EN 206 - Power Electronics and Machines

Induction Motor

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Lecture Organization - Modules

- Introduction and Power Semiconductor Switches
- Module 1: Transformers
- Module 2: AC/DC converter / Rectifier
- Module 3: DC machines and Drives
- Module 4: DC/DC converter
- Module 5: Induction Machine
- Module 6: DC/AC converter / Inverter
- Module 7: AC/AC converter / Cyclo converter
- Module 8: Synchronous Machine
- Module 9: Special Topics: Machines, HVDC, APF

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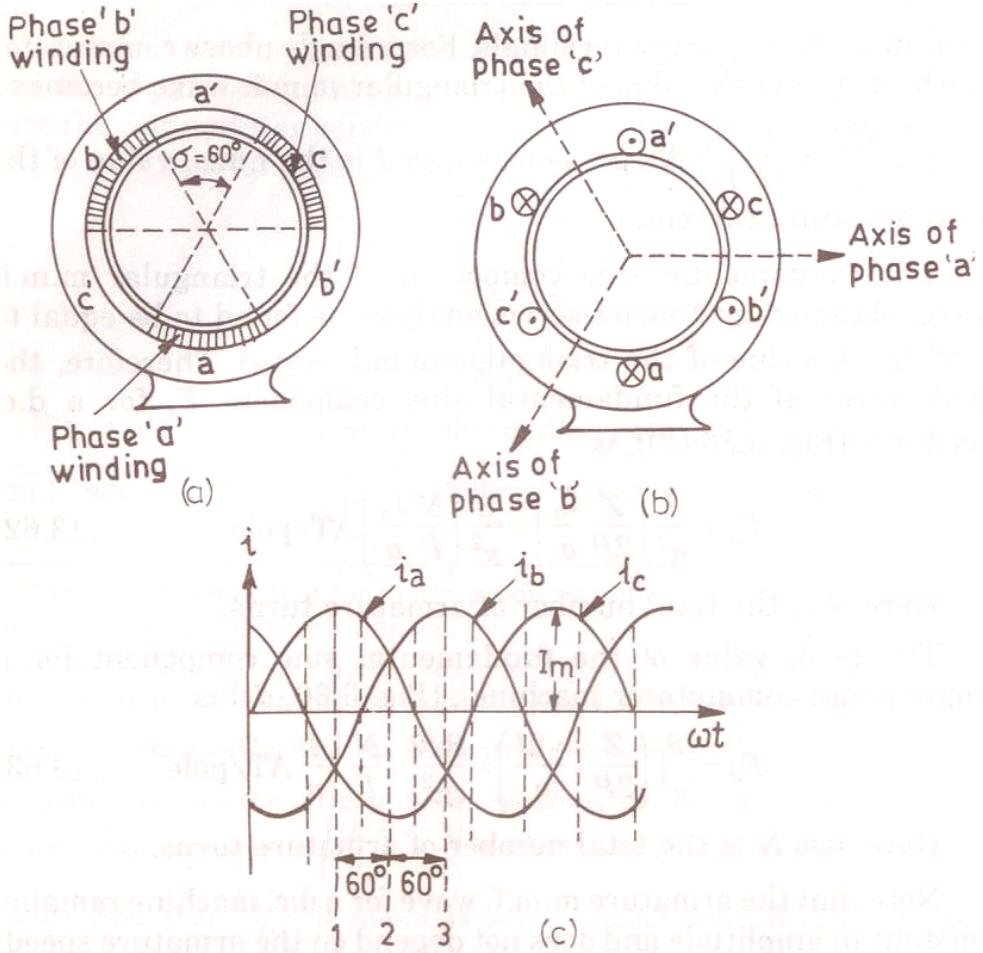
- For a 3 phase machine, the three windings are displaced from each other by 120^o electrical space degrees along the air-gap periphery.
- Production of rotating magnetic field can be verified both by graphical and mathematical analysis.

