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Assignment: 03
(DC Generator)

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BCT A
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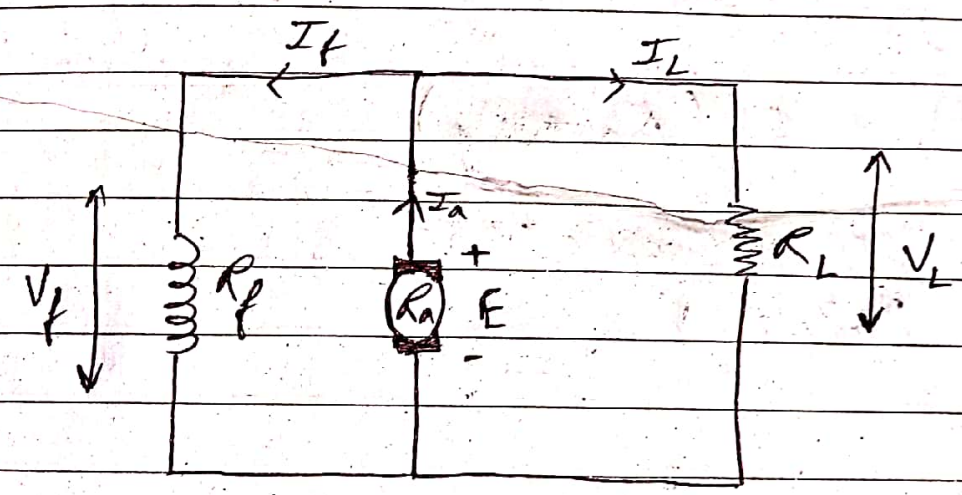
1.) Shunt Generator gives full load output of 30 KW at a terminal voltage of 200 V. The armature and field resistance are 0.05 Ω and 50 Ω respectively. The Iron & Friction Loss are 1000 W. Calculate Generated voltage ~~if. Eo~~, Current and copper loss. Also calculate the efficiency

Here,

We know that for a Shunt generator;



given;

$V_L = 200\ V$

$R_a = 0.05\ \Omega$

$R_f = 50\ \Omega$

$(W_i + W_f) = 1000\ W$

power o/p = 30 KW

So,

$30\ KW = I_L \times V_L$

$\therefore I_L = \frac{30,000}{200} = 150\ A$

$\therefore R_L = \frac{200}{150} = 1.33\ \Omega$

Then, we have

$I_L \times R_L = I_f \times R_f$ [parallel branches]

