

EE2029: Introduction to Electrical Energy System

What is the Reactive Power of a Generator?

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Learning Outcomes

- Reactive Power Output
- Reactive Power Exchange
- Control of Reactive Power Output

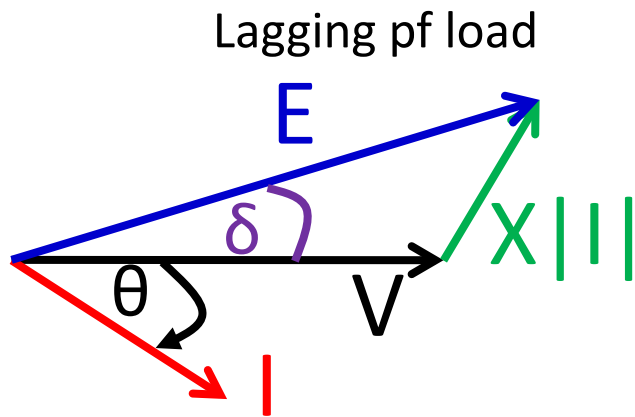
Reactive Power Output

- From
$$Q_{3\Phi} = 3 \frac{|V||E|}{X} \cos(\delta) - 3 \frac{|V|^2}{X} = 3 \frac{|V|}{X} \{ |E| \cos(\delta) - |V| \}$$
- Reactive power control is done by **adjusting $|E|$** .
- Consider three cases,

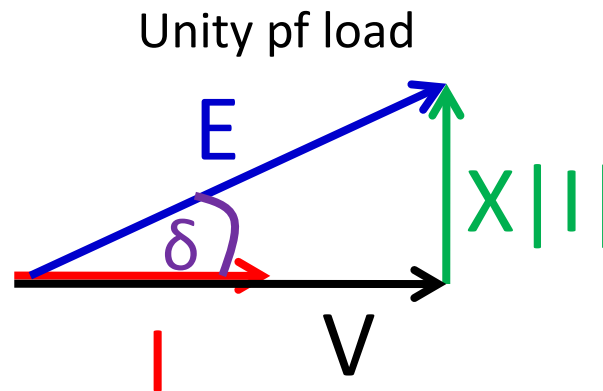
Cases	Reactive power output	Operation mode
$ E \cos \delta > V $	$Q > 0$	Supply reactive power. This mode is called ' Overexcited '.
$ E \cos \delta = V $	$Q = 0$	No reactive power exchange
$ E \cos \delta < V $	$Q < 0$	Absorb reactive power. This mode is called ' Underexcited '.

Reactive Power Exchange

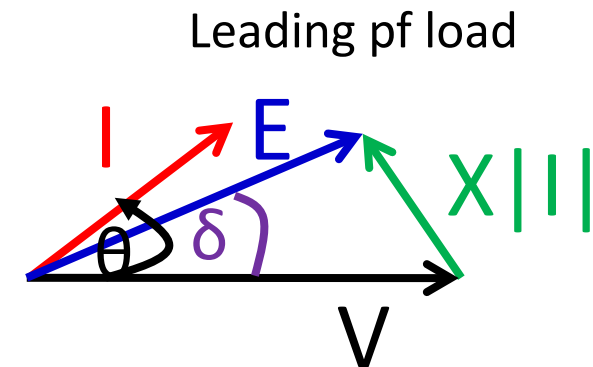
- We can vary the magnitude of excitation voltage to either supply or absorb variable amount of reactive power.



