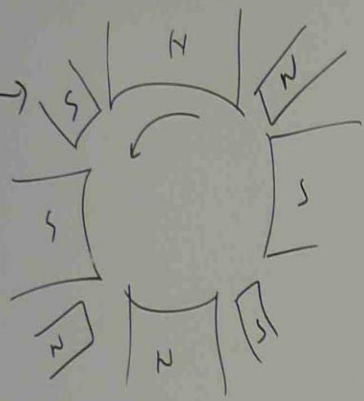
METHODS TO REDUCE ARMATURE REACTION

(1) INTER POLE



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

Z = NO. OF CONDUCTORS

I_a = ARMATURE CURRENT

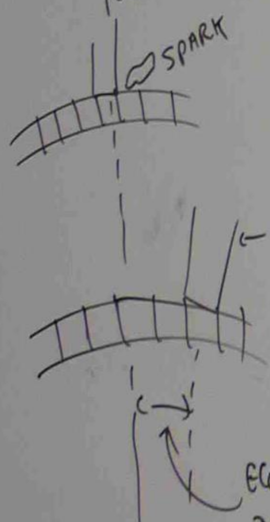
a = ARMATURE PARALLEL PATH

β = SHIFTING OF BRUSH ANGLE

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

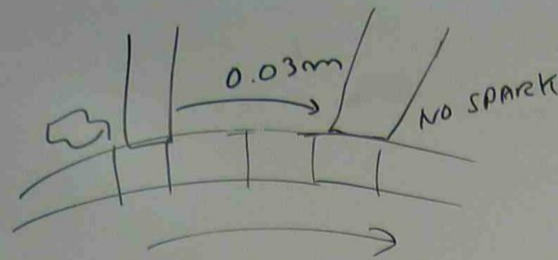
P = NO. OF POLES.

(2) SHIFT THE BRUSH



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

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. (SIMPLEX LAP



$$\beta = \frac{\text{SHIFTING CIRCUMFERENTIAL DISTANCE}}{\pi \times \text{DIAMETER}} \times 360^\circ$$

$$= \frac{0.03}{3.1416 \times 0.4} \times 360 = 8.6^\circ$$

$$\text{DEMAGNETIZING } (AT_d) = \frac{\beta Z I_a}{360\, a} = \frac{8.6 \times 378 \times 800}{360 \times 6}$$

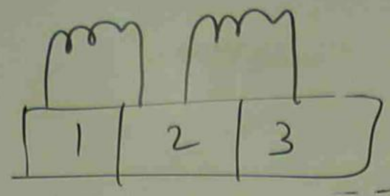
$$\left(\begin{aligned} a &= m \times P \\ &= 1 \times 6 = 6 \end{aligned} \right) \qquad = 1210 \text{ AT/POLE.}$$

$$\text{CROSS MAGNETIZING } (AT_c) = \frac{Z I_a}{2P} \left(\frac{360 - 2P\beta}{720} \right)$$

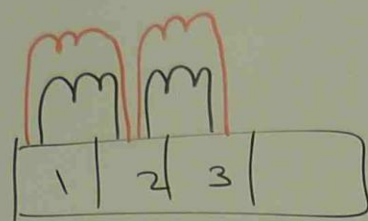
$$= \frac{378 \times 800}{2 \times 6} \left(\frac{360 - 2 \times 6 \times 8.6}{720} \right)$$

