Code - 27110

Q.3 b) A 200 V shunt motor having armature resistance of 0.4 and shunt field resistance of 100Ω drives a load at 500 taking 27 A. It is desired to run to motor at 700 rpm. Assuming the load torque to be constant, find the value of resistance to be used as field regulator. Neglect satura effect.

Solⁿ :-

Initial conditions: $N_1 = 500$ rpm ; $I_L = 27$ A ; $I_{sh_1} = \frac{200}{100} = 1$ A

$I_{a_1} = I_L - I_{sh_1} = 27 - 2 = 25$ A.

$E_{b_1} = 200 - 25 \times 0.4 = 190$ V.

Final conditions:

$E_{b2} = V - I_{a2} R_a = 200 - 0.4 I_{a2}$

As the load torque is constant,

$\phi_1 I_{a_1} = \phi_2 I_{a2}$ But $\phi \propto I_{sh}$

$\therefore I_{sh_1} I_{a_1} = I_{sh2} I_{a2}$

$\therefore I_{sh2} = \frac{I_{sh_1} I_{a_1}}{I_{a2}} = \frac{2 \times 25}{I_a} = \frac{50}{I_{a2}}$.

Now, $\frac{N1}{N2} = \frac{E_{b1}}{E_{b2}} \times \frac{I_{sh2}}{I_{sh_1}}$

$\therefore \frac{500}{700} = \frac{190}{200 - 0.4 I_a} \times \frac{(50/I_{a2})}{2}$

$\therefore I_{a_2}^2 - 500 I_{a_2} + 16625 = 0$.

After solving this equation, $I_{a2} = 35$ A

$\therefore I_{sh2} = 50/I_{a2} = 50/35 = 1.43$ A

$\therefore R_{sh2} = V/I_{sh} = 200/1.43 = 139.86$ Ω

$\therefore$ Field Rheostate resistance $= 139.86 - 100$

$= 39.86$ Ω.

Anoj Kumar

Q.4 b) A 20 hp, 220 V shunt motor takes a full-load current of 82 A, speed 1000 rpm, armature resistance 0.1 Ω, shunt field resistance 110 Ω. It is to be braked by plugging. What resistance must be placed in series to limit the current to 120 A? Find also the initial value of the braking torque.

Soln:-

Field current, $I_{sh} = \frac{220}{110} = 2A.$

∴ Full-load armature current, $I_a = I_L - I_{sh} = 82 - 2 = 80A.$

$E_b = V - I_a R_a = 220 - 80 \times 0.1$

$= 212$ volts.

Voltage across armature when braking $= V + E_b$

$= 220 + 212$

$= 432$ volts.

∴ Total resistance required to limit current to 120A.

$= \frac{432}{120} = 3.6\,\Omega$

Resistance to be added $= 3.6 - 0.1 = 3.5\,\Omega.$

Full Load torque $= 9.55 \times \frac{\text{Output}}{N}$

$= 9.55 \times \frac{20 \times 746}{1000} = 142.5$ N-m

∴ Initial Braking torque $= \frac{120}{80} \times 142.5 = 213.8$ Nm

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Q.4 (b) [illegible]

[illegible] braking is [illegible].

Sol:

Field current $= \frac{220}{110} = 2A$.

∴ Full-load armature current $I_a = I_L - I_{sh} = 56 - 2 = 54A$,

$E_b = V - I_a R_a = [illegible] - 54 \times 0.4$

$= [illegible]$

Voltage across resistance when braking $= [illegible]$

$= [illegible]$

$= 454 [illegible]$

Total resistance required to limit current to 126A.

$= \frac{454}{126} = 3.62$

Resistance to be added $= 3.6 - 0.4 = 3.2\Omega$

Full load torque $= 9.55 \times \frac{\text{Output}}{N}$

$= \frac{9.55 \times 20 \times 746}{1000} = 142.5 \text{ Nm}$

∴ Initial Braking torque $= \frac{126}{54} \times 142.5 = 2[illegible] \text{ Nm}$

Q.5 b) A Field's Test on two similar series machines gave the following data:

Motor: armature current = 60A.

Voltage across armature = 500V.

Voltage across field = 40V.

Generator: Terminal Voltage = 450 V.

output current = 46 A.

voltage across field = 40 V.

Armature resistance (including brushes) of each machin is 0.25Ω. Calculate efficiency of both machines.

Soln:-

Power input to the whole set = (500+40+40)(60)

= 34,800 W.

Generator output = 450 × 46 = 20,700 W.

∴ Total losses in the whole set = 34,800 − 20,700

= 14,100 W

Total ohmic losses $= (60)^2 \times 0.25 + 60(40+40) + (46)^2 \times 0.25$

= 6230 W

∴ No Load rotational loss of each machine

$= \frac{14,100 - 6230}{2} = 3935 \text{ W}$

∴ Motor power input = (500+40)(60) = 32,400 watts

Total motor losses = Armature circuit loss + Field circuil loss + No-load rotational lo.

$= (60)^2 \times 0.25 + 60 \times 40 + 3935 = 7235$ W

∴ motor Efficiency, $\eta_m = \left(1 - \frac{7235}{32,400}\right) \times 100 = 77.68\%$

Total generator losses = Armature circuit loss + Field circuit loss + No-Load rotational loss

$= (46)^2 (0.25) + 60 \times 40 + 3935$

Anuj Kumar

Generator Input = 20,700 + 6865

= 27,005 W

∴ Generator efficiency, $\eta_g = \left(1 - \frac{6865}{27,005}\right) \times 100$

$= 74.49\%$

Q.6 a) Determine the step angle of Variable - reluctance stepper motor with 12 teeth in the stator & 8 rotor teet

Soln :-

Number of stator teeth, $N_s = 12$
Number of rotor, teeth $N_r = 8$

$$\therefore \text{step angle}, \alpha = \frac{N_s - N_r}{N_s \cdot N_r} \times 360^\circ$$

$$= \frac{(12-8)}{12 \times 8} \times 360^\circ$$

$$= 15^\circ/\text{step}$$

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