Supply reactive
power →
Overexcited

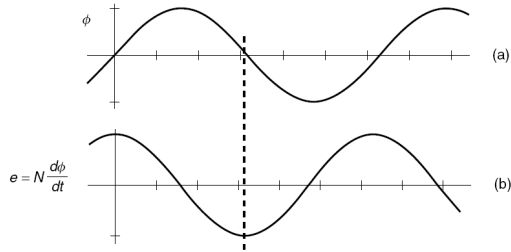


No reactive
power exchange

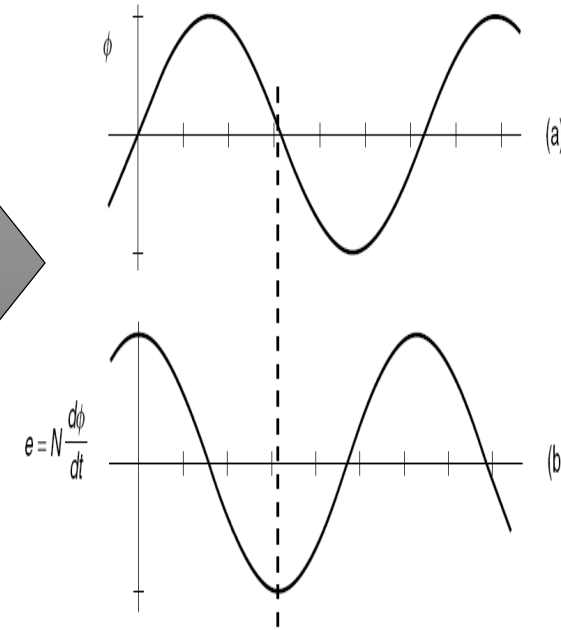


Absorb reactive
power →
Underexcited.

Adjusting Excitation Voltage

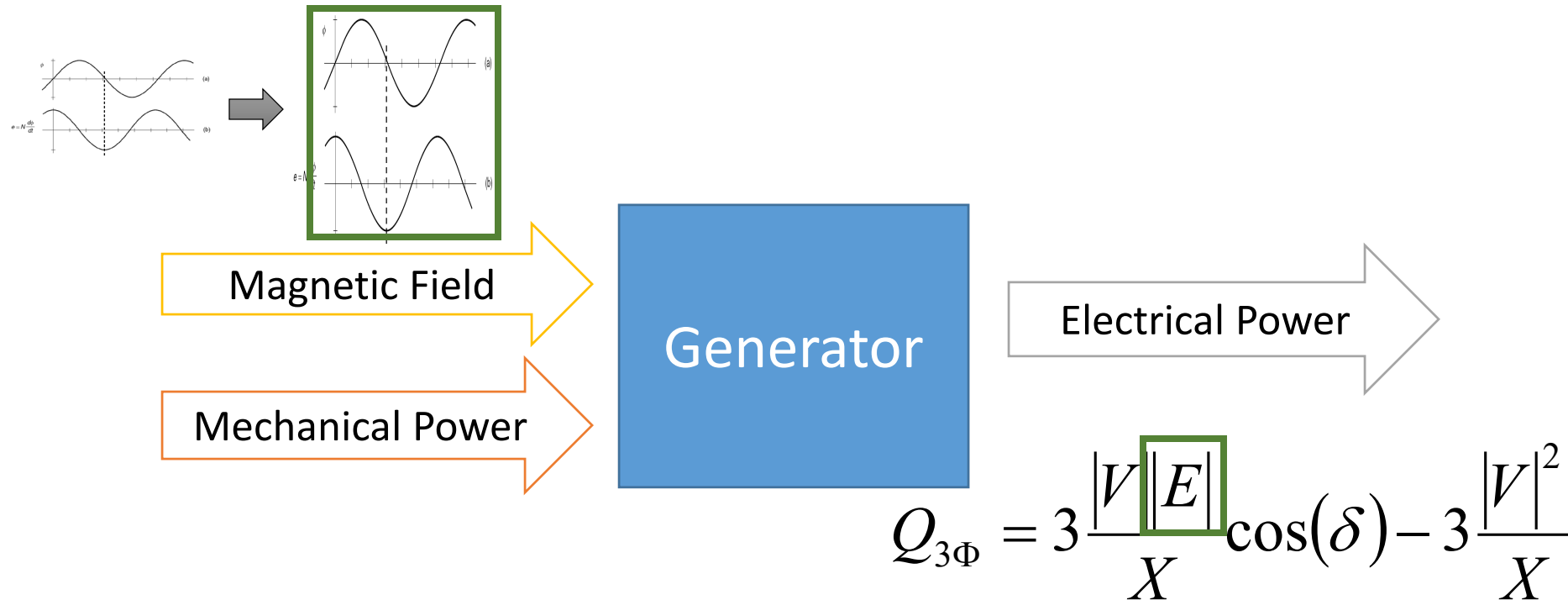


Magnetic field will still rotate at the same frequency with higher magnitude.