$$= 3000 \text{ AT/POLE}$$

SIMPLEX



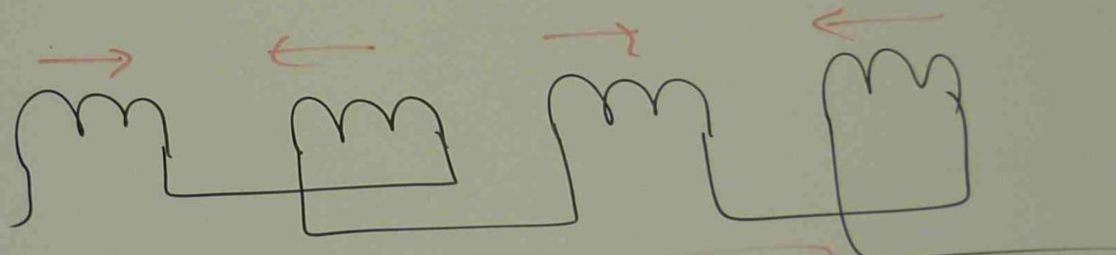
DUPLEX



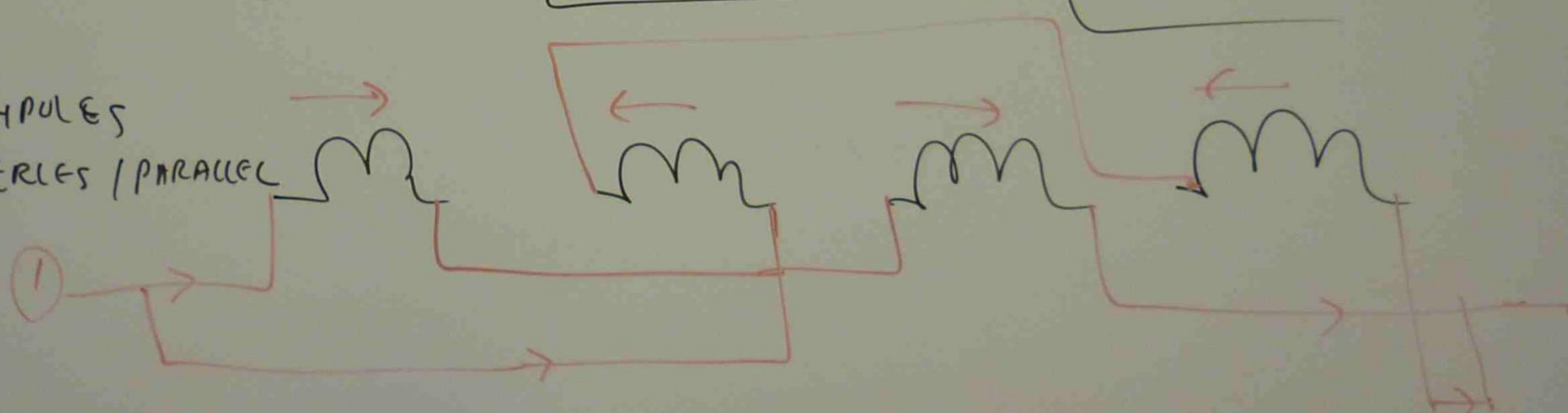
$a = m \times P$ LAP

$a = 2 \times m$ WAVE

4 POLES SERIES



4POLES SERIES / PARALLEL



VOLTAGE OF SELF INDUCTION

THE VOLTAGE OF SELF INDUCTION = $\dfrac{N\ Z\ \phi_c}{t}$ VOLT

N = TURN / COIL SHORT CIRCUITED DURING COMMUTATION

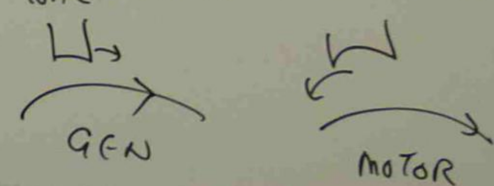
t = TIME DURING WHICH CURRENT IS REVERSING

Z = NO. OF ARMATURE CONDUCTORS

ϕ_c = FLUX

- THE BRUSH CONTACT RESISTANCE PLAYS A VERY IMPORTANT PART IN LIMITING THE CIRCULATING CURRENT WHEN THE BRUSH SHORT CIRCUITS THE COIL.

- TO IMPROVE THE COMMUTATION, IT NEEDS TO MOVE A LITTLE THE BRUSH IN FORWARD DIRECTION OF MACHINE ROTATION FOR GENERATOR AND BACKWARD FOR MOTOR.



