ASSIGNMENT

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Name of the Student	ALOK KUMAR SINGH
Reg. No	17ETCS002020
Semester/Year	FIRST
Course Leader/s	Mr. Sachin S.

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<tr><td>Student Name</td><td colspan="5">ALOK KUMAR SINGH</td></tr>
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Declaration

The assignment submitted herewith is a result of my own investigations and that I have conformed to the guidelines against plagiarism as laid out in the Student Handbook. All sections of the text and results, which have been obtained from other sources, are fully referenced. I understand that cheating and plagiarism constitute a breach of University regulations and will be dealt with accordingly.

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Contents

Question No. A

Solution to Question No. A:

A1.1 Selection criteria of electrical machines for traction system

Starting torque, possibility of electric braking, simple speed control and l, capacity of withstanding voltage fluctuations, speed pivoting., control factor Are the main requirements/criteria of an electric motor for transition system.

Mechanical necessities of an electric powered machines are robustness & its capacity to face up to vibrations, the burden of traction motor should be minimal for you to increase the payload capacity, the traction motor must be small in standard dimensions and the traction system should be absolutely enclosed type to offer safety in opposition to dust, dust, water, mud and so on.

A1.2 Critical review of the characteristics of AC and DC machines for traction system

The characteristics of AC machines are as follows:

Running speed is dependent on the power supply frequency, the number of motor poles and the amount of slip. The frequency and number of poles define what the synchronous speed of the motor will be.

In comparison to other motor types, starting torque is the chief limitation of an AC motor. A single phase motor will not start on and must have help. Single phase motors are defined by the methods they use to start. Some common types of single phase motors are the shaded pole motor, the split phase motor, the permanent split capacitor motor (also called the single value capacitor motor), and the two-value capacitor motor. All these motor types either use an out of phase secondary coil or a capacitor to create a secondary phase to start the motor. Remember, if your application requires the motor to start with a load on it, consult your motor manufacturer to ensure the motor has enough torque to start at load and to ensure the correct motor type is specified for your application.

AC single phase motor are not suitable for urban services as it requires high acceleration. However, single phase motors are extensively used for main line services.

The speed of an AC series motor may be controlled efficiently by tapping the transformer which isn't possible in a DC series motor.

However, single phase AC series motor have better performance at reduced frequencies as higher frequencies result in high leakage reactance and hence a relatively poor factor

Now, Characteristics of DC machines are as follows:

DC motor has high starting torque which is important in traction system, it has good communication property up to twice the full load. It possesses the stability to run in parallel with other loads.

Commutating properties of collection motor also are superb as a boom in the armature contemporary because of heavy load results in a decrease of armature speed. This reduces the significance of EMF brought on in the coils undergoing commutation which allows reaching flickers present-day collections.

In DC collection motor, as much as the point of magnetic saturation, the torque developed is proportional to the rectangular of the present day. therefore, DC cars require relatively much less extended power input with the growth in load torque. for that reason, the series motor is able to withstand immoderate hundreds. the velocity of DC motors can be managed through many techniques.

A1.3 The need of high starting torque for traction system

normally speak, motor serves the characteristic of rotationally accelerating a few components, and torque is what offers this acceleration. most machines at a few points have to boost up from the angular pace of zero, in one direction or the different, which is another manner of describing the circumstance wherein the starting torque is applicable In easy words we can say a machine which has extraordinarily excessive inertia. Such as a teacher or crane which is approximate to elevate a heavy load is absolutely going to require a high starting torque in order to set system in motion.

A1.4 Justification of your stance and conclusion

Since there are much more advantages of Dc motors over the Ac series motor. Thc DC motor hs 1.5 to 2 time less weight and size than AC transition system.

The starting torque of DC series motor is higher than that of AC series motor., Smooth speed control is possible in DC series motor which is very important advantage.

Solution to Question No. B1:

(i) Determine the efficiency and regulation of the transformer on full load and half

load for Case 1 and Case 2.

Case 1: Assume iron loss of the transformer as 2.5 kW

Case 2: Area of the core is 1800 cm2, 200 turns, Kh= 0.80, Ke = 0.60

Given

power (P)=400KVA

R_1=0.5 Ω X_1=2 Ω

R_2=0.001 Ω X_2=0.05 Ω

V_1=11kV=11 × 10^3 V V_2=440V

cosΦ = 0.85

so,

Φ=$\cos^{-1}$0.85=31.788

sinΦ=0.526782:

case 1:

Assumed iron loss from transformer=2.5kW=2500W

Current I_1 and I_2 will be:

$$I_1 = \frac{P}{V_1} = \frac{4 \times 10^5}{11 \times 10^3} = 36.3636\ A \qquad and \qquad I_2 = \frac{P}{V_2} = \frac{4 \times 10^5}{440} = 909.09\ A$$

power in cupper loss:

$$P_{cu} = {I_1}^2 R_1 + {I_2}^2 R_2$$

- ⇨ $(36.3636)^2 0.5 + (909.09)^2 0.001$
- ⇨ 1487.60W

Efficiency of fully loded: (x=1):

$$n\% = \frac{I_1 V_1 X \cos\Phi}{I_1 V_1 X \cos\Phi + P_i + x^2 P_{cu}} \times 100$$

$$n\% = \frac{11000 \times 36.3636 \times 0.85}{11000 \times 36.3636 \times 0.85 + 2500\ +\ 1487.6} \times 100$$

⇨ N%=98.84%

Efficiency at half load(x=0.5) :

$$n\% = \frac{I_1 V_1 X \cos\Phi}{I_1 V_1 X \cos\Phi + P_i + x^2 P_{cu}} \times 100$$

$$n\% = \frac{0.5 \times 11000 \times 36.3636 \times 0.85}{0.5 \times 11000 \times 36.3636 \times 0.85 + 2500 + 0.25 \times 1487.6} \times 100$$

n%=98.339%

Regulation of transformer:

$$R\% = \frac{I_1 R_{01} \cos\Phi + I_2 X_{01} \sin\Phi}{V_1} \times 100$$

Since,

$R_{O1} = R_1 + R_2'$-----------(1)

$R_2' = R_2 / K^2$ ------------ (2)

$$K = \frac{V_2}{V_1} = \frac{440}{11000} = 0.04$$

From (2)

$R_2' = 0.001/(0.04)^2$

$R_2' = 0.625\Omega$

From (1)

$R_{O1} = 0.5 + 0.625 = 1.125\Omega$

Now,

$X_2' = X_2 / K^2$

⇨ $0.05/ (0.04)^2 = 31.25\Omega$

$X_{O1} = X_1 + X_2'$

⇨ $2 + 31.25 = 33.25\Omega$

regulation of transformer

$$R\% = \frac{I_1 R_{01} \cos\Phi + I_2 X_{01} \sin\Phi}{V_1} \times 100$$

$$R\% = \frac{36.36 \times 1.125 \times 0.85 + 36.36 \times 33.35 \times 0.5267}{11000} \times 100$$

⇨ 6.12%

Regulation for both half load and full load transformer will remain same as load isn't varying

Case 2: Area of the core is 1800 cm2, 200 turns, Kh= 0.80, Ke = 0.60:

Given :

Area (A) = $1800cm^2 = 0.18m^2$

Hysteresis losses(K_h)= 0.80

Frequency(f) = 50Hz

Number of turns (N) = 200

Eddy current losses(K_e) = 0.60

$E_1 = 4.44 \times \Phi_M \times f \times N$

- ⇨ $11000 = 4.44 \times \Phi_M \times 50 \times 200$
- ⇨ $\Phi_M = 0.2477Wb$

We know that, $\Phi_M = B_M \times A$

So, $B_M = 0.2477 \times 100 \times 100/1800$

- ⇨ $B_M = 1.376Wb/m^2$

Now, $P_h = K_h * \times f \times (B_M)^{1.6}$

- ⇨ $P_h = 0.80 \times 50 \times 1.376^{1.6}$
- ⇨ $P_h = 66.657W$

Now, $P_e = K_e \times f^2 \times K_f \times B_M^2$

- ⇨ $P_e = 0.6 \times 50^2 \times (1) \times (1.376)^2$
- ⇨ $P_e = 2840.064W$

As $P_i = P_h + P_e$

- ⇨ $P_i = 66.657W + 2840.064W$
- ⇨ $P_i = 2906.721W$

We already calculated $P_{Cu} = 1487.601W$

Efficiency at full load(x = 1) :

$$n\% = \frac{I_1 V_1 X \cos\Phi}{I_1 V_1 X \cos\Phi + P_i + x^2 P_{cu}} \times 100$$

$$n\% = \frac{0.5 * 11000 * 36.3636 * 0.85}{0.5 * 11000 * 36.3636 * 0.85 + 2906.721 + 1487.6} \times 100$$

n%= 98.72%

Efficiency at half load(X=0.5) :

$$n\% = \frac{I_1 V_1 X \cos\Phi}{I_1 V_1 X \cos\Phi + P_i + x^2 P_{cu}} \times 100$$

$$n\% = \frac{0.5 * 11000 * 36.3636 * 0.85 * 100}{0.5 * 11000 * 36.3636 * 0.85 * 100 + 2906.721 \ + 0.25 * 2906.721} \times 100$$

n% = 98.10 %

Regulation of Transformer -

$$R\% = \frac{I_1 R_{01} \cos\Phi + I_2 X_{01} \sin\Phi}{V_1} \times 100$$

$R_{O1} = R_1 + R_2'$-----------1

$R_2' = R_2 / K^2$------------2

$K = V_2 / V_1$

- ⇨ 440/11000
- ⇨ 0.04

So, K = 0.04

From(2),

$R_2' = 0.001/(0.04)^2$

- ⇨ 0.625Ω

From (1)

