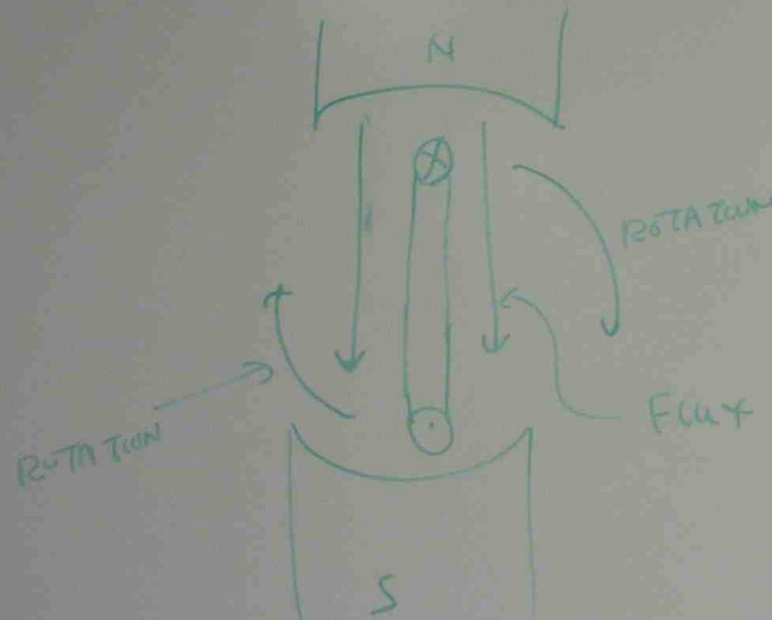
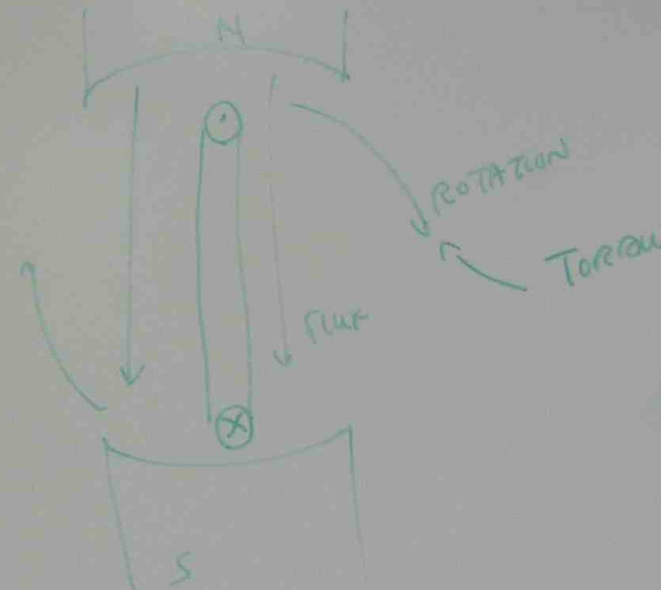
MECHANICAL ACTION OF DC GENERATOR AND MOTOR



⊗ ⊙ CURRENT DIRECTION

GENERATOR ACTION



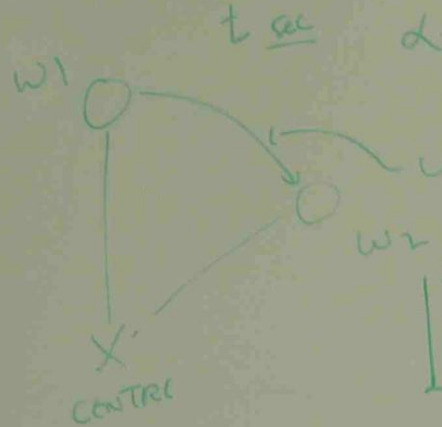
MOTOR ACTION

$$\boxed{T = I\alpha}$$

T = TORQUE N-m

I = MOMENT OF INERTIA N-m/s^2

α = ANGULAR ACCELERATION RAD/s^2



ω = ANGULAR VELOCITY RAD/s

$$\boxed{\omega_2 = \omega_1 + \alpha t}$$

pb A MOTOR HAS A COMBINED MOMENT OF INERTIA OF 10 N-m/s^2 AND INITIAL VELOCITY OF 200 RAD/s. IF THE TORQUE PRODUCED BY THE MOTOR IS INCREASED BY 50 N-m

CALCULATE (a) THE TIME FOR THE SPEED TO REACH 300 RAD/s

(b) THE FINAL SPEED IF THE TORQUE WAS MAINTAINED FOR 10 SEC

(c) THE TORQUE INCREASE NECESSARY TO OBTAIN AN INCREASE OF 50 RAD/SEC IN 2.5 SEC.

