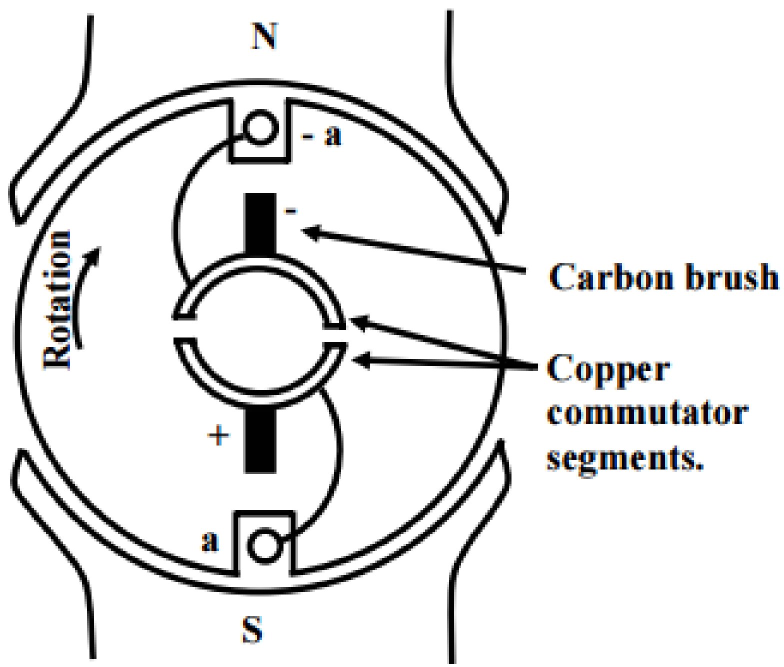
UNIT 4

Control of DC Motor Drives

Introduction

The cross-sectional view of a DC motor has been shown. Consider a particular position in space between stator and rotor.

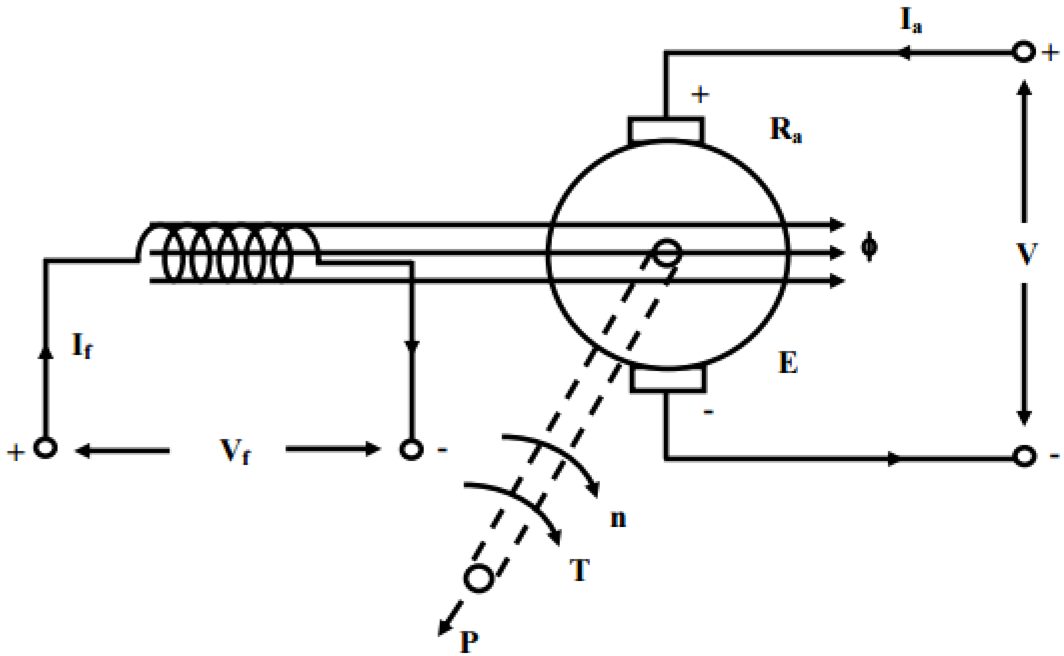


Whichever conductor is present there, will have current flowing through it, which depends on the applied armature voltage. This current would produce a flux which would interact with the field flux to produce torque. In course of rotation of the armature adjacent conductors will occupy this position in space. No matter which conductor comes to that particular position at any given point of time, it will have same current flowing through it.

This is true for all the positions although the magnitude and polarity of the torque produced by individual conductors in different positions may be different. The polarity of the torque is identical for conductor positions under north or south pole, since the direction of the current flowing through it at that position is unique, given the direction of rotation and the applied armature voltage due to the commutators slipping over the brushes

Basic Machine Equations

Two equations are required to define the behavior of a dc machine: the torque and the voltage equations.



