Lecture 15

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EE114 - Power Engineering 1

Course instructor: Prof. Sandeep Anand

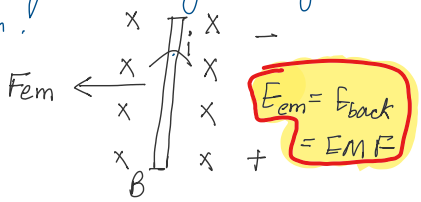
Scribe: Saurabh Singh

* Basic electromechanical conversion equation

See figure. ① B is inside the paper
② A wire is kept on the plane of paper with current i flowing

③ A force is experienced by the wire given by the following expression.

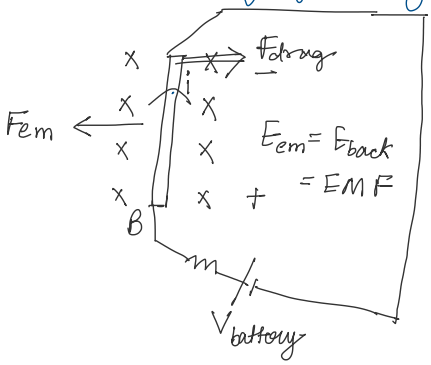
$$F_{em} = i\,l \times B$$



④ Now due to force wire moves in direction of force. At $t = t_1$ it attains speed v_1, $t = t_1$, $v = v_1$

A conductor of length l moving with speed v_1 in the magnetic field B, generates an emf given by

$$E_{em} = l\,v_1 \times B$$



⑤ Back emf as shown in figure increases as the speed increases. The emf opposes the flow of current. Current reduces. Force on wire reduces. The acceleration of wire reduces. Soon the Eem becomes equal to $V_{battery}$ Current becomes zero, force becomes zero, wire moves at steady state.

Steady state at

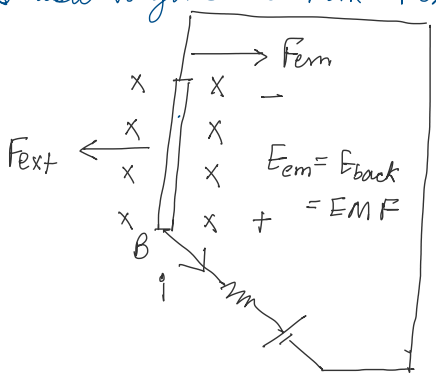
$$v = \frac{V_{battery}}{l\,B}$$

Motoring mode

Generating mode :-

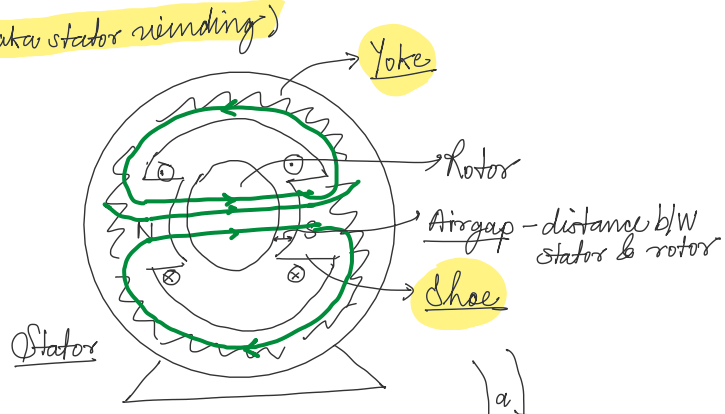
① Wire is pulled externally with force Fext & Eem becomes more than $V_{battery}$

② Current now flows into the battery. Direction of current is now opposite. Hence the electromechanical force on wire is now opposing the externally applied force. Soon, v increases such that Eem pushes current i, that is able to generate Fem = Fext & hence the wire keeps moving with that steady speed.



* DC machines :-

Field winding (aka stator winding)



flows through path a and not through path b (lesser reluctance)

Would there be a core loss in stator if DC current flows through the field winding?

No. No change in flux.
So no hysteresis loss
No eddy current loss

Would there be core loss in rotor if it is rotating. Yes.
Laminations for rotor are necessary. Not for stator

Consider figure. Wire with current i as shown is kept between N pole & S pole and is made to rotate at constant ω
The resulting electromechanical torque & back emf in wire.