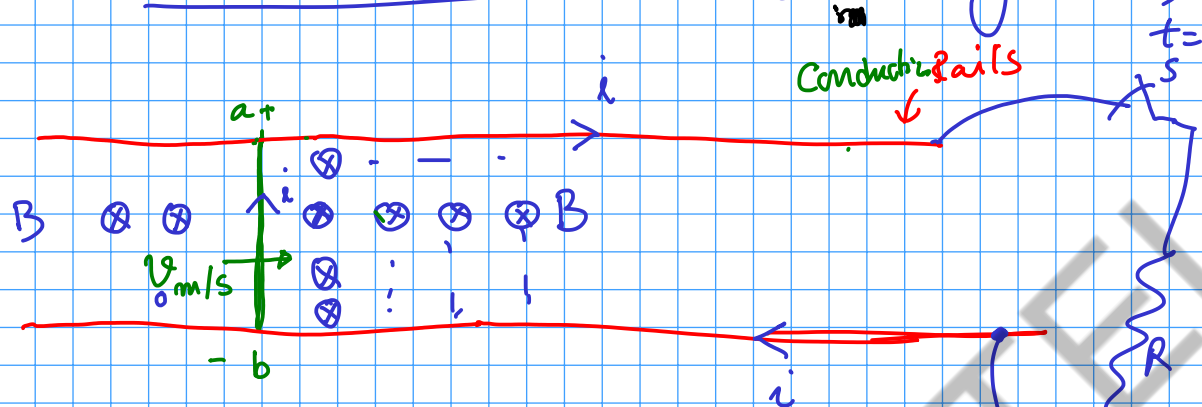


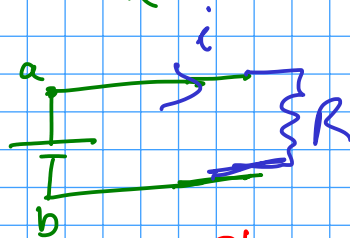
D.C Machines: (Rotating M/cs)



no friction
on the track
 v_0 m/sec.

$ab = \text{conductor length} = l$

$$e_{ab} = Blv$$



$$Bil$$

$$\frac{1}{2} m v_0^2$$

Equation of motion for the conductor ab

$$m \frac{dv}{dt} = -Bil = -Bl \frac{Blv}{R} = -\frac{B^2 l^2}{R} v$$

or

$$\frac{dv}{dt} + \frac{B^2 l^2}{Rm} v = 0$$

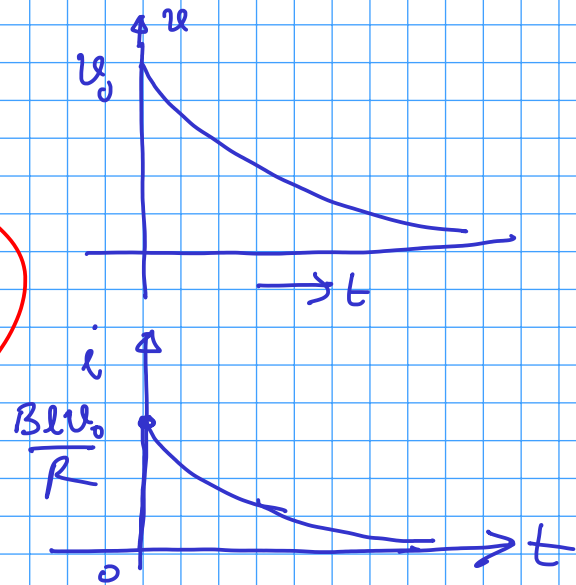
$$v = A e^{-\frac{B^2 l^2}{mR} t}$$

Ch. root
 $= -\frac{B^2 l^2}{mR}$
 at $t=0^+$ $v=v_0$
 $A = v_0$

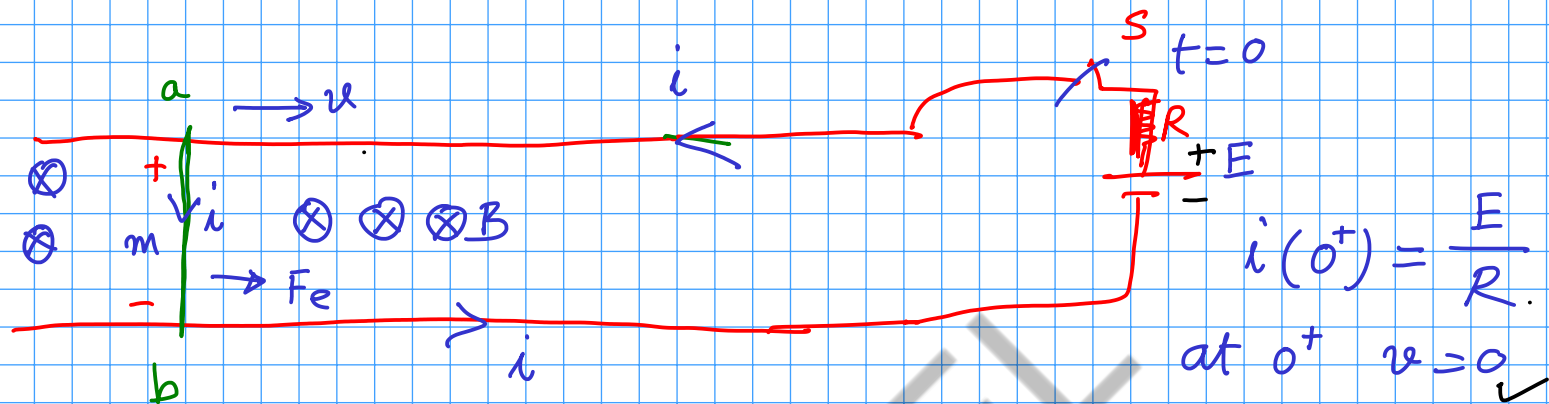
Total energy
loss $\int_0^{\infty} i^2 R dt$

$$v(t) = v_0 e^{-\frac{B^2 l^2}{mR} t}$$

$$i(t) = \frac{Blv}{R} = \frac{Blv_0}{R} e^{-\frac{B^2 l^2}{mR} t}$$



$$\text{Total Energy loss} = \int_0^{\infty} i^2 R dt = \frac{1}{2} m v_0^2$$



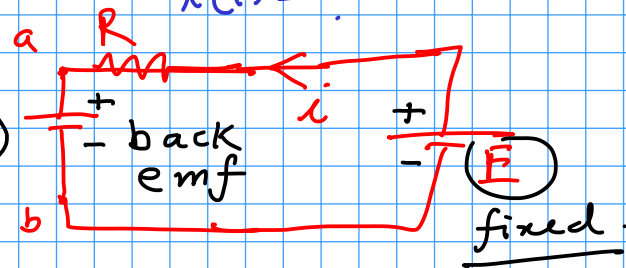
ab initially at rest for $t \geq 0$

conductor ab experiences a force from left to right

Bil

$$m \frac{dv}{dt} = Bil$$

$v(t) = ?$
 $i(t) = ?$



$$i = \frac{E - B l v}{R}$$

$$m \frac{dv}{dt} = B(i)l$$

$$i = \frac{E - Blv}{R}$$

$$i = ?$$

$$v = ?$$

final velocity

$$v_0 = \frac{E}{Bl}$$

$$i_{\text{final}} = 0$$

$$m \frac{dv}{dt} = \frac{Bl(E - Blv)}{R}$$

or

$$\frac{dv}{dt} + \frac{B^2 l^2}{mR} v = \frac{BlE}{mR}$$

$$\text{Ch. root} = -\frac{B^2 l^2}{mR}$$

$$\therefore v(t) = A e^{-\frac{B^2 l^2}{mR} t} + \frac{Bl}{mR} \frac{mR E}{B^2 l^2} = A e^{-\frac{B^2 l^2}{mR} t} + \frac{E}{Bl}$$

