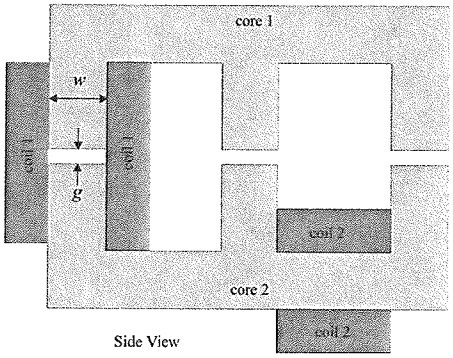
PE-1
August 2011 QE

Problem 1. 34 pts. Consider the magnetic device below. The permeability of the cores is infinite, and you may neglect fringing and leakage flux. The air gap $g = 3.14159$ mm, $w = 2.5$ cm, and the depth into the page is 10 cm. Coil 1 has 100 turns (with a direction such that positive current tends to cause flux to go up in the leftmost leg) and a current of 10cos(100t) A. Coil 2 has 100 turns (with a direction such that positive current tends to cause positive flux to travel to the left through the coil) and a current of 40cos(100t) A. The resistance of both coils is zero. What is the voltage across coil 2 as a function of time.



Problem 2. 33 pts. The flux linkage equations for a two-phase electromagnetic device are shown below, where θ_{rm} is the rotational position. Derive an expression for torque in terms of i_{as}, i_{bs}, and θ_{rm}. Assume that both currents are greater than or equal to zero.

$$\lambda_{as} = 5i_{as} - 3\cos(2\theta_{rm})(i_{as} + i_{bs})^{1/2} + 2\cos(\theta_{rm})$$
$$\lambda_{bs} = 5i_{bs} - 3\cos(2\theta_{rm})(i_{as} + i_{bs})^{1/2} + 2\sin(\theta_{rm})$$

Problem 3. 33 pts. The stator flux linkage equations of a new type of induction machine are given by

$$\lambda_{as} = 5i_{as} - i_{ar} - i_{br}$$
$$\lambda_{bs} = 5i_{bs} - i_{as} - i_{br}$$

In analyzing this machine, the qd0 transformation for stator variables is

$$f_{qds} = \begin{bmatrix} 2 & 1 \\ -1 & 2 \end{bmatrix} f_{abs}$$

The transformation for rotor variables is

$$f_{qdr} = \begin{bmatrix} 4 & 4 \\ 2 & 4 \end{bmatrix} f_{abr}$$

Express the stator flux linkage equations in terms of qd variables. Answers can be left in terms of fractions.

Write in Exam Book Only