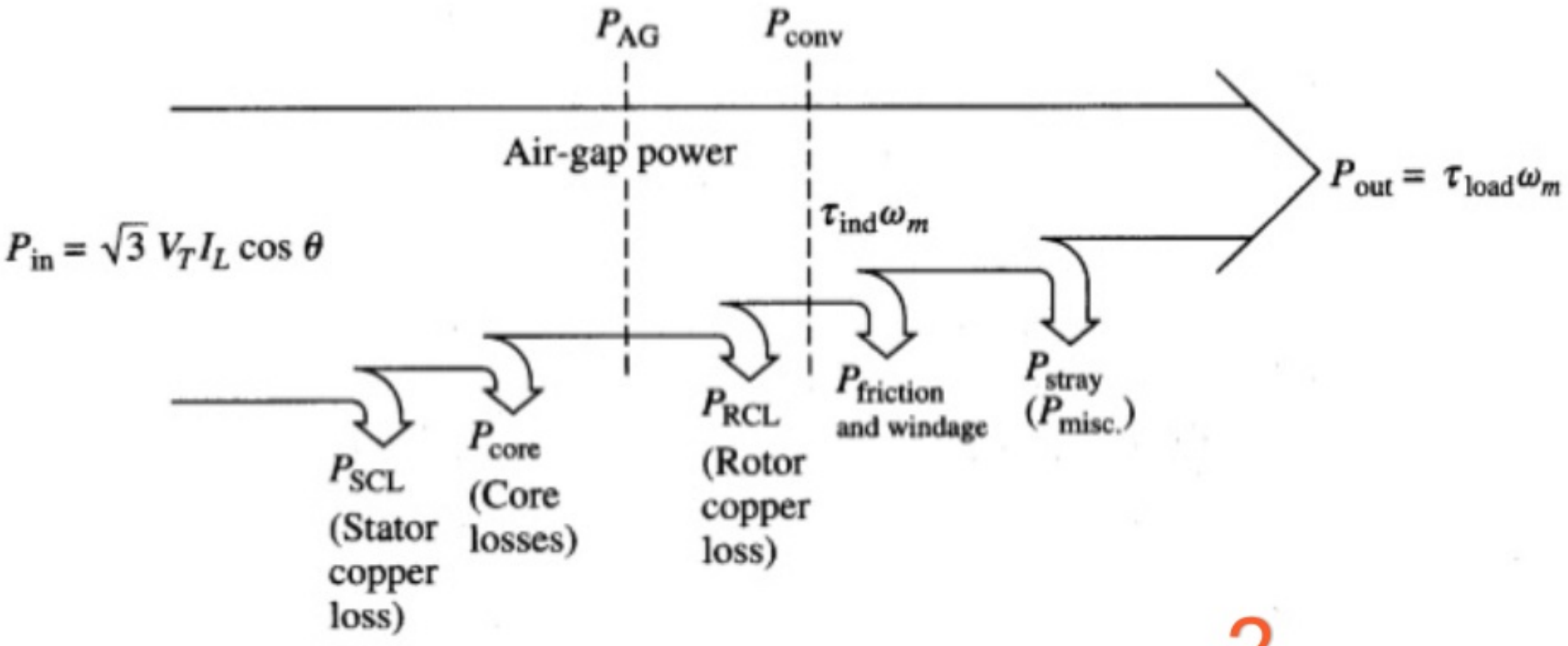
Power losses in Induction machines

- Copper losses
  - Copper loss in the stator (P_{SCL}) = $I_1^2 R_1$
  - Copper loss in the rotor (P_{RCL}) = $I_2^2 R_2$
- Core loss (P_{core})
- Mechanical power loss due to friction and windage
- How this power flow in the motor?

