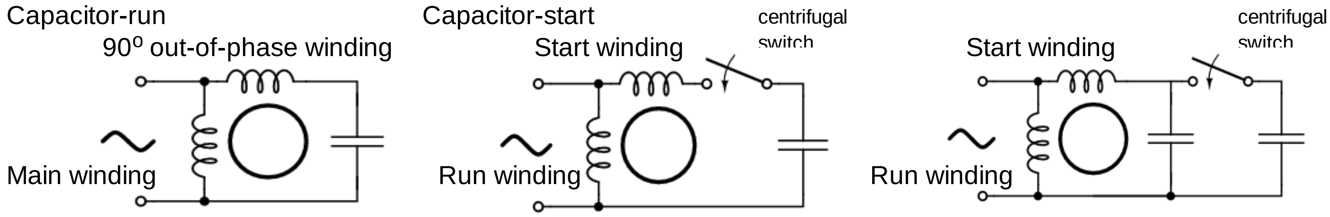
ECE 3600 Exam 3 Information

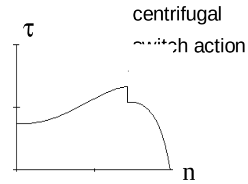
You may write more on this sheet. You may also use Exam 1 & 2 Information sheets

Single-phase Induction Motors

No Starting Torque without a Start winding



An ideal capacitor value would cause the current in the start winding to be 90° out-of-phase with the current in the run winding. That value turns out to be more for a stalled (or not-yet started) motor than one that is running at rated speed and output.



Split-Phase The run winding has a large inductance and little resistance.
The start winding has little inductance and lots of resistance.

DC Motors (brushed)

Armature The rotating part (rotor)

Field (Excitation) Provided by the stationary part of the motor (Stator)
- Permanent Magnet
- Winding
  - Separately excited
  - Parallel with terminal voltage source (Shunt excited)
  - Series with terminal voltage source (Series excited)

Important relationships

$E_A = K\cdot\phi\cdot\omega$

$\tau_{ind} = K\cdot\phi\cdot I_A$

<u>If the field is constant</u>

$\frac{\omega_2}{\omega_1} = \frac{E_{A2}}{E_{A1}} = \frac{n_2}{n_1}$

$\frac{\tau_{ind2}}{\tau_{ind1}} = \frac{I_{A2}}{I_{A1}}$

Commutator and commutation

Rotary contacts and brushes which keep switching the current direction in the armature so that the motor torque is always in the same direction.

Electrical Model

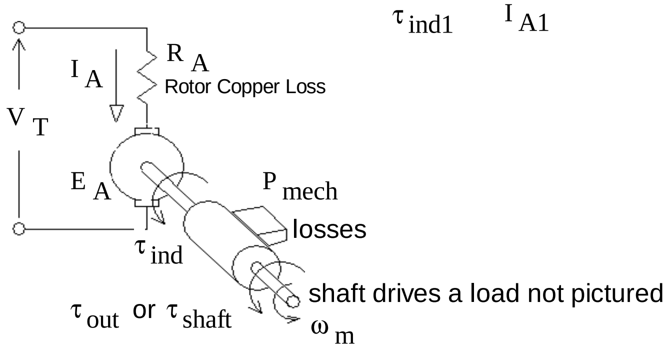
$V_T = I_A\cdot R_A + E_A$

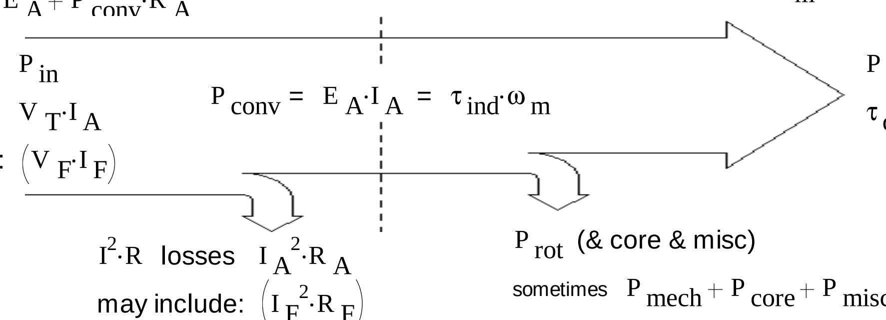
$P_{conv} = E_A\cdot I_A = \tau_{ind}\cdot\omega_m$