So,

$V_L = I_f \times R_f$

or, $I_f = \frac{200}{50} = 4\ A$

Then, we have

$I_a = I_L + I_f$

$= 150 + 4 = 154\ A$ Ans

Now, using emf equation for shunt Generator,

$E = V_L + I_a (R_a$ [illegible] $)$

$= 200 + 154 \times 0.05$

$= 207.7\ V$ Ans

Then,

Copper loss $= I_a^2 R_a + I_f^2 R_f$

$= 1185.8 + 80$

$= 1985.8\ W$ Ans

$\eta = \frac{P_{out}}{P_{out} + W_C + W_i + W_f} \times 100\ \%$

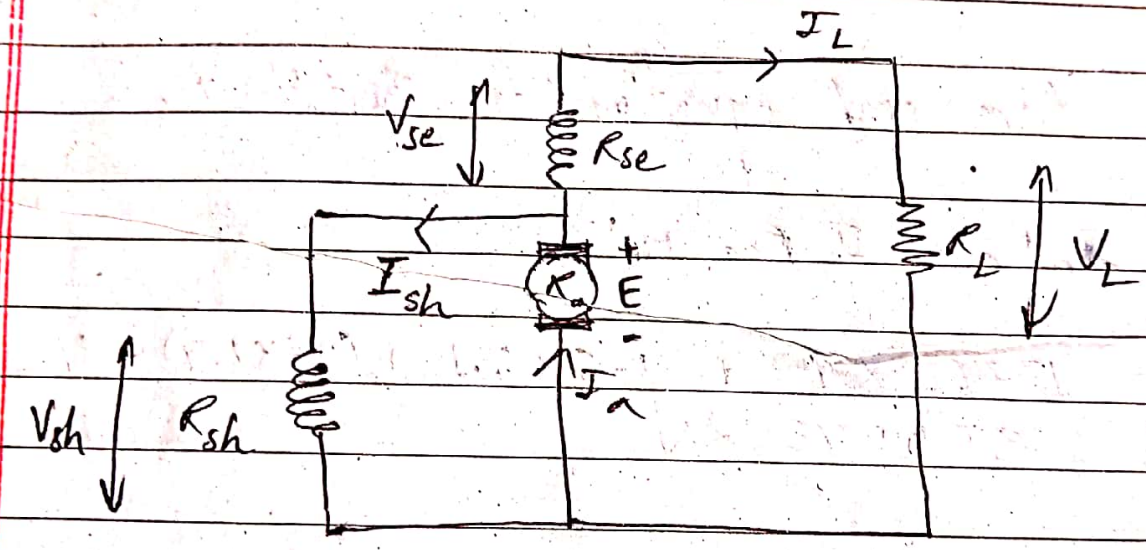
$= \frac{30\,000}{30\,000 + 1000 + 1985.8}$

$= 90.948\ \%$ Ans

2.) A short shunt compound dc generator supplies a load current of 175 A to a series of parallel heater load whose effective resistance is 1.4 Ω. The generator has armature, series and shunt field resistance are 15 Ω, 0.1 Ω and 100 Ω respectively. Calculate emf generator if carbon ~~brush~~ drop per brush is 2V.

Here,

We know that, for a compound short shunt Generator,



given,

$I_L = 175\ A,$

$R_L = 1.4\ \Omega$

$R_a = 15\ \Omega$

$R_{se} = 0.1\ \Omega$

$R_{sh} = 100\ \Omega$

$V_{brush} = 2 \times 2 = 4\ V$

Here,

$I_L \times R_L + I_1 \times R_{se} = I_{sh} \times R_{sh}$ (Parallel branches)

or, $175(1.4 + 0.1\,\Omega) = I_{sh} \times 100$

or, $I_{sh} = 2.625$ A

So, Using KCL,

$$I_a = I_{sh} + I_L$$
$$= 2.625 + 175$$
$$= 177.625 \text{ A}$$

then,

we have, from emf equation for short shunt -

$$-V_{brush} + E = I_a R_a + I_L R_{se} + V_L$$

or, $E = 177.625 \times 15 + 175 \times 0.1 + (175 \times 1.4) + 4$

$= 2.930875$ KV Ans

then,

copper loss $= I_a^2 R_a + I_{sh}^2 R_{sh} + I_L^2 R_{se}$

$= 177.625^2 \times 15 + 2.625^2 \times 100 + 175^2 \times 0.1$

$= 477011$

then,

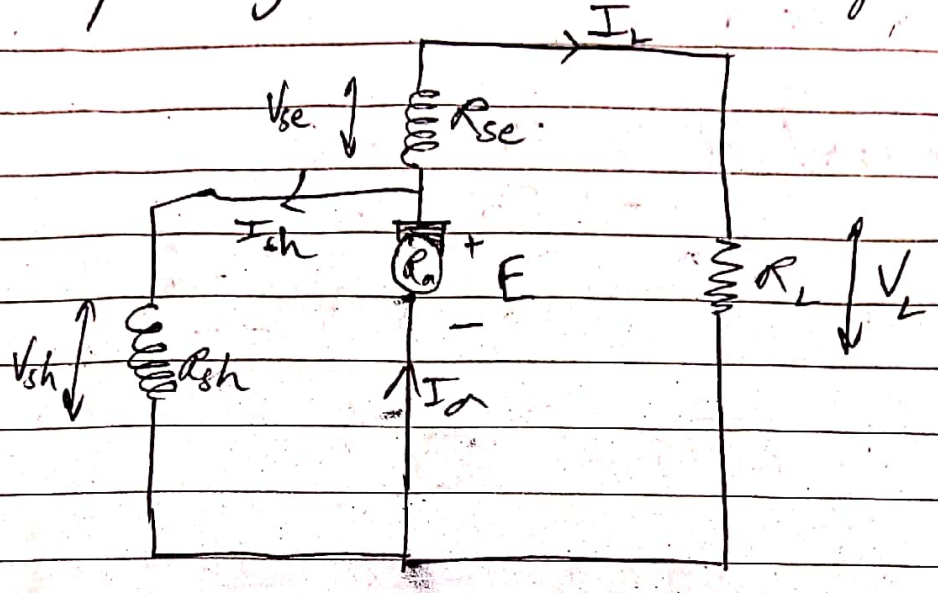
efficiency $= \dfrac{I_L \times V_L}{E \times I_a} \times 100\%$

$= $ ~~8800.2 %~~ Any

$= 8.235\%$

Any.

