1. Electric machines

An electric machine is a device that can convert electrical energy to mechanical or mechanical energy to electrical with the existence of magnetic field (M.F).

Motor: Electrical $\xrightarrow{\text{M.F}}$ Mechanical

Generator: Mechanical $\xrightarrow{\text{M.F}}$ Electrical

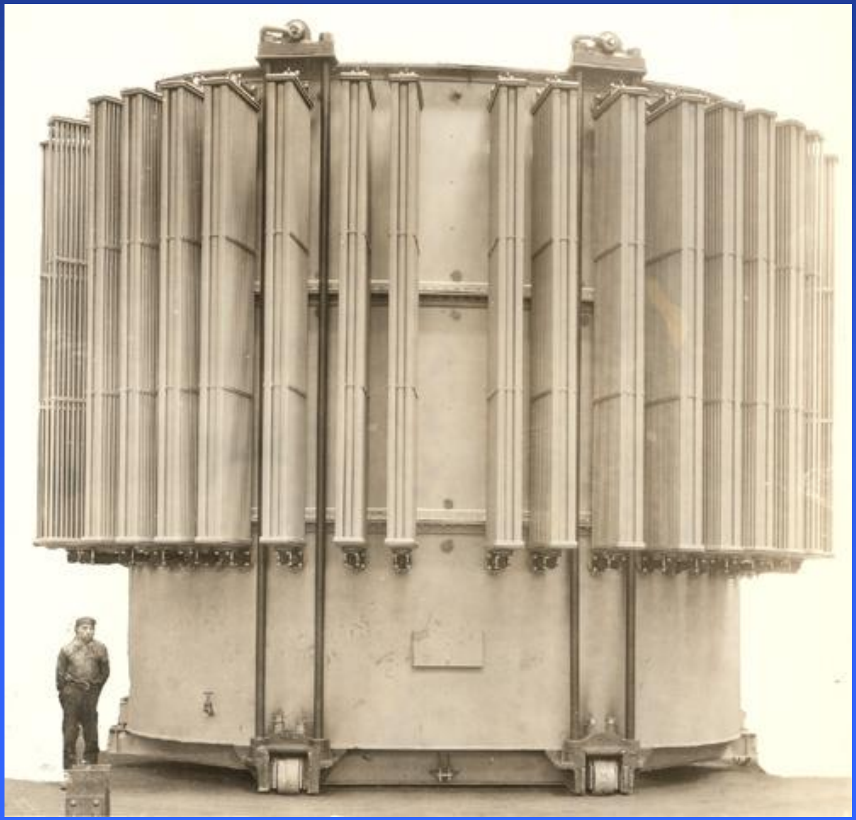
Transformer: Electrical $\xrightarrow{\text{M.F}}$ Electrical

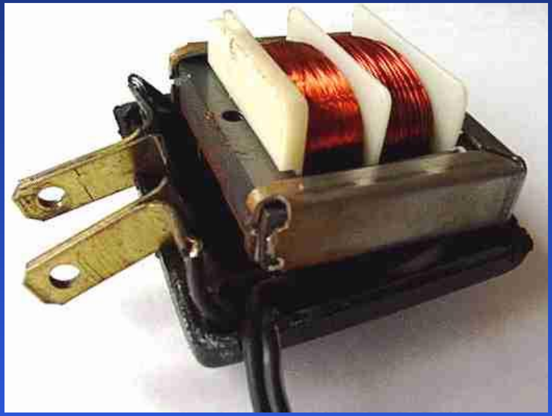
1. Electric machines

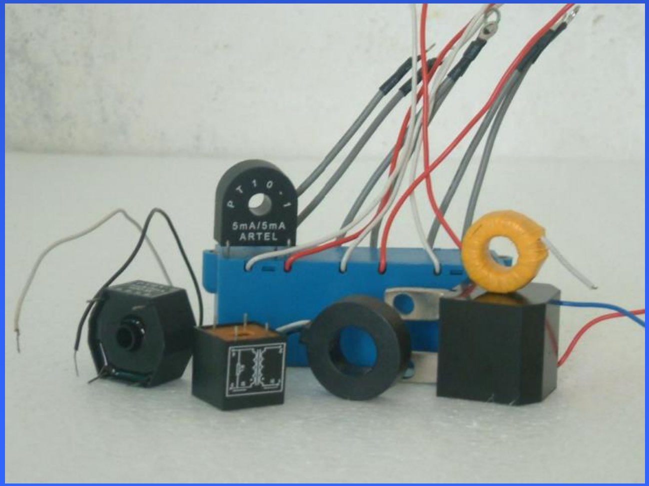
1.1. Generators convert mechanical energy from a prime mover to electrical energy through the action of the magnetic field.

1. Electric machines

1.2. Transformers convert AC electrical energy at one voltage level to AC electrical energy at (an)other voltage level(s).







2. Rotational motion, Newton's law

Majority of electric machines rotate about an axis called a shaft of the machine.

2.1. Angular position θ - an angle at which the object is oriented with respect to an arbitrary reference point.

2.2. Angular velocity (speed) ω - a rate of change of the angular position.

$$\omega = \frac{d\theta}{dt} \quad [rad/s] \tag{2.8.1}$$

ω_m – angular velocity in radians per second
f_m – angular velocity in revolutions per second
n_m – angular velocity in revolutions per minute

$$f_m = \frac{\omega_m}{2\pi} \tag{2.8.2}$$

$$n_m = \frac{\omega_m}{2\pi}$$

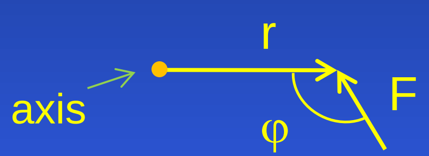
$$n_m = 60 f_m \tag{2.8.3}$$

2. Rotational motion, Newton's law

2.3. Angular acceleration α - a rate of change of angular velocity.

$$\alpha = \frac{d\omega}{dt} \quad \left[rad/s^2 \right] \qquad (2.9.1)$$

2.4. Torque (moment) τ - a "rotating force".



$$\tau = r \times F = rF \sin\varphi \quad \left[Nm \right] \qquad (2.9.2)$$

Here *F* is an acting force, *r* is the vector pointing from the axis of rotation to the point where the force is applied, φ is the angle between two vectors.

Newton's law of rotation:

$$\tau = J\alpha \qquad (2.9.3)$$

J is a moment of inertia (a mass equivalent). [kg.m^2]

2. Rotational motion, Newton's law

2.5. Work *W* – amount of energy transferred by a force.

$$W = \int \tau \, d\theta \quad [J] \tag{2.10.1}$$

If the torque is constant:

$$W = \tau\theta \tag{2.10.2}$$

2.6. Power *P* – increase in work per unit time.

$$P = \frac{dW}{dt} \quad [W] \tag{2.10.3}$$

For a constant torque:

$$P = \frac{dW}{dt} = \frac{d(\tau\theta)}{dt} = \tau \frac{d\theta}{dt} = \tau\omega \tag{2.10.4}$$