ECE 331 - Homework #1

Magnetics, Generated Voltage, Energy Conversion

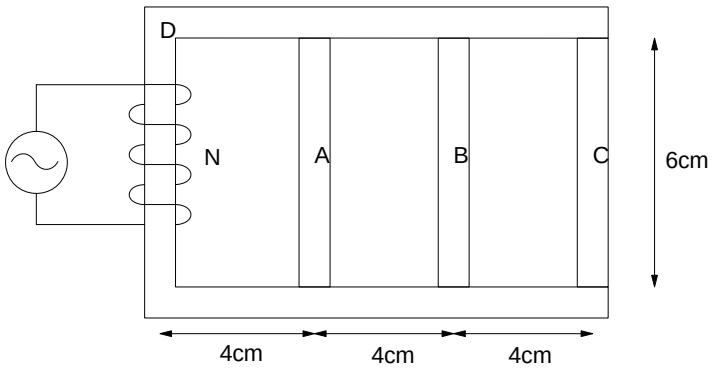
1) An inductor has a reluctance of 1000 A-T/Wb. The inductor has 500 turns of copper wire and draws 5A when connected to +30VDC. Determine a) the core flux, b) the resistance of the wire.

2) A magnetic circuit has a length of 2m and a cross sectional area of 0.1m2. Excitation is provided by a 100-turn 50 Ohm coil. Determine the voltage required to establish a flux density of 2T. The reluctance of the magnetic circuit is 800 A-T/Wb.

3) A coil with 100 turns draws 3A. The material of the core has a cross sectional area of 3cm x 3cm for each part. Four different materials are used:

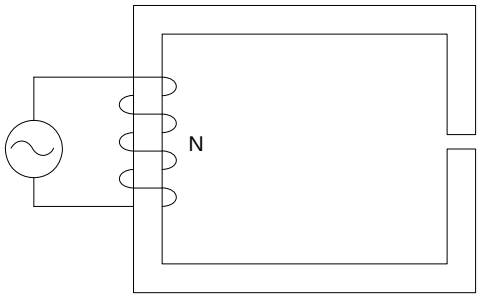
- A: Aluminum: permeability = 1
- B: Purified Iron: permeability = 180,000
- C: 4% Silicon Iron: permeability = 7,000
- D: 78-Permalloy: permeability = 800,000

The length of A/B/C are 4cm and the length of



Determine the flux in each section of the core.

4) The magnetic circuit below has a cross sectional area of 3cm x 3cm and a length of 20cm. The coil has a resistance of 60 Ohms and has 100 turns. The air gap is 1mm. Determine the battery voltage required to obtain flux density of 2T in the air gap.



5) Assume the air gap is removed. The input is 240VDC, the resistance is 60 Ohms, and there are 100 turns. Determine a) the magnetic field intensity, b) the core flux density, c) the relative permeability of the core, and d) the reluctance of the magnetic circuit.

6) Find the inductance of this device. Assume N = 100 turns, R = 60 Ohms, the cross sectional area is 3cm x 3cm, the length of the iron is 20cm, and the material is Silicon-steel.

7) Find the hysteresis losses at a) 60Hz, b) 180 Hz, and c) 600Hz. Assume n=2.

8) Find the eddy current losses at a) 60Hz, b) 180Hz, and c) 600Hz. Assume the lamination thickness is 1mm, and Ke = 0.001.

9) Give a model for this inductor operating at a) 60Hz, b) 180Hz, and c) 600Hz.

10) A coil with 100 turns and a cross sectional area of 10cm x 10cm is rotating in a magnetic field of 0.5T. Determine the voltage produced if this coil is rotating at a) 60Hz, b) 400Hz.

Bonus! What is the peak energy usage of the U.S. in kW?