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STAGE (4)

G044 | 7762AC

G044_7762AC1

G044_7762AC2

G044_Tutorial

G043 + G045

7762AF

G043_G045_7762AF Notes 1

G043_G045_7762AF Notes 2

G015_ G046_ G040_ G043_ G045_ G042 Tutorial

7762AA
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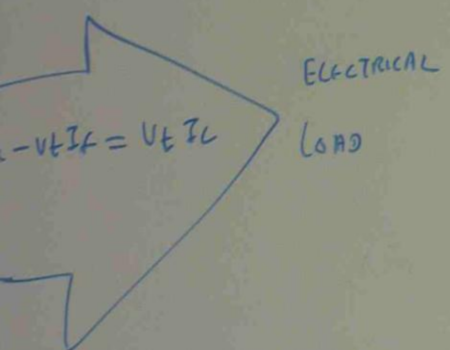
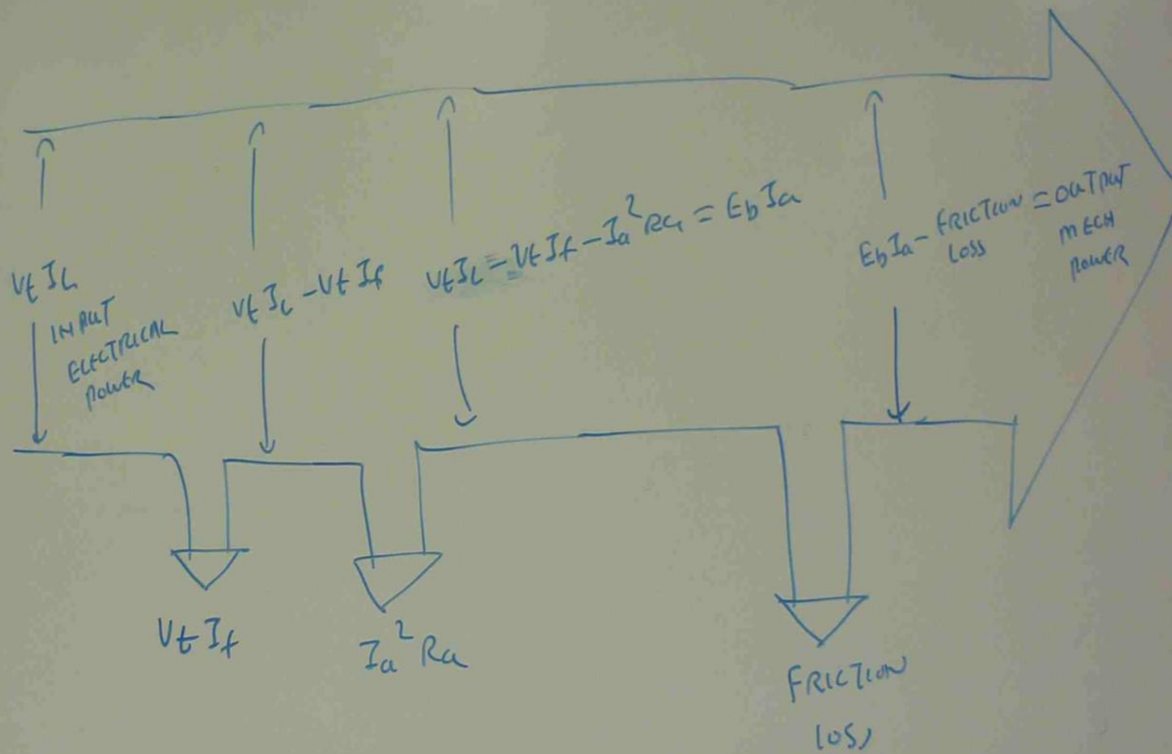
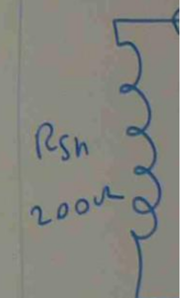