$$v(0) = 0 \text{ Then } A = -E/Bl$$

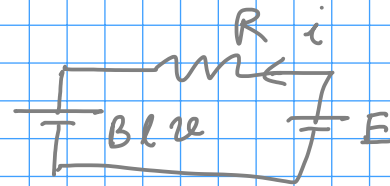
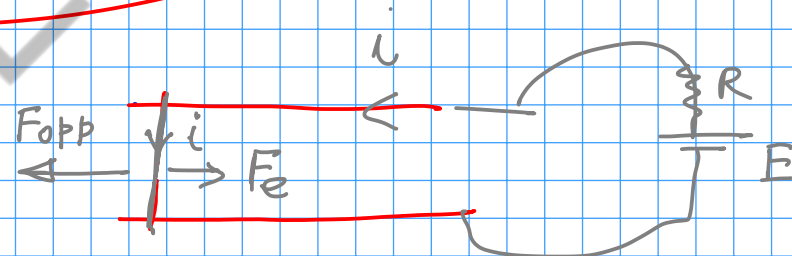
$$v(t) = \frac{E}{Bl} \left(1 - e^{-\frac{B^2 l^2}{mR} t} \right)$$

$$v \Big|_{t \rightarrow \infty} = \frac{E}{Bl}$$

$$i(t) = \frac{E - Blv}{R} = \frac{E}{R} - \frac{Bl}{R} v(t)$$

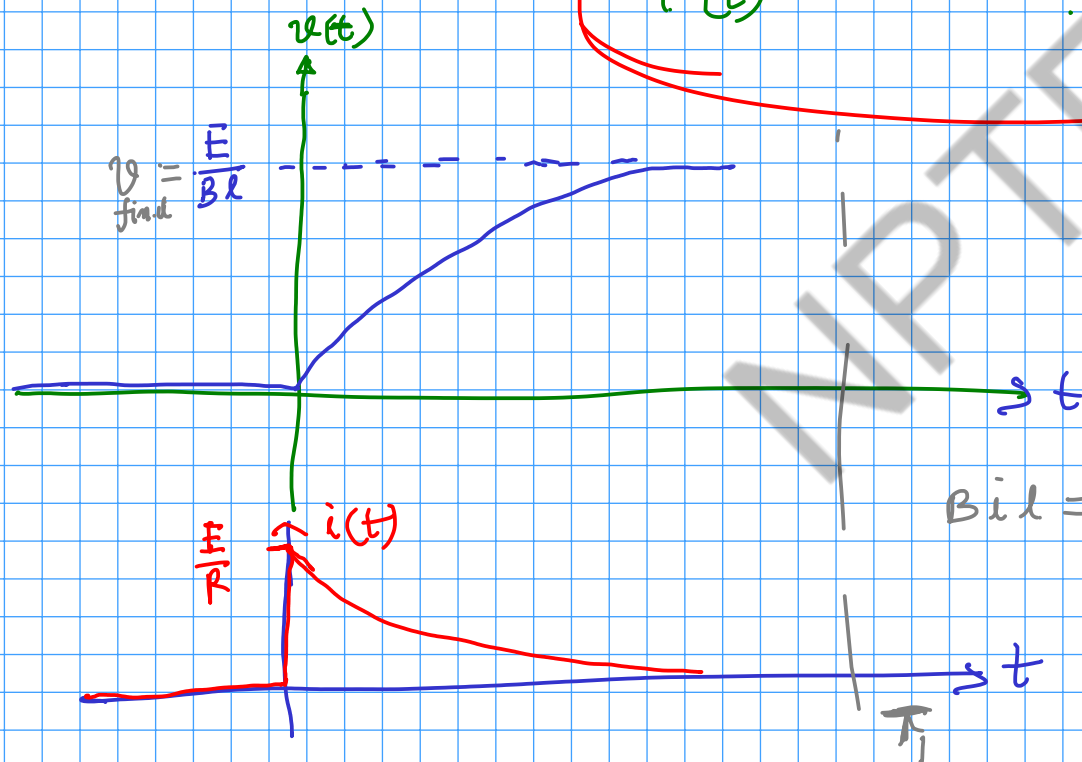
$$= \frac{E}{R} - \frac{Bl}{R} \left[\frac{E}{Bl} \left(1 - e^{-\frac{B^2 l^2}{mR} t} \right) \right]$$

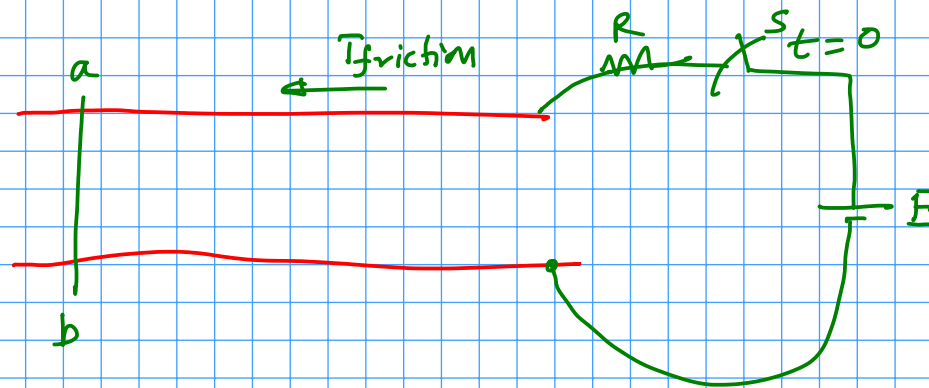
$$i(t) = \frac{E}{R} e^{-\frac{B^2 l^2}{mR} t}$$



$F_e > F_{opp}$ Conductor accelerates
 $F_e < F_{opp}$ Conductor decelerates
 $F_e = F_{opp}$ Conductor constant velocity.

