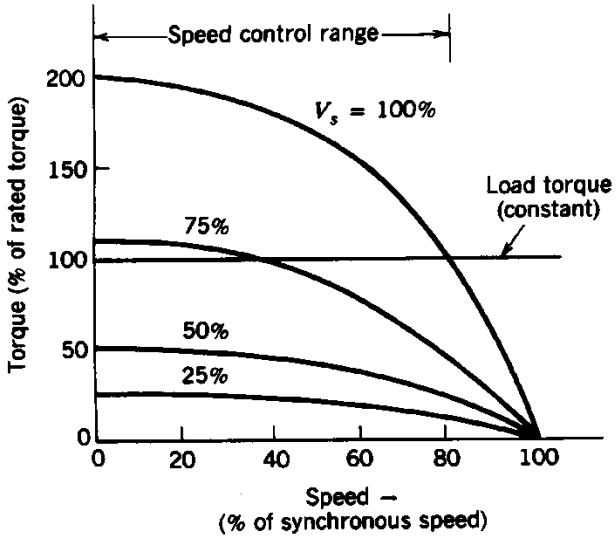
# CSI Drives
# ultra large power



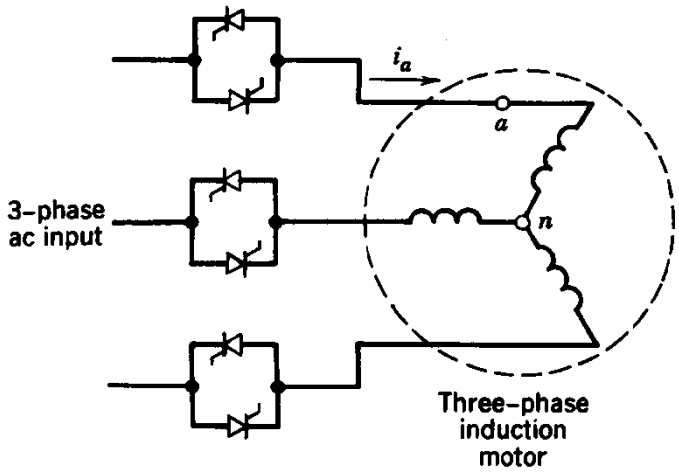



# Speed Control by Adjusting the Stator Voltage Magnitude

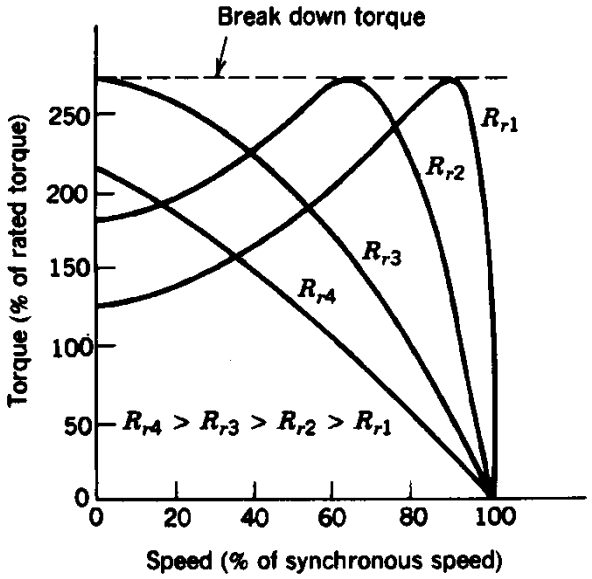


