SNS COLLEGE OF ENGINEERING

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AN AUTONOMOUS INSTITUTION

Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER SYSTEM ANALYSIS
UNIT – I
PERMANENT MAGNET PMBLDC MOTOR
PROBLEM

Problems.

a) PMBLDC motor has a torque constant of 0.12 N-m per amp. Estimate its no load speed in rpm when connected to a 48V dc supply.

b) If the armature resistance per phase is 0.15 Ω and voltage drop in the controller transistor is 2V. Determine the starting current.

c) Find the starting torque, the DC current is 8.2A, when the motor delivers 330W of mechanical power to a load at 3400 rpm. The motor is Y connected and has two phases on at any instant with a total of 2V drop across two conducting transistors in series. This V_{drop} is assumed to be constant. Frictional torque is 0.046 N-m at this speed. If the supply voltage is 48 V dc.

d) i) calculate the 'η' of complete drive and the seperate power loss components due to ii) V_{drop} in the transistors iii) Winding resistances, iv) friction v) iron losses. vi) If the iron loss is modelled by means of a resistor connected in parallel with each phase of the motor, Determine the Value of this resistance.

e) If the iron loss is modelled by means of Resistor connected in parallel with each phase of the motor. Determine the value of the Resistance.

SOLUTION:

a) No load speed in rpm.

$$\omega_{mo} = \frac{V}{k_m}$$

$k_m = 0.12 \text{ Nm/A}$

$V = 48 \text{ V}$

$$\omega_{mo} = \frac{48}{0.12} = 400 \text{ rad/sec}$$

$1 \text{ rad/sec} = 9.549$

$N_o = 3819 \text{ rpm}$

b) starting current

$$I_{st} = \frac{V - V_{drop}}{2 R_{ph}}$$

$R_{ph} = 0.15 \Omega$

$V_{drop} = 2 \text{ V}$

$$I_{st} = \frac{48 - 2}{2 \times 0.15} = 153.3 \text{ A}$$

c) starting Torque

$$T_{st} = k_m I_{st}$$

$= 0.12 \times 153.3 \text{ N-m}$

$= 18.4 \text{ N-m}$

d) (i) $\eta = \frac{\text{output power}}{\text{Input power}} \times 100$

output power = 330 W

input power = 48 × 8.2 = 393.6 W

$\eta = \frac{330}{393.6} \times 100 = 83.84\ \%$

e) Device loss

(ii) Power loss in transistors = $V_{dd} I$

$= 2 \times 8.2 = 16.4\ W.$

(iii) Loss in the winding resistance

cu loss $= I^2 (2R_{ph})$

$= (8.2)^2 (2 \times 0.15)$

$= 20.17\ W$

(iv) Friction loss

$P_f = \frac{2\pi N T_f}{60}$

$= \frac{2\pi \times 3400 \times 0.046}{60}$

$= 16.37\ W$

(v) Iron loss = Input power − (output power + cu loss + loss in device + friction loss)

$= 393.6 - (330 + 20.17W + 16.4 + 16.37)$

$= 10.65\ W = \frac{10.65}{2} = 5.33\ W$ [2 windings are series] vi). Iron loss $= \frac{V^2}{r}$

voltage is divided to each phase of armature winding

$R_{iron} = \frac{V^2_{pho}}{P_{iron}}$

$P = VI$

$5.33 = \frac{24^2}{r}$

$P = V \times \frac{V}{R}$

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

$r = 99.24\ \Omega$

Voltage across each phase