$$Bil = F_{opp}$$





$v(t), i(t)$

$$\text{at } t=0^+ = \frac{E}{R}$$

$$F_e = B \frac{E}{R} l \text{ at } 0^+$$

$$F_e = B i l$$

$$= B l \frac{(E - B l v)}{R}$$

$$v_{\text{final}} = \frac{E}{B l} \times$$

$$m \frac{dv}{dt} = F_e - F_{\text{fric}}$$

final steady at steady state
velocity will such

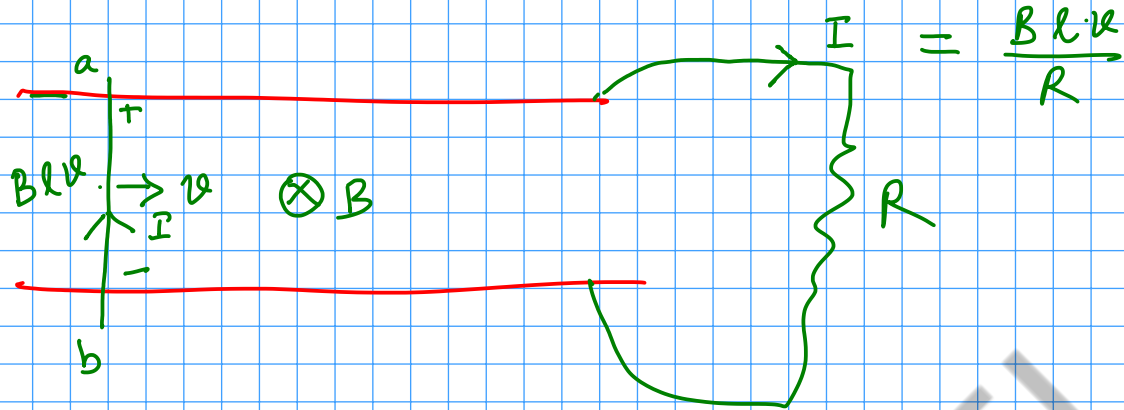
That

$$\frac{E - B l v_{\text{new}}}{R} = I_{\text{final}}$$

$$F_e = F_{\text{fric}} = B I_{\text{final}} l$$

$$I_{\text{final}} = \frac{F_{\text{fric}}}{B l}$$

Gen

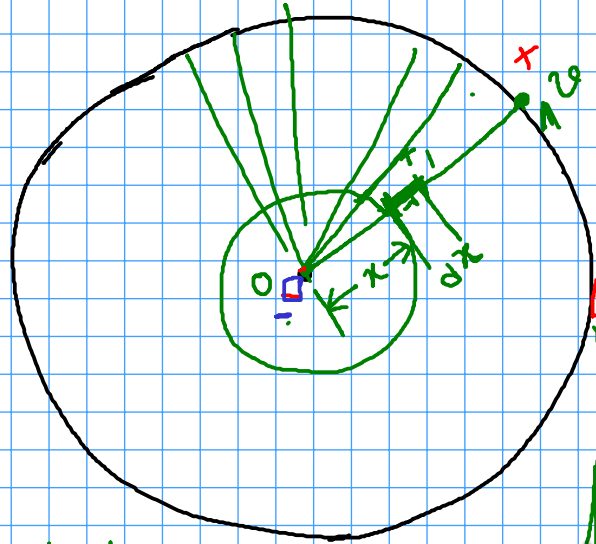


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$$F_e = F_{\text{mech}}$$
$$= BIl$$

prime mover

$B \otimes$

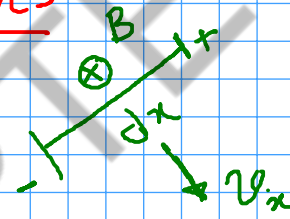


$B, \underline{rps.}$

$$v = \frac{2\pi r n}{m/sec}$$

$n \underline{rps}$

DC Homopolar
M/c



$$de_x = B dx v_x$$

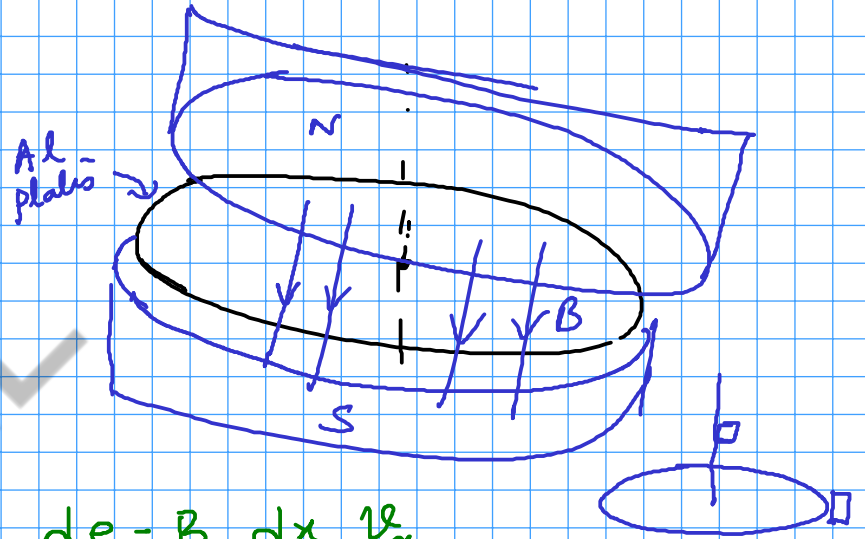
$$v_x = 2\pi x n \underline{m/sec}$$

$$de_x = B v_x dx = B 2\pi n x dx$$

$$= 2\pi n B \frac{r^2}{2} = \text{Gen Voltage}$$

Gen Voltage between points A and O

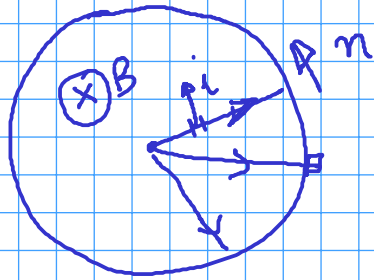
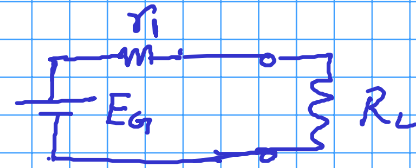
$$= 2\pi n B \int_0^r x dx$$



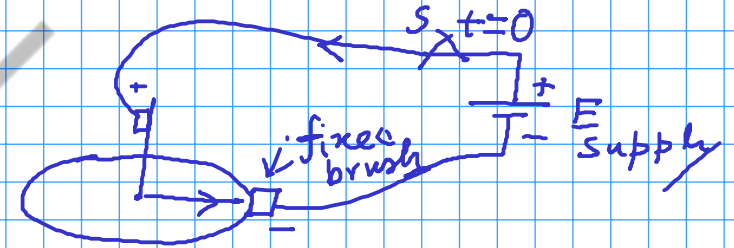
D. C Machines Introduction continued

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Homopolar D.C M/C $\begin{cases} \text{Gen} \\ \text{Motor} \end{cases}$



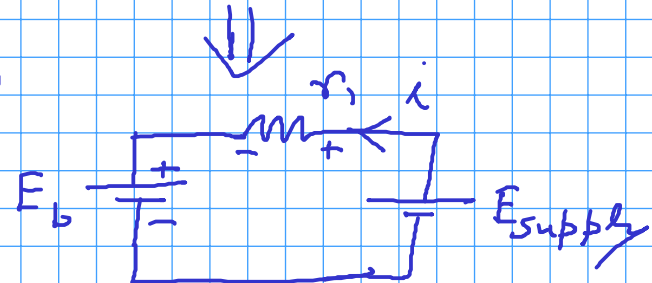
$$E_G = \omega n B r^2 \quad \text{radius of the disc}$$

