DC Generator

- Separately Excited
- Self Excited
  - Shunt ~~wond~~ wound generator
  - Series wound generator
  - Compound Generator

ϕ = flux

N = Speed of ~~r.m~~ armature r.p.m

P = Number of poles.

A = number of parallel Path.

wave winding = 2

lab winding = P = A

Z = total number of armature conductors.

CamScanner

Emf Equation of a DC Generator:

ϕ = flux/pole in web

Z = total number of armature Conductors

P = number of poles

A = number of parallel path

~~Web~~ wave winding = 2

lab winding = P

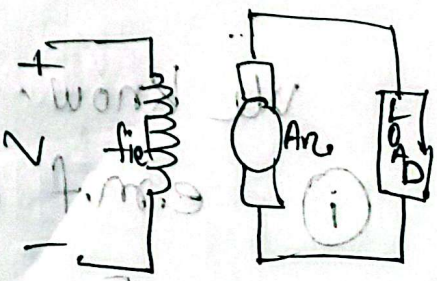
N = speed of armature in r.p.m

E_g = e.m.f of the generator = e.m.f/Parallel Path

সূত্র: $E_g = \frac{P\phi ZN}{60A}$

A DC generator has following Parts:

1. Field Circuit
2. Armature Circuit
3. Load



Math problem

Example 2.11 : A 6-Pole lab-wound dc generator has 600 Conductor on its armature. The flux per pole is 0.02 wb. Calculate

(i) the speed at which the generator must be run to generate.

Solution:

~~(i) La~~ Given that,

$P = 6$ Pole

Total number of armature Conductor, $Z = 600$

flux, $\phi = 0.02$ wb

lab-wound, $A = P = 6$

~~Give~~ $E_g = 300V$

We know,

(i) e.m.f of the generator

$$E_g = \frac{Z\phi PN}{60A}$$

$$N = \frac{E_g\, 60\, A}{Z \phi P} = \frac{\cancel{300} \times \overset{30}{\cancel{60}} \times \cancel{6}}{\underset{2}{\cancel{600}} \times 0.02 \times \cancel{6}}$$

$$= 1500 \text{ r.p.m.s}$$

(ii) Wave wound $A = 2$

$$\therefore N = \frac{E_g\, 60\, A}{Z \phi P} = \frac{\cancel{300} \times \overset{10}{\cancel{60}} \times \cancel{2}}{\underset{2}{\cancel{600}} \times 0.02 \times \cancel{6}_{3}}$$

$$= 500 \text{ r.p.m.s}$$

Example 2.12

Given that

$P = 6 = A$

$N = 350$ r.p.m

$E_g = 260\,V$ and $\phi = 0.05$

$$E_g = \frac{Z \phi P N}{60 A} \Rightarrow \cancel{A = \frac{Z \phi P N}{60 E_g}}$$

$$Z = \frac{E_g 60 A}{\phi P N} = \frac{260 \times 60 \times 8}{\cancel{8} \times 0.05 \times 8 \times 350}$$

$$= 891.4$$

$$= 890$$

$\therefore$ No of Conductor/slot $= \frac{890}{120}$

$$= 7.41$$

Thish value must be an even number $\therefore$

Conductor/slot $= 8$.

2.13

$P = 6$

$N = 600$ r.p.m

$E_g = 288$ Volt

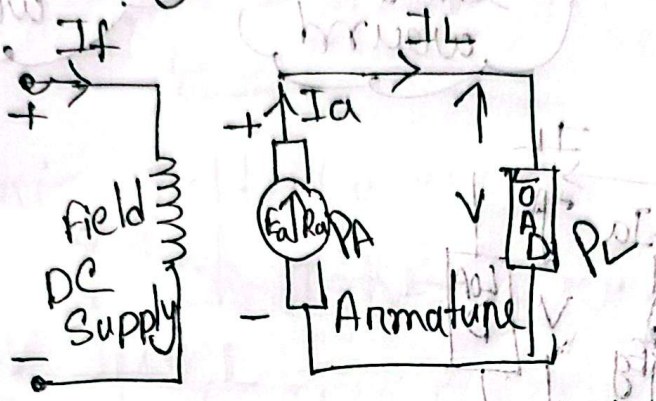
$\cancel{A = 4}$

$Z = 4 \times 2 \times 90 = 720$

$$E_g = \frac{Z \phi P N}{60 A} \Rightarrow \phi = \frac{E_g 60 A}{Z P N}$$

$$= \frac{288 \times 60 \times 6}{720 \times 6 \times 600} = 0.04\ Wb$$

Separately excited DC generator (2)



Ia = armature Current | If = Field Current

IL = load Current | V = terminal Voltage.

