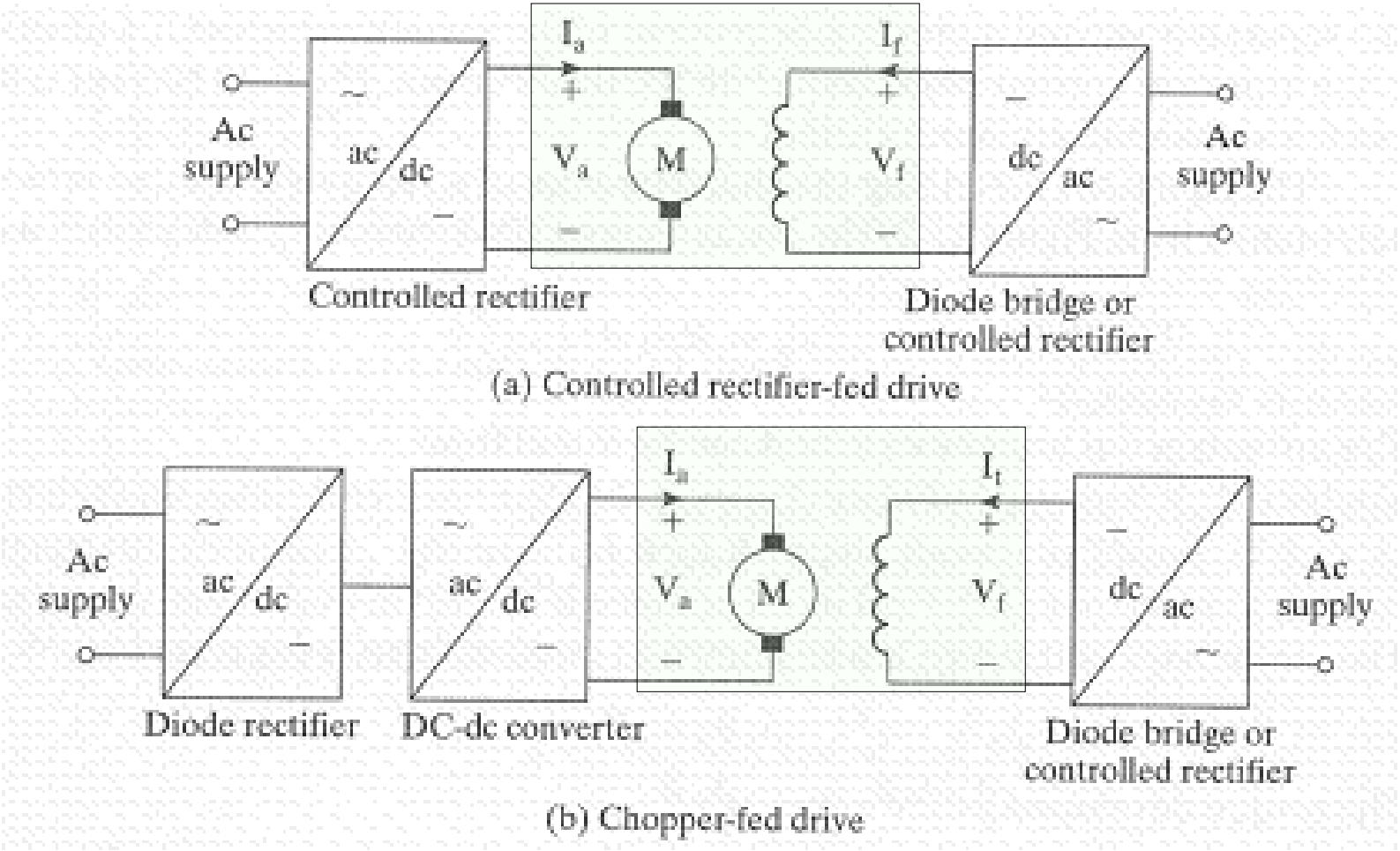
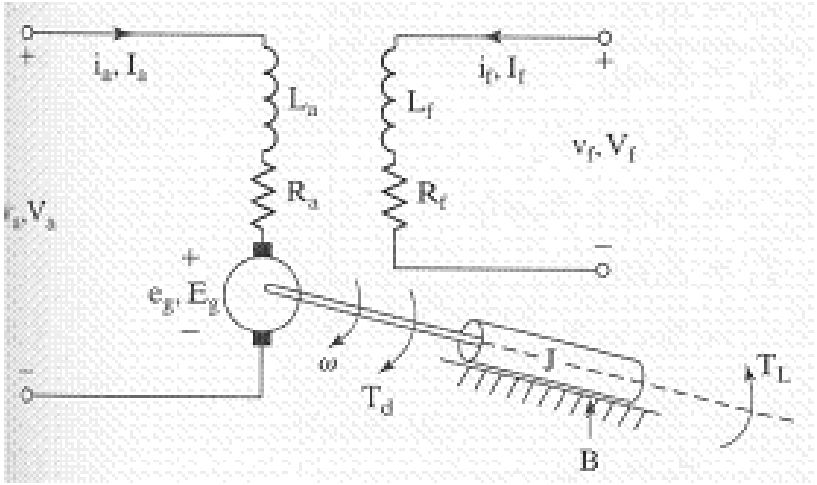
Single-phase Separately Excited Drives