Rotating Magnetic Field

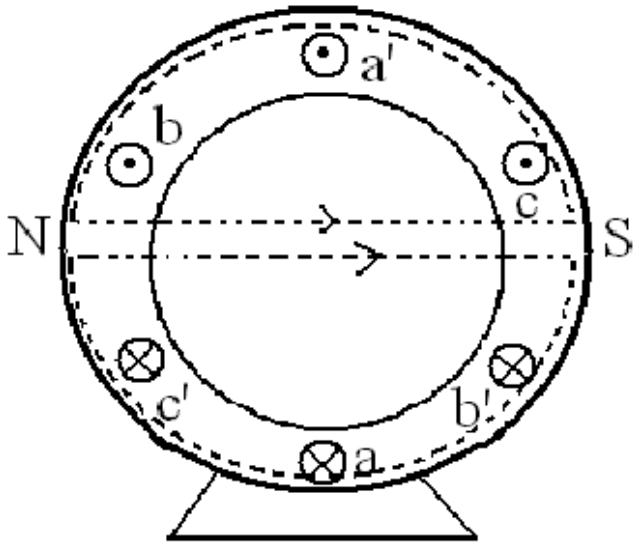


- Three phase winding space distributed by 120^o electrical, Three coils represent three phase winding and Three phase instantaneous currents

Rotating Magnetic Field

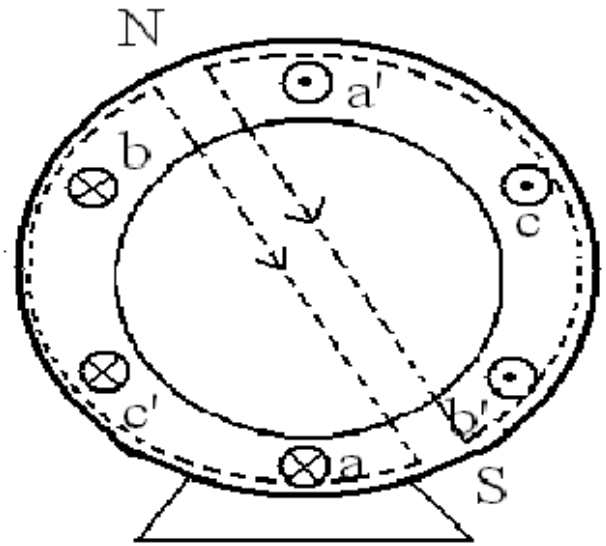
State-1

$I_a = I_m$; $I_b = -I_m/2$; $I_c = -I_m/2$
The maximum mmf set by the current is F_m,
The resultant mmf F_r is given by $F_r = F_m + \frac{2F_m cos(60)}{2}$ directed along 'a' axis



State-2

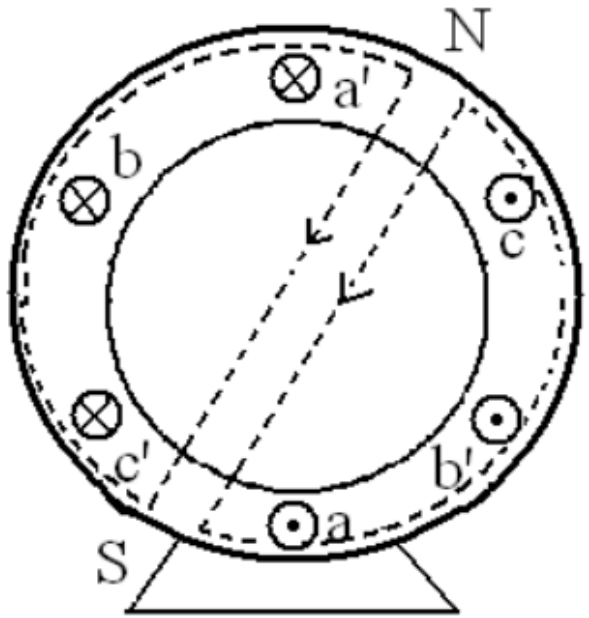
$I_a = -I_m/2$; $I_b = -I_m/2$; $I_c = I_m$
The resultant mmf F_r is given by $F_r = F_m + \frac{2F_m cos(60)}{2}$ directed along 'c' axis



Rotating Magnetic Field

State-3

$I_a = -I_m/2$; $I_b = I_m$; $I_c = -I_m/2$
The resultant mmf F_r is given by $F_r = F_m + \frac{2F_m cos(60)}{2}$ directed along 'b' axis