$R_{O1} = 0.5 + 0.625$

- ⇨ 1.125 Ω

Since,

$X_{O1} = X_1 + X_2'$--------3

And $X_2' = X_2 / K^2$ --------4

From (4),

$X_2' = 0.05/ (0.04)^2$

- ⇨ 31.25Ω

$X_{O1} = 2 + 31.25$

- ⇨ 33.25Ω

For the regulation of transformer,

$$R\% = \frac{I_1 R_{01} \cos\Phi + I_2 X_{01} \sin\Phi}{V_1} \times 100$$

$$R\% = \frac{36.36 * 1.125 * 0.85 + 36.36 * 33.35 * 0.5267}{11000} \times 100$$

$R\% = 6.12\%$

The regulation for half load and full load transformer will be same as the load doesn't change. The values of resistances and current will remain same.

(ii) Comment on the result:

For both cases the efficiency in full load and half load are almost same even though value of iron loss was different in case 2. We also calculated regulation for both cases and got the same results for both as circuit parameters like resistance, current and the phasor angle(Φ) remained same.

Solution to Question No. B2

B2.1 Draw the block diagram of given system:

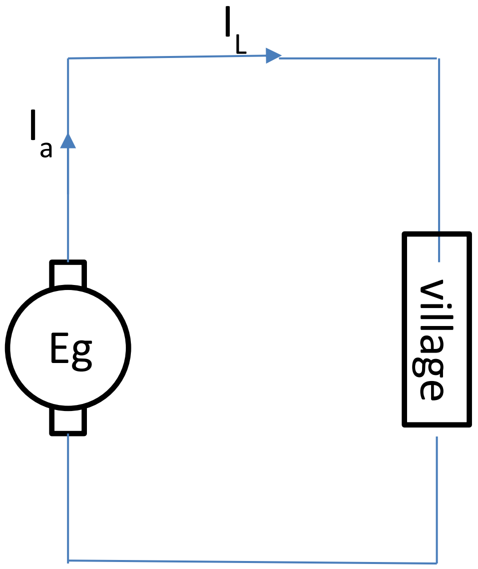

Fig 2.1 Block diagram of Equivalent circuit

B2.2 Resistance of the leads from the dynamo to the village:

Generated voltage = 230 V

Voltage across the village=220V

We know that $I_L=I_a=15A$

Resistance=Voltage drop/Load Current

- ⇨ (230-220)/15
- ⇨ 10/15
- ⇨ **0.67Ω**

B2.3 The number of Board of Trade (BOT) units of energy consumed in 10 hours

Power=Voltage across village × Load Current

Power=220×15

- ⇨ 3300W

Energy=Power×time

- ⇨ 3300×10hrs
- ⇨ 33000Wt hr =**33kW hr**

⇨

The number of Board of Trade units are same as that of energy in kW hr.

Therefore,

The number of Board of Trade units of energy consumed in these 10hrs is 33 units

B2.4 Energy wasted in the leads for the same duration

Power = $\frac{V^2}{R}$

Assuming the voltage drop already

So, V=10V

Power consumed=$\frac{V^2}{resistance}$

- ⇨ $\frac{10^2}{0.67}$
- ⇨ 149.253 W

Energy wasted = power × time

- ⇨ 149.2537*10
- ⇨ 1492.537 W hr
- ⇨ **1.492 kW hr**

Solution to Question No. B3:

B3.1 Identify whether the loads should be connected in parallel or series and justify:

The loads should be connected in parallel as if there is any problem in one appliance, then also remaining appliances will run without affecting. Bun in the case of series connection, if one appliance fails then the remaining appliances will also fail. and if they were connected in series, some of the energy will be lost overcoming the internal resistance since it's effect is high when in series than when in parallel.