Terminal Voltage is given as,

$$V = E_g - I_a R_a \quad \text{—— (1)}$$

(যদি brush এর drop)

If the Contact brush drop is known, the equation (1) is written as,

$$V = E_g - I_a R_a - 2V_b \quad \text{—— (2)}$$

The power developed is given by equation

Power developed $= E_g I_a = P_A$

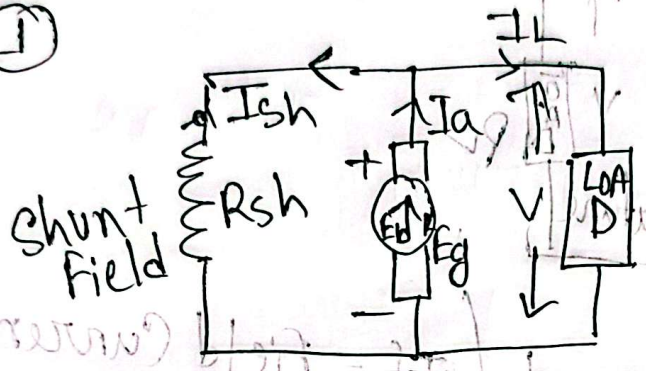
Power output, $P_L = VI_L = VI_a$

~~Ex~~ The self excited DC Crane Rotor

Self excited

- ~~Shunt wound~~
- ~~Series wound~~
- ~~Compund wound~~

(1)



(i) Shunt field current as

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

R_{sh} = Shound field winding Registance

(ii) armature Current,

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

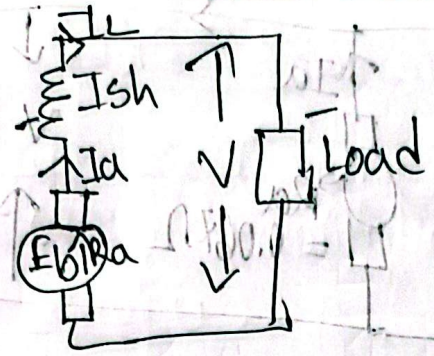
(iii) Terminal Voltage, $V = E_g - I_a R_a$

(iv) 2টি brush এর জন্য, $V = E_g - I_a R_a - 2V_b$

(v) Power developed $= E_g I_g$

(vi) Power output $= V I_L$

② Series wound Generator:



(i) Series field Current

$I_{sh} = I_a = I_L$

(ii) Terminal Voltage is, $V = E_g - I_aR_a - I_{se}R_{se}$

$\Rightarrow V = E_g - I_a(R_a + R_{se})$

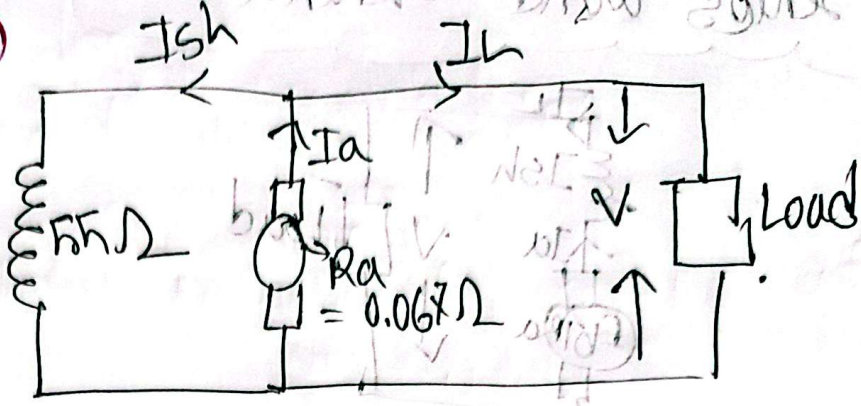
(iii) যদি brush থাকে $V = E_g - I_aR_a - I_sR_{se} - 2V_b$

(iii) Power developed $= E_gI_a$

(iv) Power output $= VI_L = VI_a$

Example 1

slide 1st math



Given that

Power Output = 100 kW

$= 100 \times 10^3$ W

~~Ra = 55Ω~~ ,

$R_{sh} = 55\Omega$ and $R_a = 0.067\Omega$

$V = 240V$

∴ Full load generator Voltage.