The magnetic field can be intensified with higher field current magnitude. As a result, excitation voltage of a generator will be increased when we increase the magnitude of magnetic field.

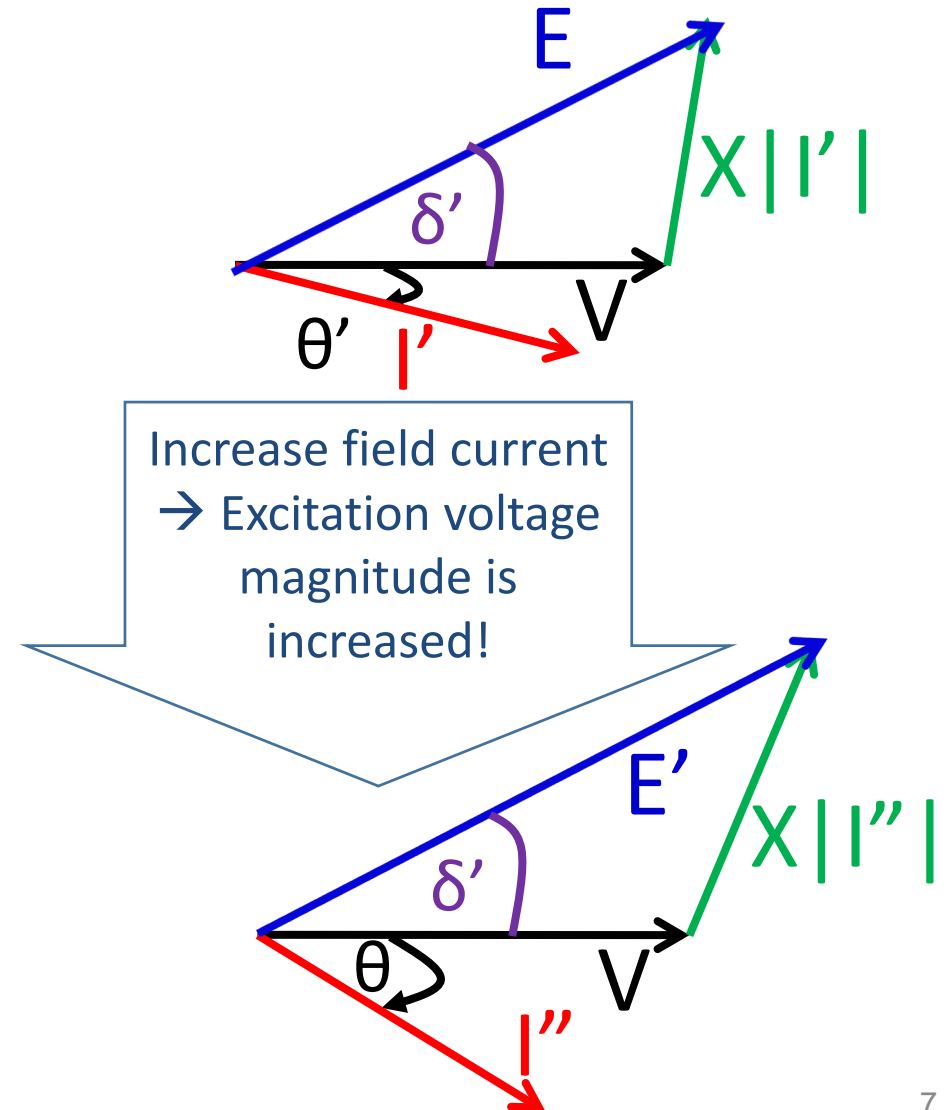
Reactive Power Output



- When we increase field current, the magnetic field is intensified. As a result, internal excitation voltage is increased. The reactive power output is increased.
- Two operating conditions of a generator: supplying reactive power is called overexcited and absorbing reactive power is called underexcited.

Control of Reactive Power Output

- $|V|$ and power angle remain unchanged.
- The current magnitude and angle, θ (power factor) will change as a result of the change in excitation voltage magnitude.
- We can now adjust the excitation voltage to maintain the power factor of the original load.





Control of Reactive Power Output



Summary