Where T = magnetic torque, N.m

ϕ = flux per pole, Wb

Ia = current in armature circuit, A

E = induced voltage (emf), V

w = angular velocity, rad/s

Kf = constant determined by design of winding

If = Field current

n = speed of the motor in rpm

Vf = field voltage P = mechanical power

The torque equation relates the torque, to the armature current:

$$T = K_f \phi I_a$$

and the voltage equation relates the induced voltage in the armature winding to the rotational speed:

$$E = K_f \phi \omega$$

For a motor, an input voltage V is supplied to the armature, and the corresponding voltage equation becomes

$$E = V - I_a R_a = K_f \phi \omega$$

where R_a is the resistance of the armature circuit and $I_a R_a$ is the voltage drop across this resistance. The armature inductance is negligible in Eq.(33.1). Equation 33.3 multiplied by Armature current I_a, yields the power equation,

$$P = \omega T = V I_a - I_a^2 R_a$$

electrical power loss.

$$T = K_t I_a$$

$$V - I_a R_a = K_v \omega$$

The parameters K_t and K_v are referred to as the torque and voltage constants. In SI units the torque constant in Newton-meters per ampere equals the voltage constant in volt-seconds per radian.

Zones of steady state torque-speed characteristics of the motor are shown in Fig. . Note that constant torque characteristics can be maintained by armature voltage control up to a certain speed. At the rated speed this would require rated voltage to be applied to the armature voltage, and further increase would not be possible due to limitations of the motor such as insulation ratings and thermal ratings. Speed increase beyond this point would only be possible at the cost of a reduction in torque and the machine will operate in the constant power mode. The corresponding power characteristics are shown in dotted lines.

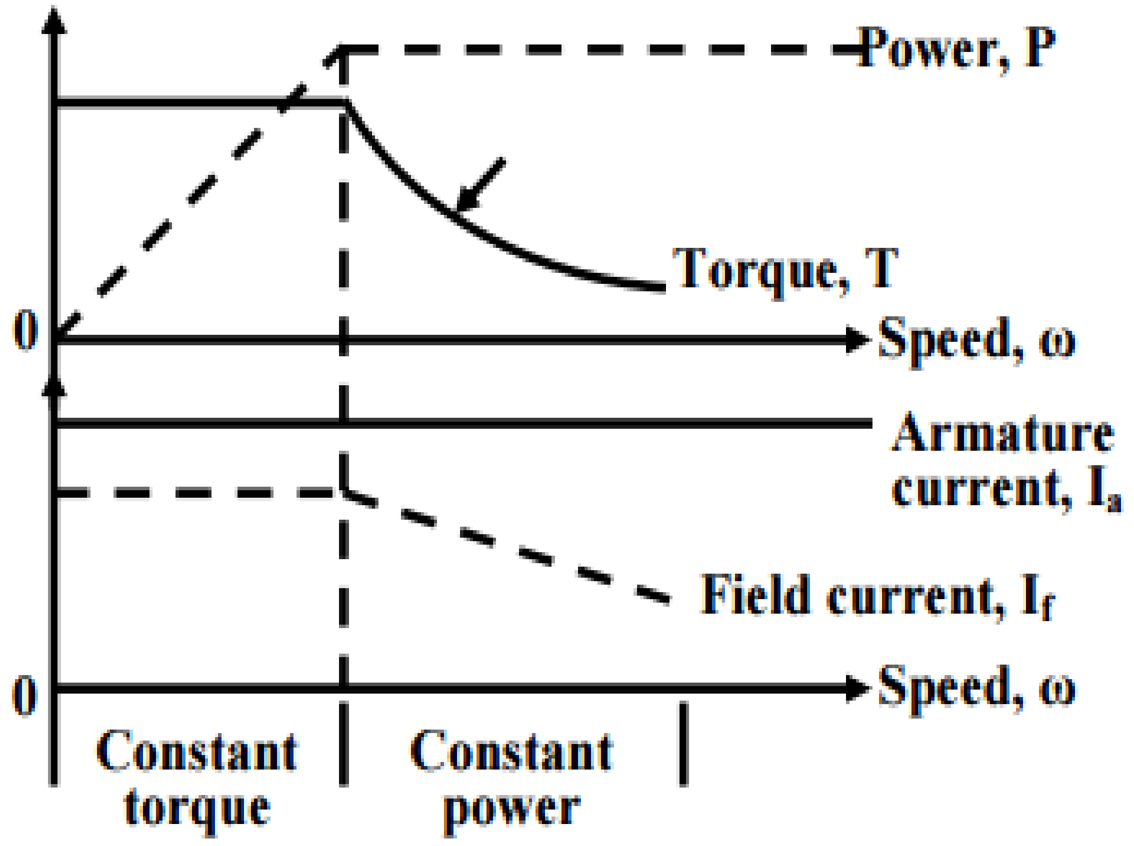


Fig. Speed, torque and power characteristics of separately excited DC motors