$I = 10\ N\text{-}m/s^2$

$T = 50\ N\text{-}m$

$\omega_1 = 200\ RAD/s$

$\omega_2 = 300\ RAD/s$

$t = ?$

(a) $\omega_2 = \omega_1 + \alpha t$

$T = I\alpha$

$50 = 10\alpha$

$\alpha = \frac{50}{10} = 5\ RAD/s^2$

$\omega_2 = \omega_1 + \alpha t$

$300 = 200 + 5 \times t$

$t = \frac{300 - 200}{5}$

$= \frac{100}{5} = 20\ Sec$

(b) $t = 10$ sec

$\omega_2 = ?$

$\omega_2 = \omega_1 + \alpha t$

$= 200 + 5 \times 10$

$= 250$ RAD/s

(c) $\omega_2 - \omega_1 = 50$ RAD/s

$t = 2.5$ sec

$T = ?$

$$\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{50}{2.5} = 20 \text{ RAD/s}^2$$

$$T = I\alpha = 10 \times 20 = 200 \text{ N-m}$$

CONFIGURATION OF DC MACHINE WINDINGS

SHUNT GENERATOR

R_{sh} = SHUNT FIELD RESISTANCE

R_a = ARMATURE RESISTANCE

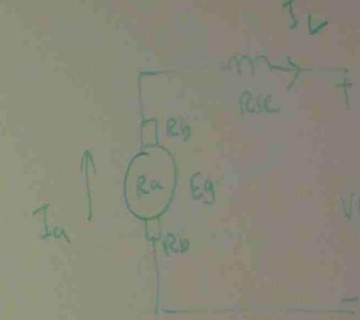
R_b = BRUSH RESISTANCE

E_g = GENERATED VOLTAGE

V_t = TERMINAL VOLTAGE

$I_a = I_L + I_{sh}$ $\qquad E_g = V_t + I_a(R_a + 2R_b)$

$$I_{sh} = \frac{V_t}{R_{sh}}$$



SERIES GENERATOR

$I_a = I_L$

$E_g = V_t + I_L($

$$I_L = \frac{\text{LOAD POW}}{V_t}$$

(b) $t = 10\,\text{sec}$

$\omega_2 = ?$

$\omega_2 = \omega_1 + \alpha t$

$= 200 + 5 \times 10$

$= 250\ \text{RAD}/s$

(c) $\omega_2 - \omega_1 = 50\ \text{RAD}/s$

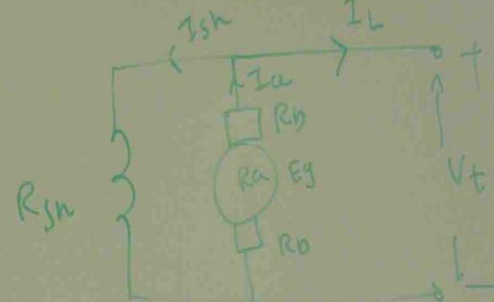
$t = 2.5\,\text{sec}$

$T = ?$

$$\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{50}{2.5} = 20\ \text{RAD}/s^2$$

$$T = I\alpha = 10 \times 20 = 200\ \text{N-m}$$

CONFIGURATION OF DC MACHINE WINDINGS



SHUNT GENERATOR

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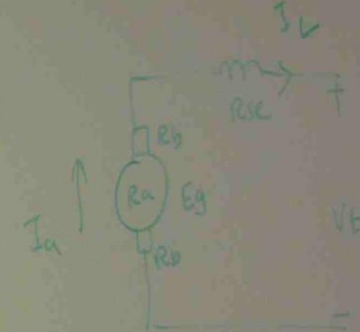
$I_{sh} = \frac{V_t}{\ }$

