Torque-speed characteristics

Armature circuit:

$$V_a = R_a i_a + L\frac{di_a}{dt} + e_a$$

In steady state,

$$V_a = R_a I_a + E_a$$

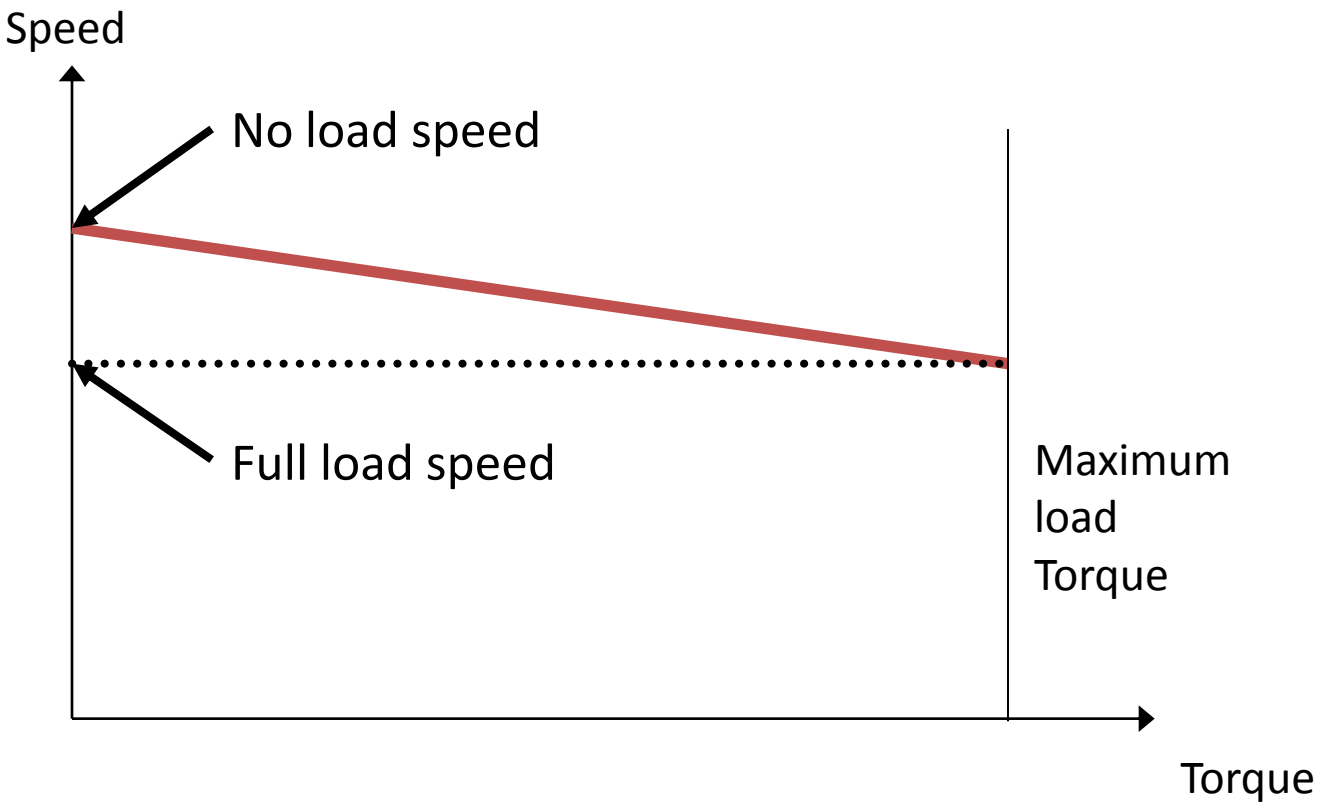
Therefore speed is given by,

$$\omega = -\frac{R_a}{\left(k_T\phi\right)^2} T_e + \frac{V_a}{k_T\phi}$$

Three possible methods of speed control:

Armature resistance Ra
Field flux Φ
Armature voltage Va

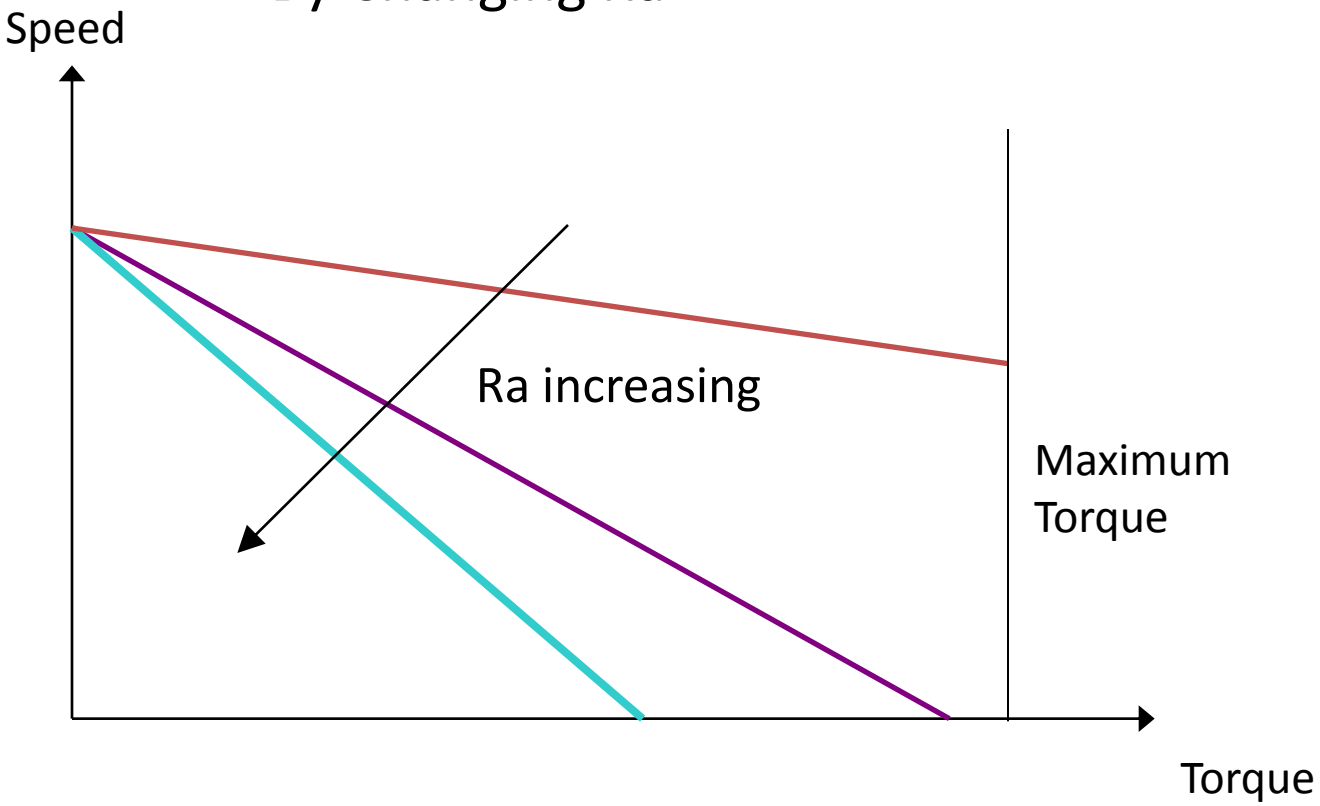
Torque-speed characteristics of DC motor



Separately excited DC motors have good speed regulation.