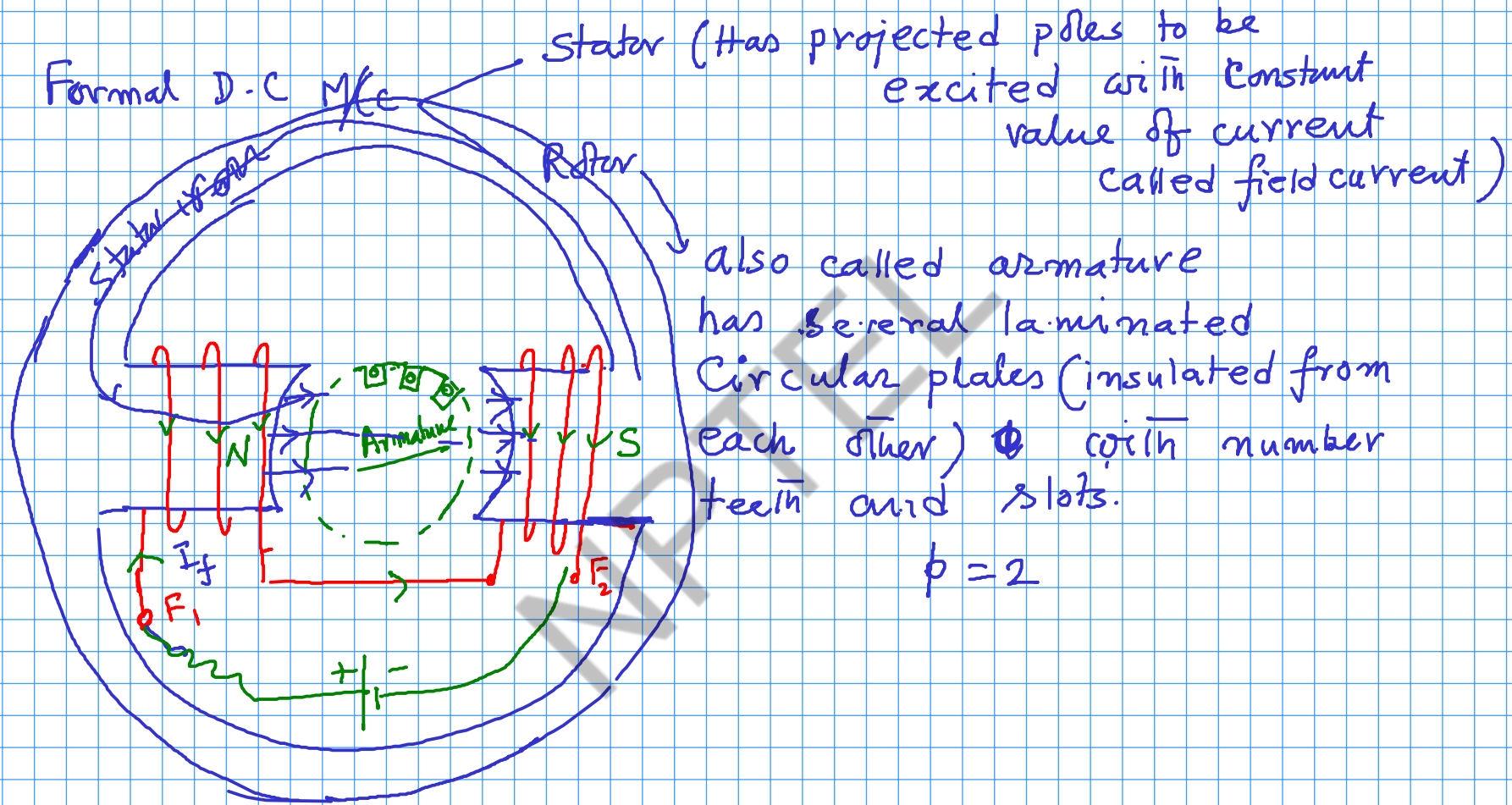


$$E_{\text{supply}} = i r_i + E_b$$

$$E_{\text{supply}} i = i^2 r_i + E_b i$$

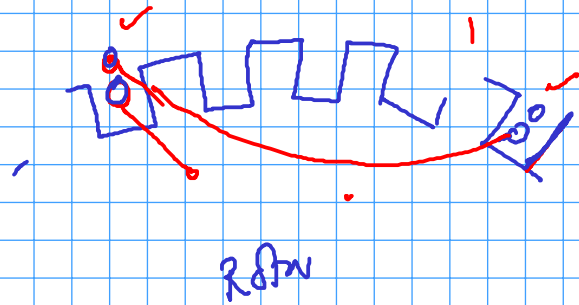
$E_b i$ mech power



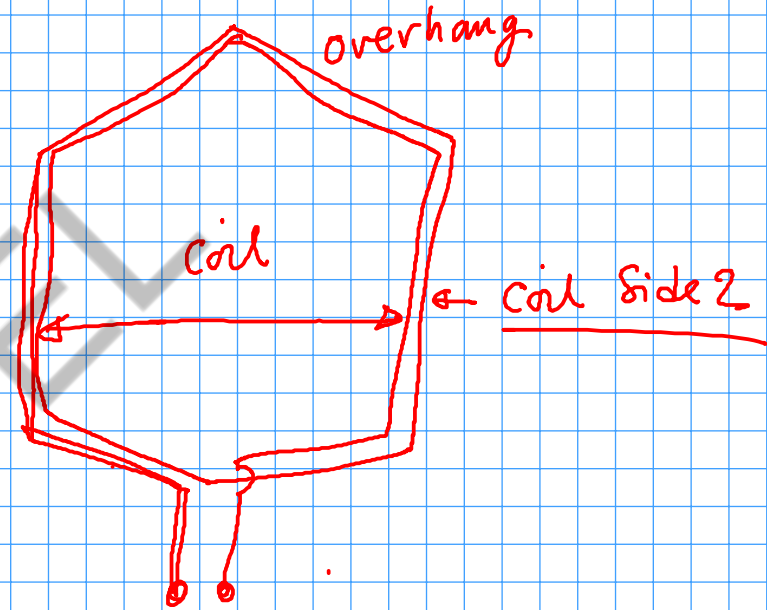


Rotating D.C Machines

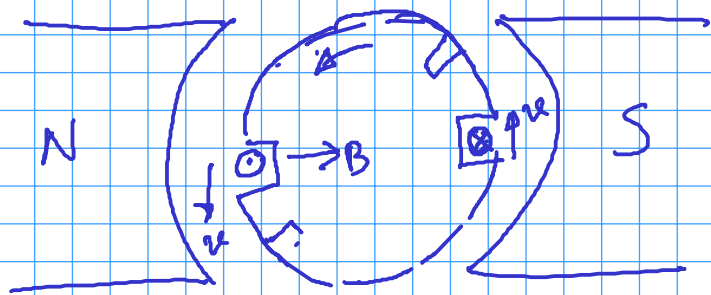
