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Spring 2015

ELEC 318 – *Electromagnetic Fields*

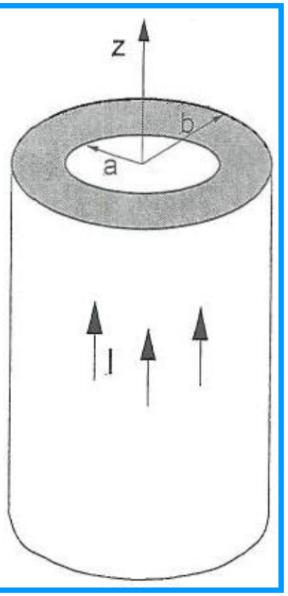
<u>Lecture 6(x,3)</u>

Exam #3
Discussion

1. An infinitely-long cylindrical conductor of radius a is placed along the z axis. The current density in the conductor is $J_0 r\,\hat{\mathbf{z}}$ (where J_0 is a constant in A/m^3). Determine the magnetic field intensity everywhere.

A hollow cylindrical metal shell illustrated below with a = 10 cm and b = 15 cm carries 3 A of current in the $+z$ direction.

(b) Determine the magnetic field intensity as a function of r for all values of r.



Exam review packet #3, Problem #19

Homework #6
Problem #3

An infinitely-long cylindrical conductor of radius a is placed along the z axis. The current density in the conductor is $\dfrac{J_0}{r}\hat{\mathbf{z}}$ (where J_0 is a constant). Determine the magnetic field intensity everywhere.

ELEC 318, Exam #3 – Problem #2

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2. The boundary between two magnetic media is $12x + 5y = 0$.
Medium 1 contains all points for which $x < 0$ and $y < 0$.
The magnetic field intensity in medium 1 is $1521\,\hat{\mathbf{x}} + 2028\,\hat{\mathbf{y}}$ A/m.
The permeability of medium 1 is $7\mu_0$. The permeability of medium 2 is $21\mu_0$.

(Assume that there is no surface current along the boundary.)

Determine the magnetic field intensity in medium 2.

Exam review packet #3, Problem #31

Region 1, described by $3x + 4y \geq 10$, is free space, whereas region 2, described by $3x + 4y \leq 10$, is a magnetic material for which $\mu = 10\mu_0$. Assuming that the boundary between the material and free space is current-free, find the magnetic flux density in region 2 if the magnetic flux density in region 1 is $0.1\,\hat{\mathbf{x}} + 0.4\,\hat{\mathbf{y}} + 0.2\,\hat{\mathbf{z}}$ Wb/m^2.

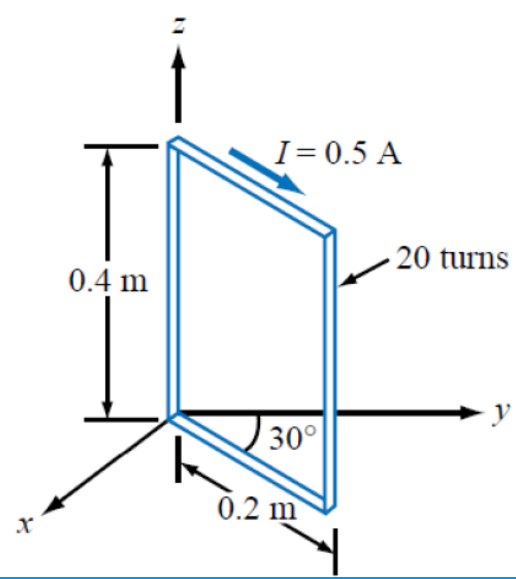
3. A square loop of current, 2 m on each side, lies in the *x*-*y* plane and is centered on the origin. The loop carries 10 A of current, counter-clockwise around the *z* axis.

Describe the motion of this loop if it is inside the uniform magnetic field intensity $378\,\hat{\mathbf{x}} + 557\,\hat{\mathbf{z}}$ A/m and it is free to move.

(Does it move in the *x*, *y*, or *z* directions? Does it rotate? Which way?) Assume $\mu = \mu_0$.

Homework #7, Problem #1

The rectangular loop shown in the figure consists of 20 closely-wrapped turns and is hinged along the *z* axis. The plane of the loop makes an angle of 30° with the *y* axis and the current in the windings is 0.5 A. The loop experiences a magnetic flux density of $2.4\,\hat{\mathbf{y}}$ $\mathrm{Wb/m^2}$. Using a magnetic moment, determine (a) the magnitude of the torque exerted on the loop, and (b) the direction of rotation when viewed from above.



