EE2029: Introduction to Electrical Energy System

What is the Real Power of a Generator?

Lecturer : Dr. Sangit Sasidhar

Department of Electrical and Computer Engineering

Learning Outcomes

- Real Power Output
- Maximum Power Transfer
- Control of Real Power Output

Real Power Output

- From

$$P_{3\Phi} = 3\frac{|V||E|}{X}\sin(\delta)$$

- |V| and X are constant values.
- |E| depends on the magnitude of magnetic field at the rotor.
- When the magnetic field is kept constant and mechanical power input is increased, the electrical power output will be increased.
- Since |V|, |E|, and X are kept constant, power angle will be increased.

Power Angle

- From

$$P_{3\Phi} = 3\frac{|V||E|}{X}\sin(\delta)$$

- Consider three cases:

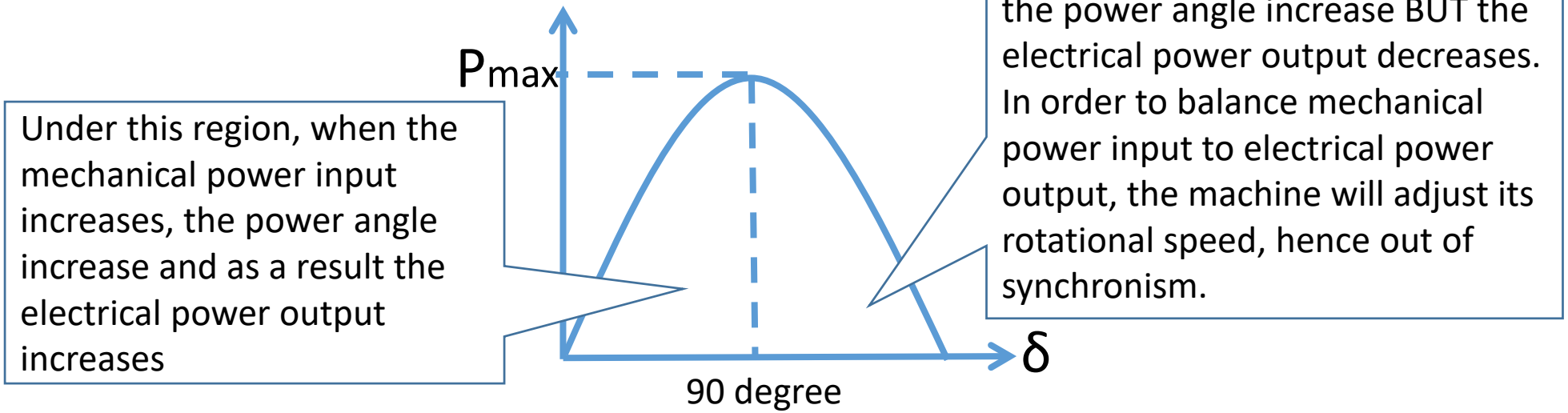
Power angle	Real power output	Operation mode
δ > 0	P > 0	Supply power as generator
δ = 0	P = 0	No power exchange
δ < 0	P < 0	Absorb power as a motor

This is why δ is called ‘power angle’!