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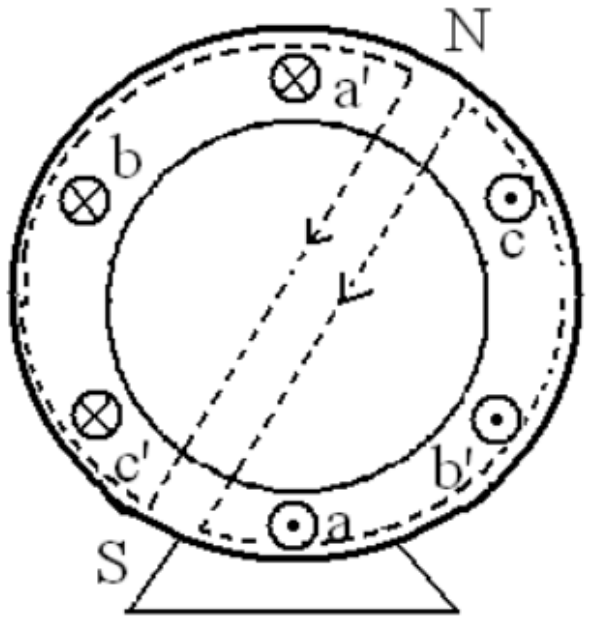
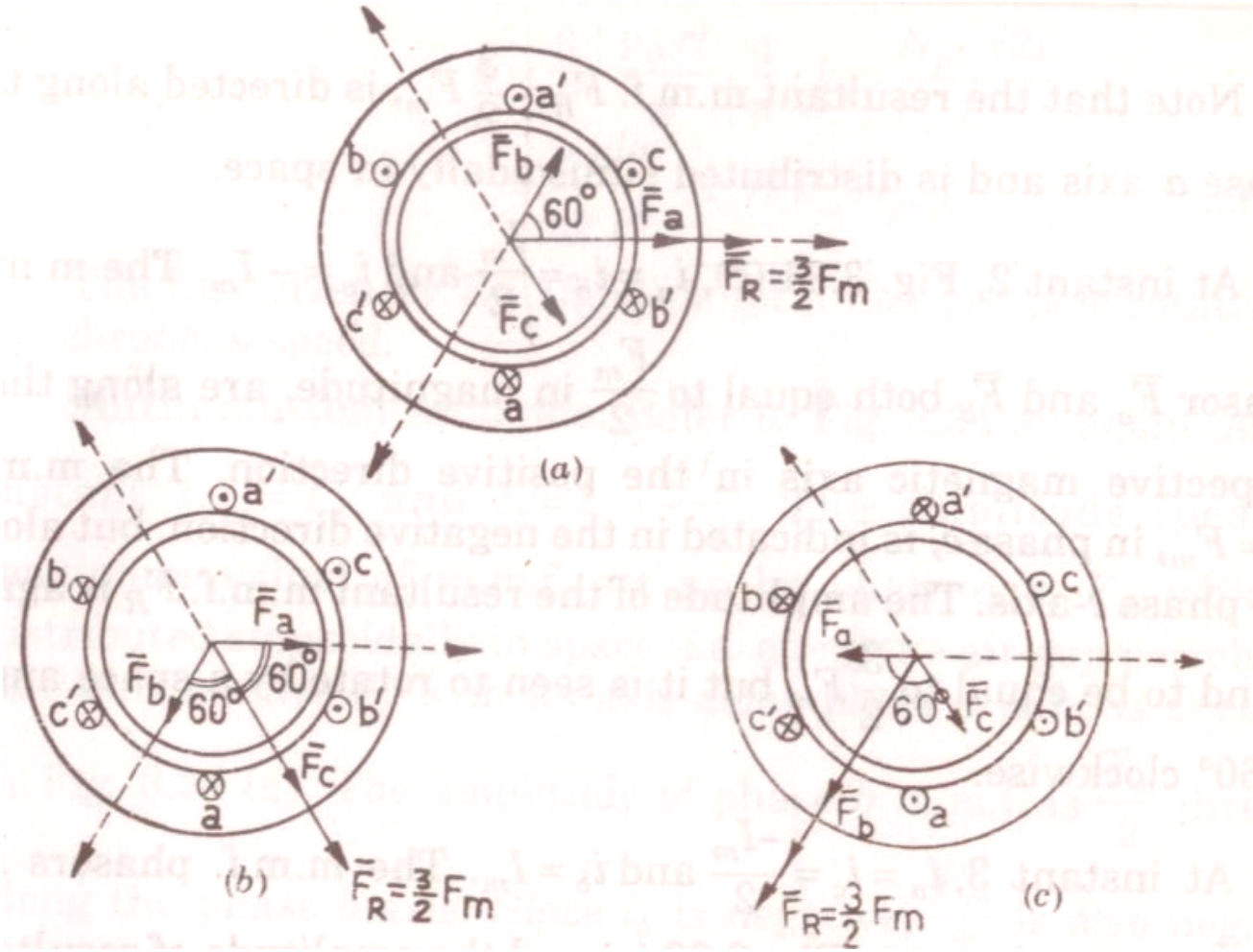


- When a poly phase current flow in a balanced poly phase circuit, a rotating magnetic field of constant magnitude is created and the speed of rotation is synchronous speed
- The effect of polyphase currents in polyphase windings is equivalent to the mechanical rotation of permanent magnets, or dc excited field poles, at synchronous speed.