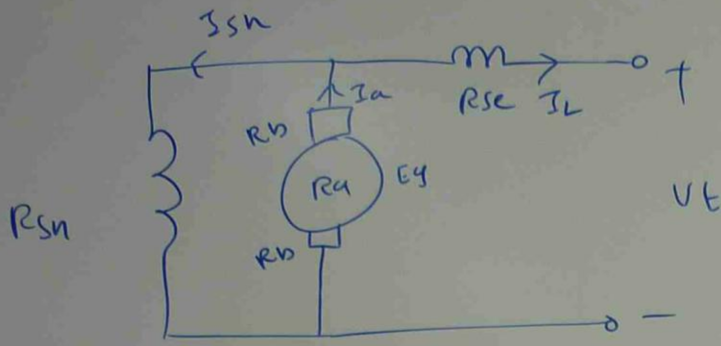


SERIES GENERATOR

$I_a = I_L$

$E_g = V_t + I_L($

$I_L = \frac{\text{LOAD POW}}{V_t}$



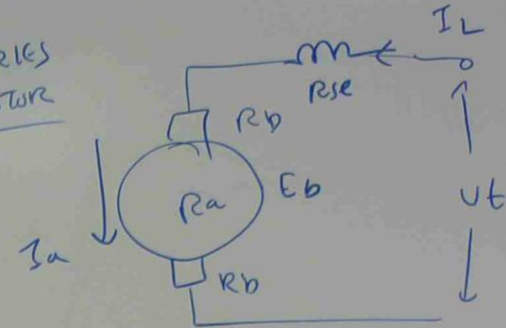
SHORT SHUNT COMPOUND

$$I_a = I_L + I_{sh}$$

$$I_{sh} = \frac{V_t + I_L R_{se}}{R_{sh}}$$

$$E_g = V_t + I_a (R_a + 2R_b)$$

SERIES MOTOR

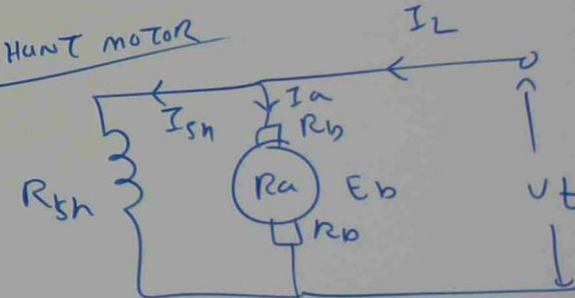


E_b = BACK EMF

$$I_L = I_a$$

$$E_b = V_t - I_a (R_a + 2R_b)$$

SHUNT MOTOR



$$I_{sh} = \frac{V_t}{R_{sh}}, \quad E_b = V_t - I_a (R_a + 2R_b)$$

$$I_a = I_L - I_{sh}$$

GENERATED VOLTAGE + BACK EMF

$$E_g = \frac{\phi Z N}{60} \times \frac{P}{a} \quad \text{(GENERATOR)}$$

E_g = GENERATED VOLTAGE

Z = NO. OF CONDUCTORS

N = RPM

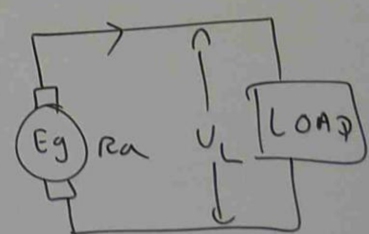
P = NO. OF POLES

a = NO. OF ARMATURE PARALLEL PATHS

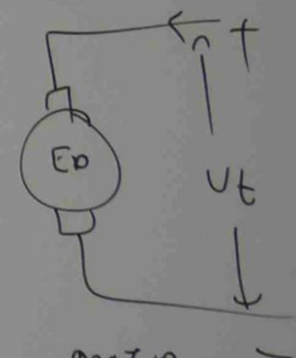
$a = m \times P$ (LAP)