POWER FLOW DIAGRAM IN DC MOTOR



pb THE
MOTOR
IF THE
DETER
(a)
(b)



$$\eta = \frac{\text{OUTPUT}}{\text{INPUT}} \times 100 = \left(1 - \frac{\text{Power loss}}{P_{out} + P_{loss}}\right) \times 100$$

(OUT

I_{sh}

LOSSES AND EFFICIENCY IN DC MACHINE

CONSTANT LOSS

ROTATIONAL LOSSES

- → HEAT PRODUCED BY BEARING
- → HEAT PRODUCED BY ARMATURE CONDUCTOR

BEARING FRICTION, WIND FRICTION, BRUSH FRICTION,

EDDY CURRENT & HYSTERESIS LOSS, WINDAGE LOSS,

AMOUNT OF LOSS DEPENDS ON

- MAGNETIC IRON
- FREQUENCY OF SUPPLY
- FLUX DENSITY
- MASS OF IRON

HYSTERESIS LOSS $\boxed{P_h = K_h f B^{1.6} m}$ WATT

K_h = CONSTANT DEPENDING ON MATERIALS & UNIT USED

f = FREQUENCY OF SUPPLY

B = MAXIMUM FLUX DENSITY OF SUPPLY (T)

m = MASS OF CORE (Kg)

EDDY CURRENT LOSS $\boxed{P_e = K_e f^2 t^2 B^2 V}$ WATT

K_e = CONSTANT DEPENDS ON RESISTIVITY OF IRON & DIMENSION

f = FREQUENCY (HZ)

t = THICKNESS OF LAMINATION (m)

B = MAXIMUM FLUX DENSITY IN CORE (T)

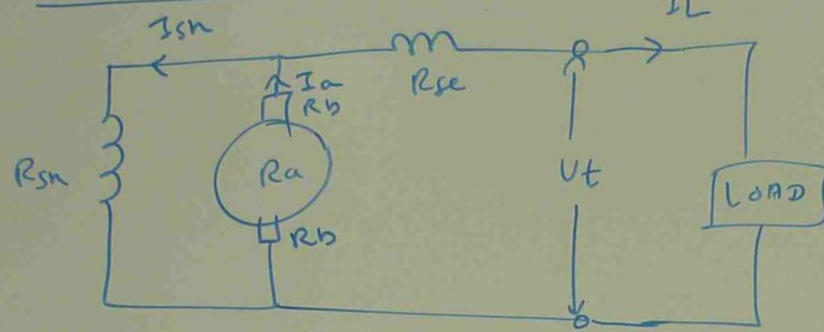
V = VOLUME OF IRON CORE (m^3)

