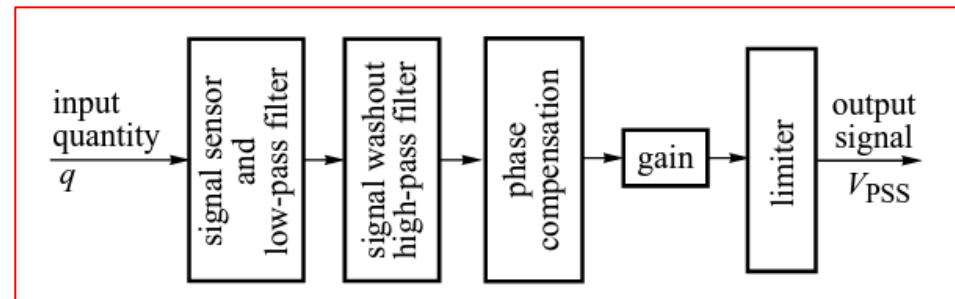
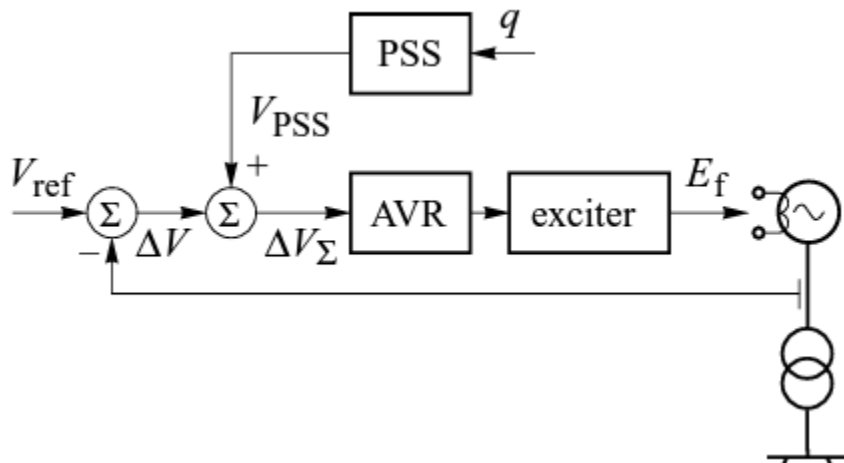


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Chap 10: Stability Enhancement

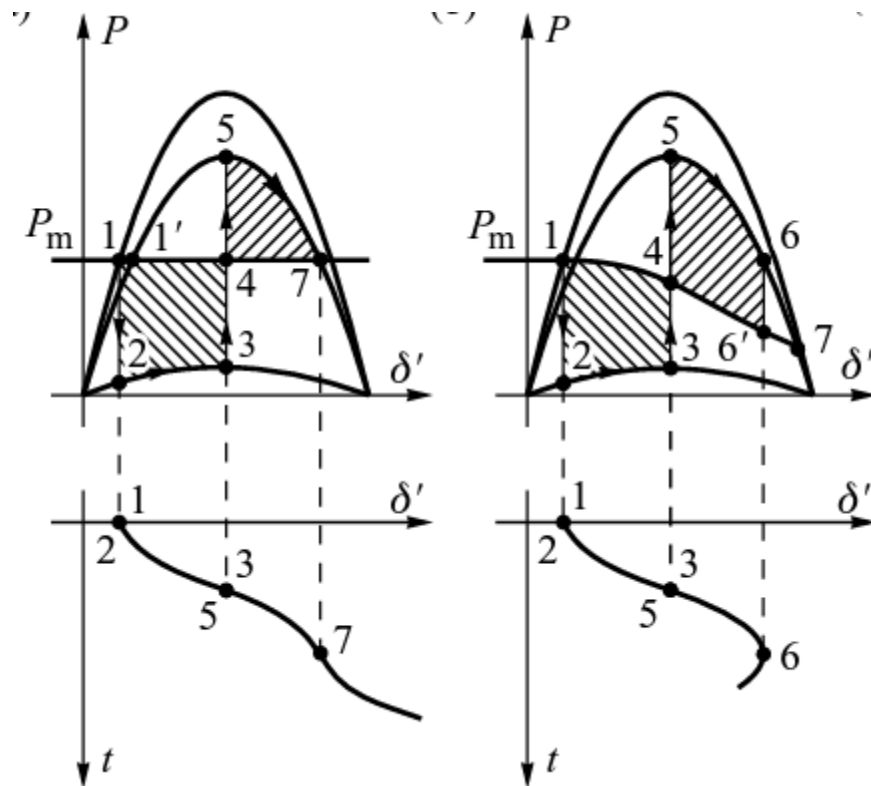
Power System Stabilizer (PSS)

- Recall that the AVR can weaken the damping provided by the damper and field windings (Chap. 5).
- The task of the PSS is to add a signal which compensates for ΔV oscillations and provides a damping component that is in phase with $\Delta\omega$.
- The input signal to a PSS can be either generator terminal voltage, generator active power, or generator speed deviation.
- A PSS can also be applied to the turbine governor, i.e., force changes in mechanical power to provide positive damping.