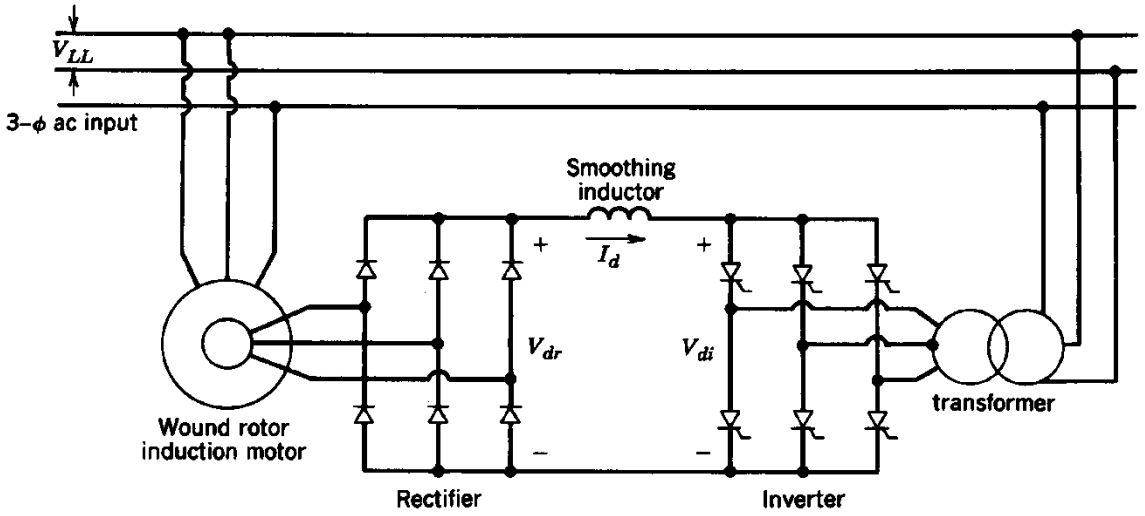




- Highly inefficient in most cases
- Simpler then v/f-const

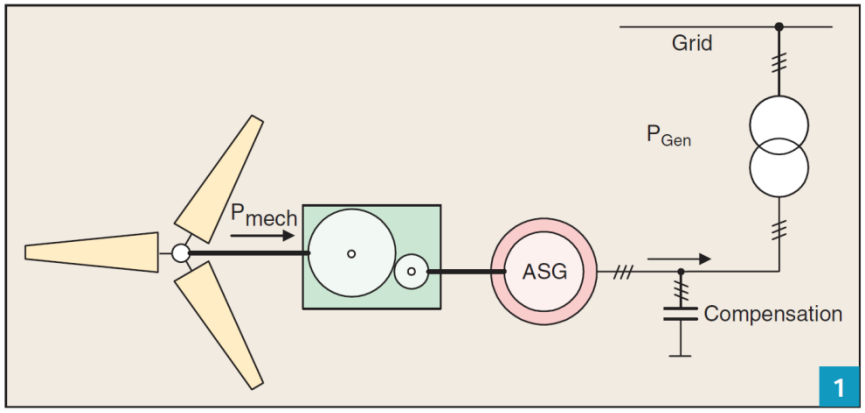


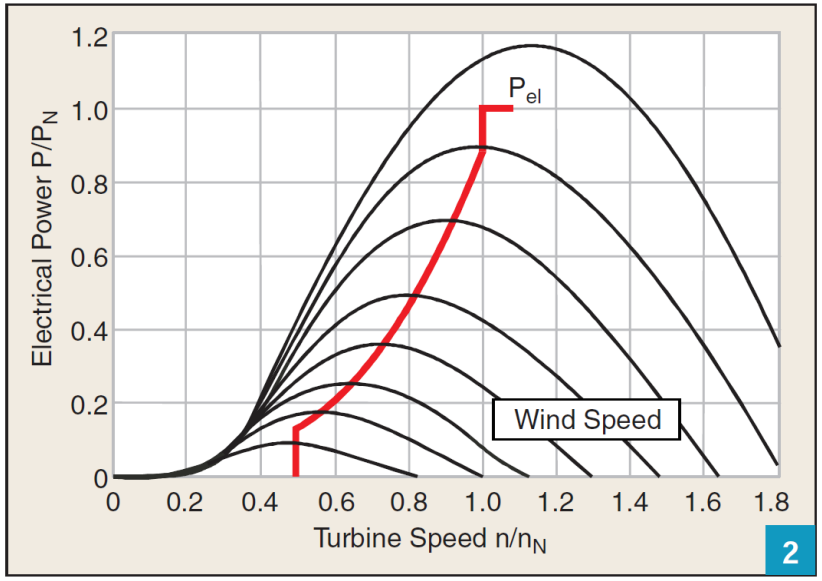
