In polar, $\bar{S} = 10,610 \angle -19.59°$ VA

↑ negative means current leads voltage

We know the total complex power and voltage, so

$$\bar{S} = \frac{1}{2}\bar{V}\bar{I}^* = 10,610 \angle -19.59°$$

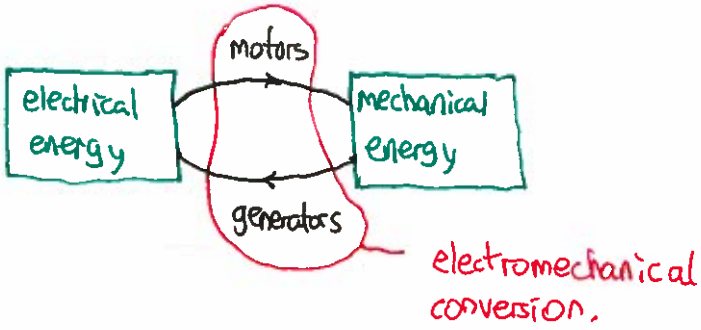
$$\text{so } \bar{I}^* = \frac{\bar{S}}{\frac{1}{2}\bar{V}} = \frac{10,610 \angle -19.59°}{\frac{1}{2} \times 1414 \angle 30°}$$

$$= 15.0 \angle -49.59°$$

$$\text{so } \bar{I} = 15.0 \angle 49.59°$$

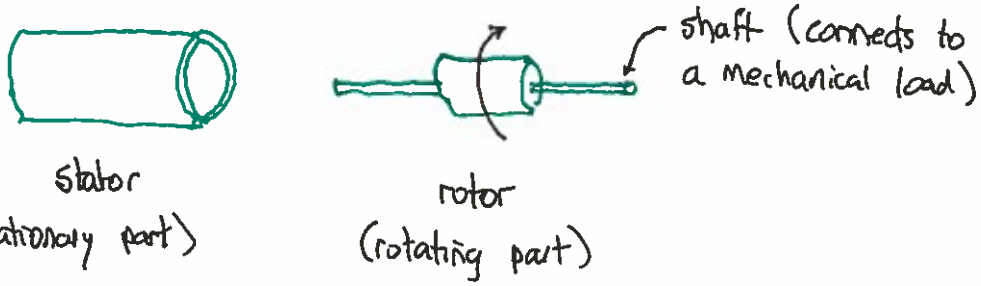
DC Machines

We now study electric motors and generators, primarily on motors.



Overview of motors

Motors (and generators) are constructed with two major components.



Depending on machine type, the rotor and stator contain conductors wired in coils (called windings).

- produces interacting magnetic fields
- thereby produces physical torque

Torque → a twisting force that tends to cause rotation.

Motors everywhere! (2/3 of a power consumed in North America)

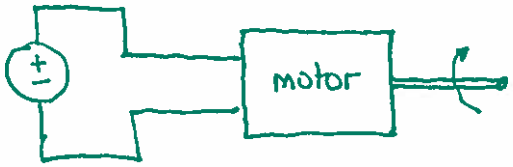
- fans, ventilation.
- vacuum cleaners
- rock crushers
- trains
- disk drives, robotic systems.

Stator produces magnetic field.

- often produced by the stator's field windings
- could also be a permanent magnet.

Operating characteristics of motors

Efficiency is a very important motor parameter.



mechanical output power P_{out}.

electrical input power P_{in}

Efficiency is defined as $\eta = \frac{P_{out}}{P_{in}} \times 100\%$

For a DC machine, $P_{in} = vi$ (Watts)

Mechanical power obt $P_{out} = T_{out}\,\omega_m$ (Watts) [1 HP = 746 W]

where T_{out} = output Torque, in Newton-meters

ω_m = angular shaft speed, in rads/sec.

and where $\omega_m = n_m \times \frac{2\pi}{60}$

n_m = shaft speed, revolutions per minute, rpm.

Speed regulation

Depending on the motor type, speed may decrease with load.
Speed regulation (SR) defined as

$$SR = \frac{n_{no\text{-}load} - n_{full\text{-}load}}{n_{full\text{-}load}} \times 100\%$$

- the smaller the better
(and can be bigger than 100%)

Example: Given a DC motor with a 50 HP rating.

From measurements on the motor: $V = 220$ V

$n_{no\text{-}load} = 1200$ rpm

$n_{full\text{-}load} = 1150$ rpm.

Under full (rated) load: power losses = 3350 W.

At full load, find efficiency, speed regulation., input current.

Efficiency: Motor is delivering 50 HP.

In watts, $P_{out} = 50 \times 746 = 37,300$ W.

And total power delivered plus lost: $P_{total} = 37,300 + 3350$

$= 40,650$ W.