KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

SECOND SEMESTER 2006/2007

EE 340 (01) MAJOR EXAM II

LOCATION: 7-122

TIME: 6:30 -8:00 P.M.

DATE: SATURDAY 19-MAY-2007

Student's Name:……………………………………………

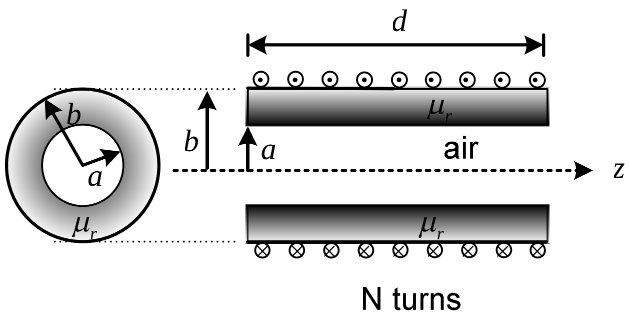
Student's I.D. Number: ………………….

	Maximum Score	**Score**
Problem 1	**25**	
Problem 2	**25**	
Problem 3	**25**	
Problem 4	**25**	
Total	**100**	

Problem 1 [25 points]

A solenoidal inductor is formed by wrapping N turns of negligibly thin wire around a cylindrical shell. The cylindrical shell has a relative permeability μ_r, an inner radius a and an outer radius b. Assume that the length of the solenoidal inductor is much larger than its outer cross sectional radius (i.e. $d >> b$).

Derive an expression for the self inductance.

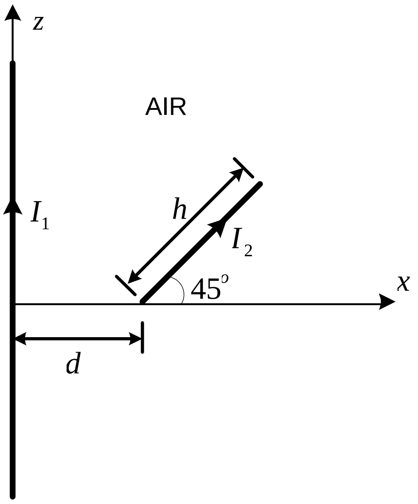


Problem 2 [25 points]

The diagram shows an infinitely-long filamentary conductor which carries the steady current I_1. The ***coplanar finite-length*** filamentary conductor of length h carries the steady current I_2. This conductor is placed in the $x-z$ plane at 45^o with respect to the $x-$ axis. The separation between the infinitely-long conductor and the ***near edge*** of the finite-length conductor equals d. The surrounding medium is air.

Derive an expression for the resulting magnetic force $\vec{F}_m$ acting on the ***finite-length*** conductor.

[Hint: The steady current I_1 induces the magnetic field $\vec{H}_1$. An expression for $\vec{H}_1$, valid only in the $x-z$, is given by: $\vec{H}_1 = \frac{I_1}{2\pi x}\vec{a}_y$].



Problem 3 [25 points]

Consider the plane boundary $x = 0$, which separates two semi-infinite media. Medium 1 $(x > 0)$ is air and medium 2 ($x < 0)$ is a magnetic material with a relative permittivity $\mu_r = 6$. The magnetic flux density vectors in medium 1 and medium 2 are respectively given by:

$$\vec{B}_1 = 3\vec{a}_x - 5\vec{a}_y + 10\vec{a}_z \quad [\mu Wb / m^2]$$

$$\vec{B}_2 = B_{2x}\vec{a}_x + 36\vec{a}_y + 48\vec{a}_z \quad [\mu Wb / m^2]$$

a) Find the numerical value of B_{2x} in $\mu Wb / m^2$.

b) Calculate the surface current density vector $\vec{K}$ at the boundary.

Problem 4 [25 points]

The cross-sectional area of an infinitely-long cylindrical conductor of radius a is shown in the diagram. The conductor carries the steady current I, which flows in the positive $z-$direction. Assume nonmagnetic media throughout.

a) Derive an expression for the $\vec{B}$ field:

i) Inside the conductor ($\rho < a$).

ii) Outside the conductor ($\rho > a$).

b) Derive an expression for the magnetostatic energy per unit length, stored inside the conductor.