# Wound Motor Machines
# Speed Control

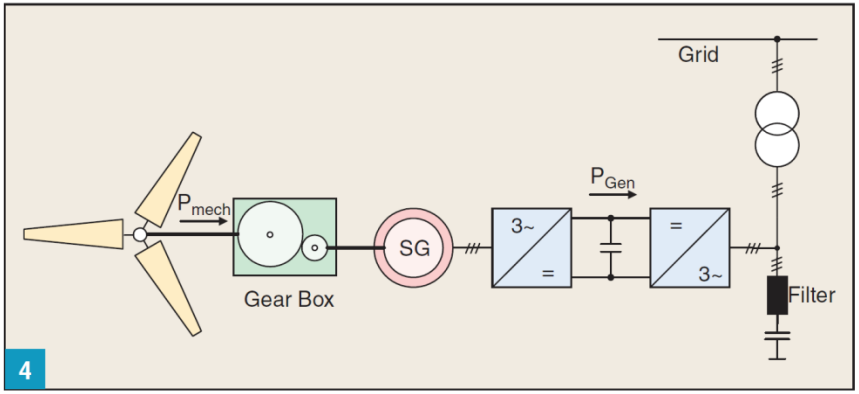


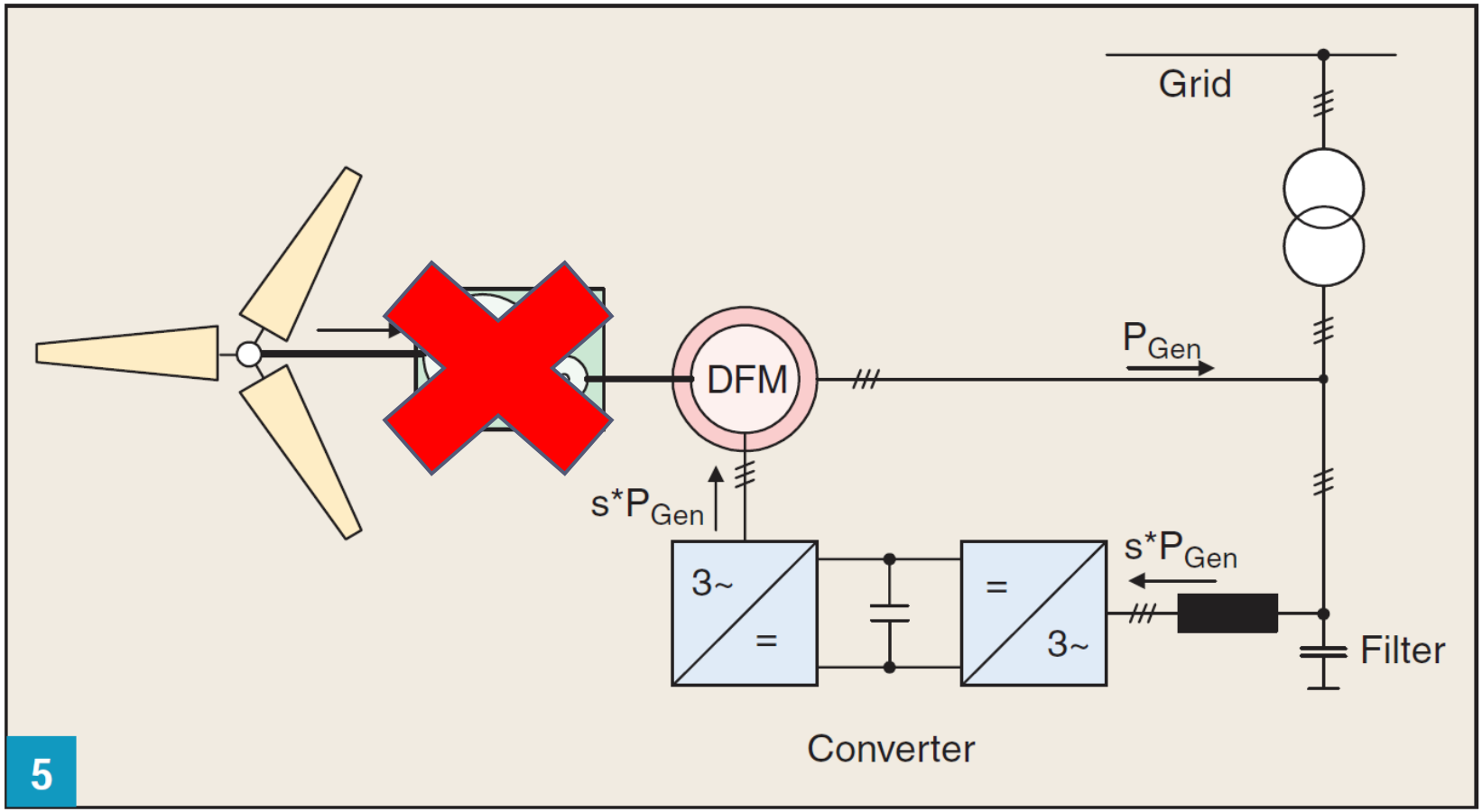
# Wound motor wind turbine concept



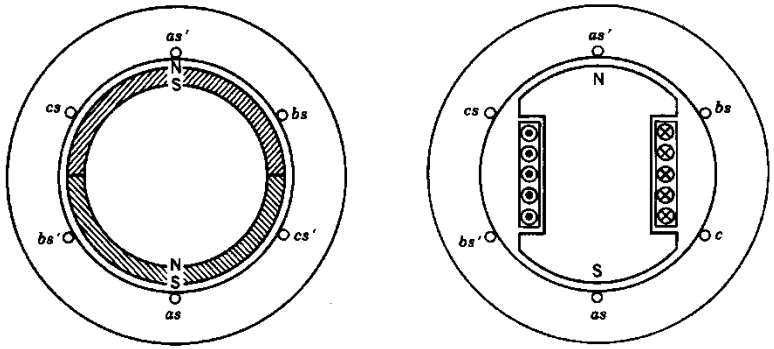



