D.C motor

D.c motor nearly three characteristic curves are considered important for [DC motors](http://www.electricaleasy.com/2014/01/basic-working-of-dc-motor.html) 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](http://www.electricaleasy.com/2012/12/classifications-of-dc-machines.html). These characteristics are determined by keeping the following two relations in mind**.**Ta ∝ɸ.Ia and N∝Eb/ɸ. These above equations can be studied at - [emf and torque equation of dc machine](http://www.electricaleasy.com/2012/12/emf-and-torque-equation-of-dc-machine.html). For a DC motor, magnitude of the back emf is given by the same emf equation of a dc generator i.e. Eb = PɸNZ / 60A. For a machine, P, Z and A are constant, therefore, N ∝ Eb/ɸ

**Characteristics Of DC Series Motors**

**Torque Vs. Armature Current (Ta-Ia) :**

This characteristic is also known as **electrical characteristic**. We know that torque is directly proportional to the product of armature current and field flux, Ta ∝ ɸ.Ia. In DC series motors, field winding is connected in series with the armature, i.e. Ia = If. Therefore, before magnetic saturation of the field, flux ɸ is directly proportional to Ia. Hence, before magnetic saturation Ta α Ia2. Therefore, the Ta-Ia curve is parabola for smaller values of Ia. After magnetic saturation of the field poles, flux ɸ is independent of armature current Ia. Therefore, the torque varies proportionally to Ia only, T ∝ Ia.Therefore, after magnetic saturation, Ta-Ia curve becomes a straight line. The shaft torque (Tsh) is less than armature torque (Ta) due to [stray losses](http://www.electricaleasy.com/2014/01/losses-in-dc-machine.html). Hence, the curve Tsh vs Ia lies slightly lower. In DC series motors, (prior to magnetic saturation) torque increases as the square of armature current, these motors are used where high starting torque is required.

**Speed Vs. Armature Current (N-Ia) :**

We know the relation, N ∝ Eb/ɸ

For small load current (and hence for small armature current) change in back emf Eb is small and it may be neglected. Hence, for small currents speed is inversely proportional to ɸ. As we know, flux is directly proportional to Ia, speed is inversely proportional to Ia. 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**. But, at heavy loads, armature current Ia is large. And hence, speed is low which results in decreased back emf Eb. Due to decreased Eb, more armature current is allowed.

**Speed Vs. Torque (N-Ta) :**

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.