COPPER LOSS

VARIABLE LOSS

DC COMPOUND GENERATOR

SHORT SHUNT COMPOUND

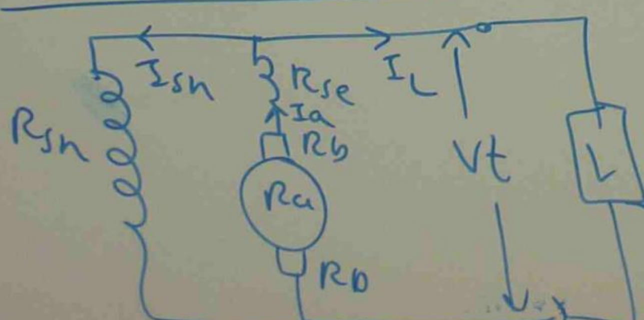


$$I_a = I_{sh} + I_L$$

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

TOTAL COPPER LOSS = $I_a^2 R_a + 2 I_a^2 R_b + I_{sh}^2 R_{sh} + I_L^2 R_{se}$

LONG SHUNT COMPOUND



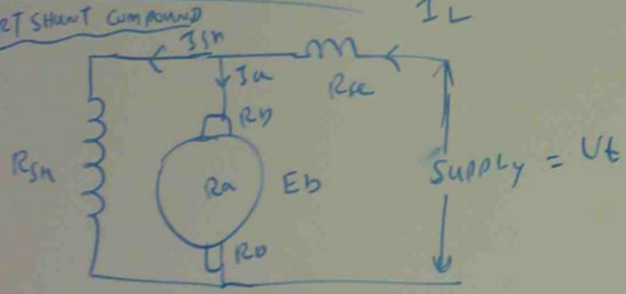
$$I_a = I_L + I_{sh}$$

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

TOTAL COPPER LOSS = $I_a^2 R_a + 2 I_a^2 R_b + I_a^2 R_{se} + I_{sh}^2 R_{sh}$

DC COMPOUND MOTOR

SHORT SHUNT COMPOUND

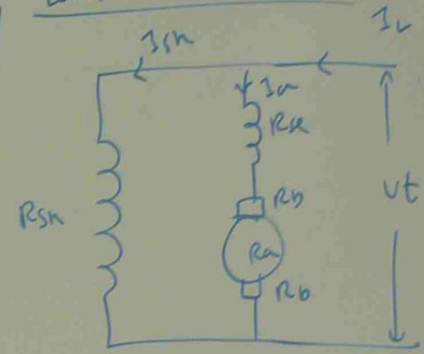


$$I_{sh} = \frac{V_t - I_L R_{se}}{R_{sh}}$$

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

TOTAL COPPER LOSS = $I_a^2 R_a + 2 I_a^2 R_b + I_{sh}^2 R_{sh} + I_L^2 R_{se}$

LONG SHUNT COMPOUND



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

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

TOTAL COPPER LOSS = $I_a^2 R_a + I_a^2 R_{se} + 2 I_a^2 R_b + I_{sh}^2 R_{sh}$.

TOTAL LOSSES = IRON LOSS + WINDAGE & FRICTION LOSS + TOTAL COPPER LOSS

INPUT POWER (MECHANICAL POWER) GENERATOR = OUTPUT ELECTRICAL POWER + TOTAL LOSSES

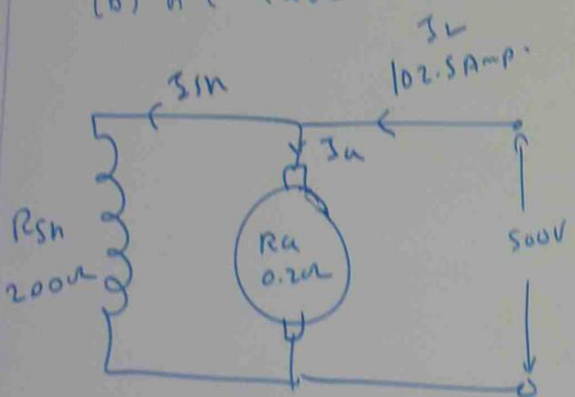
INPUT ELECTRICAL POWER (MOTOR) = OUTPUT MECHANICAL POWER + TOTAL LOSSES.

Pb THE WINDING RESISTANCE OF A 500V, 60 KW DC SHUNT MOTOR ARE $R_a = 0.2\,\Omega$, $R_f = 200\,\Omega$

IF THE ROTATIONAL LOSSES CAN BE TAKEN AS 1.4 KW, DETERMINE THE EFFICIENCY OF THE MACHINE.

(a) WHEN THE LINE CURRENT IS 102.5 AMP

(b) AT FULL LOAD



(OUT PUT POWER = 60 KW FULL LOAD.)

$$I_{sh} = \frac{V_t}{R_{sh}} = \frac{500}{200} = 2.5\,\text{Amp}$$

$$I_a = I_L - I_{sh}$$
$$= 102.5 - 2.5$$
$$= 100\ \text{Amp}.$$

$$\text{TOTAL COPPER LOSS} = I_a^2 R_a + I_{sh}^2 R_{sh}$$
$$= 100^2 \times 0.2 + 2.5^2 \times 200$$
$$= 3250\,\text{W}$$