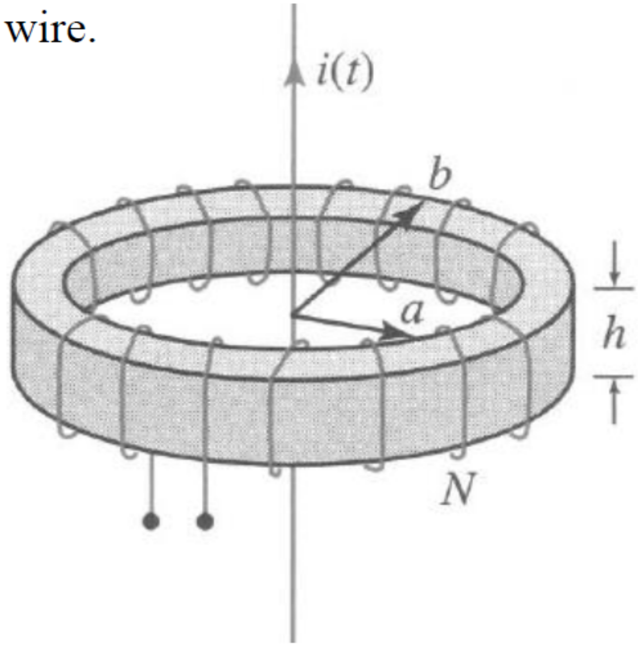
4. A coil is wrapped tightly around the magnetic ring-shaped core depicted. The cross section of the core is rectangular.

The core has an inner radius of $a = 7.9$ mm , an outer radius of $b = 12.4$ mm , a height of $h = 9.0$ mm , and a relative permeability $\mu_r = 600$.

A long, straight wire passes through the center of the ring.

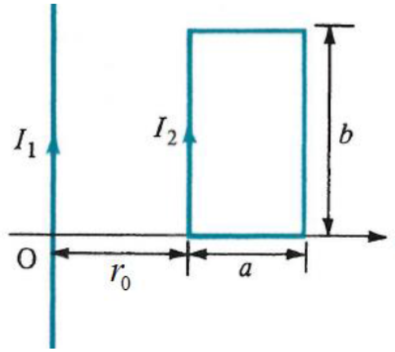
The number of turns of the coil is $N = 1500$.

Determine the mutual inductance between the coil and the wire.



Homework #7, Problem #5

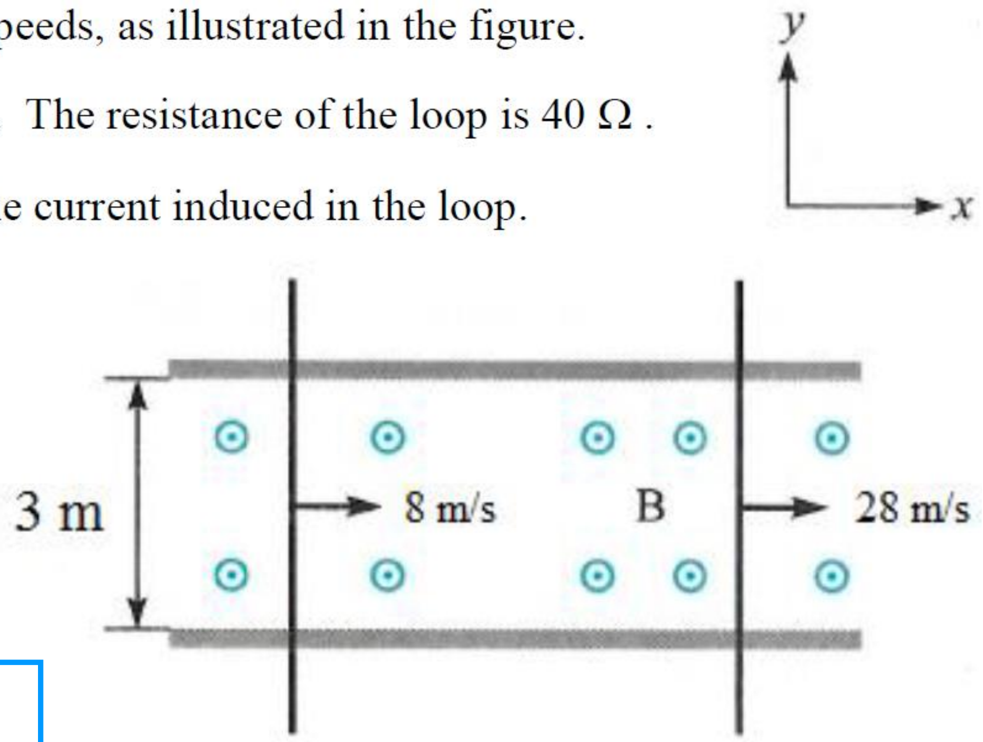
Determine the mutual inductance between the rectangular loop and the infinite line current in the figure when $a = b = r_0 = 1$ m .



5. Two conducting bars slide over two stationary rails and move in the $+x$ direction at different speeds, as illustrated in the figure.

The magnetic flux density is $4\,\hat{\mathbf{z}}$ mWb/m^2. The resistance of the loop is 40 Ω.

Determine the magnitude and direction of the current induced in the loop.



Exam review packet #3, Problem #45

Two conducting bars slide over two stationary rails, as illustrated in the figure.

The magnetic flux density is $0.2\,\hat{\mathbf{z}}$ Wb/m^2. Determine the voltage induced in the loop.