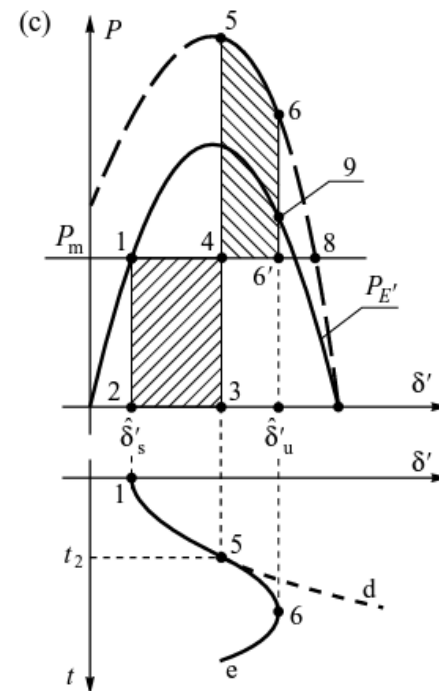
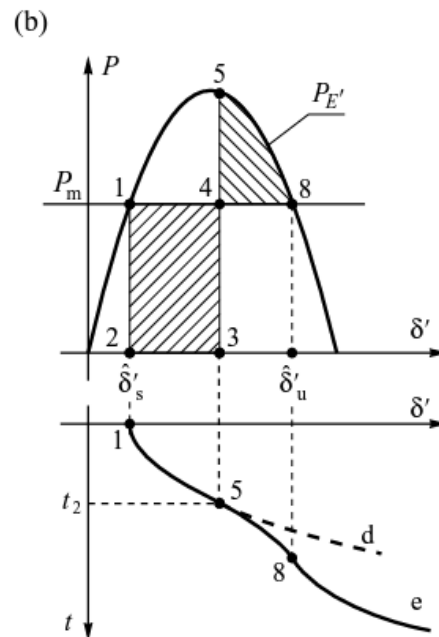
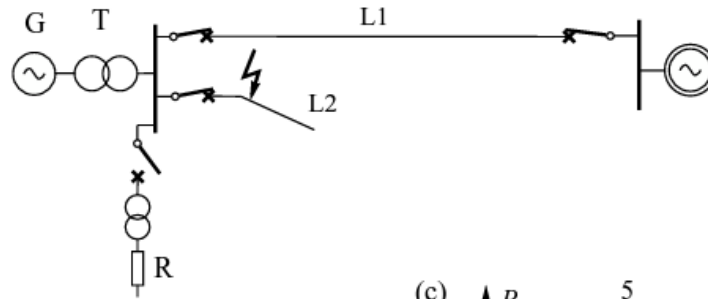
Fast Valving

- Fast valving refers to counteracting the drop in electrical power (during a fault) by rapidly reducing the mechanical power, thus limiting the accelerating torque.
- Fast valving (few tenths of a second) can be achieved in steam turbine, but not in hydro turbines due to the large change in water pressure.



