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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-1

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Factors determining the electromagnetic torque

When armature conductors of a DC motor carry current in the presence of stator field flux, a mechanical torque is developed between the armature and the stator. Torque is given by the product of the force and the radius at which this force acts.

Torque $T = F \times r$ (N-m) …where, F = force and r = radius of the armature

Work done by this force in once revolution = Force × distance = $F \times 2\pi r$ (where, $2\pi r$ = circumference of the armature)

Net power developed in the armature = word done / time

= (force × circumference × no. of revolutions) / time

= $(F \times 2\pi r \times N) / 60$ (Joules per second) .... eq. 2.1

But, $F \times r = T$ and $2\pi N/60$ = angular velocity ω in radians per second. Putting these in the above equation 2.1

Net power developed in the armature = $P = T \times \omega$ (Joules per second)

Factors determining the electromagnetic torque (Cont..)

Armature torque (Ta)

The power developed in the armature can be given as, $P_a = T_a \times \omega = T_a \times 2\pi N/60$

The mechanical power developed in the armature is converted from the electrical power,

Therefore, mechanical power = electrical power

That means, $T_a \times 2\pi N/60 = E_b.I_a$

We know, $E_b = P\Phi NZ / 60A$

Therefore, $T_a \times 2\pi N/60 = (P\Phi NZ / 60A) \times I_a$

Rearranging the above equation,

$T_a = (PZ / 2\pi A) \times \Phi.I_a$(N-m)

The term (PZ / 2πA) is practically constant for a DC machine. Thus, armature torque is directly proportional to the product of the flux and the armature current i.e. $T_a \propto \Phi.I_a$

Shaft Torque (Tsh)

Due to iron and friction losses in a dc machine, the total developed armature torque is not available at the shaft of the machine. Some torque is lost, and therefore, shaft torque is always less than the armature torque.

Shaft torque of a DC motor is given as,
Tsh = output in watts / (2πN/60) ....(where, N is speed in RPM)

Types of DC Generators

The types of DC motor can be listed as follows- DC motor

- Permanent Magnet DC Motor
- Separately Excited DC Motor
- Self Excited DC Motor