TOTAL LOSS = COPPER LOSS + IRON/FRICTION LOSS

$$= 3250 + 1400$$
$$= 4650\,\text{W}$$

$$\text{INPUT POWER} = V_t I_L = 500 \times 102.5 =$$

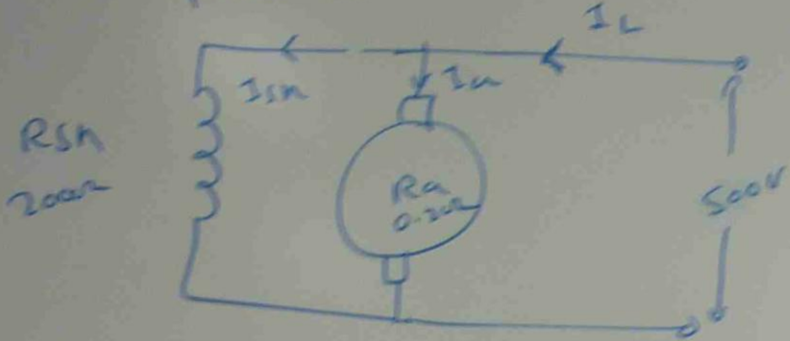
$$\text{OUT PUT POWER} = \text{INPUT} - \text{TOTAL LOSS}$$
$$= 500 \times 102.5 - 4650$$

$$\text{EFFICIENCY} = \frac{\text{OUT PUT POWER}}{\text{INPUT POWER}} \times 100$$

$$= \frac{500 \times 102.5 - 4650}{500 \times 102.5} \times 100$$

$$= 90.93\,\%.$$

FULL LOAD



POWER OUT PUT (P_{OUT}) = 60,000 WATT

$$P_{OUT} = 60,000 \text{ W}$$

$$(I_L + 2.5)^2$$

$$\begin{array}{l} I_L + 2.5 \\ I_L + 2.5 \\ \hline I_L^2 + 2.5 I_L \\ \quad\quad\; 2.5 I_L + (2.5)^2 \\ \hline I_L^2 + 5 I_L + 6.25 \end{array}$$

P_{OUT} + IRON LOSS + FRICTION LOSS + COPPER LOSS = TOTAL POWER INPUT

$$60,000 + 1400 + I_{sh}^2 R_{sh} + I_a^2 R_a = V I_L$$

$$61400 + (2.5)^2 \times 200 + (I_L + I_{sh})^2 \times 0.2 = 500 \times I_L$$

$$61400 + 6.25 \times 200 + (I_L + 2.5)^2 \times 0.2 = 500 I_L$$

$$62650 + (I_L^2 + 5 I_L + 6.25) \times 0.2 = 500 I_L$$

$$62650 + 0.2 I_L^2 + 1 I_L + 1.25 = 500 I_L$$

$$0.2 I_L^2 - 499 I_L + 62651.25 = 0$$

$$A x^2 + B x + C = 0$$

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

$$I_L = \frac{-(-499) \pm \sqrt{499^2 - 4 \times 0.2 \times 62651.25}}{2 \times 0.2}$$

$$\frac{499 \pm \sqrt{249001 - 50121}}{0.4}$$

$$I_L = \frac{499 \pm 445.95}{0.4}$$

$$= \frac{499 + 445.95}{0.4} \text{ (or) } \frac{499 - 445.95}{0.4}$$

$$= 2362\,A \text{ (or) } 132.65\,A \checkmark$$

Impossible

$$I_a = I_L - I_{sh} = 132.65 - 2.5 = 130.15 \text{ Amp.}$$

$$\text{Total copper loss} = I_a^2 R_a + I_{sh}^2 R_{sh}$$

$$= (130.15)^2 \times 0.2 + (2.5)^2 \times 200$$

$$= 4637 \text{ WATT.}$$

Total iron loss / rotational loss = 1400 WATT

Total losses = 4637 + 1400 = 6037 WATT

Input power = Output power + Total losses

$$= 60{,}000 + 6037$$

$$= 66037 \text{ WATT}$$

$$\text{Efficiency} = \frac{\text{Output power}}{\text{Input power}} \times 100$$