- Direct current (dc) motors have variable characteristics and are used extensively in variable-speed drives.
- DC motors can provide a high starting torque and it is also possible to obtain speed control over a wide range.
- The methods of speed control are normally simpler and less expensive than those of AC drives.
- DC motors play a significant role in modern industrial drives.
- Both series and separately excited DC motors are normally used in variable-speed drives, but series motors are traditionally employed for traction applications.
- Due to commutators, DC motors are not suitable for very high speed applications and require more maintenance than do AC motors.
- With the recent advancements in power conversions, control techniques, and microcomputers, the ac motor drives are becoming increasingly competitive with DC motor drives.
- Although the future trend is toward AC drives, DC drives are currently used in many industries. It might be a few decades before the DC drives are completely replaced by AC drives.

- Controlled rectifiers provide a variable dc output voltage from a fixed ac voltage, whereas a dc-dc converter can provide a variable dc voltage from a fixed dc voltage.
- Due to their ability to supply a continuously variable dc voltage, controlled rectifiers and dc-dc converters made a revolution in modern industrial control equipment and variable-speed drives, with power levels ranging from fractional horsepower to several megawatts.
- Controlled rectifiers are generally used for the speed control of dc motors.
- The alternative form would be a diode rectifier followed by dc-dc converter.
- DC drives can be classified, in general, into three types:
  - 1. Single-phase drives
  - 2. Three-phase drives
  - 3. DC-DC converter drives

Controlled Rectifier- and DC-DC Converter-Fed Drives





$$\omega = \frac{V_a - R_a I_a}{K_v I_f} = \frac{V_a - R_a I_a}{K_v V_f / R_f}$$

- The motor speed can be varied by
  - controlling the armature voltage V_a, known as voltage control;
  - controlling the field current I_f, known as field control; or
  - torque demand, which corresponds to an armature current I_a, for a fixed field current I_f.
- The speed, which corresponds to the rated armature voltage, rated field current and rated armature current, is known as the rated (or base) speed.

Basic Characteristics of Separately Excited DC Motors

- In practice, for a speed less than the base speed, the armature current and field currents are maintained constant to meet the torque demand, and the armature voltage V_a is varied to control the speed.
- For speed higher than the base speed, the armature voltage is maintained at the rated value and the field current is varied to control the speed.
- However, the power developed by the motor (= torque X speed) remains constant.
- Figure below shows the characteristics of torque, power, armature current, and field current against the speed.