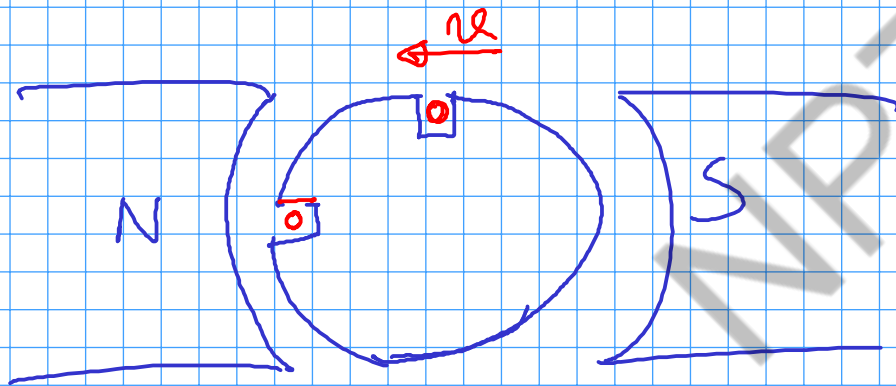
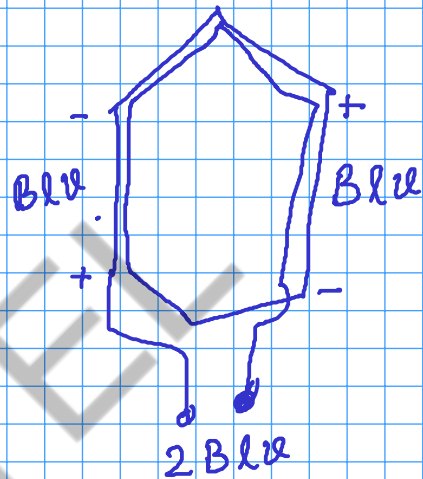
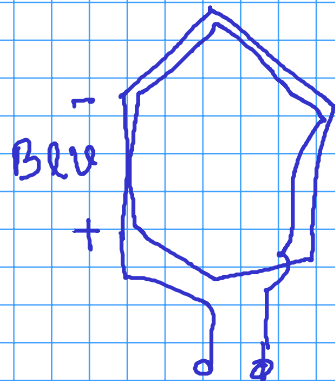
dec 58



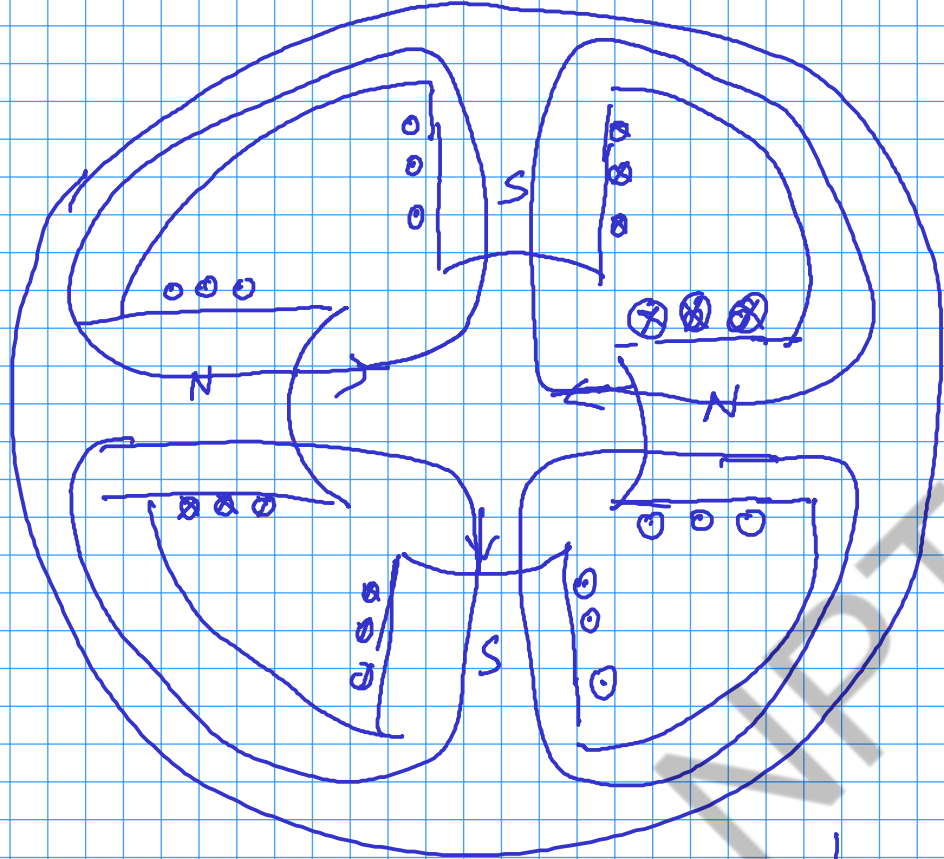
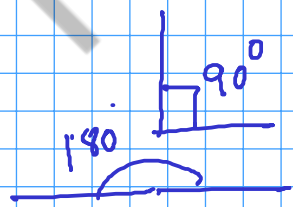
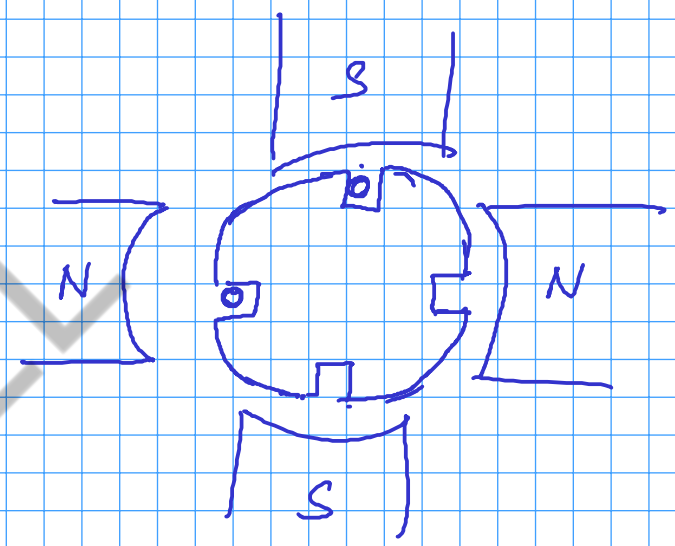
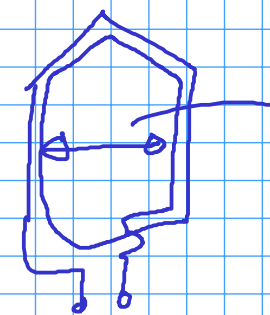
Coil
Side-1