3.) A short shunt cumulative compound generator supplies 7.5 kW at 230 V. The shunt, field, series field and armature resistance are 100, 0.3 & 0.4 Ω respectively. Calculate induced emf & load resistance.



Here, given,

$V_L = 230\ V$,

$P_{out} = 7.5\ kW$

$\therefore I_L = \frac{7.5\ kW}{230\ V} = 32.608\ A$

$\therefore R_L = \frac{V_L}{I_L} = \frac{230}{32.608} = 7.053\ \Omega$

also,

$R_{sh} = 100\ \Omega$

$R_{se} = 0.3\ \Omega$

$R_a = 0.4\ \Omega$

So,

$V_{sh} = V_{se} + V_L$

or, $I_{sh} \times 100\ \Omega = I_L(0.3 + 7.053\ \Omega)$

or, $I_{sh} = \frac{32.608\,(0.3 + 7.053)}{100} = 2.397\ A$

$\therefore I_a = 32.608 + 2.397$

$= 35\ A$

Then, we have the emf equation,

$$E = I_a R_a + I_L R_{se} + I_L R_L$$
$$= 35 \times 0.4 + 32.608 \times 0.3 + 250$$
$$= 253.78 \text{ V}$$

∴ Load Resistance = 7.053 Ω

∴ Emf gen = 253.78 V.

Ans

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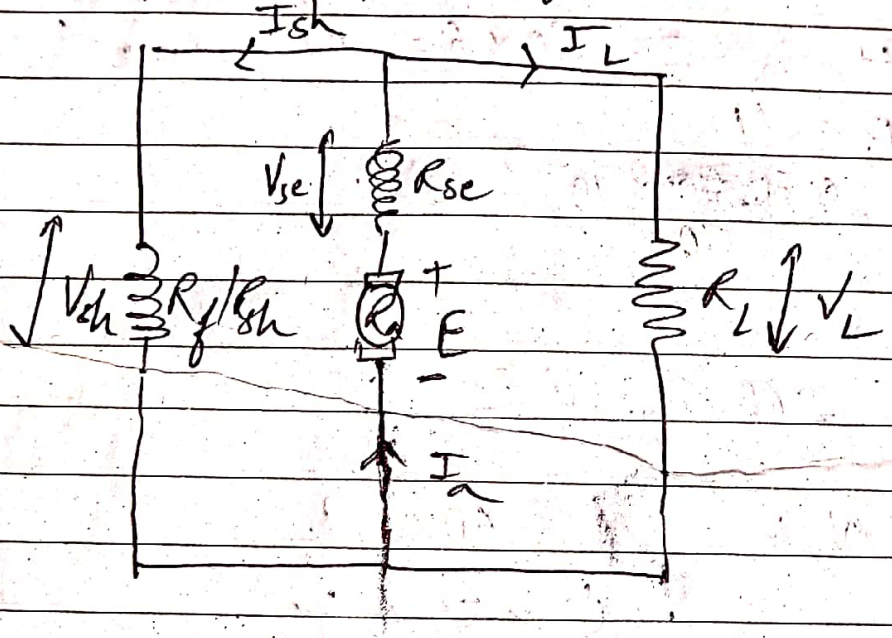
4.) 4 pole 250 V dc long shunt C. generator supplies a load of 10 KW at rated voltage. The armature series and shunt field resistance are 0.1 Ω, 0.15 Ω and 250 Ω respectively. Armature is lap wound with 50 slots, each slot containing 6 conductors. If the flux per pole is 50 mwb, calculate the speed of generator. What would be the speed if armature is wave wound?



