Tutorial Sheet 4 – Self excited actuators

4.1 Terms

4.2 Equations

$$L = 3 + \frac{0.03}{x}$$

$$E = \frac{LI^2}{2}$$

$$Work = F\Delta x = \frac{1}{2}\tau^2 \Delta l$$

$$F = \frac{1}{2}\tau^2 \frac{\Delta L}{\Delta x}$$

Tutorial Sheet 4 - Self Excited Actuators

Q1

L = 3 + 0.03/x
X= 2 mm = 2E-3 m

a)DC current τ = 3A

$$E = \frac{LI^2}{2} = (3 + \frac{0.03}{2E-3}).3^2.\frac{1}{2} = 81mJ$$

b) Energy = Force x Distance

$$E = \frac{LI^2}{2} = F\Delta x = \frac{1}{2}\tau^2 \Delta L..... \therefore F = \frac{1}{2}\tau^2 \frac{dL}{dx}$$

$$L = \left(3 + \frac{0.03}{x}\right)E - 3..... \frac{dL}{dx} = \frac{0.03}{x^2}E - 3$$

$$F = \frac{1}{2}.3^2.\frac{0.03}{(0.002)^2}E - 3 = 33.75N$$

Q2
i) MMF = Flux x Reluctance

$$N\tau = \phi s.....\phi = \frac{NI}{s}, s = \frac{l}{\mu_0 A}$$

$$N\tau = \frac{NI}{s}.\frac{l}{\mu_0 A}.....L = \frac{N^2}{s}$$

$$N\tau = \frac{L}{N}.I.\frac{l}{\mu_0 A}$$

$$L = \frac{N^2 \mu_0 A}{l}.....F = \frac{I^2}{2}.\frac{dL}{dx}$$

$$F = \frac{I^2}{2}.\frac{N^2 \mu_0 A}{x^2} = \frac{(NI)^2 \mu_0 A}{2x^2}$$

ii) N=1000, A= 120mm^2, x_{open}=5mm, x_{closed}=3mm, F= 3N

$$F = \frac{(NI)^2 \mu_0 A}{2x^2}$$

$$I = \sqrt{\frac{(2)(3)x^2}{(1.2E-4)(4\pi E-7)(1000)^2}} = close > 1A, open < 0.6A$$