$a = m \times 2$ (WAVE)

$$E_b = \frac{\phi Z N}{60} \times \frac{P}{a} \quad \text{(MOTOR)}$$

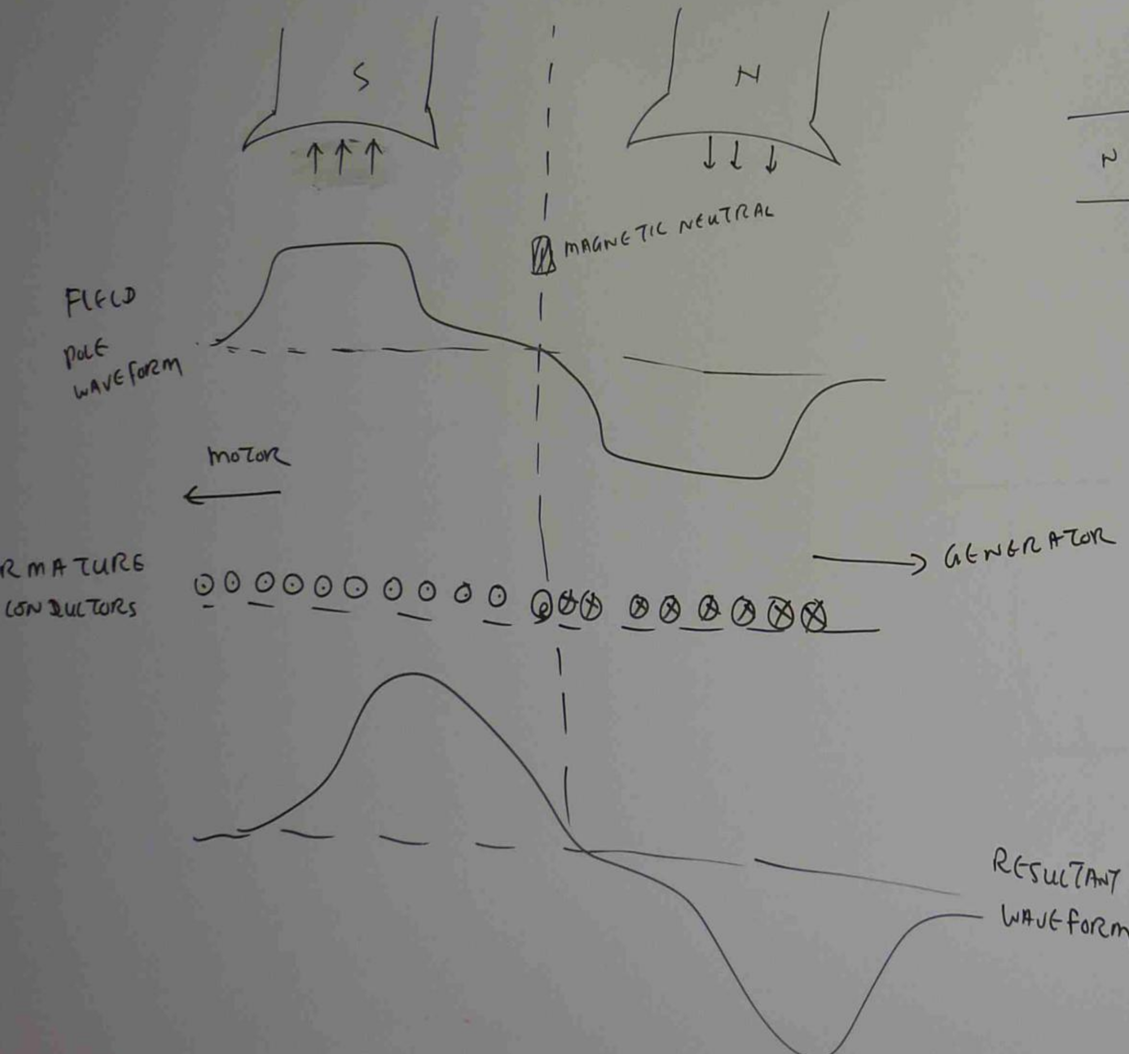


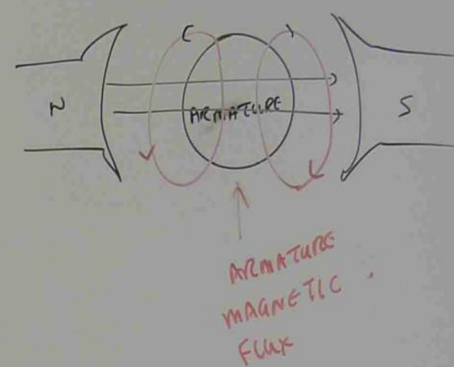
GENERATOR



MOTOR

MAGNETIC ACTION OF ARMATURE FIELD DISTORTION





ARMATURE REACTION
- OPPOSING MAIN FIELD FLUX → DEMAGNETIZING FLUX
- CROSSING MAIN FIELD FLUX → CROSS MAGNETIZING FLUX

→ EFFECTS GENERATED VOLTAGE & TORQUE

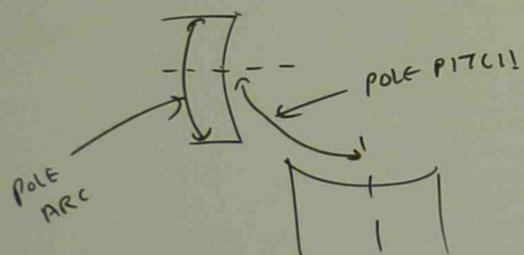
(AT_c) CROSS MAGNETIZING FLUX $= \dfrac{\gamma Z I_a}{2aP}$

UNIT → (Amp-TURNS/POLE)

...AGNETIZING FLUX

...S MAGNETIZING FLUX

$$\gamma = \frac{\text{POLE ARC}}{\text{POLE PITCH}}$$



Z = NO. OF ARMATURE CONDUCTORS

a = NO. OF ARMATURE PARALLEL PATHS