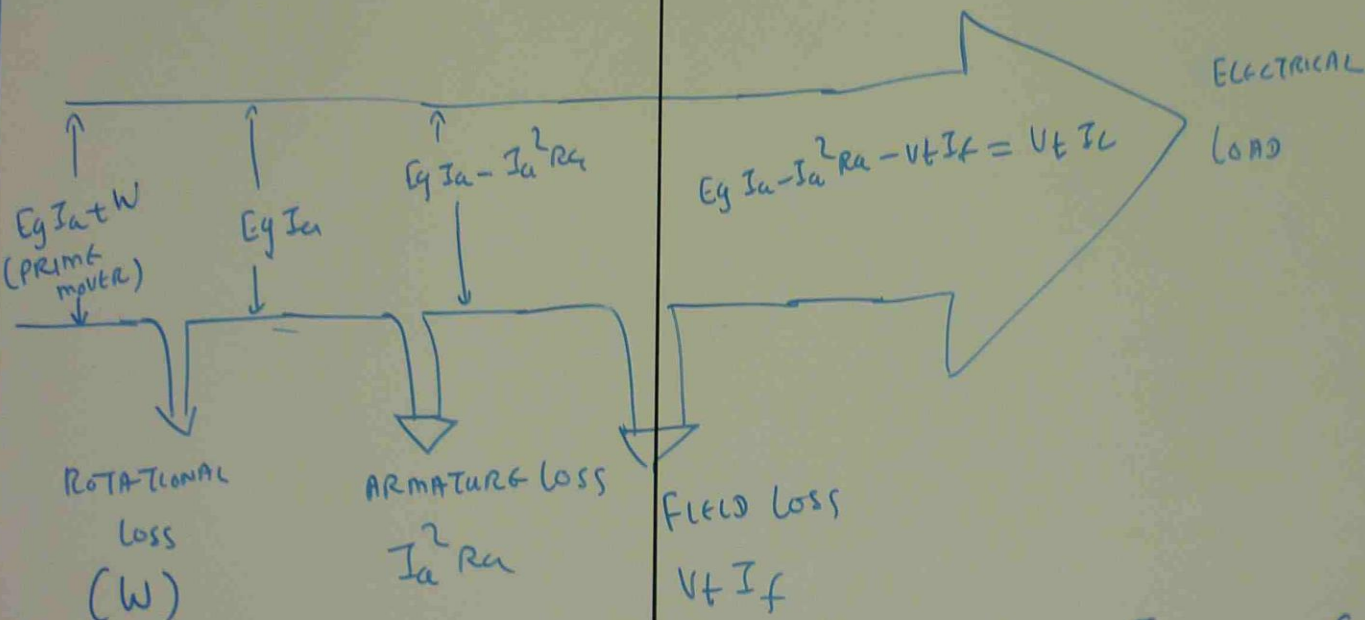
$$= \frac{60{,}000}{66037} \times 100$$

$$= 90.85\%$$

POWER FLOW DIAGRAM IN DC GENERATOR

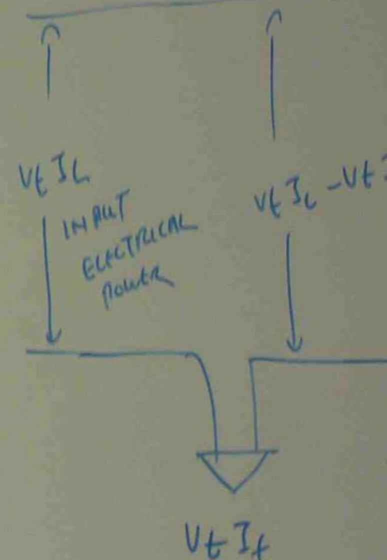
$$P_{OUT} = V_t \times I$$

$$P_{IN} = E_g I_a + \text{ROTATIONAL LOSSES}$$



$$\eta\,\% = \frac{\text{OUTPUT}}{\text{INPUT}} \times 100 = \left(1 - \frac{\text{Power loss}}{P_{OUT} + P_{LOSS}}\right) \times 100$$