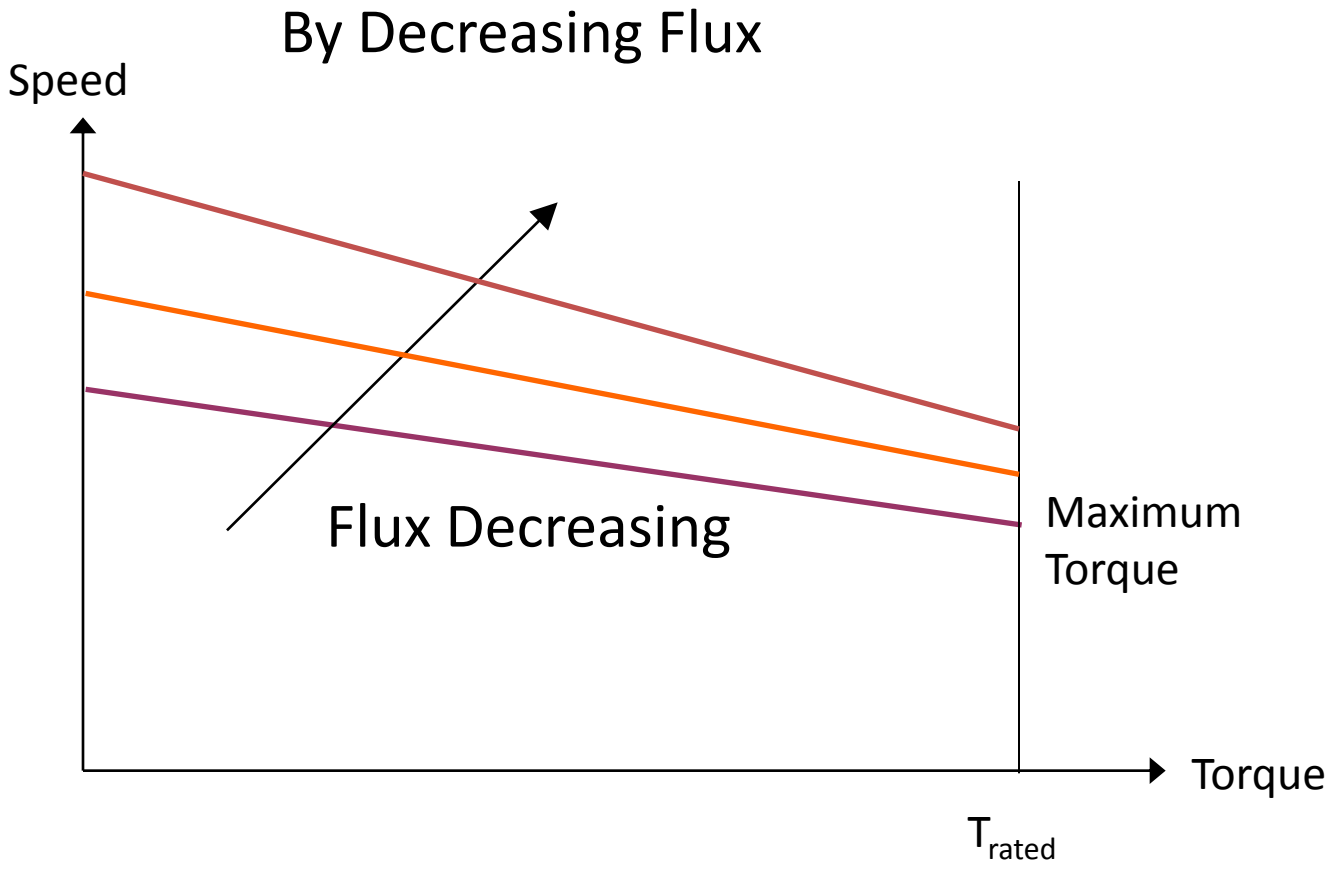
DC Motor Speed Control

By Changing Ra



- Power loss in Ra
- Does not maintain maximum torque capability
- Poor speed regulation