Production of RMF- Space Phasor MMF



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- Electromagnetic torque is proportional to product of interacting magnetic fields and sine of electrical space angle between their magnetic axes.

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- Also, δ_r is not time varying and is considered to be cosntant.

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  - The transformer windings are concentrated while in induction machines they are distributed

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- The rotating magnetic field wave travels at synchronous speed with frequency of supply .

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- Slip is defined as ration of relative speed to synchronous speed, $s = \frac{(N_s - N_r)}{N_s}$

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- Speed of rotor field wrt stator structure = mechanical speed of the rotor + speed of the rotor field wrt rotor structure
- The relative speed between the stator mmf and rotor mmf is zero and hence both mmf are stationary with respect to each other resulting in steady torque

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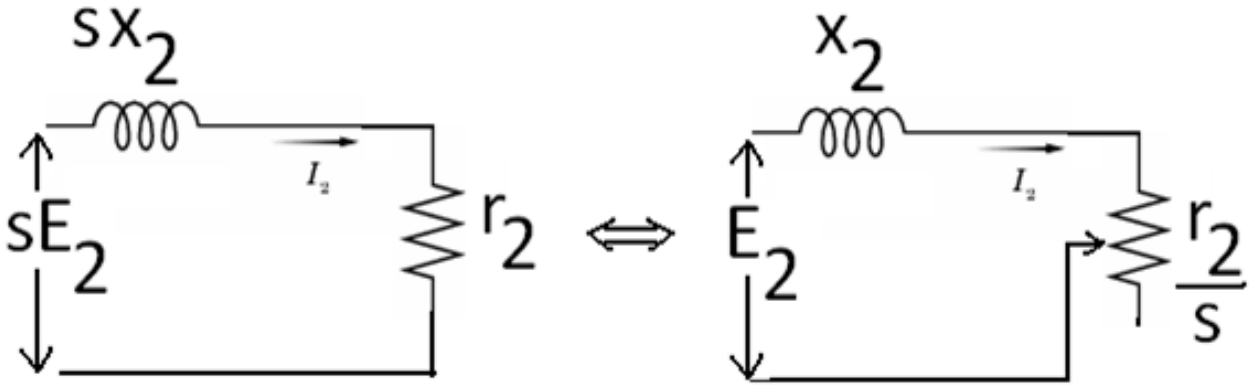

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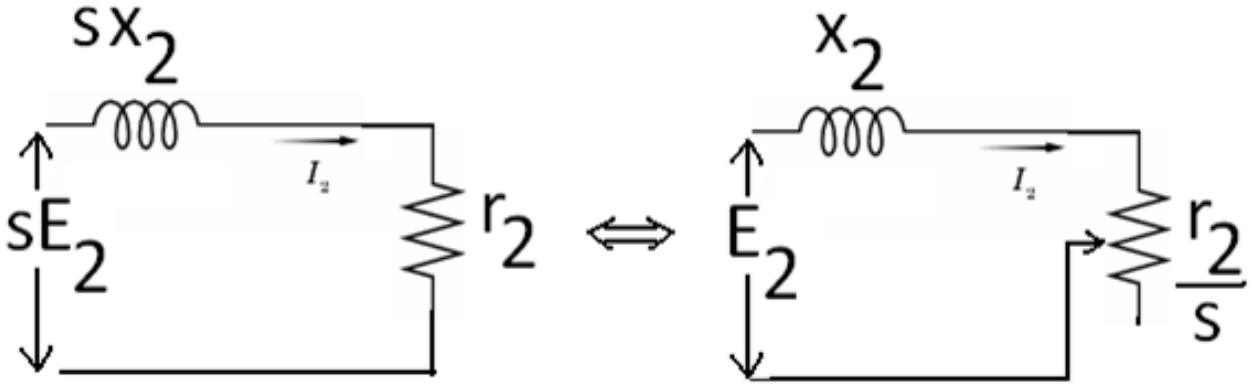

