Lecture 16

Tuesday, 12 March 2024 3:37 PM

EE114 - Power Engineering 1

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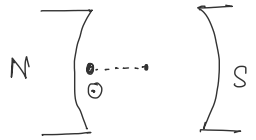
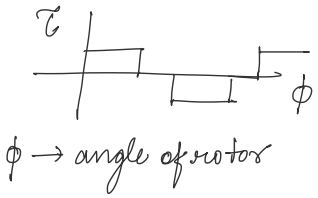
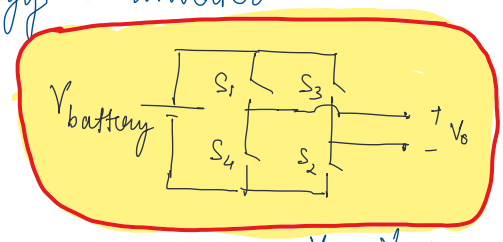
$F = i\vec{l} \times \vec{B}$





The average torque in this scenario is 0. But we want the motor to behave like a motor. So a net torque is required. The motor will produce positive torque if an AC current is pushed in the rotor winding (armature winding)

Analogy → inverter



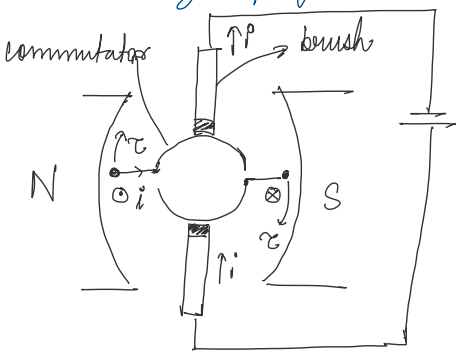
Inverter has been in use in contemporary times, earlier, it was the brushes that used to do all the work.

If S_1 & S_2 are on $V_0 = V_{battery}$

& if S_3 & S_4 are on $V_0 = -V_{battery}$

This inverter is common today but such was not the case a few decades ago.

How to have alternating supply without inverter.



$\tau = 2i\vec{l} \times \vec{B}\, n$

The brushes are pushing against the commutator making a physical connection. As the ring rotates the brush touch the other commutator reversing the direction of current in the conductor.

Brush commutator assembly :-

→ Converts DC to AC

→ synchronises current direction with position. ★

If the conductor is rotating very slow, the change in the direction of current with the position of wire

Terminologies :-

Z → number of conductors.

N → total number of turns = $\frac{Z}{2}$

a → number of parallel paths.

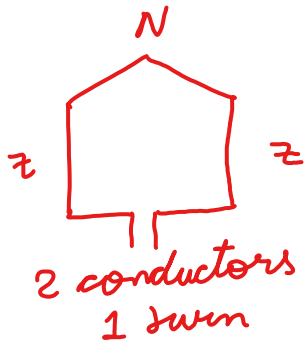
↳ depends on how the N are connected to each other (series / parallel).

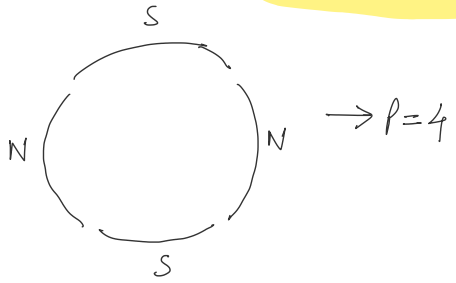
i → current in each conductor

$= \frac{I_{total}}{a} = \frac{I_a}{a}$ (armature current)

P → number of poles.

$\theta_{elect} = \frac{P}{2} \theta_{mech}$.





→ $P = 4$

* Total torque :-

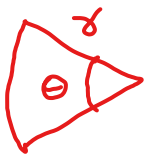
Torque per conductor = $r \times i l B$.

Some conductors are producing torque and some are not

In uniform distribution of conductors, let γ be the percentage of conductors producing torque

$\gamma = \frac{\sum \theta_1}{360}$

$i = \frac{I_a}{a}$



$CSA = \theta r l$

$T_{total} = r i l B Z \gamma$

$= r \frac{I_a}{a} l \frac{\phi}{r l \theta_1} Z \gamma$

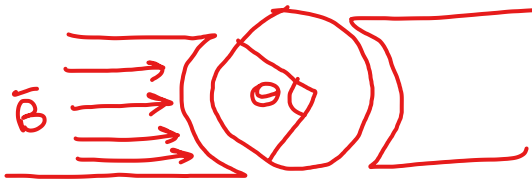
$= K \phi I_a$

$B = \frac{\phi}{l r \theta_1}$

$\theta_1 = \frac{\gamma \pi}{(P/2)}$

$K = \frac{NP}{\pi a}$

$\theta_1 = \frac{2\pi}{P}$ ★



* Total induced voltage :-

$e = vl \times B$

$E = \frac{vlB \times Z}{a} r = \omega r l \frac{\phi}{2\pi r l} \times \frac{2N r}{a} \times \frac{P}{2 r \pi}$

$E_a = K \phi \omega = \frac{PN}{\pi a} \times \omega \phi$

$E_a \rightarrow$ back emf, induced V

$\boxed{I_a E_a = \tau \omega}$ always true

$\tau \rightarrow$ electromechanical torque

Not to be confused by output torque at shaft

(?)

$\tau = K \phi I_a$

$E_b = K \phi \omega$