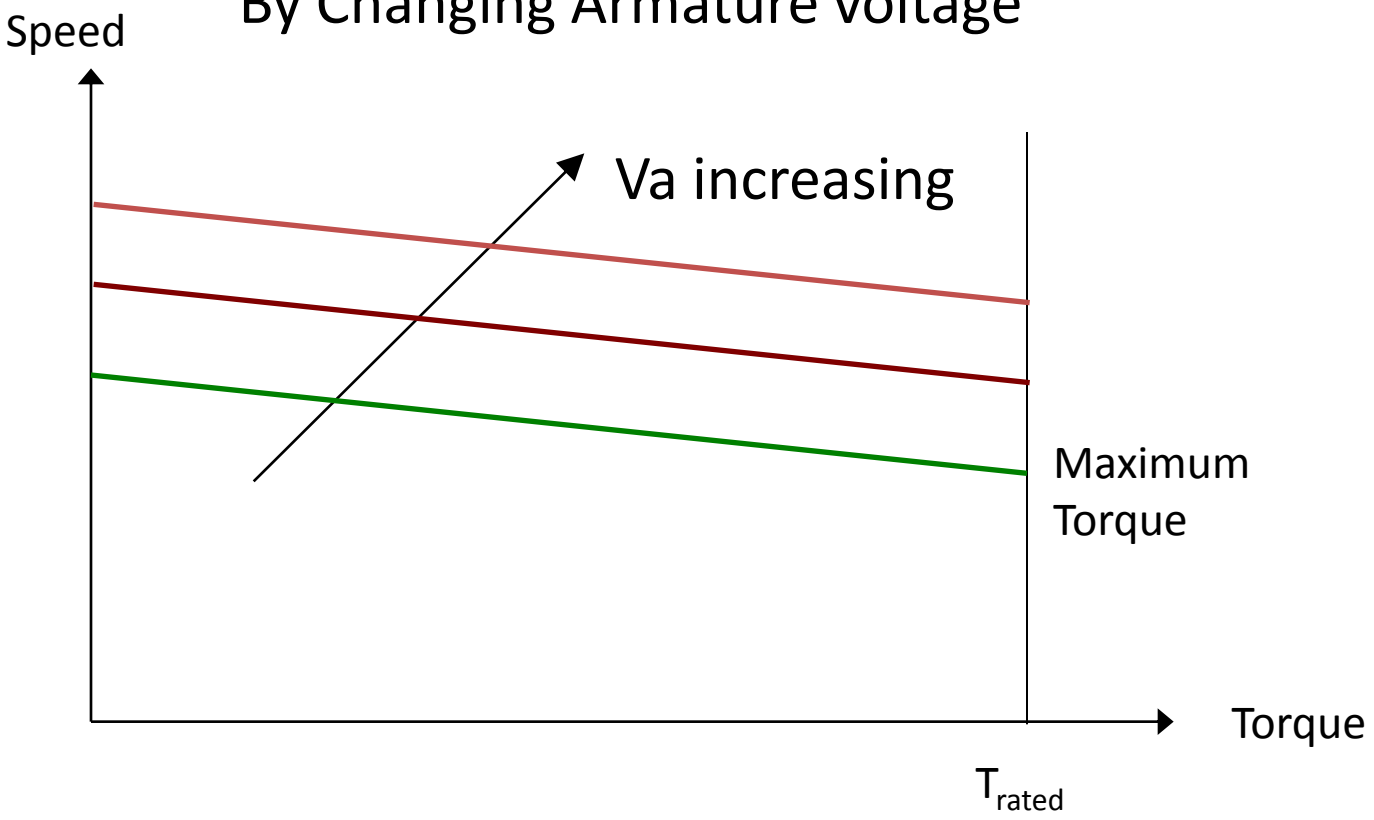
DC Motor Speed Control



- Slow transient response
- Does not maintain maximum torque capability

DC Motor Speed Control

By Changing Armature voltage

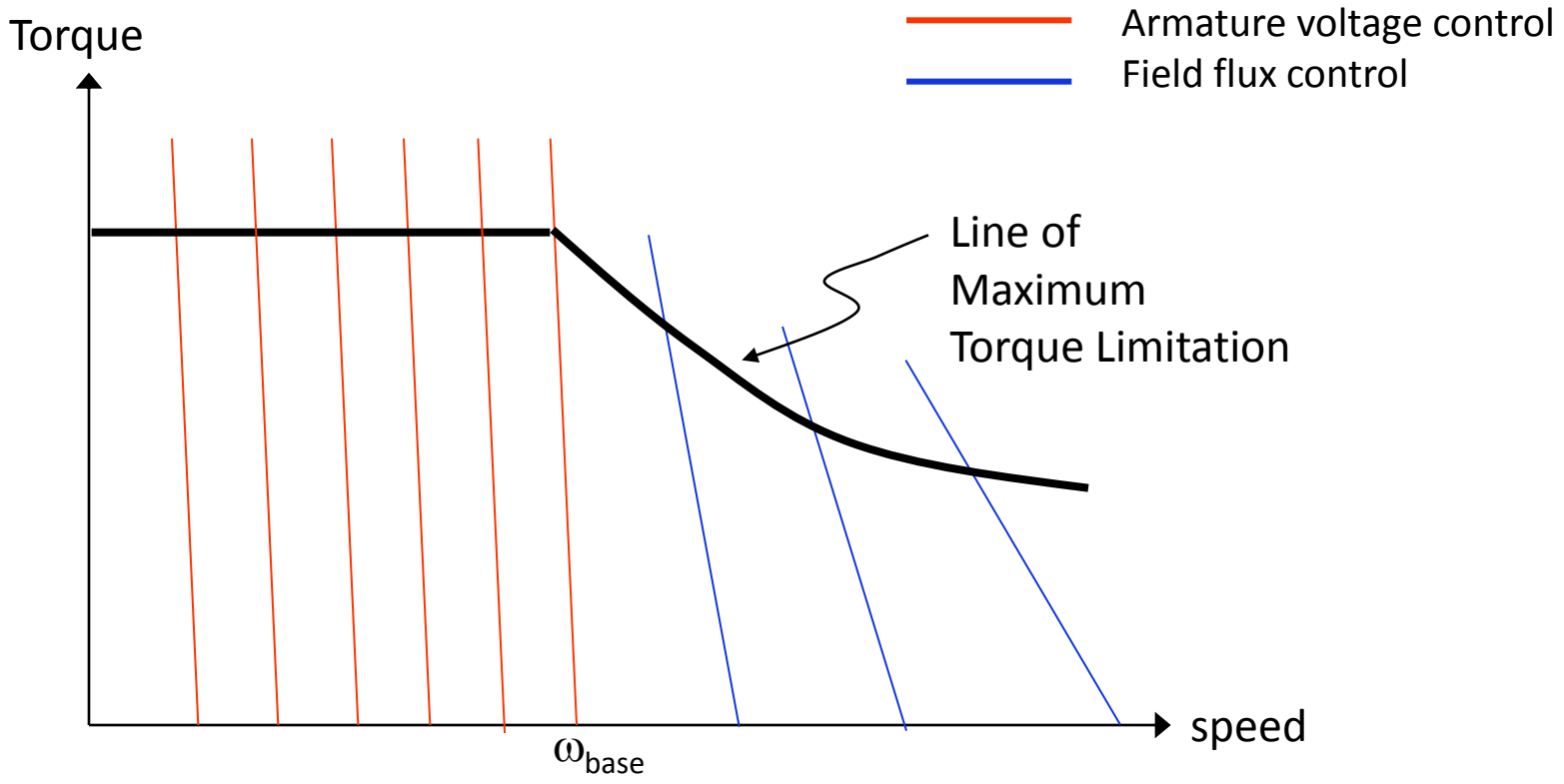


- good speed regulation
- maintain maximum torque capability

Speed control of DC Motors

Below base speed: Armature voltage control (retain maximum torque capability)

Above base speed: Field weakening (i.e. flux reduced) (Trading-off torque capability for speed)



Methods of Armature Voltage Control

Phase-controlled rectifier (AC–DC)