$E_g = V + I_a R_a$

$= 240 + I_a(0.067)$ — (i)

$\therefore \quad I_{sh} = \frac{240}{55} = 4.36$ A

$I_L = \frac{P_L}{V} = \frac{100 \times 10^3}{240} = 416.67$ A

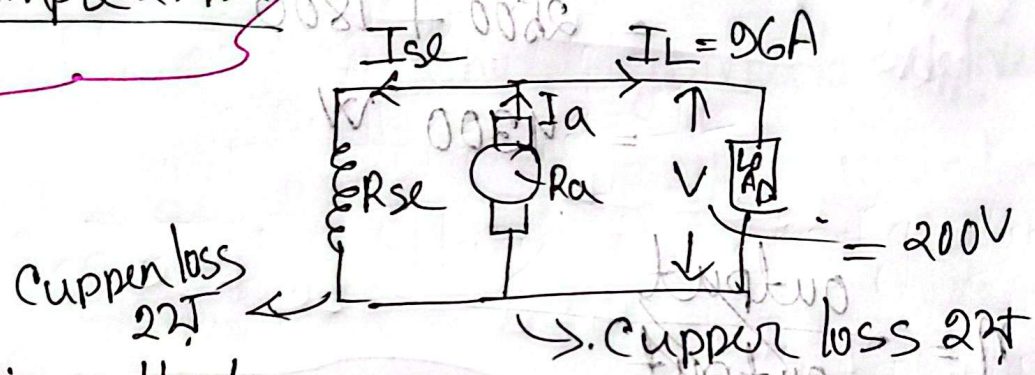
~~(i) ⇒ Eg = 240 +~~ KCL $I_a = 4.36 + 416.67$

$= 421.03\ A$

(i) $\Rightarrow$ $E_g = \cancel{V+I}\ 240 + (421.03) \times (0.067)$

$= 268.2\ V$

Example 2.12



Given that:

$I_L = 96\ A$

$V = 200\ V$

Armature R, $R_a = 0.1\ \Omega$

Shunt field R, $R_{se} = 50\ \Omega$

(i) $I_L = 96$

$I_{se} = \frac{200}{50} = 4$

$I_a = 96 + 4 = 100\ A$

$\therefore E_g = 200 + (100 \times 0.1)$

$= 210\ V$

I^2R A.S.

(ii) Armature Copper loss

$= I_a^2 R_a$

$= (100)^2 (0.1)$

$= 1000\ W$

Shunt Cu loss

$= (I_{se})^2 R_{se}$

$= (4)^2 \times (50)$

$= 800$

$\therefore$ Total Cu loss $= 1000 + 800$

$= 1800\ W$

(iii) Rotational losses = 2500 iron loss

$\therefore$ Total loss = Rotational losses + Total Iron loss + Cu loss

$= 2500 + 1800$

$= 4300\ W$

$\therefore \eta = \frac{\text{output}}{\text{output}}$

(ii) $\eta = \frac{\text{output power}}{\text{Input power}} \times 100\%$

(output power) $= 200 \times 96 = V \times I_L$ (Load)

$= 19200\ W$

(Input power = output power + Total loss)

$= 19200\ W + 4300\ W$

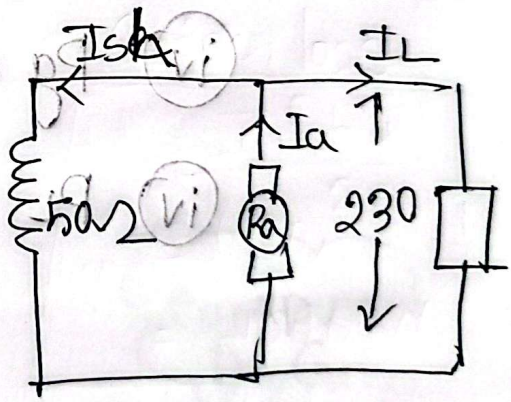
$= 23500\ W$

Commercial efficiency

$$\eta_c = \frac{19200}{23500} \times 100$$

$$= 81.7\%$$

Example 1 (26.3) A shunt generator delivers 450 A at 230 V and the resistance of the shunt field and armature are 50 Ω and 0.3 Ω respectively. Calculate the generated e.m.f.



