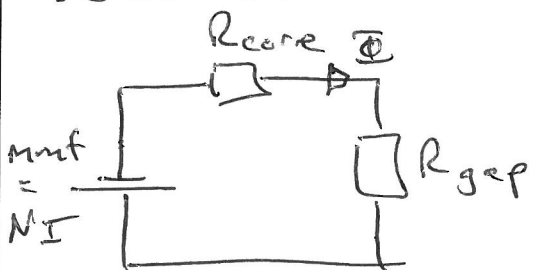


School of Logistics and Mechanical Engineering

EXAMINATION SOLUTIONS: SESSION 2015

Programme:		Level:	6
Module/Unit:	Electrical Machines - M6X00373		
Author:	P. CHARLTON	Page:	1 of 7

Question No	Question	Marks
①	Description of capacitor or shaded pole stator configuration.	⑩
②	Assuming no leakage flux and no fringing the flux in air gap is also the flux in the core. Simple series circuit arrangement.  Ampere's Law $NI = \int \vec{H} \cdot d\vec{l}$ $NI = \sum mmf_s$ $NI = mmf_{core} + mmf_{gap}$ $I = \frac{mmf_{core} + mmf_{gap}}{N}$ $B_{core} = \frac{\Phi}{A} = \frac{180 \times 10^{-6}}{(20 \times 10^{-3})^2} = 0.45 T.$	

Continuation Sheet

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Question No	Question	Marks
② cont.	From the cast-iron B-H curve $H_{core} = 1250 \text{ A.t/m}$ $\text{mmf}_{core} = H_{core} \times L_c$ $= 1250 \times 420 \times 10^{-3}$ $= \underline{525 \text{ A.t}}$ $\text{mmf}_{gap} = H_{gap} \times L_a$ $= \frac{B_{gap}}{\mu_0} \times L_a$ $= \frac{0.45}{4\pi \times 10^{-7}} \times 60 \times 10^{-3}$ $= \underline{21485.92 \text{ A.t.}}$ $\therefore I = \frac{525 + 21485.92}{1000} = \underline{22.011 \text{ A}}$	10

Continuation Sheet

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Question No	Question	Marks
3	Given $W = \frac{1}{2} \int_{\text{vol}} B \cdot H \, dv$ $H = \frac{B}{\mu_0} \rightarrow W = \frac{1}{2} \int_{\text{vol}} \frac{B^2}{\mu_0} \, dv$ if B uniform, μ_0 is constant $W = \frac{B^2}{2\mu_0} \int_{\text{vol}} dv$ $W = \frac{B^2}{2\mu_0} \times \text{vol}$ $W = F \times \text{distance}$ $\therefore F \times \text{length} = \frac{B^2 \times \text{vol}}{2\mu_0} = \frac{B^2 \times A \times \text{length}}{2\mu_0}$ $\div \text{Horo! by length}$ $F = \frac{B^2 A}{2\mu_0}$	6

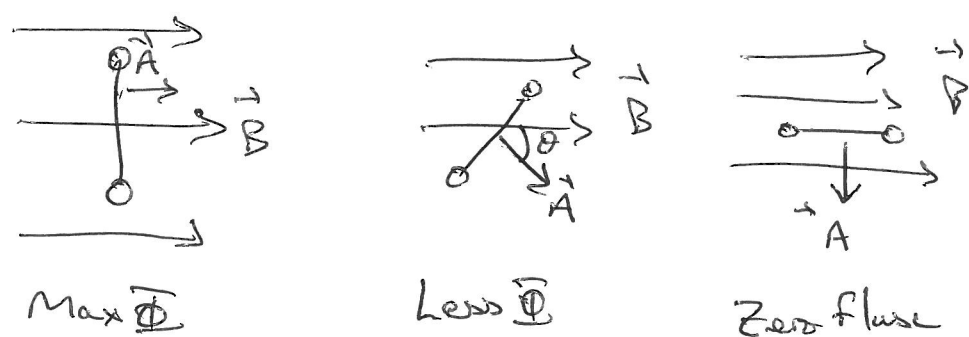
Continuation Sheet

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Question No	Question	Marks
(4)	Energy stored in gap $W = \frac{0.45^2 \times L \times A}{2\mu_0}$ $= \frac{0.45^2 \times 60 \times 10^{-3} \times (20 \times 10^{-2})^2}{2(4\pi \times 10^{-7})}$ $= \underline{1.934 \text{ J}}$ $F = \frac{B^2 A}{2\mu_0} = \underline{32.23 \text{ N}}$	(2)
(5)	Using $F = BIL$; $I = \frac{V}{R} = \frac{2.4}{0.08} = 30 \text{ A}$ $F = 0.75 \times 30 \times (150 \times 10^{-3})$ $= \underline{3.375 \text{ N}}$	(2)

Continuation Sheet

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Question No	Question	Marks
⑥	 Max Φ Less Φ Zero flux $\Phi = \vec{B} \cdot \vec{A}$ taking part of B $A \rightarrow$ cross section in direction of A (dot product) coil. $\Phi_B = AB \cos \theta$ Using Faraday's Law of Induction $\mathcal{E} = -N \frac{d\Phi}{dt}$ assuming uniform flux distribution $\Phi = AB \cos \theta$ $\therefore \mathcal{E} = -N \frac{d}{dt} [AB \cos \theta]$ $\theta = \omega t$ $= -N \frac{d}{dt} [AB \cos(\omega t)]$ AB constants $\mathcal{E} = -NBA \frac{d}{dt} [\cos(\omega t)]$	

Continuation Sheet

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Question No	Question	Marks
6 cont.	$\frac{d}{dt} [\cos(\omega t)] = -\omega \sin(\omega t)$ $\therefore \underline{\mathcal{E} = +NBA\omega \sin(\omega t)}$	8
7	a) $\mathcal{E}_{\max} = NBA\omega$ $A = (50 \times 10^{-3}) \times (300 \times 10^{-3})$ $= \underline{15 \times 10^{-3} \text{ m}^2}$ $\omega = 2\pi f ; f = \frac{rpm}{60} = \frac{3000}{60} = 50 \text{ Hz.}$ $\mathcal{E}_{\max} = 200 \times 0.25 \times (15 \times 10^{-3}) \times 2\pi \times 50$ $= \underline{235.62 \text{ V.}}$ b) When coil is at 90° to Φ $\Phi_{\max} = BA$ $= 0.25 \times (15 \times 10^{-3})$ $= \underline{3.75 \text{ mWb.}}$	3 2

Continuation Sheet

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Question No	Question	Marks
8	a) Force acting on one side of coil Coil is 150 turns so each side ~~experiences~~ equivalent to 150 conductors each 20mm long. $F_{\text{per cond}} = B I l$ $= 450 \times 10^{-3} \times 25.4 \times 10^{-3} \times 20 \times 10^{-3}$ $= \underline{228.6 \mu\text{N}}$ $\therefore$ Force on each side of coil $= 150 \times 228.6 \times 10^{-6}$ $= \underline{34.29 \text{ mN}}$ b) Max. Torque on coil $\tau = F \times w$ $= 34.29 \times 10^{-3} \times 15 \times 10^{-3}$ $= \underline{514.35 \mu\text{N}}$ c) Maximum torque when coil area at 90° to B and minimum when coil area at 0° to B.	3 2 2
9	Description of self starting synchronous motor.	10