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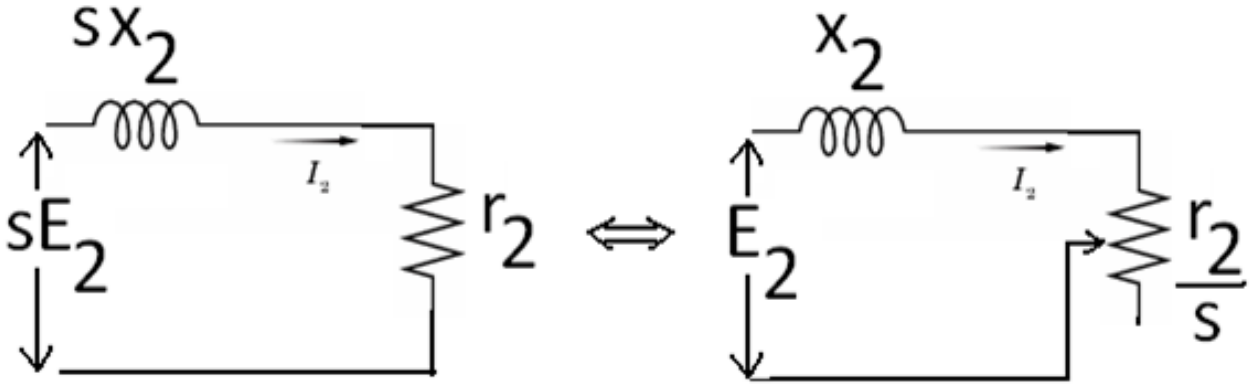
- The rotor leakage reactance at stand still, $x_2 = 2\pi f_1 l_2$ and at any slip is given by $2\pi f_2 l_2 = s x_2$



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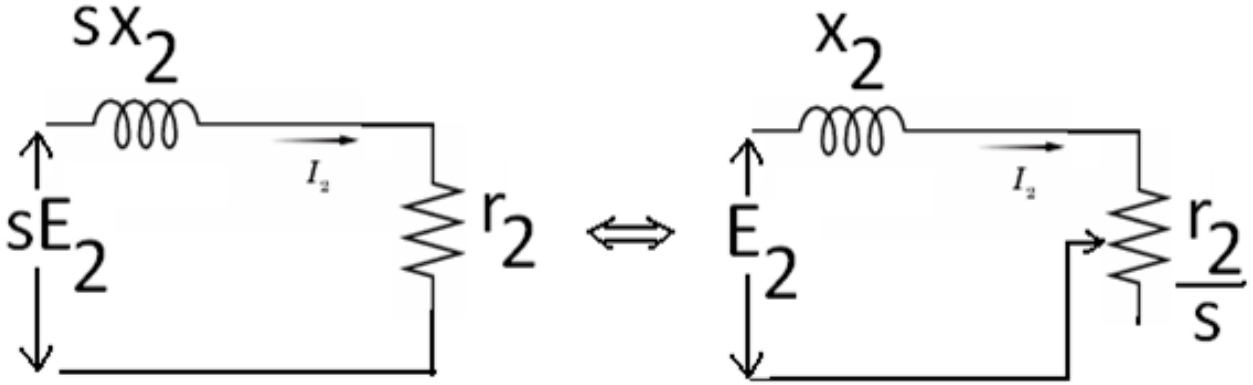

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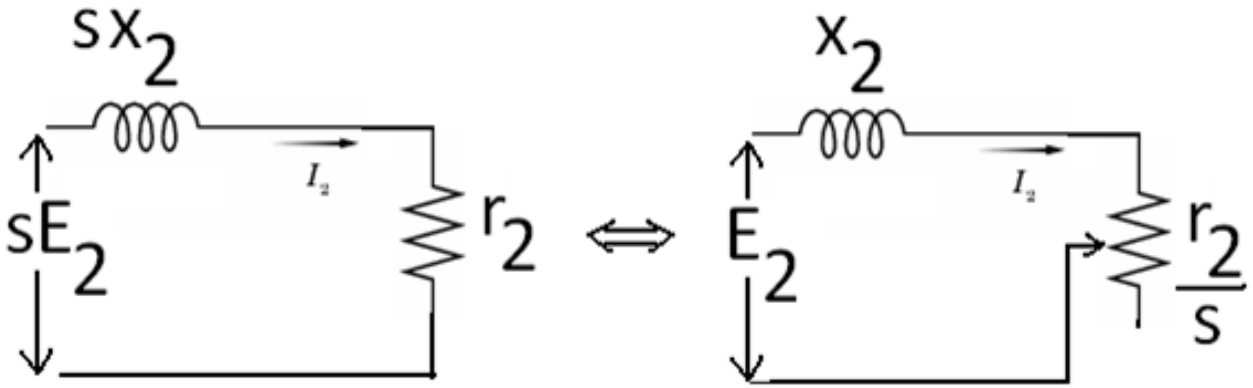