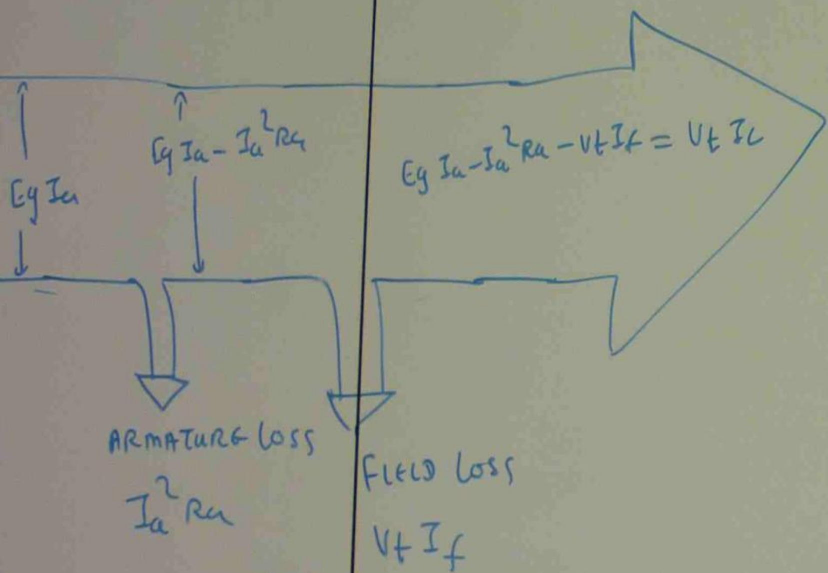
POWER FLOW DIAGR



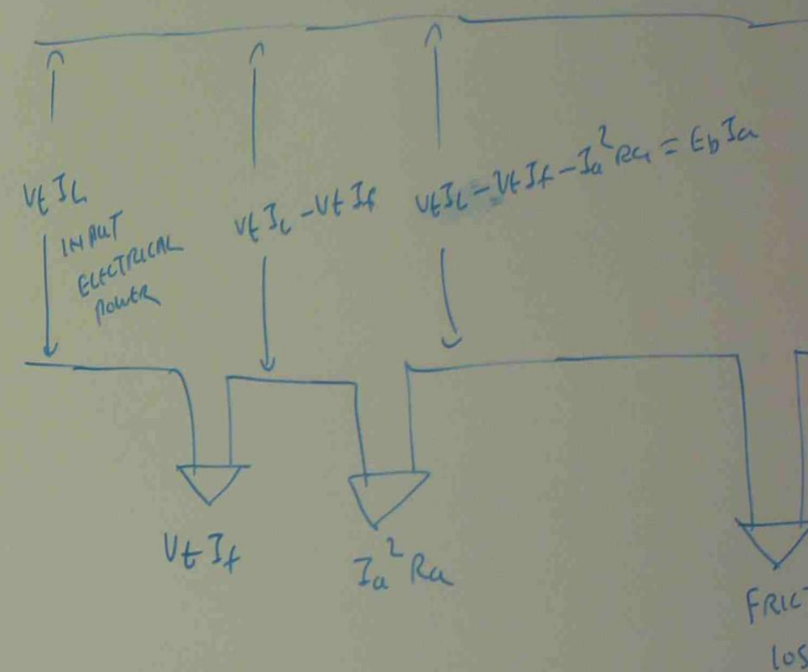
FLOW DIAGRAM IN DC GENERATOR

$_T = V_t \times I$

$= E_g I_a +$ ROTATIONAL LOSSES



POWER FLOW DIAGRAM IN DC MOTOR



$$\eta\% = \frac{\text{OUTPUT}}{\text{INPUT}} \times 100 = \left(1 - \frac{\text{Power loss}}{P_{out} + P_{loss}}\right) \times 100$$