ECE 320: Lecture 24
Example

Rotating Machine Case:

Now put a loop of wire in a magnetic field. The loop is free to rotate.

Example: $R := 0.3\text{ohm}$

$Vdc := 120V$

$r := 0.5m$

$l := 1m$

$B := 0.25T$

Initial Starting Current and Torque (no load)

$Istart := \frac{Vdc}{R}$ $\quad Istart = 400\,A$

$\tau init = \frac{2}{\pi}\cdot\phi\cdot Istart = 2\cdot r\cdot l\cdot B\cdot Istart$ $\quad \tau init := 2\cdot r\cdot l\cdot B\cdot Istart$ $\quad \tau init = 100\,N\cdot m$

- Steady-state rotational velocity at no-load

$Ea := Vdc$

$\omega := \frac{Ea}{2\cdot r\cdot l\cdot B}$ $\quad \omega = 480\,\frac{rad}{sec}$

- No load with flux dropping to 0.2 T

$B2 := 0.2T$

$\omega := \frac{Ea}{2\cdot r\cdot l\cdot B2}$ $\quad \omega = 600\,\frac{rad}{sec}$

Note that if B goes to 0, infinite speed.
B goes to zero if remove the field

Add 10 N-m load

$\tau load := 10N \cdot m$ opposing rotation

$Iload := \frac{\tau load}{2 \cdot r \cdot l \cdot B}$ $Iload = 40\,A$

$Ea\_load := Vdc - Iload \cdot R$ $Ea\_load = 108\,V$

$\omega motor := \frac{Ea\_load}{2 \cdot r \cdot l \cdot B}$ $\omega motor = 432 \frac{rad}{sec}$

$Pin := Vdc \cdot Iload$ $Pin = 4800\,W$

$Pelec := Pin - R \cdot Iload^2$ $Pelec = 4320\,W$

Also for a rotating machine:

$Pmech := \tau load \cdot \omega motor$ $Pmech = 4320\,W$ same a Pelec is no friction/windage losses

Generator

$\tau gen := 7.5N \cdot m$ in direction of rotation

$Igen := \frac{-\tau gen}{2 \cdot r \cdot l \cdot B}$ $Igen = -30\,A$ reverse polarity of current in circuit....

$Eagen := Vdc - Igen \cdot R$ $Eagen = 129\,V$ larger than Vdc

$\omega gen := \frac{Eagen}{2 \cdot r \cdot l \cdot B}$ $\omega gen = 516 \frac{rad}{sec}$

$Pout := Vdc \cdot (-Igen)$ $Pout = 3600\,W$

$Pelec := Pout + R \cdot Igen^2$ $Pelec = 3870\,W$

Also for a rotating machine:

$Pmech := \tau gen \cdot \omega gen$ $Pmech = 3870\,W$