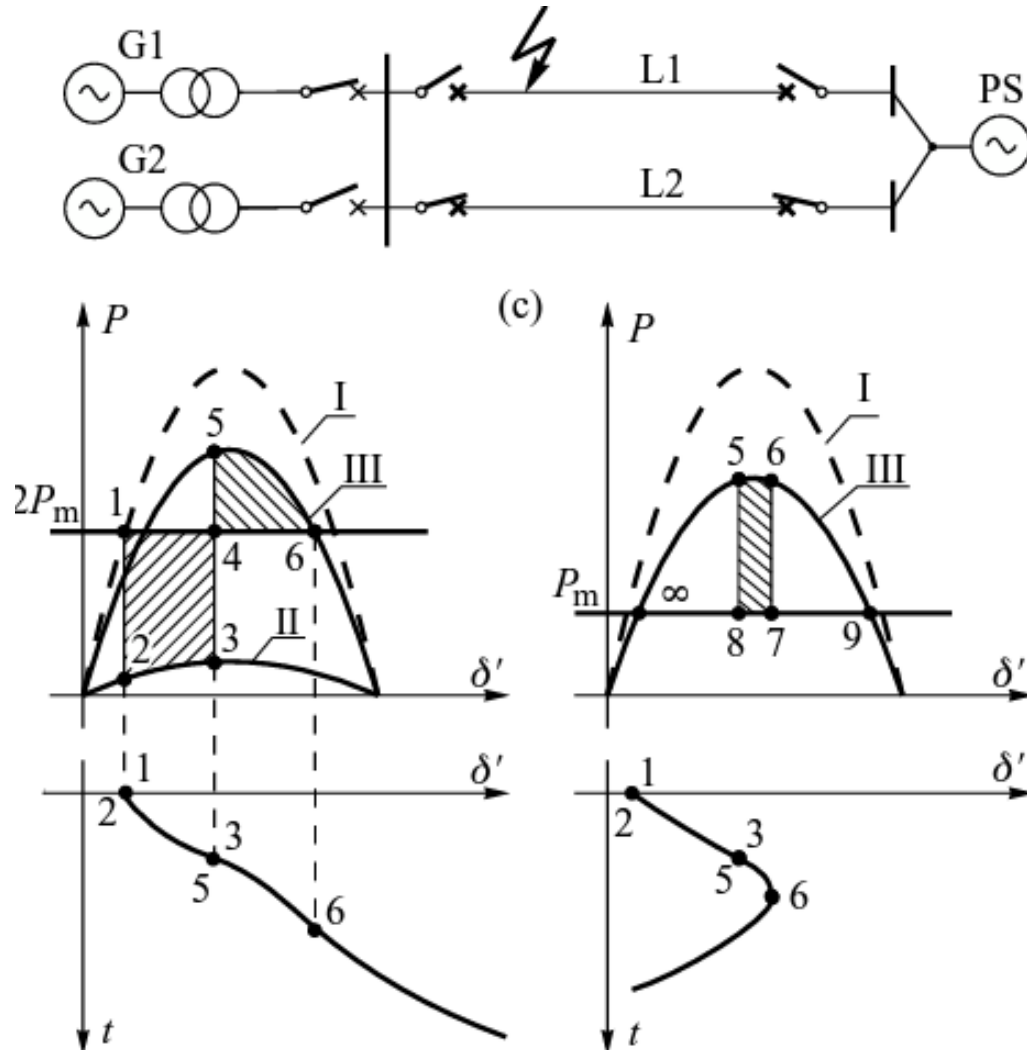
Breaking Resistor

- Inserting a breaking resistor (BR) amounts to electrical braking of the accelerating rotor. This causes an increase in the amplitude (and a phase shift) of the power-angle characteristic.
- The BR is removed when at point 6 when the rotor speed deviation changes to a negative value.



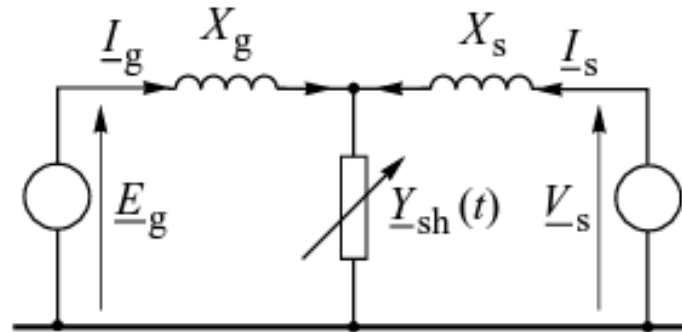
Generator Tripping

- In the example below, the synchronism of one generator has been saved at the expense of tripping the other.

