

# EE2029: Introduction to Electrical Energy System

## What is Rotor Speed?

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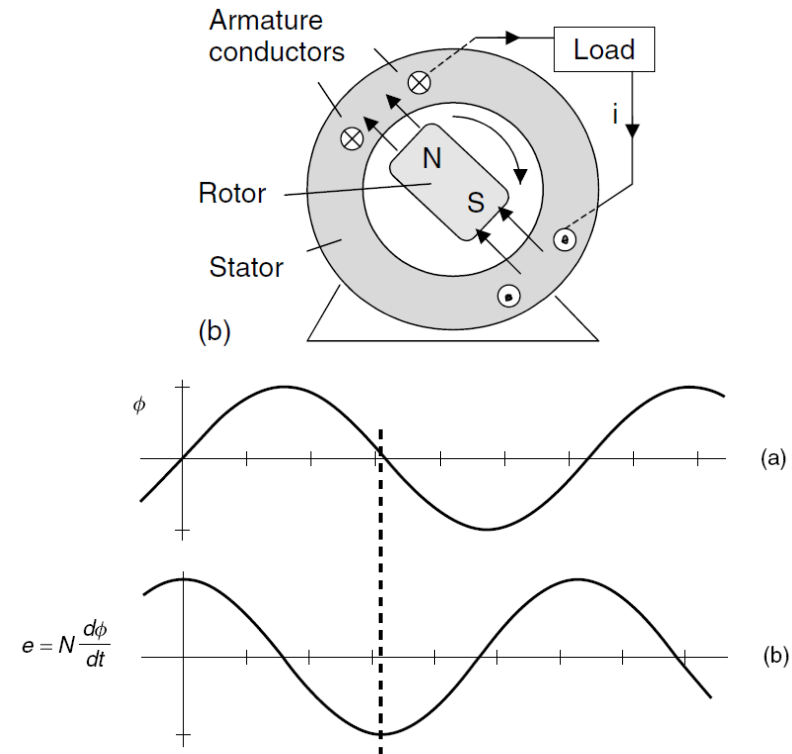


# Learning Outcomes

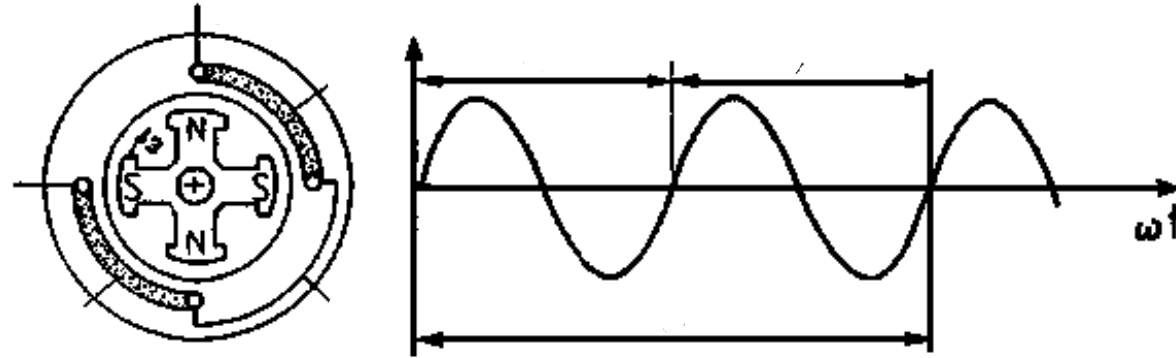
- Rotor Speed
- Synchronous Speed

# Rotor Speed for 2-Pole Generators

- The speed of the rotor shaft ( $n$ ) is given in revolution per minute (rpm).
- For example, consider a two-pole single-phase generator on the right, the frequency of induced AC voltage is the same as the speed of rotor.
- Assuming 50 Hz voltage, we can find the rotation speed by simply changing the unit from 'Hz' to 'rpm'.



# Rotor Speed for 4-Pole Generators



When the machine rotate for **1 revolution**, the induced voltage has **2 cycles**.

$$n \text{ (rpm)} = \frac{1 \text{ revolution}}{2 \text{ cycle}} \times f \text{ (cycles/sec)} \times \frac{60 \text{ sec}}{\text{min}}$$

If the frequency is 50 Hz, the rotor speed is 1500 rpm.

Source: [http://www.fastonline.org/CD3WD\\_40/CD3WD/ELECTRIC/GTZ021E/EN/B309\\_6.HTM](http://www.fastonline.org/CD3WD_40/CD3WD/ELECTRIC/GTZ021E/EN/B309_6.HTM)

# Rotor Speed for Multi-Pole Generators

- For p-pole generators, when the machine rotate for 1 revolution, the induced voltage has \_\_\_\_\_cycles.
- Then,
- We can relate the voltage frequency (Hz) to rotor speed (rpm) using,
  - f: voltage frequency (Hz)
  - n: rotor speed (rpm)
  - p: number of poles

# Frequency (Hz) VS Rotor Speed (rpm)

$$f = \frac{np}{120}$$

f: voltage frequency (Hz)


n: rotor speed (rpm)

p: number of poles

Number of Poles	50 Hz	60 Hz
2	3000	3600
4	1500	1800
6	1000	1200
8	750	900
10	600	720
12	500	600

# Synchronous Speed

- All generators connected to the system must produce AC voltage at the same frequency,  $f_e$ .
- This implies that a generator must run at a constant speed.
- We refer to this rotor speed as 'synchronous speed',  $n_{sync}$ .
- A synchronous speed is found from:



**Example:** A hydroelectric power plant needs to install a synchronous generator that can rotate at a synchronous speed of 100 rpm. What type of generator should the power plant install to generate a voltage at a frequency of 50 Hz?





# Summary