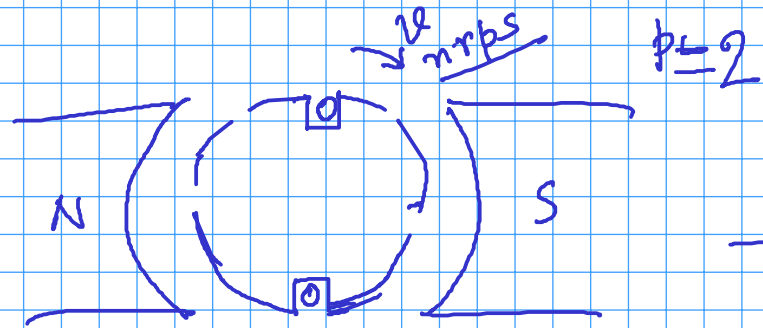
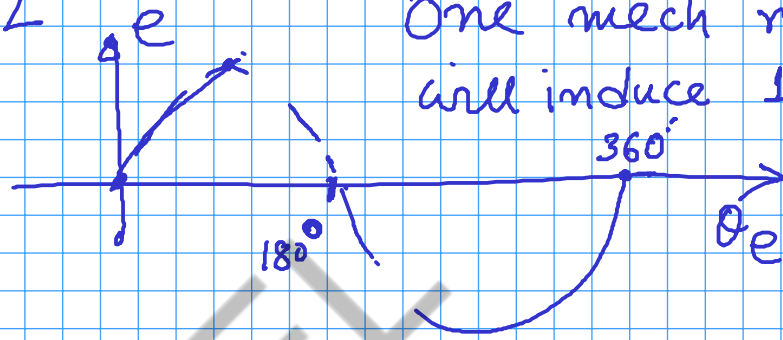
Two coil sides
make a coil



$$p=4$$

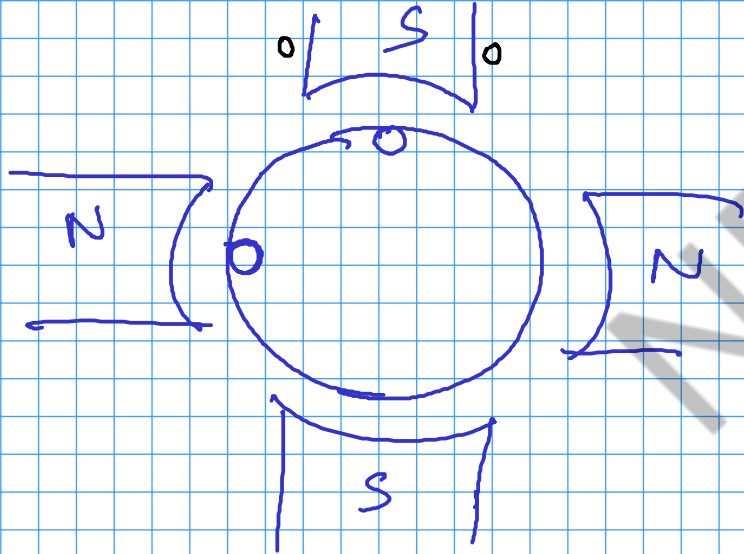


Coil span
 $= 180^\circ$ (electrical)



One mech rotation
will induce 1 cycle of emf

$$\underline{\theta_e = \theta_{mech}}$$



one mechanical rotation
will induce 2 cycles of emf

$$\theta_e = \frac{p}{2} \theta_{mech} \checkmark$$

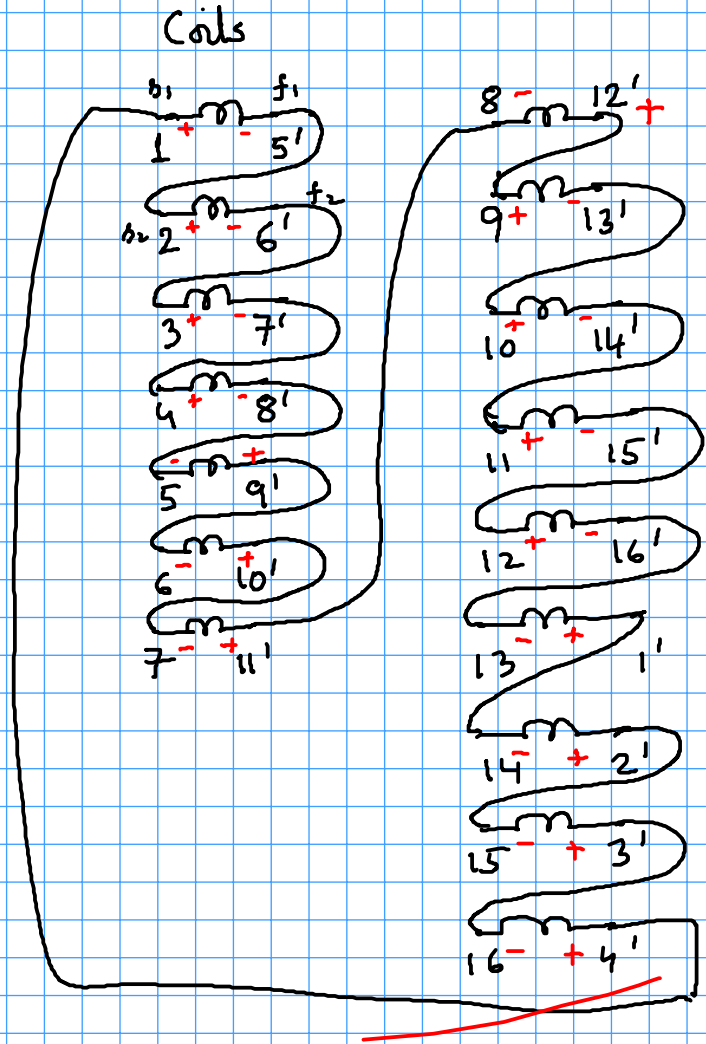
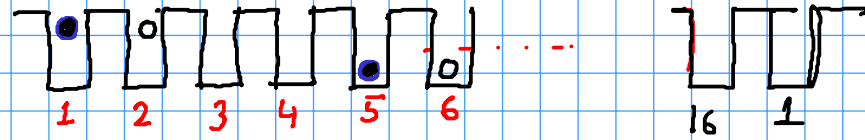
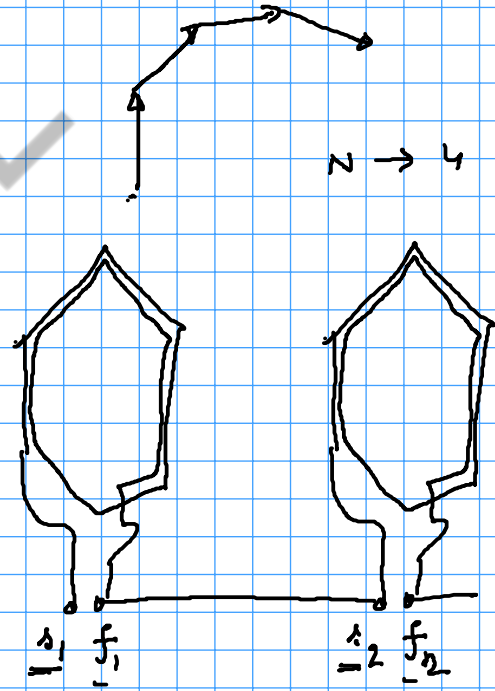
Double Layer winding : Each coil will have two sides
Coil span = 180° (electrical)

