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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-1

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Performance and characteristics of different types of DC motors

Generally, three characteristic curves are considered important for DC motors which are, (i) Torque vs. armature current, (ii) Speed vs. armature current and (iii) Speed vs. torque. These are explained below for each type of DC motor. These characteristics are determined by keeping the following two relations in mind.

$$T_a \propto \phi \cdot I_a \text{ and } N \propto E_b / \phi$$

These above equations can be studied at - emf and torque equation of dc machine. For a DC motor, magnitude of the back emf is given by the same emf equation of a dc generator i.e. $E_b = P\phi NZ / 60A$. For a machine, P, Z and A are constant, therefore, $N \propto E_b / \phi$

Characteristics of DC series motors

Torque vs. armature current (T_a - I_a)

This characteristic is also known as electrical characteristic. We know that torque is directly proportional to the product of armature current and field flux, $T_a \propto \phi \cdot I_a$. In DC series motors, field winding is connected in series with the armature, i.e. $I_a = I_f$. Therefore, before magnetic saturation of the field, flux ϕ is directly proportional to I_a . Hence, before magnetic saturation $T_a \propto I_a^2$. Therefore, the T_a - I_a curve is parabola for smaller values of I_a . After magnetic saturation of the field poles, flux ϕ is independent of armature current I_a . Therefore, the torque varies proportionally to I_a only, $T \propto I_a$. Therefore, after magnetic saturation, T_a - I_a curve becomes a straight line. The shaft torque (T_{sh}) is less than armature torque (T_a) due to stray losses. Hence, the curve T_{sh} vs I_a lies slightly lower.

DC MACHINES

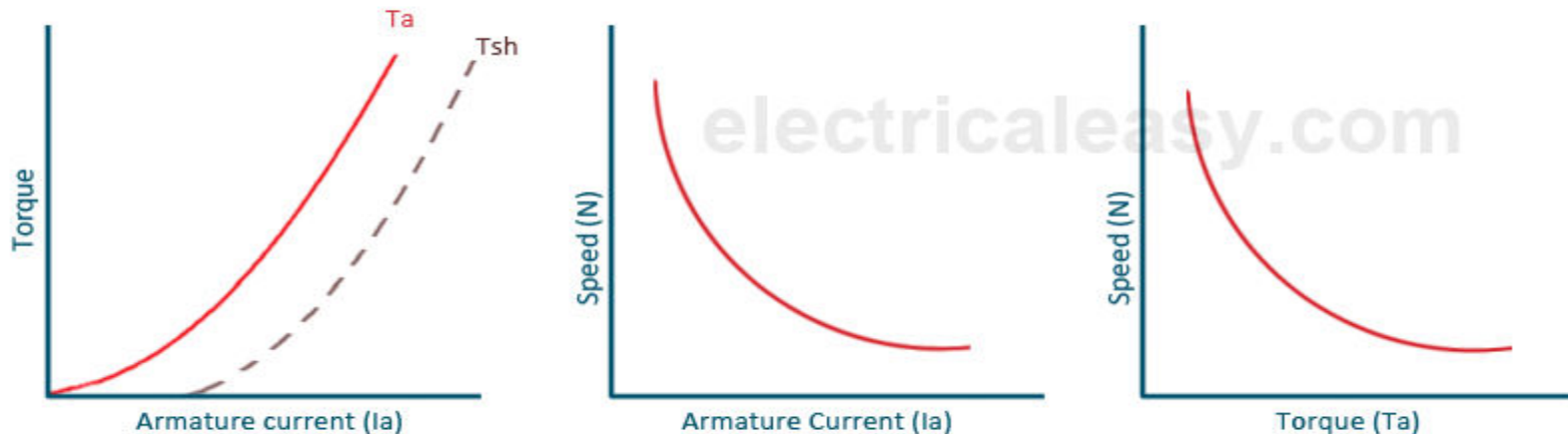
Speed vs. armature current (N-I_a)

We know the relation, $N \propto E_b/\phi$

For small load current (and hence for small armature current) change in back emf E_b is small and it may be neglected. Hence, for small currents speed is inversely proportional to ϕ . As we know, flux is directly proportional to I_a , speed is inversely proportional to I_a . Therefore, when armature current is very small the speed becomes dangerously high. That is why a series motor should never be started without some mechanical load.

Speed vs. torque (N-T_a)

This characteristic is also called as mechanical characteristic. From the above two characteristics of DC series motor, it can be found that when speed is high, torque is low and vice versa.



Characteristics of DC series motor