# Wound motor wind turbine concept

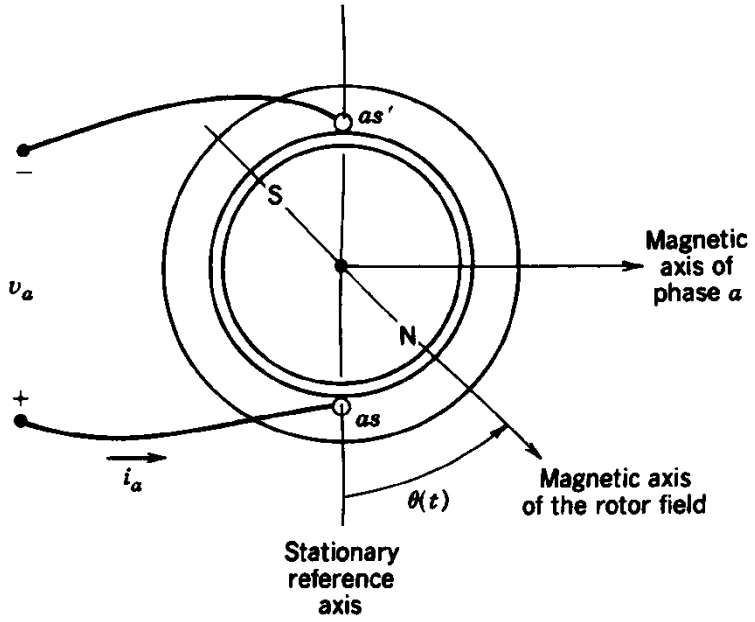


# Synchronous Motor Drive

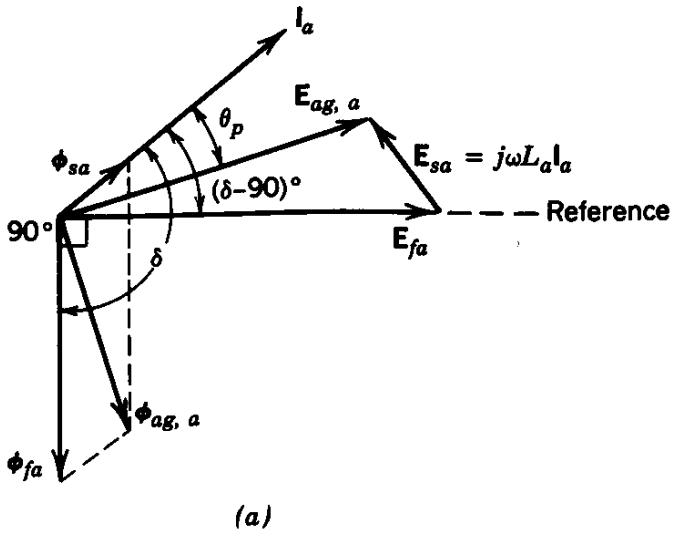
- Permanent-magnet or wound field



