ECE61014 Fall 2019
Homework 1

1 Consider a Cartesian co-ordinate system on a plane (the plane lies on the x- and y-axis). A current of 100 A is flowing up out of the plane at the origin. Find the MMF drop between the point x=1,y=0 and the point x=3, y=2.

2 Consider a Cartesian co-ordinate system (x,y,z). A uniform B-field of 1 T exists along the direction of the x-axis. Now consider the rectangular plane bounded by the points (1,0,0),(0,1,0),(0,1,1),(1,0,1). How much flux is traveling through the rectangular plane?

3 Consider a toroid with a rectangular cross section of 1 cm by 1 cm. The mean radius is 8 cm. Into this toroid, there is cut a 1 mm airgap. The toroid has 100 turns of wire. The magnetic material has a permeability of

$$\mu_B(B) = \mu_0 \frac{\sqrt[n]{B^n + a^n}}{\sqrt[n]{B^n + a^n} - 1}$$

where $n = 5$ and a=1.001. This form looks strange mathematically but has the correct shape. Plot the flux linkage versus current for flux linkages in the range of 0 to 5 mVs. Ignore leakage inductance.

4 Consider a UI core with the following parameters: $w_b = w_e = w_i = 1$ cm; $w_s = w_w = 5$ cm; $d_s = d_w = 2$ cm; $l_c = 5$ cm; $g = 1$ mm; $N = 100$. Suppose the material used is such that for a flux density less than 1.3 T (the saturation point), the magnetic material is linear and has a permeability 1500 times that of free space (i.e. a relative permeability of 1500). Neglecting fringing and leakage, what current will result in a flux density of 1.3 T? In other words, if we call this the point of magnetic saturation, what current will saturate the core.

5 Consider Problem 4. What is the field intensity in the core and in the air gap?

6 Consider Problem 4. What is the inductance?

7 Consider Problem 4. For the stated conditions, how much energy is stored in the air gap? How much energy is stored in the core?

8 Using (2.7-20) and the definition of flux, derive (2.7-25).

9 Using (2.7-34) derive (2.7-35).

10 From (2.7-36)-(2.7-38) derive (2.7-40)-(2.7-43).

11 From Figure 2.24 derive (2.7-55).

12 Consider the magnetic equivalent circuit shown in Figure 2.25(b). Suppose that all reluctances have a value of 1 H^{-1}, and that Ni=100. Order the branches in ascending order wherein branch number increases as one moves from top to bottom and from left to right. Write the branch list for the circuit. Then, using the NAFA, compute $\mathbf{P}_N$ and $\mathbf{\Phi}_N$.

13 Consider the magnetic equivalent circuit shown in Figure 2.25(b). Suppose that all reluctances have a value of 1 H^{-1}, and that Ni=100. Using the MAFA, compute $\mathbf{R}_N$ and $\mathbf{F}_N$.

14 Consider Example 2.9A. Suppose the cross section of the magnet is different that the cross section of the air gap. Denoting the magnet and air gap cross sections as A_m and A_g, derive an expression for the field intensity in the magnet similar to (2.9A-4)