1

Power flow in induction motor



2

Power relations

$$P_{in} = \sqrt{3}\, V_L I_L \cos\theta = 3 V_{ph} I_{ph} \cos\theta$$

$$P_{SCL} = 3\, I_1^2 R_1$$

$$P_{AG} = P_{in} - (P_{SCL} + P_{core})$$

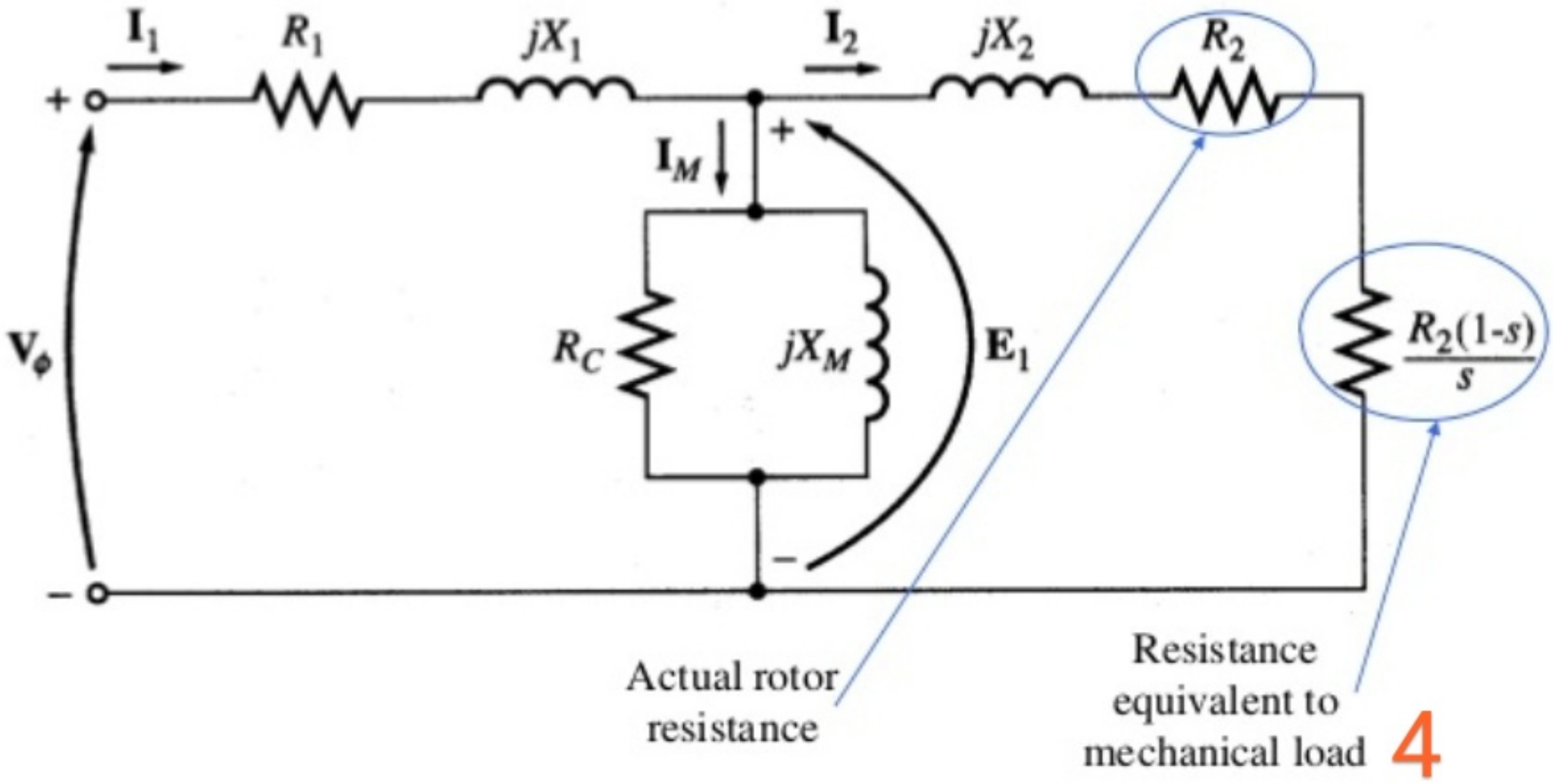
$$P_{RCL} = 3 I_2^2 R_2$$

$$P_{conv} = P_{AG} - P_{RCL}$$

$$P_{out} = P_{conv} - (P_{f+w} + P_{stray}) \qquad \tau_{ind} = \frac{P_{conv}}{\omega_m}$$

Equivalent Circuit

- We can rearrange the equivalent circuit as follows



Power relations

$$P_{in} = \sqrt{3}\, V_L I_L \cos\theta = 3 V_{ph} I_{ph} \cos\theta$$

$$P_{SCL} = 3\, I_1^2 R_1$$

$$P_{AG} = P_{in} - (P_{SCL} + P_{core}) \quad = P_{conv} + P_{RCL} \quad = 3 I_2^2 \frac{R_2}{s} \quad = \frac{P_{RCL}}{s}$$

$$P_{RCL} = 3 I_2^2 R_2$$

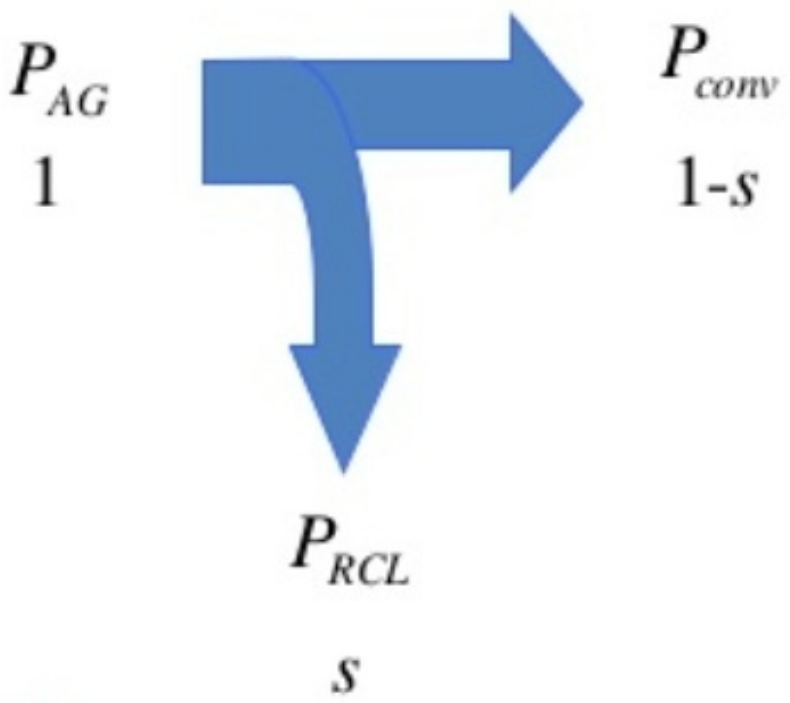
$$P_{conv} = P_{AG} - P_{RCL} \quad = 3 I_2^2 \frac{R_2 (1-s)}{s} \quad = \frac{P_{RCL}(1-s)}{s}$$

$$P_{conv} = (1-s) P_{AG}$$

$$P_{out} = P_{conv} - (P_{f+w} + P_{stray}) \qquad \tau_{ind} = \frac{P_{conv}}{\omega_m} = \frac{(1-s) P_{AG}}{(1-s)\omega_s}$$

5

Power relations



$$P_{AG} : P_{RCL} : P_{conv}$$
$$1 : s : 1-s$$