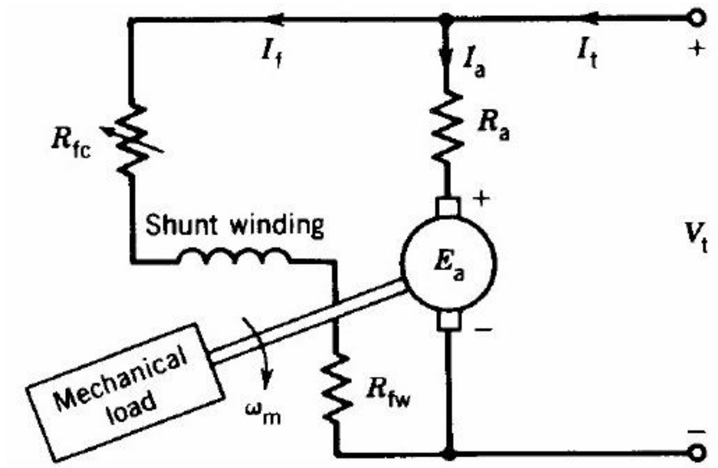
SHUNT FIELD DC MOTOR

A schematic diagram of a shunt field DC motor is shown in Fig.3.30. The armature circuit and the shunt field circuit are connected across a DC source of fixed voltage Vt. An external field rheostat (Rfc) is used in the field circuit to control the speed of the motor. The motor takes power from the DC source, and therefore the current It flows into the machine from the positive terminal of the DC source. As both field circuit and armature circuit are connected to a DC source of fixed voltage, the connections for separate and shunt excitation are the same. The behavior of the field circuit is independent of the armature circuit. The governing equations for steady-state operation of the DC
motor are as follows:

$$V_t = I_a R_a + E_a$$
$$I_t = I_a + I_f$$
$$E_a = K_a \phi \omega = \Phi (P/A) Z (N/60)$$
$$E_a = V_t - I_a R_a$$

where K_a is the machine constant.



The armature current I a and the motor speed ω m depend on the mechanical load connected to the motor shaft. Fig.3.30 Shunt DC motor equivalent circuit

Torque Equation

By the term torque is meant the turning or twisting moment of a force about an axis. It is measured by the product of the force and the radius at which this force acts.Consider a pulley of radius r meters acted upon by a circumferential force of F Newton which causes it to rotate at N rps

Then, torque T = F * r Newton meter (N-m)

Work done by this force in one revolution=Force * distance = F * 2π r

Power developed = F * 2π r * N joule/second

power developed = T * ω joule/second or watt

Armature Torque of a Motor

Let Ta be the torque developed by the armature of a motor running at N rps If Ta

is in
N-m, then power developed,

$$P_{dev} = T_a * 2\pi N \text{ watt}$$

running at N rps If Ta is in N-m, then power developed,

We also know that electrical power converted into mechanical

power in the armature is $E_a * I_a$ (3.33)

Equating (3.32) and (3.33), we get $T_a * 2\pi N = E_a I_a$

Since $E_a = \phi ZN(P/A)$ volts

$T_a * 2\pi N = \phi ZN(P/A) I_a$

$T_a = (1/2\pi) \phi Z(P/A) I_a$

$T_a = 0.159 \phi Z(P/A) I_a$

Note. From the above equation for the torque, we find that

$T_a \alpha \phi I_a$

(a) In the case of a series motor,

ϕ is directly proportional to I_a. (before saturation) because field windings carry full armature
current. $\therefore T_a \alpha I_a^2$

(b) For shunt motors,

ϕ is practically constant, hence ∴$T_a \propto I_a$

Shaft Torque

The whole of the armature torque, as calculated above, is not available for doing useful work, because a certain percentage of this is required for supplying iron and friction losses in the motor. The torque which is available for doing useful work is known as shaft torque T_{sh} . It is so called because it is available at the shaft. The horse-power obtained by using the shaft torque is called Brake Horse-Power (B.H.P.) because it is the horse-power available at the brake.

Source : http://mediatoget.blogspot.in/2011/07/shunt-field-dc-motor.html