Here,

$V_L = 250\ V, \quad P_{out} = 10\ KW$

$\therefore I_L = \frac{10\ KW}{250\ V} = \underline{\underline{40\ A}}$

also,

$R_a = 0.1\ \Omega$

$R_{se} = 0.15\ \Omega$

$R_{sh} = 250\ \Omega$

then,

$V_{sh} = V_L$

or, $I_{sh} = \frac{250}{R_{sh}} = 1\ A$

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

$= \underline{\underline{41\ A}}$

Then, we have, the emf equation,

$$E = V_L + I_a(R_a + R_{se})$$
$$= 250 + 41(0.1 + 0.15)$$
$$= 260.25 \text{ V}$$

Then,

for lap wound,

$$P = 4, \quad Z = 50 \times 6 = 300 \text{ conductors}$$
$$A = P = 4$$
$$\phi = \frac{\text{[illegible]}}{50} \times 10^{-3} \text{ wb}$$

$N = ?$

$E = 260.25 \text{ V}$

So,

$$N = \frac{E \times 60 \times A}{\phi \times Z \times P}$$

$$= \frac{260.25 \times 60 \times 4}{50 \times 10^{-3} \times 300 \times 4}$$

$$= 1041 \text{ rpm}$$ Ans

for wave wound, $A = 2$, so,

$$N = \frac{260.25 \times 60 \times 2}{50 \times 10^{-3} \times 300 \times 4} = 520.5 \text{ rpm}$$

Ans

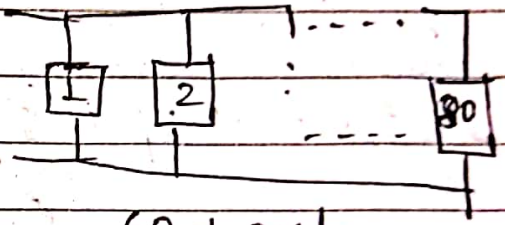
5.) In a 220 V compound generator, the armature series and shunt windings have resistance of 0.3 Ω, 0.2 Ω & 60 Ω respectively. The load consists of 80 lamps each rated at 60 W and 220 V. Find the total emf and armature current when the machine is connected for
(i) Long Shunt
(ii) Short Shunt.