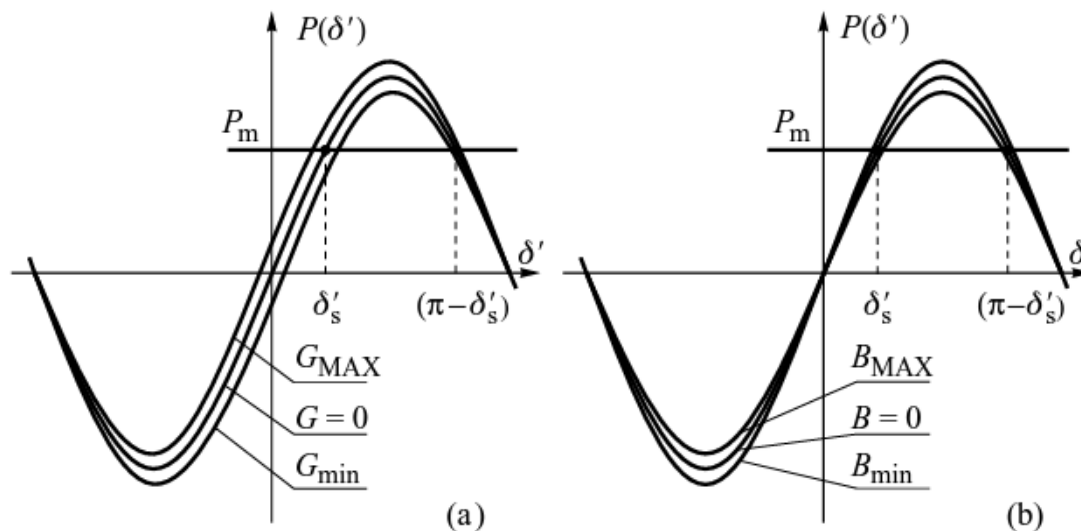


Adding Shunt FACTS Devices

- A shunt element (represented by a variable conductance and susceptance) influences the shape of the power-angle characteristic as shown below, hence can be used to improve stability.

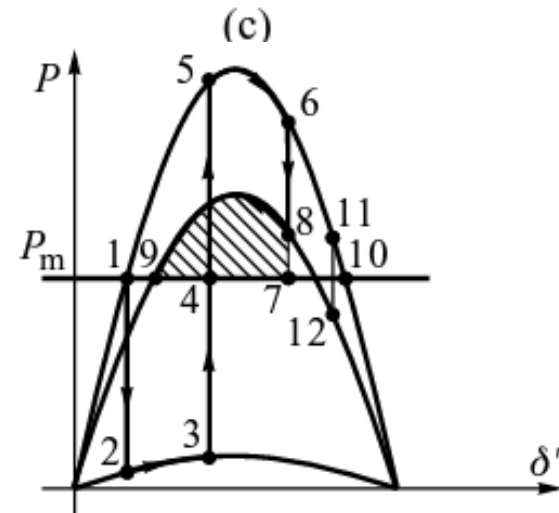
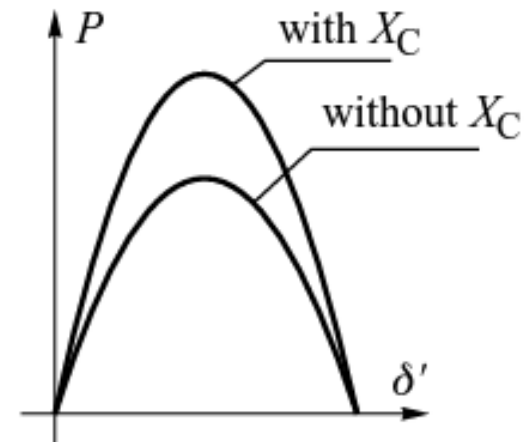
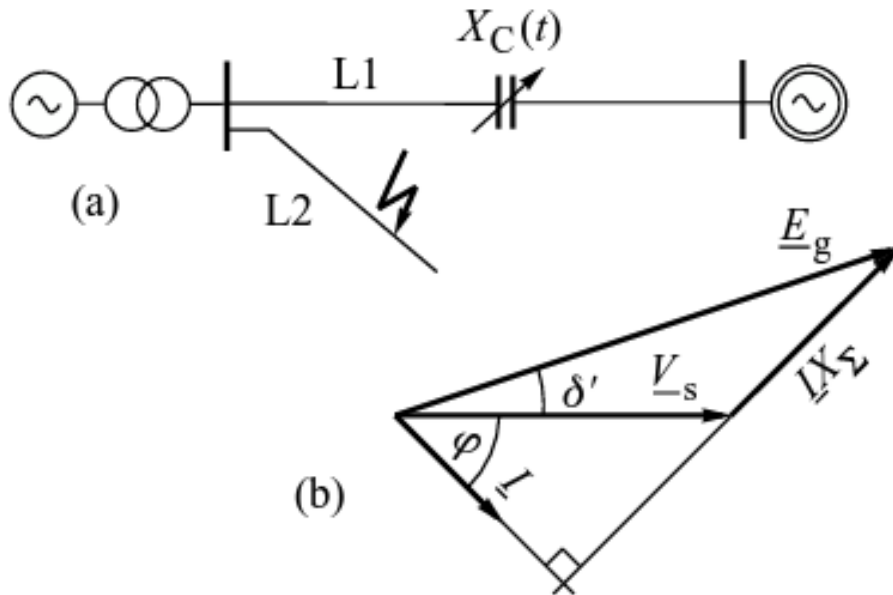