$I_A = \frac{P_{conv}}{E_A}$ $E_A = \frac{P_{conv}}{I_A}$

$0 = I_A^2 - \frac{V_T}{R_A}\cdot I_A + \frac{P_{conv}}{R_A}$

OR $0 = E_A^2 - V_T\cdot E_A + P_{conv}\cdot R_A$

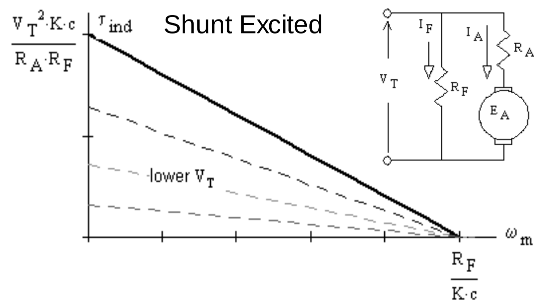


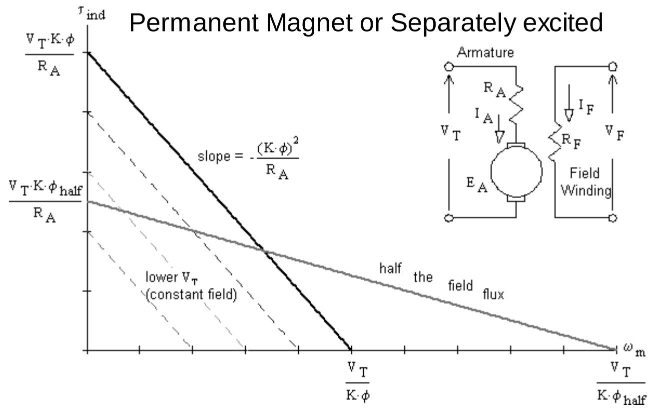


Nameplate Operation

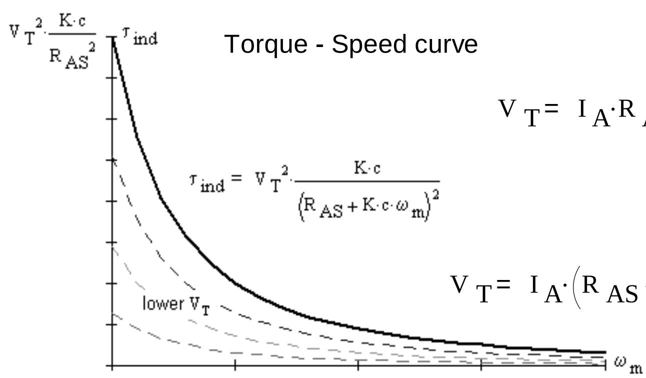
The Nameplate gives the rated Voltage, Current(s), Speed and output Power (often as horsepower, hp). $1\cdot hp = 745.7\cdot W$
This is considered full-load operation.

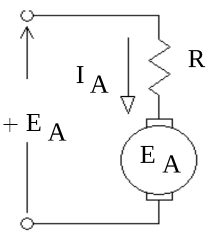
DC Motor Types and Characteristics





Series Excited





Armature and field $R_{AS} = R_A + R_S$ R_S is the field

$V_T = I_A \cdot R_{AS} + E_A$

If flux is proportional to field current $\phi = c \cdot I_A$ & $I_A^2 = \frac{\tau_{ind}}{K \cdot c}$

$$V_T = I_A \cdot (R_{AS} + K \cdot c \cdot \omega_m) = \sqrt{\frac{\tau_{ind}}{K \cdot c}} \cdot (R_{AS} + K \cdot c \cdot \omega_m) = \sqrt{\frac{\tau_{ind}}{K \cdot c}} \cdot R_{AS} + K \cdot c \cdot I_A \cdot \omega_m$$

Mechanical Loads and losses $P = \tau \cdot \omega_m$

Constant power: Torque is inversely proportional to the speed.
Power proportional to speed: Torque and I_A are constant with speed.
Power is proportional to the square of the speed: Torque and I_A are proportional to speed

Torque is proportional to the Square of the speed $\frac{\omega_2^2}{\omega_1^2} = \frac{n_2^2}{n_1^2} = \frac{\tau_2}{\tau_1} = \frac{\phi_2 \cdot I_{A2}}{\phi_1 \cdot I_{A1}} = \frac{E_{A2}^2}{E_{A1}^2} \cdot \left(\frac{\phi_1}{\phi_2}\right)^2$

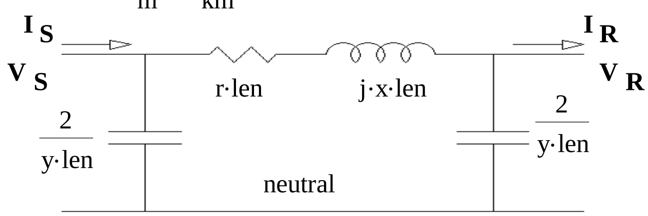
A combination of cases: Use superposition, separate causes and add results.

Brushless Commutation may be done electronically, then rotor is usually the permanent-magnet field & armature is stator. Many so-called brushless DC motors are actually 3-phase motors controlled by and ESC (Electronic Speed Controller), much like a VFD.

Transmission Lines

		Units				Units
line length:	len , d	m or km		stick to the same unit length for all parameters miles may also be used		
Resistance per unit length:	r	$\frac{\Omega}{m}$ or $\frac{\Omega}{km}$				
Inductance per unit length:	l	$\frac{H}{m}$ or $\frac{H}{km}$	OR	Inductive reactance per unit length:	x	$\frac{\Omega}{m}$ or $\frac{\Omega}{km}$
Capacitance per unit length:	c	$\frac{F}{m}$ or $\frac{F}{km}$	OR	Admittance per unit length:	y	$\frac{S}{m}$ or $\frac{S}{km}$ (y is often given without the required j)
Conductance to ground:	g	$\frac{S}{m}$ or $\frac{S}{km}$		Common assumption: $g = 0 \cdot \frac{S}{km}$		

Medium-length Lines:
80 - 240 km
(50 to 150 miles)



Exam 3 info