P = NO. OF POLES.

pb

AN ARMATURE 0.5m DIAMETER OF 6 POLES LAP WOUND GENERATOR HAS 378 CONDUCTORS CARRIES 800 AMP AND HAS A POLE ARC 0.17m. CALCULATE CROSS MAGNETIZING ARMATURE REACTION AMPERE TURN. SIMPLEX (LAP)

$$AT_c = \frac{\gamma Z I_a}{2aP}$$

$$\gamma = \frac{\text{POLE ARC}}{\text{POLE PITCH}}$$

$$= \frac{0.17}{\dfrac{\pi D}{\text{No. of POLES}}}$$

$$= \frac{0.17}{\dfrac{3.1416 \times 0.5}{6}} = 0.65$$

$a = ?$

LAP

$a = m \times P$

$m = 1$ simplex

$m = 2$ duplex

WAVE

$a = 2m$

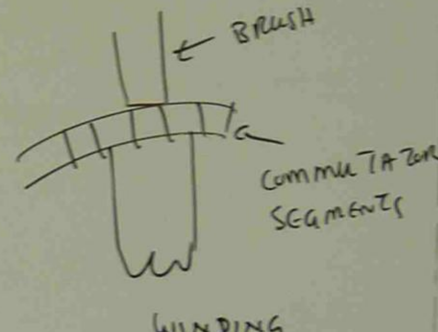
$m = 1$ simplex

$m = 2$ duplex

$a = m \times P = 1 \times 6 = 6$

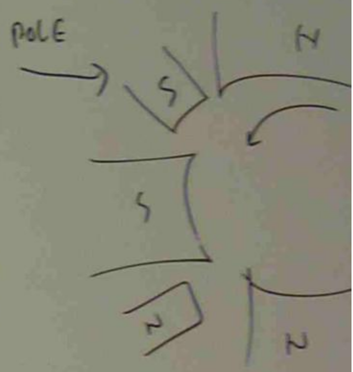
$$AT_c = \frac{0.65 \times 378 \times 800}{2 \times 6 \times 6}$$