$V = 230\,V$

$I_L = 450\,A$

$R_{sh} = 50\,\Omega$, $R_a = 0.3\,\Omega$

(A) $I_{sh} = \frac{230}{50} = 4.6\,A$

$I_a = 4.6 + 450 = 454.6$

$E_g = 230 + (454.6 \times 0.3)$

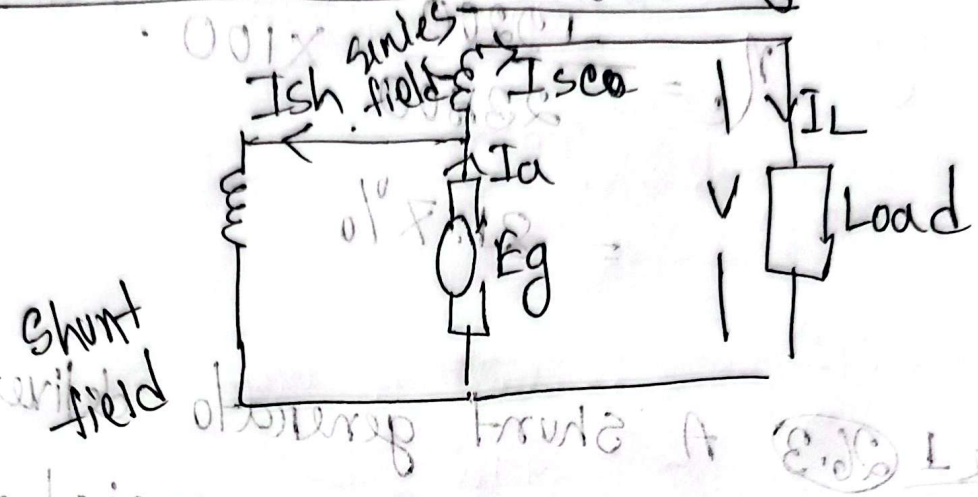
$= 366.38$

$R_a = 0.03$

$E_g = 230 + (454.6 \times 0.03)$

$= 243.6\,V$

Short- Shunt Compound Generator



(i) $I_{sc} = I_L$

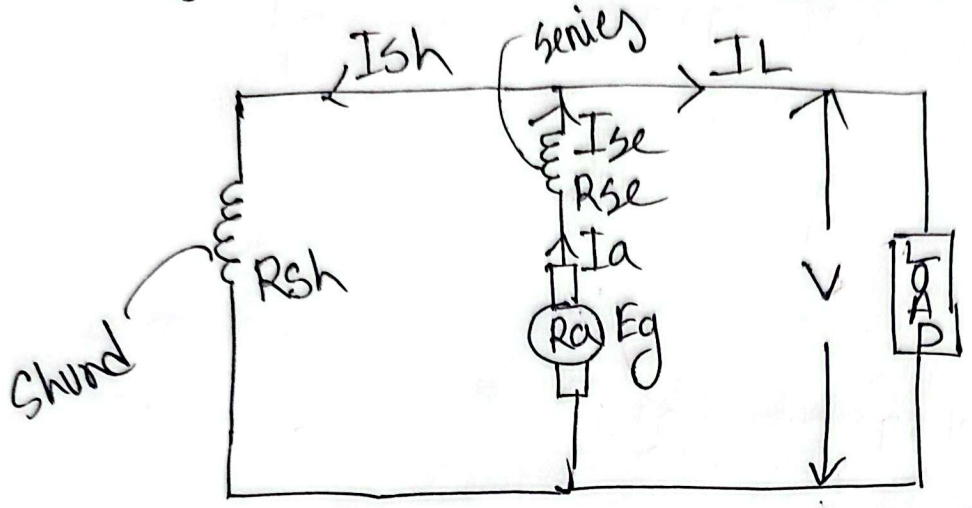
(ii) $V = E_g - I_a R_a - I_{sc} R_{sc}$

(iii) $I_a = (I_{sh} + I_{sc} \text{ or } I_L)$

(iv) $P_g = E_g \times I_a$

(iv) $P_L = V \times I_L$

Long Shunt Compound DC Generator



(i) $I_{sh} = \frac{V}{R_{sh}}$

(ii) I_a ~~or Ise =~~ $I_{sh} + I_L$

$I_a = I_{se}$

(iii) $V = E_g - I_a R_a - I_{se} R_{se}$

(iv) $P_g = E_g I_a$

(v) $P_L = V \times I_L$

Compund DC Generator

- Short-Shunt Compound DC Generator
- Long-Shunt Compount DC Generator