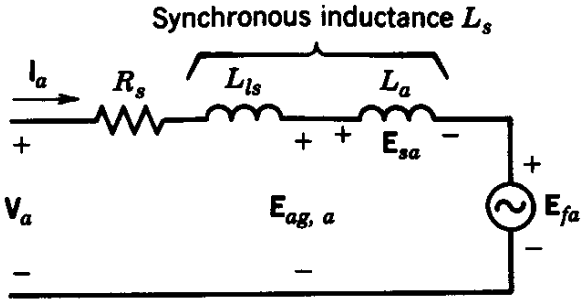

- Rotor position

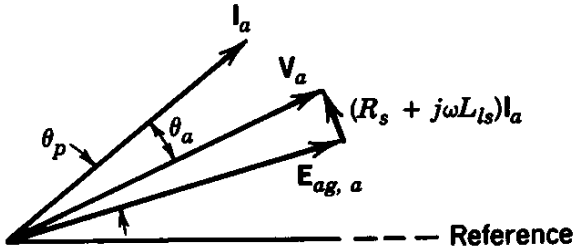


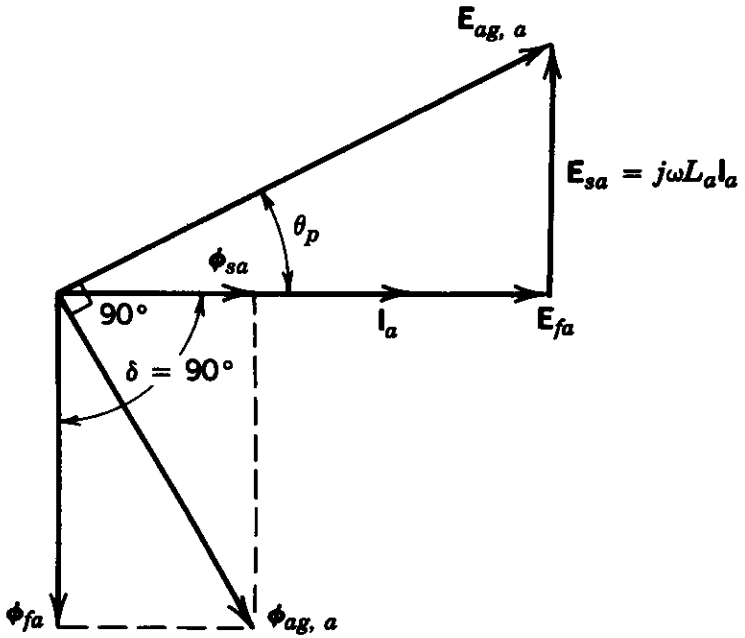
# Synchronous Motor phasor representation




(a)