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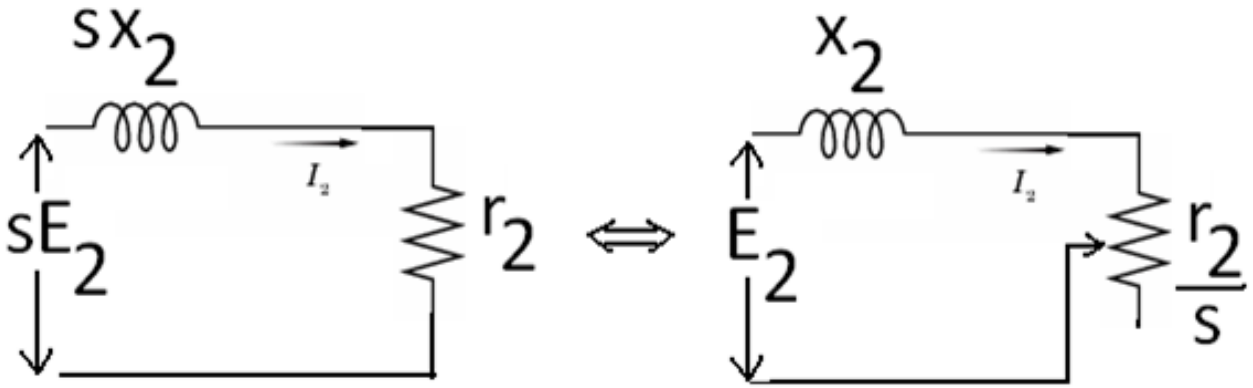

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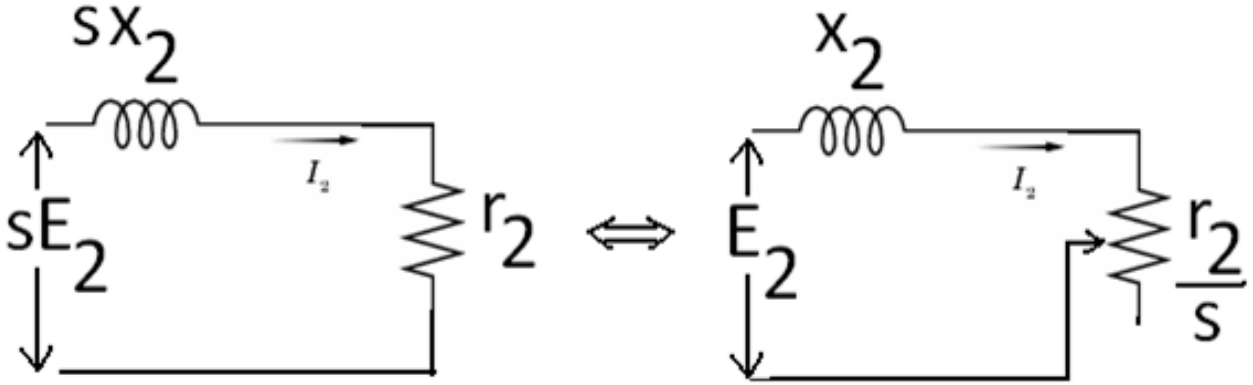

