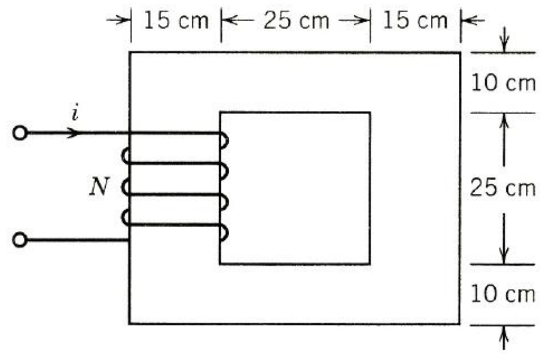
Quiz – EE6503 Chapter 1 to 3 (24 March 2020, 10 marks, 1 hour)

For Q. 1 to Q. 4, consider a magnetic system as shown below. Two sides are thicker than the other two sides. It consists of the depth of the core is 10 cm, the relative permeability of 2000, the number of turns of 300 and current flow of 1 A.



1. Find the reluctance of the thick core

   A. 13270 At/Wb

   B. 18577 At/Wb

   C. 31847 At/Wb

   D. 50424 At/Wb

2. Find the reluctance of the thin core

   A. 13270 At/Wb

   B. 18577 At/Wb

   C. 31847 At/Wb

   D. 50424 At/Wb

3. Find the reluctance of the whole core

   A. 13270 At/Wb

   B. 18577 At/Wb

   C. 31847 At/Wb

   D. 50424 At/Wb

4. Find the flux in the core

   A. 0.006 Wb

   B. 0.007 Wb

   C. 0.008 Wb

   D. 0.009 Wb

<u>Answer</u>

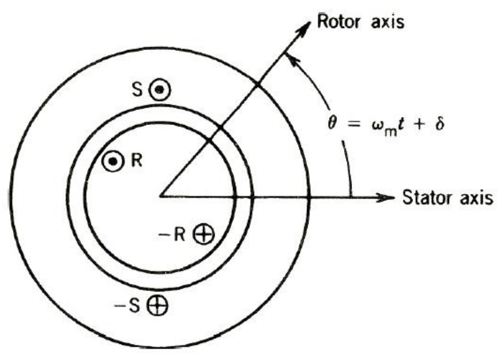
$$R_{thick} = \frac{70\ x\ 10^{-2}}{(2000\ x\ 4\pi\ x\ 10^{-7})\ x\ (15\ x\ 10^{-2})\ x\ (10\ x\ 10^{-2})} = 18577$$

$$R_{thin} = \frac{80\ x\ 10^{-2}}{(2000\ x\ 4\pi\ x\ 10^{-7})\ x\ (10\ x\ 10^{-2})\ x\ (10\ x\ 10^{-2})} = 31847$$

$$R_{thick} + R_{thin} = 50424$$

$$\emptyset = \frac{Ni}{R} = \frac{300\ x\ 1}{50424} = 0.006\ Wb$$

For Q. 5 to Q. 8, consider the rotating machine, as shown below, consists of L_{sr} = 0.08 cos θ H.



5. Suppose the stator and rotor coils are connected in series, and a current of 5 A (rms) at 60 Hz is passed through them. The developed torque is

   A. $T = \sin(\omega_m t + \delta) + \sin(\omega_m t + \omega t + \delta) + \sin\,(\omega_m t - \omega t + \delta)$

   B. $T = \sin(\omega_m t + \delta) + \sin(\omega_m t + 2\omega t + \delta) + \sin\,(\omega_m t - 2\omega t + \delta)$

   C. $T = -2\sin(\omega_m t + \delta) + \sin(\omega_m t + \omega t + \delta) + \sin\,(\omega_m t - \omega t + \delta)$

   D. $T = -2\sin(\omega_m t + \delta) + \sin(\omega_m t + 2\omega t + \delta) + \sin\,(\omega_m t - 2\omega t + \delta)$

6. Find the values of rotor speed at which the machine will develop an average torque

   A. 0 and ½ ω

B. 0 and ω

C. 0 and 2 ω

D. ½ ω and 2 ω

7. Find the maximum torque can be developed at each speed

A. 1 Nm

B. ½ Nm and 1 Nm

C. 1 Nm and 2 Nm

D. ½ Nm and 2 Nm

8. Find the mechanical power that can be developed

A. 376.8 W

B. 753.6 W

C. 1507.2 W

D. 3014.4 W

<u>Answer</u>

$T = i_s i_r \frac{dL_{sr}}{d\theta} = i^2 \frac{dL_{sr}}{d\theta}$ and $i = \sqrt{2}\, x\, 5 \sin(\omega t)$

$T = 50 \sin^2(\omega t)[-0.08\sin(\omega_m t + \delta)] = -4(\frac{1-cos2\omega t}{2})\sin(\omega_m t + \delta)$

$= -2\sin(\omega_m t + \delta) + \sin(\omega_m t + 2\omega t + \delta) + \sin(\omega_m t - 2\omega t + \delta)$

Averaged torque can be produced when $\omega_m = 0$ and $\omega_m = \pm 2\omega = \pm 753.6\, rad/sec$

When $\omega_m = 0 \quad \rightarrow \quad T_{avg} = -2sin\delta$

$T_{max} = 2\, Nm \quad and \quad P_{max} = 0\, W$

When $\omega_m = \pm 753.6 \quad \rightarrow \quad T_{avg} = sin\delta$

$T_{max} = 1\, Nm \quad and \quad P_{max} = 753.6\, W$

For Q. 9 and Q. 10, consider a four-pole DC machine consists of winding of 300 turns with parallel paths of two and flux per pole of 0.025 Wb. If the machine rotates at 1000 rpm,

9. Find the constant K_a

A. 191.08

B. 382.17

C. 764.34

D. 1528.68

10. Find the generated voltage

A. 100 V

B. 200 V

C. 250 V

D. 500 V

<u>Answer</u>

$K_a = \frac{Np}{\pi a} = \frac{300\ x\ 4}{\pi\ x\ 2} = 191.08$

$E_a = K_a \emptyset \omega = 191.08\ x\ 0.025\ x\ 1000\ x \frac{2\pi}{60} = 500V$