B3.2 Draw the equivalent circuit:

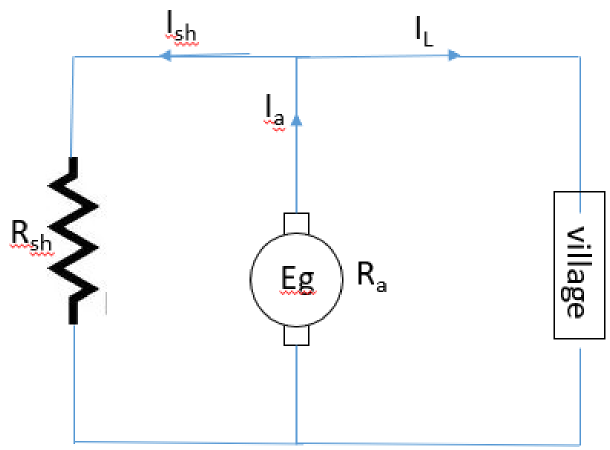

Fig 2.2 Equivalent circuit of shunt generator

B3.3 Armature current per parallel path

We have:

P=4 A=P=4 (lap wound)

R_a=1Ω R_{sh}=300 Ω

Z=120

N=speed=1000rpm

V_L=250V

Since the voltage drop per brush is 1 V

So, for 2 brushes : V_b=1*2=2V

Power of geyser= 3 kW

Power of lighting load=2 kW

Submersible pump's power=5 kW

Electric oven’s power=2.5 kW

Total power=3+2+5+2.5=12.5kW

$P=VI_L$ (V=250V)

P=12.5kW

- ⇨ $P= 12.5*1000=VI_L$

$I_L=12.5*1000/250$

- ⇨ I=50A

Now, $I_{sh}=V/R_{sh}$

=250/300=0.833A

Therefore,

$I_a=I_L+I_{sh}$

=50+0.833

=50.833A

Armature current per parallel path is 50.833A

B3.4 Magnetic flux per pole

equation for shunt generator EMF:

$E_g=V + V_b + I_aR_a$

- ⇨ $E_g = 0.833\times1+ 250 +2$
- ⇨ $E_g = 302.833V$

$$E_g = \frac{\phi NPZ}{60A}$$

$\Phi=E_g\times60\times A/N\times P\times Z$

=0.1514Wb

Hence, Magnetic flux per pole is 0.1514

Solution to Question No. B4:

B4.1 Secondary current drawn by each of the loads:
Given,

V_1=6.6kV=6600V

V_2=240V

a) For 10 kw at 0.5 pf lag

   $P_1=VI_{L1}\cos\phi$

   $10000=240\times I_{L1}\times 0.5$

   $I_{L1}=83.33A$

b) For 3kVA at 0.707 pf lag

   $P_2=V\times I_{L2}\times\cos\phi$

   $3000/240=I_{L2}*0.707$

   $I_{L2}=17.68A$

c) 5 kW at unity pf

   $P_3=V\times I_{L3}\times\cos\phi$

   $5000/240=I_{L3}*1$

   $I_{L3}=20.833A$

d) 8kVA at 0.6 pf lag

   $P_4=V\times I_{L4}\times\cos\phi$

   $8000/240=I_{L4}*0.6$

   $I_{L4}=55.55A$

B4.2 Secondary power factor:
Total load = $P_L=P_1+P_2+P_3+P_4$

⇨ 10 + 3 + 5 + 8

⇨ 26 KVA

Now secondary power factor,

$P_L=V_2\times I_2\times\cos\phi_2$

$I_L=I_{L1}+I_{L2}+I_{L3}+I_{L4}$

=83.33+17.68+20.833+55.55

$=177.393A$

Now, $26000=240I_L\cos\phi_2$

- ⇨ $26000/(240\times177.393)=\cos\phi_2$
- ⇨ $\cos\phi=0.6106$

so, the secondary power factor is $\cos\phi_2$ is 0.6106

B4.3 Primary current and primary power factor

We have: $V_1=6600V$

a) for 10kW at 0.5 pf lag

$P_1=V_1I_{L1}\cos\phi$

$10000/6600=I_{L1}\times0.5$

$I_{L1}=3.030A$

b) for 3 kVA at 0.707 pf lag

$P_2=V_2I_{L2}\cos\phi$

$3000/6600=I_{L2}\times0.707$

$I_{L2}=0.6430A$

c) for 5kW at unity pf

$P_3=V_1I_{L3}\cos\phi$

$5000/6600=I_{L3}\times1$

$I_{L3}=0.7575A$

d) for 8kVA at 0.6 pf lag

$P_4=V_4I_{L4}\cos\phi$

$8000/6600=I_{L4}\times0.6$

$I_{L4}=2.02A$

So, the total load power $P_L=P_1+P_2+P_3+P_4$

- ⇨ 10 + 3 + 5 + 8
- ⇨ 26kVA = 26000 VA

$I_P=I_{P!} + I_{P2} + I_{P3} + I_{P4}=6.4505A$

Primary power factor:

$P_L=V_1I_P\cos\phi_1$

- ⇨ $26000=6600\times6.4505\times\cos\phi_1$
- ⇨ $\cos\phi_1=0.6107$

The primary power factor of the system is 0.6107