$$\underline{Y}_{sh}(t) = G_{sh}(t) + jB_{sh}(t).$$



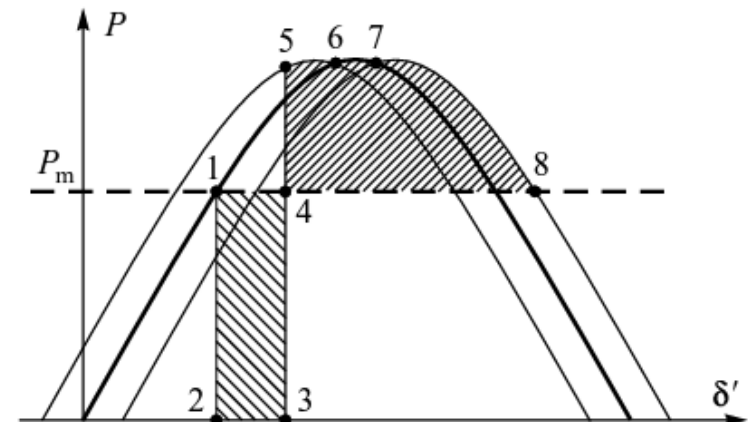
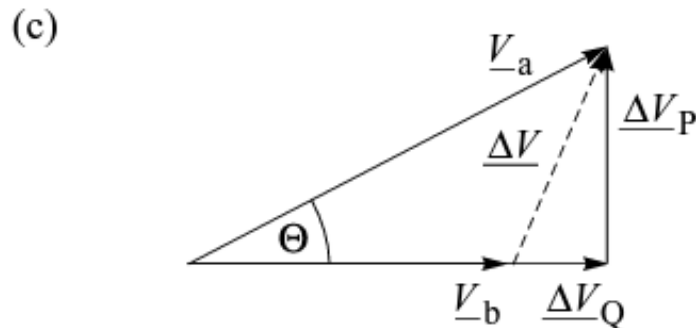
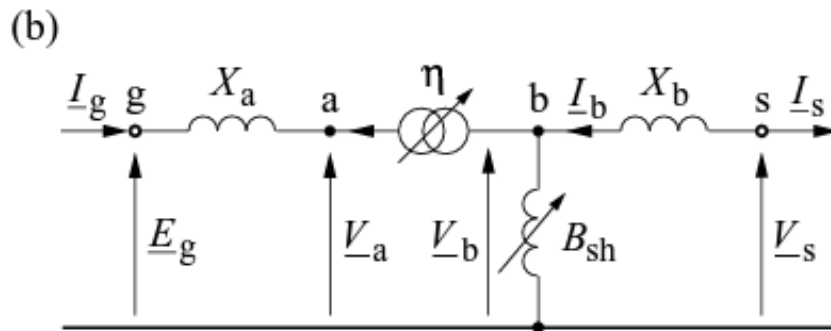
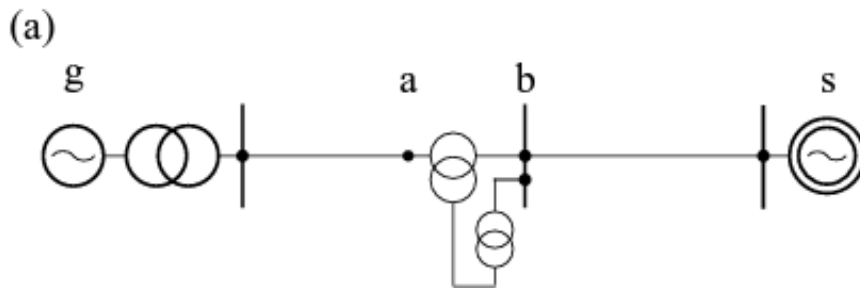
Series Compensators

- Adding a variable series capacitor obviously modifies the equivalent reactance between the two sources, hence the amplitude of the power-angle curve.



Unified Power Flow Controller (UPFC)

- The UPFC is most flexible as it modifies the power-angle characteristics by the variable shunt susceptance, phase shift and voltage transformation.



Influence of Quadrature Component ΔV_P