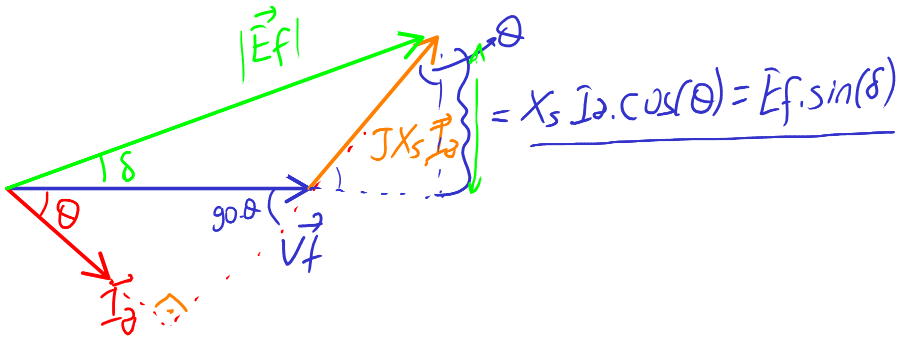
Power of a Synchronous Machine

We already showed:

$$E_f\,sin(\delta) = X_s I_a cos(\theta)$$

Note: We neglected R_a



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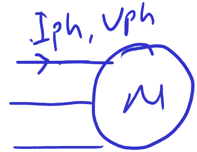

Note: We neglected R_a

Write Power equation in terms of E_f

$$P = 3V_t \underbrace{I_a cos(\theta)}_{= \frac{E_f \cdot sin(\delta)}{X_s}}$$

Power of a Synchronous Machine

We already showed:

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Write Power equation in terms of E_f

$$\boxed{P = \frac{3|V_t||E_f| sin(\delta)}{X_s}}$$

Power of a Synchronous Machine

$$P = \frac{3V_t E_f \sin(\delta)}{X_s}$$

What about Torque?

Neglect losses (core, copper etc)

$$P = T\underbrace{\omega_s}_{\text{rad/s}}$$

rad/s

+ Mechanical speed

Torque of a Synchronous Machine

$$T = \frac{P}{\omega_s}$$

$$\left[T = \frac{3 V_t E_f sin(\delta)}{X_s \omega_s} \right]$$

mechanical speed.

Torque of a Synchronous Machine

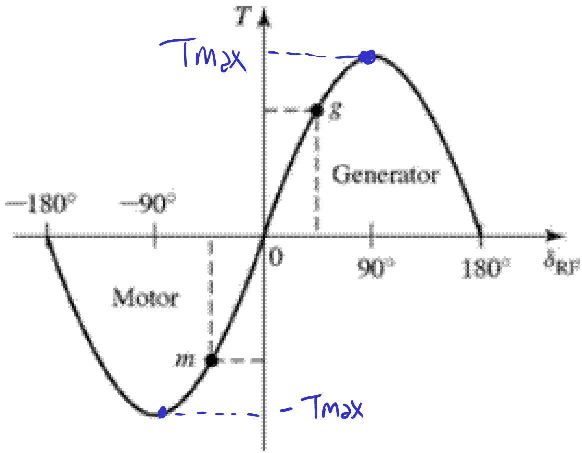
Remember the previous weeks:

$$T = T_{max} sin(\delta)$$

$$T_{max} = \frac{3V_t E_f}{X_s \omega_s}$$

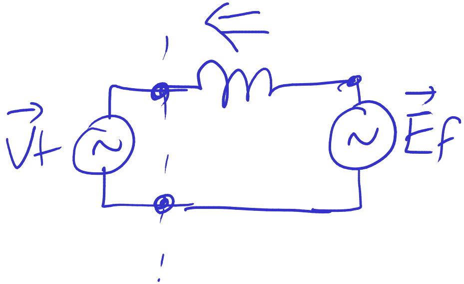
Torque of a Synchronous Machine

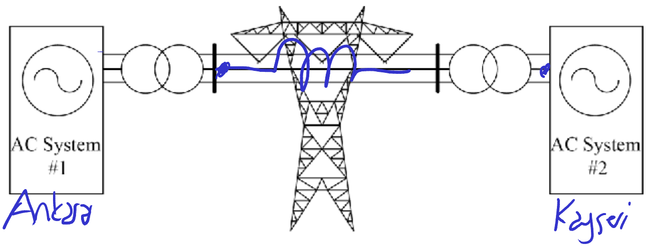
$$T_{max} = \frac{3V_t E_f}{X_s \omega_s}$$



Generalized Power Transfer in AC Systems

$$P = \frac{3|V_t||E_f| sin(\delta)}{|X_s|}$$





Kayseri

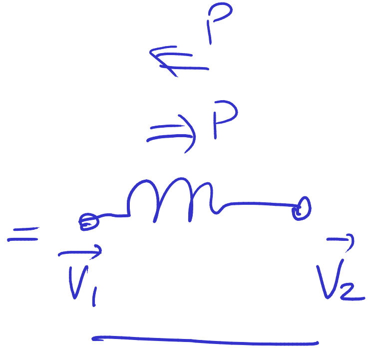
direction of power $\propto$ $sin(\delta)$

$\delta > 0 \Rightarrow P > 0$

$\delta < 0 \Rightarrow P < 0$

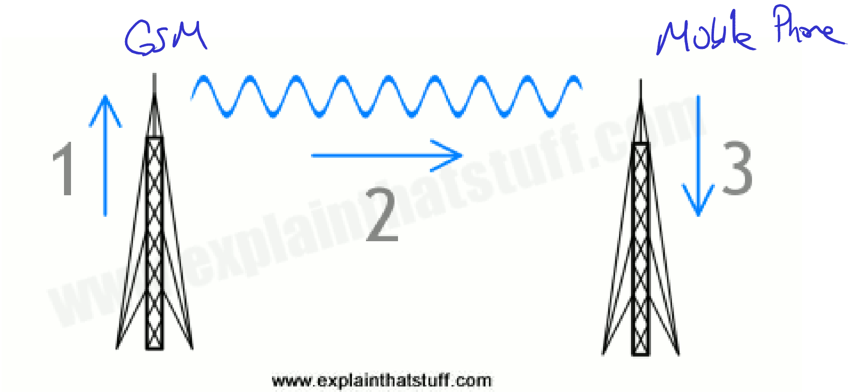
Generalized Power Transfer in AC Systems

In Transmission Systems



Generalized Power Transfer in AC Systems

In Wireless Communication



Generalized Power Transfer in AC Systems

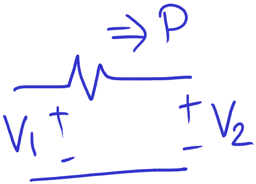
In Wave Energy Converters

[Pelamis WEC Operation](), [Full Story]()

Power Flow

DC Systems:

Power flows from high potential to low potential



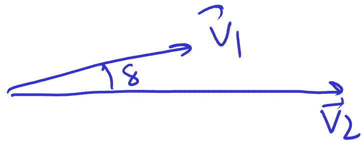
$V_1 > V_2$

Power Flow

DC Systems:

Power flows from high potential to low potential

AC Systems:



Power flows from leading voltage source to lagging voltage source (sign of load angle, δ determines the direction of power flow)

~~$|V_1| < |V_2|$~~