Here,

$V_L = 220\ V$

$P_{out} = 60 \times 80 = 4800\ W$

$\therefore I_L = \frac{4800}{220} = 21.81$



60W each
220 V. parallel

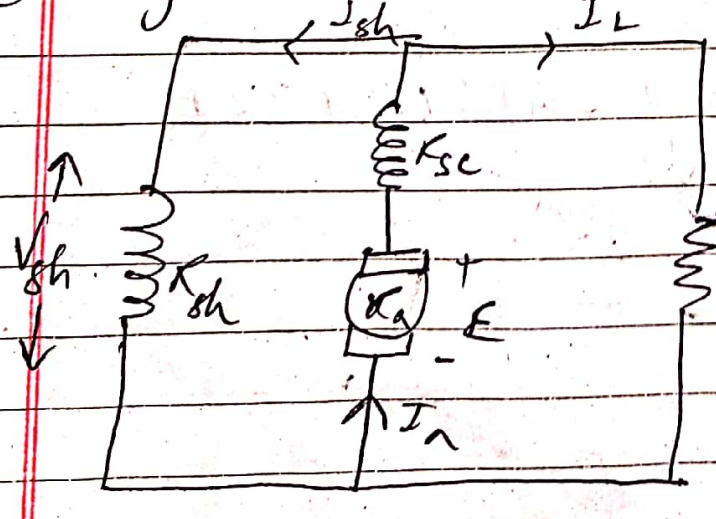
then,

$R_a = 0.3$

$R_{se} = 0.2\ \Omega$

$R_{sh} = 60\ \Omega$

(i) Long Shunt



here, $I_{sh} = \frac{V_L}{R_{sh}} = 3.67\ A$

$\therefore I_a = 25.476\ A$

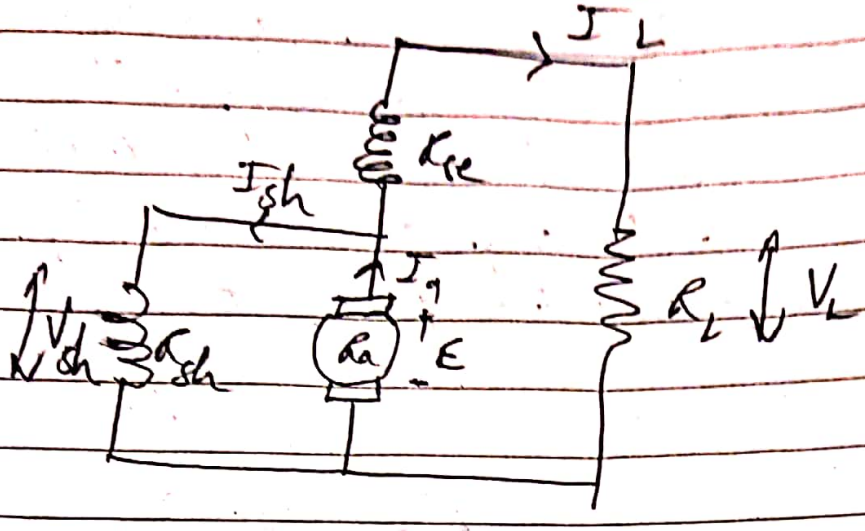
$E = V_L + I_a(R_a + R_{se})$

$= 220 + 25.476(0.3 + 0.2)$

$= 232.738\ V$

Ans

Q. Short Shunt



Here,

$$I_{sh} = \frac{V_L + I_L R_{se}}{R_{sh}} = \frac{220 + 4.362}{60}$$

$$= 3.739 \text{ A}$$

Then

$$I_a = 21.81 + 3.739$$

$$= 25.5493 \text{ A}$$

then,

$$E = I_a R_a + I_L R_{se} + V_L$$

$$= 25.5493 \times 0.3 + 21.81 \times 0.2 + 220$$

$$= 232.026 \text{ V}$$

Ans

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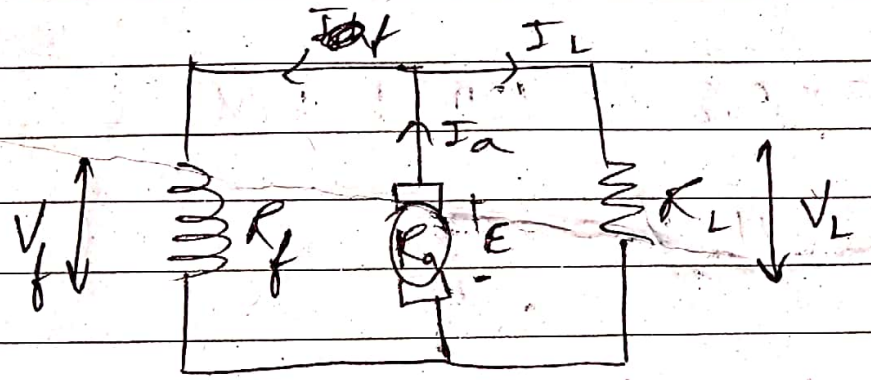
3.) A 4 pole dc Shunt Generator has wave wound armature. The armature and field winding resistance are 0.25Ω and 60Ω respectively. The brush contact drop is 1V per brush. The generator is delivering a power of 3 KW at 120 V. Calculate

(i) Total armature current coming out from the brush
(ii) Current in each armature conductor
(iii) Generated emf.

Here,



Here,

$P_{out} = 3\ kW,$

$V_L = 120\ V$

$\therefore I_L = 25\ A$

Then,

$R_a = 0.25\Omega \rightarrow V_{brush} = 1 \times 2 = 2V$

$R_f = 60\Omega$

So,

$$I_f = \frac{V_L}{R_f} = \frac{120}{60} = 2\ A$$

$$I_a = I_f + I_L$$

$\therefore I_a = 2 + 25 = 27\ A$

(i) ∴ Total armature current 27 A

Let, the number of conductors be x

Then,

(ii) ∴ Current per conductor $= \frac{27}{x}$ A

(iii) We have, the emf formula,

$$E = I_a R_a + V_L + V_{brush}$$

$$= 27 \times 0.2 + 120 + 2 V$$

$$= 127.4 V$$