Let no. of ^{rotor} slots = $S = 16$

No. of poles = $P = 4$

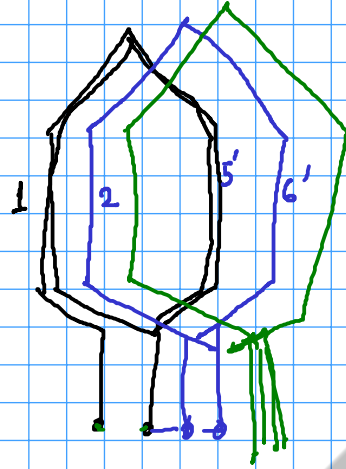
$$\text{Slots/pole} = \frac{16}{4} = 4 = \text{coil span} = 180^\circ (\text{elec})$$

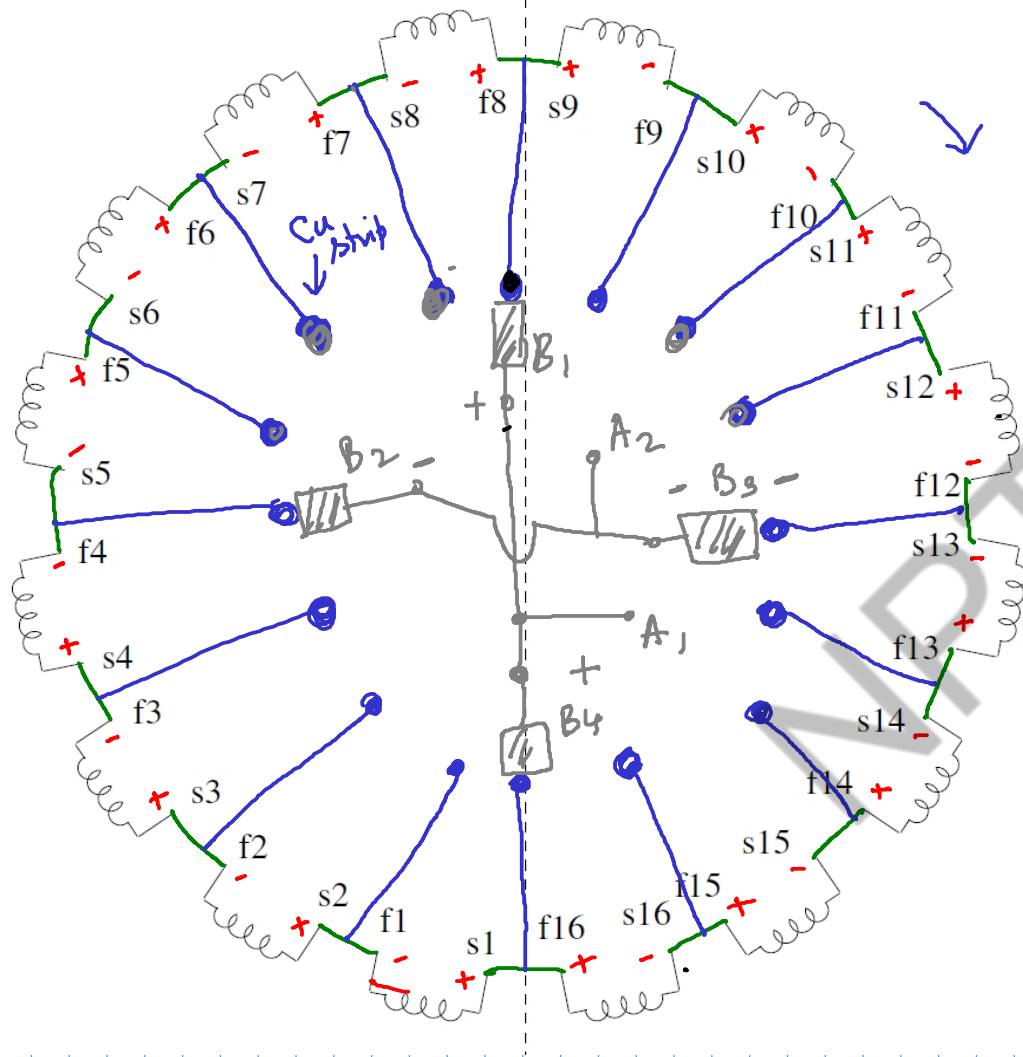
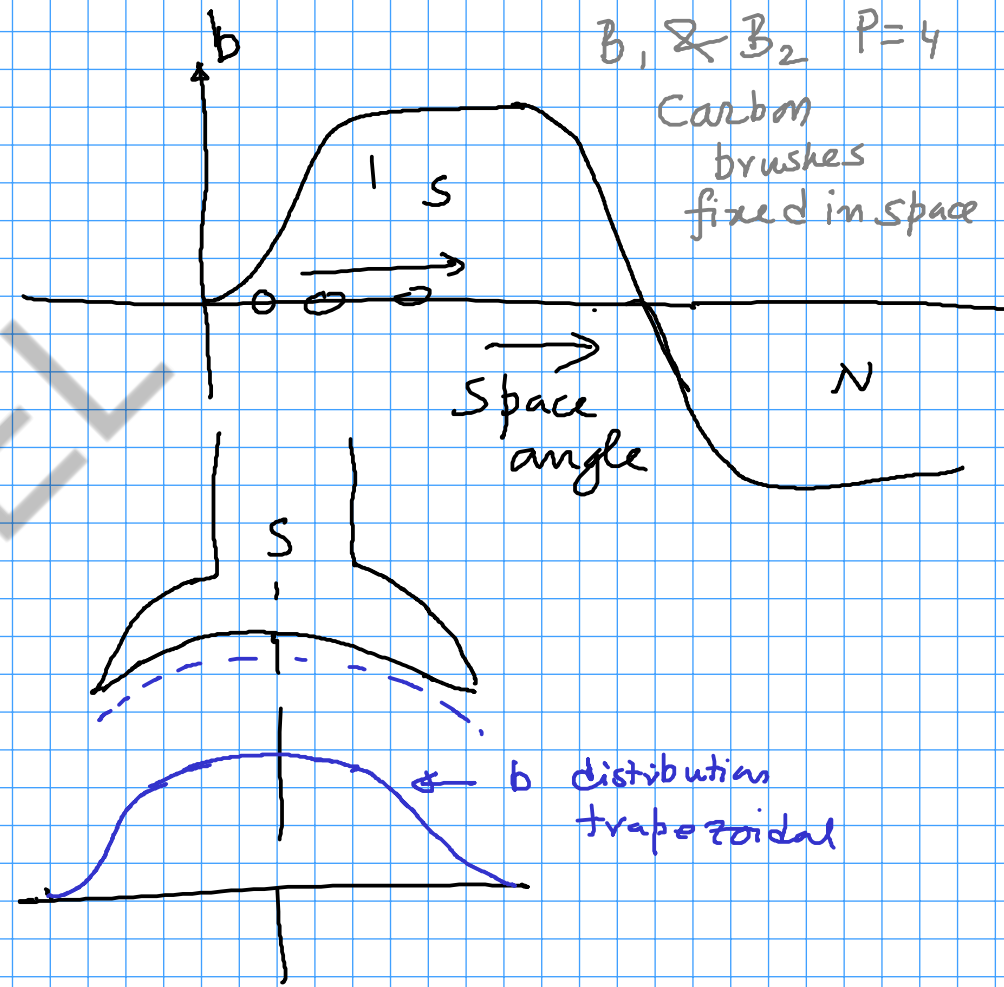
$$\text{Total number of coils} = \text{no. of slots} = S = 16$$