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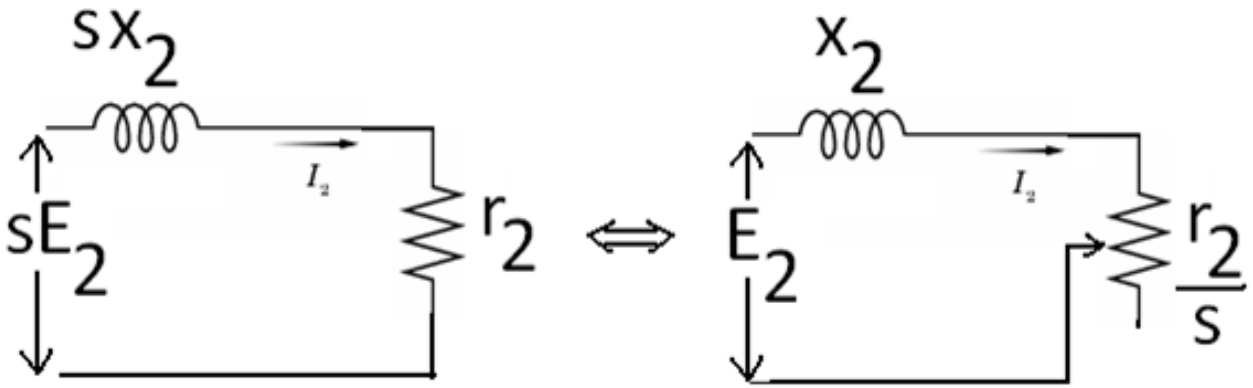

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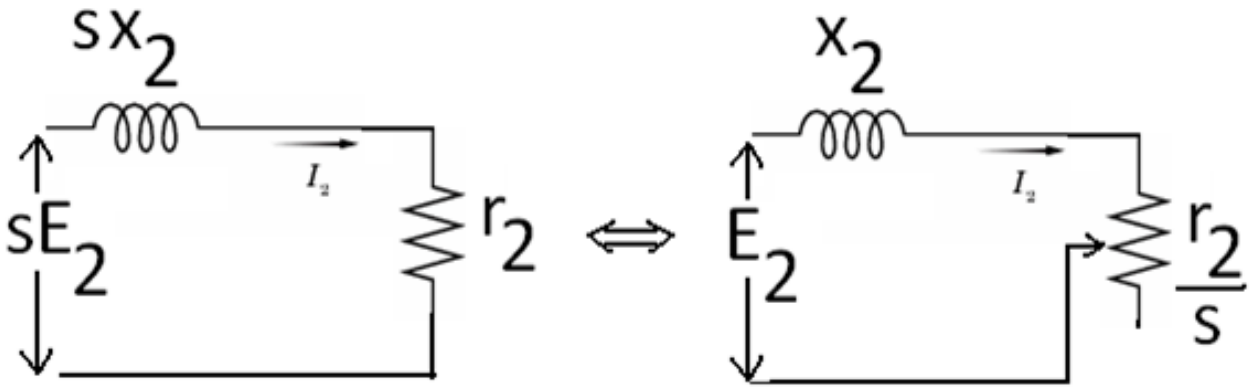

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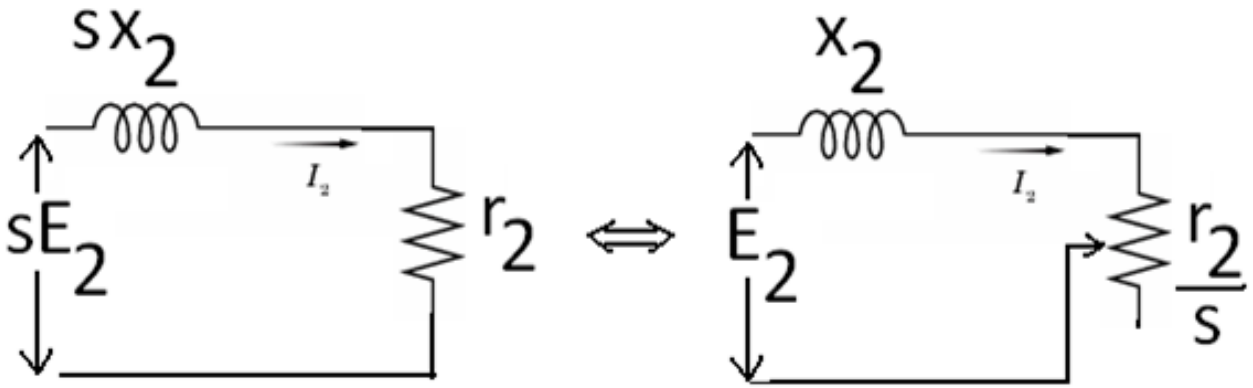

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- Internal mechanical power developed is given by $P_m = (1-s)P_g$.