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Kafrelsheikh University
Faculty of Engineering
Department: Electrical Power and Machines
Year : 2nd year (2007) 2015-2016
Subject: Energy Conversion
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Date: 4-6-2016.
Time Allowed: 3 hrs.
Full Mark: 90 Marks.
Final 2nd Term Exam: 2 pages
Academic Code: EPM 2204.

Answer All The Following Questions:

Question (1) (25 Marks)

a) Fig. 1 shows a magnetic circuit of iron of high permeability. Two air gaps each of length g and area A_g and a permanent magnet (PM) of length l_m and area A_m.
   i. ***Determine*** the necessary condition to minimize the volume of PM for a desired value of the flux density in the air gap.
   ii. With the aid of B-H curve of PM ***show*** the point of maximum energy product

b) The coils of the magnetic circuit shown in Fig. 2 are connected in series so that the mmf's of paths A and B both tend to set up flux in the center leg C in the same direction. The coils are wound with equal turns, $N_1 = N_2 = 1000$. The air gap length = 0.4 cm and the dimensions are:

Path	A	B	C
Length (cm)	17	17	5.5
Area (cm^2)	7	7	14

The core is made of M-5 grain oriented steel having B-H relation given in the following table:

H(AT/m)	8	9.5	12	17	27
B(Tesla)	0.6	0.8	1.0	1.2	1.4

Neglect fringing and leakage.
   i. ***Find*** the amperes required to produce a flux density of 1.2 T in the air gap.
   ii. ***Calculate*** the inductances.

Question (2) (20 Marks)

a) In a doubly excited magnetically linear system with saliency associated with both the rotor and stator, ***derive*** an expression for:
   i. The induced voltage in the system, ***explaining*** both motional and transformer induced voltages.
   ii. Incremental electrical energy dW_{elec} and electrical power

b) Fig. 3 shows in cross section a cylindrical solenoid magnet in which the cylindrical plunger moves vertically in brass guide rings of thickness g and mean diameter d. the permeability of brass is the same as that of free space. The coil has N turns and resistance R ohms. Its terminal voltage is *V*, and its current is *i*. the effect of magnetic leakage and reluctance of the steel are negligible.
   i. ***Derive*** expressions for the magnetic reluctances in terms of x
   ii. ***Derive*** expressions for the inductance in terms of x and dimensions.
   iii. ***Derive*** an expression for The magnetic force acting upward on the plunger

Question (3): **(25 Marks)**

a) ***Discuss*** briefly:

i. The magnetic hysteresis ii. Coenergy iii. Self and mutual inductances

b) For a linear translational electromechanical energy system, ***derive*** an expression for current, flux linkage and force in terms of stored energy and coenergy

c) Consider a singly-excited system with cylindrical stator and rotor. The excitation via the stator coil is given by:

$i_s(t) = \sqrt{2}\, I_s \cos(\omega t+\delta)$

The excitation via the rotor current is dc excitation, I_{rdc}

Find:

i. The torque on the rotor in terms of the coil current and the rotor position.

ii. The value of average torque, if the rotor rotates at a constant angular velocity of ω (i.e. it is equal to the current angular frequency).

iii. The numerical value of average torque for I_s=10 A, I_{rdc}=0.6A, M_{max}=0.05mH and δ=0.0

Question (4) **(20 Marks)**

a) ***Explain*** the dot convention employed to determine the polarity of the mutually induced voltages.

b) ***Explain***, briefly, the operation conditions and construction of the synchronous machine.

c) ***State*** three types of renewable energy sources and ***discuss*** the direct and indirect method for both solar and geothermal energy conversion, (***Give*** diagrams showing the element of such plants).

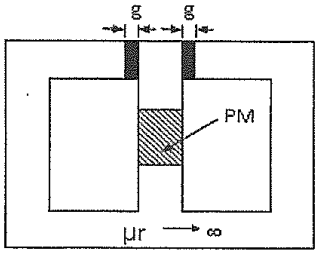

Fig. 1 Magnetic circuit of Q 1(a)

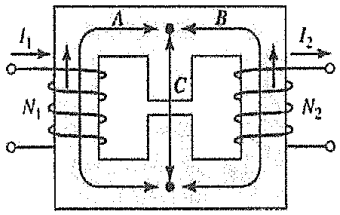

Fig. 2 Magnetic circuit of Q1 (b)

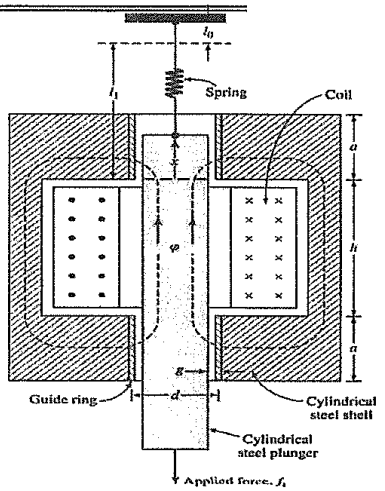

Fig. 3 Magnetic circuit of Q2

Best Wishes

Dr. Amlak Abaza