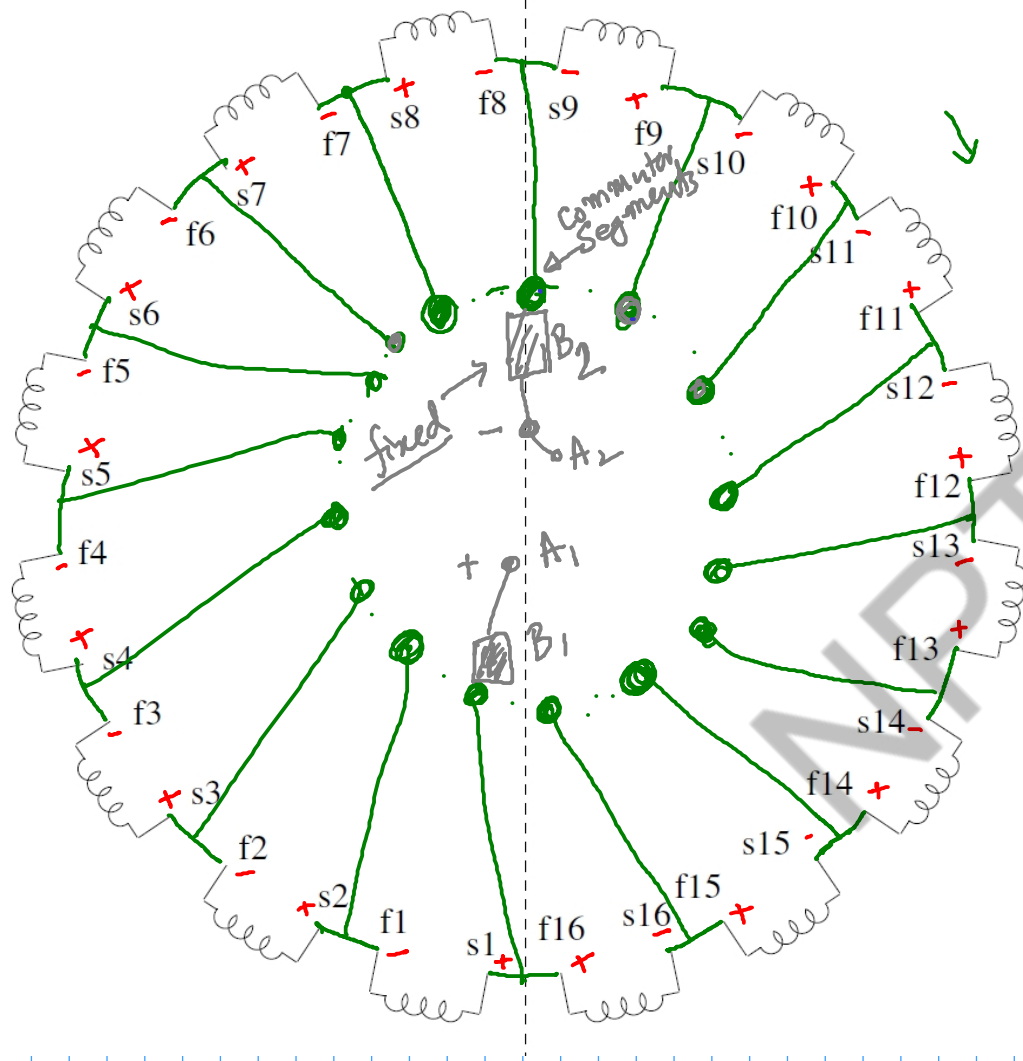


Lap wdg :-

Lec 60







$$\underline{P = 2}$$

$$S = 16$$

$$\text{coil slots/pole} = 8$$

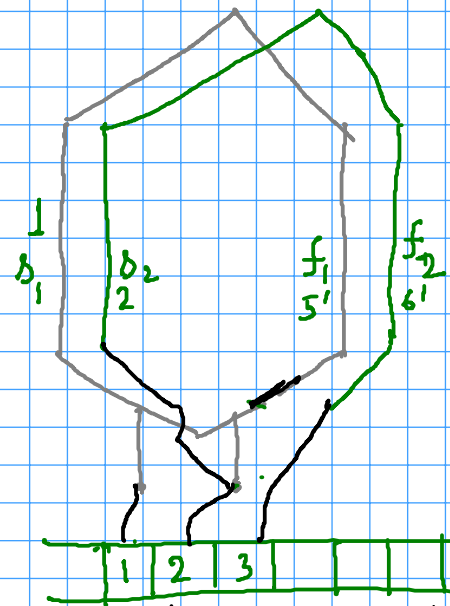
S_1 to S_8 coil sides are under N-pole

S_9 to $S_{16} \rightarrow$ coil sides must be under S pole at this given instant

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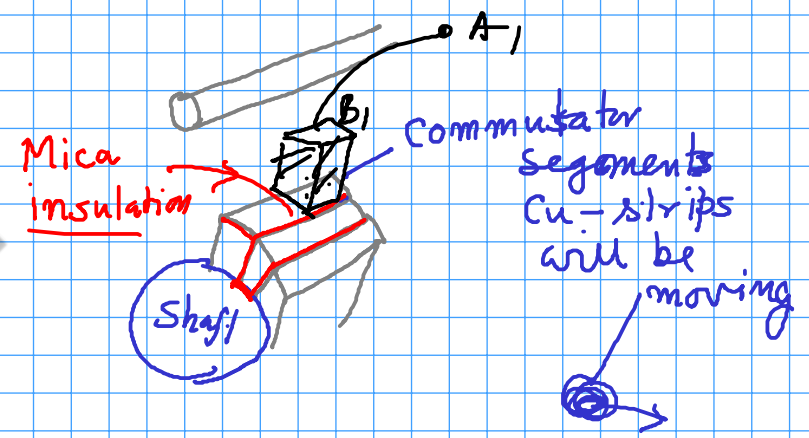
$$S = 16$$

$$p = 4$$



Lap

$$\Rightarrow \text{Commutator pitch} = Y_c = +1$$



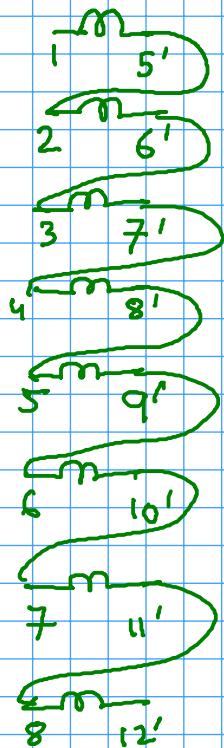
Winding Table

$$S = 16$$

$$P = 4$$

$$\text{coil span} = \frac{16}{4} = 4 \text{ slots.}$$

coil



Commutator Segments
where coil ends are terminated

1-2

2-3

3-4