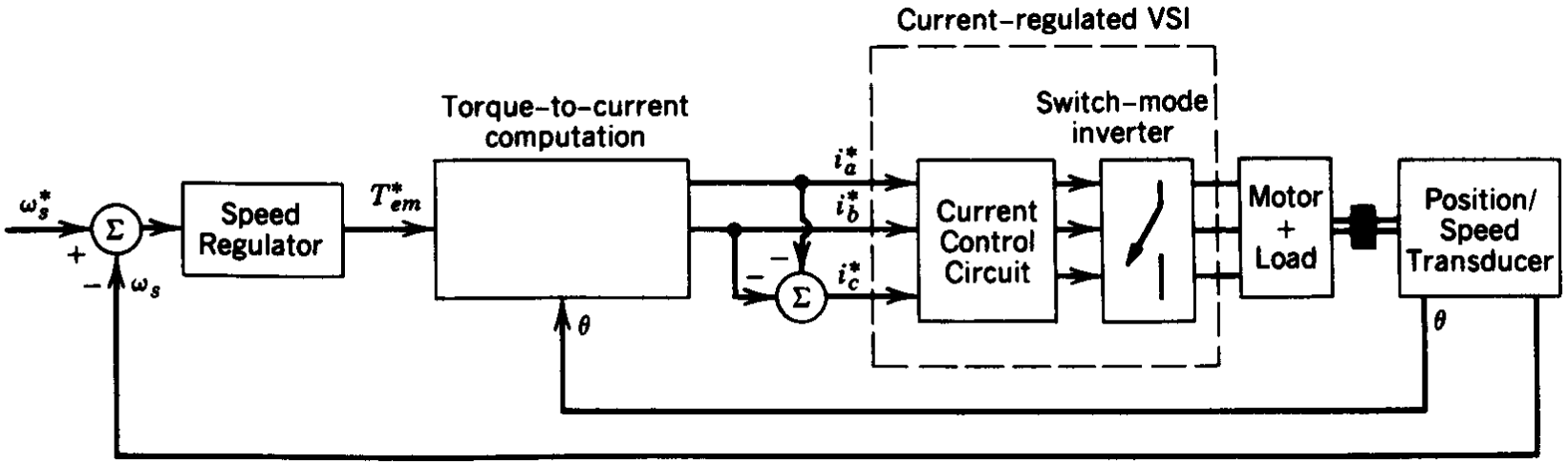


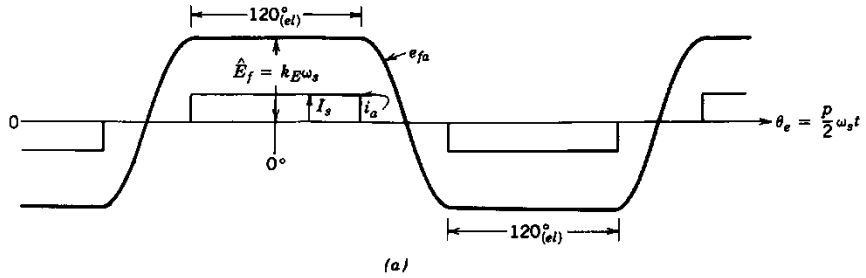




- Only in sinusoidal steady state

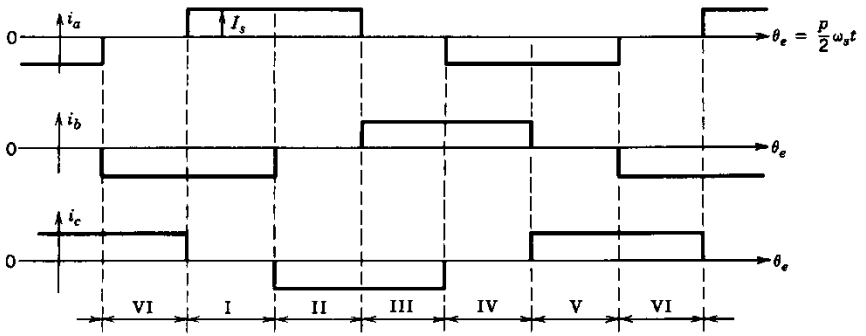
# Synchronous Motor Drive



# Trapezoidal Waveform Synchronous Motor Brushless DC Motor




(a)




(b)