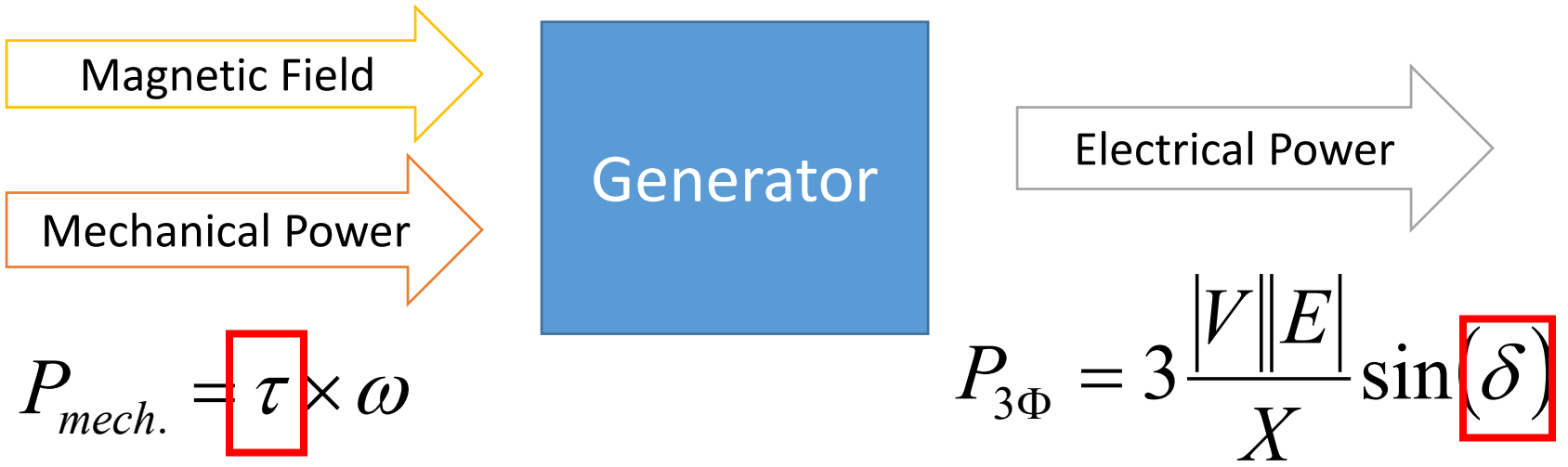
Maximum Power Transfer

- In theory, the power angle δ ≤ 90 degree.
- This limitation is called “Steady-state stability limit”.
- Above 90 degree, generator will lose synchronism.
- The maximum power transfer is the real power output when the power angle is 90 degrees.

$$P_{3\Phi} = 3\frac{|V||E|}{X}\sin(\delta)$$

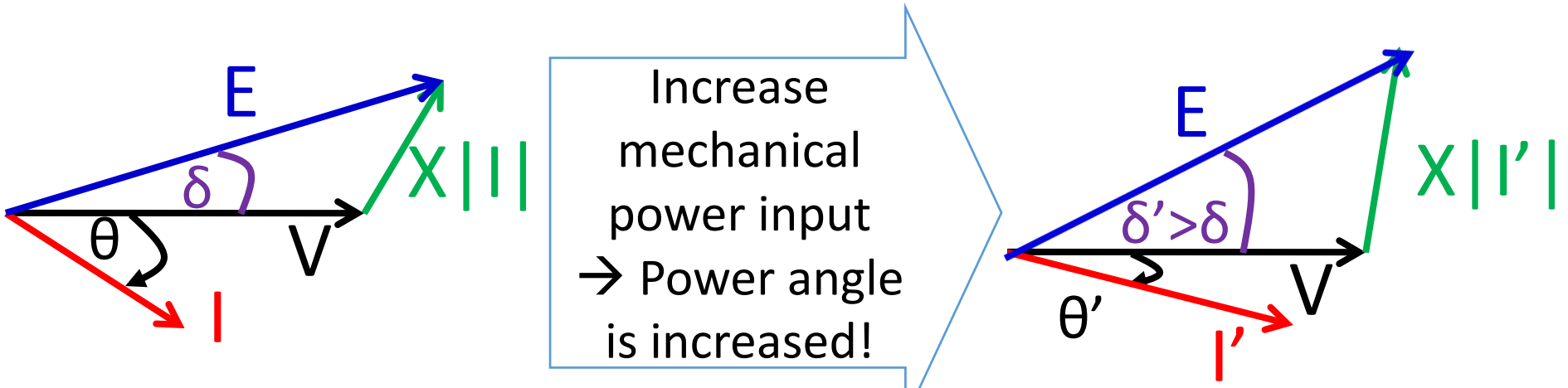


Real Power Output



- Mechanical power input is increased by increasing the torque (τ). This results in a larger power angle and higher electrical power output.
- Steady-state stability limit is reached when power angle becomes 90 degrees.

Control of Real Power Output



- |E|, |V| remains unchanged.
- Power angle increases as a result of higher mechanical power input.
- Load current |I| increases because the electrical power output is increased.
- The power factor will now change because the power angle is increased while the internal voltage magnitude is kept constant.
- We need to adjust the excitation voltage to keep the power factor constant.

Control of Real Power Output

Summary