$= 2740$ AT/POLE

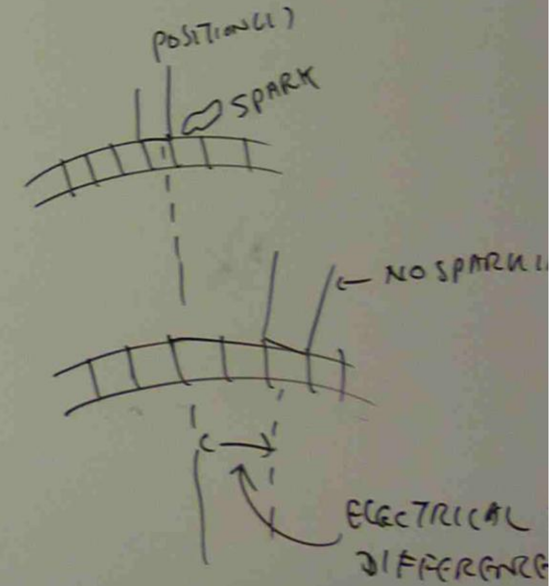


METHODS TO REDUCE ARMATURE

(1) INTER POLE



(2) SHIFT THE BRUSH



$a = m \times P$ $m = 1$ SIMPLEX

$m = 2$ DUPLEX

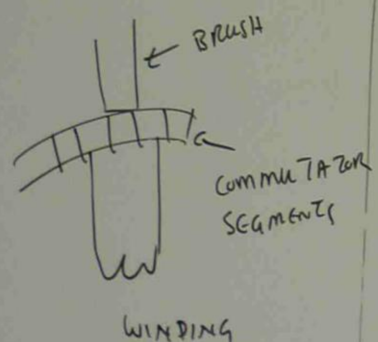
$a = 2m$ $m = 1$ SIMPLEX

$m = 2$ DUPLEX

$= 6$

800

POLE



METHODS TO REDUCE ARMATURE REACTION

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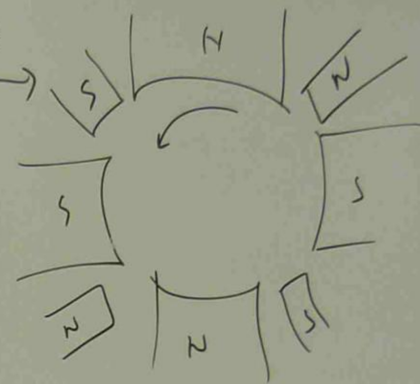

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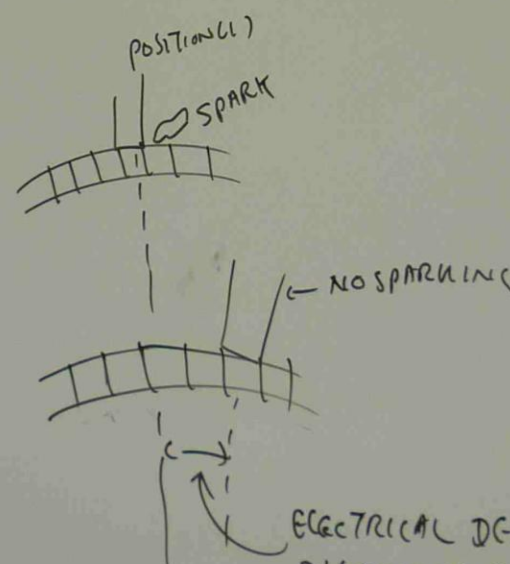

ELECTRICAL DEGREE (β)
DIFFERENCE BETWEEN
ORIGINAL & FINAL BRUSH POSITION

AT_d = DEMAGNETIZING AMP-TURNS/POLE = β

AT_c = CROSS MAGNETIZING AMP-TURNS/POLE = $\frac{Z I}{2}$

pb THE BRUSHES ON A
ROCKED 0.03 m
6 POLES, LAP WOUND
ARMATURE CURRE
AND DEMAGNETIZING

AT_d = DEMAGNETIZING AMP – TURNS / POLE $= \dfrac{\beta\ Z\ I_a}{360\ a}$

Z = NO. OF CONDUCTORS

I_a = ARMATURE CURRENT

a = ARMATURE PARALLEL PATH

AT_c = CROSS MAGNETIZING AMP – TURNS / POLE $= \dfrac{Z\ I_a}{2P} \left(\dfrac{360 - 2P\beta}{720} \right)$

P = NO. OF POLES.

pb THE BRUSHES ON A 0.4 m DIAMETER COMMUTATOR ARE ROCKED 0.03 m CIRCUMFERENTIALLY. THE MACHINE HAS 6 POLES, LAP WOUND (SIMPLEX), 378 CONDUCTORS, 800 AMP ARMATURE CURRENT. CALCULATE CROSS MAGNETIZING AND DEMAGNETIZING AMP-TURNS / POLE.