Exam 3

P208 Fall 2009,
Instructor: Prof. Abanov

11/09/09

Name_____   Section_____
          (print)

501 Fuller, Melissa	Tues, 2:20-5:10	516 Li, Feng	Thurs, 8:00-10:50
502 Mahony, James	Tues, 3:55-6:45	517 Amin, Vivek	Thurs, 9:35-12:25
503 Chen, Jason	Tues, 4:55-7:45	518 Chen, Jason	Thurs, 11:10-2:00
504 Ferguson, Jim	Tues, 5:55-8:45	519 Russell, Charles	Thurs, 12:45-3:35
505 Zhang,Xiwen	Tues, 6:55-9:55	520 Zhang,Xiwen	Thurs, 2:20-5:10

Problem 1.

Two high current transmission lines carry currents of $25A$ and $75A$ in the opposite directions. And are suspended parallel to each other $35cm$ apart. The vertical posts supporting these wires divide the lines into strait $20m$ segments.

What magnetic force does each segment exert on the other?_____

Is this force attractive or repulsive?_____

What would happen to the force if we double each current?_____

Problem 2.

An electron $e = 1.6 \times 10^{-19} C$, $m_e = 9.1 \times 10^{-31} kg$ is accelerated through a potential difference of $2kV$. It then passes into magnetic field perpendicular to its path, where it moves in a circular arc of diameter $0.36m$

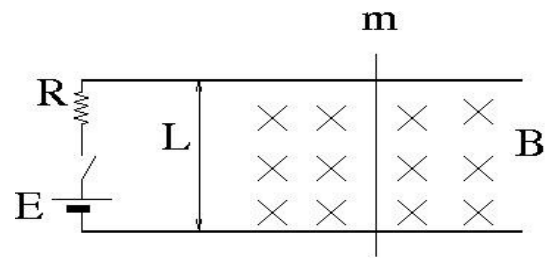**What is the magnitude of the velocity of the electron in the magnetic field?____**

What is the magnitude of the magnetic field?____

What is the frequency of the electron's motion in the magnetic field?____

Problem 3.

A metal bar is at rest on two rails, as shown on the figure. $E=10\text{V}$, $R=1\,\Omega$, $L=50\text{cm}$, $B=5\text{T}$, and $m=0.5\text{kg}$

What is the current through the bar right after the switch is closed?_____

What are the direction and magnitude of the magnetic force initially acting on the bar? _____

What is the initial acceleration of the bar?_____

Problem 4.

A planar loop of area $A = X.XX \, m^2$ carries a current $I = 8A$. The magnetic field $B = X.X \, T$ is at an angle XX° with the norm to the loop.
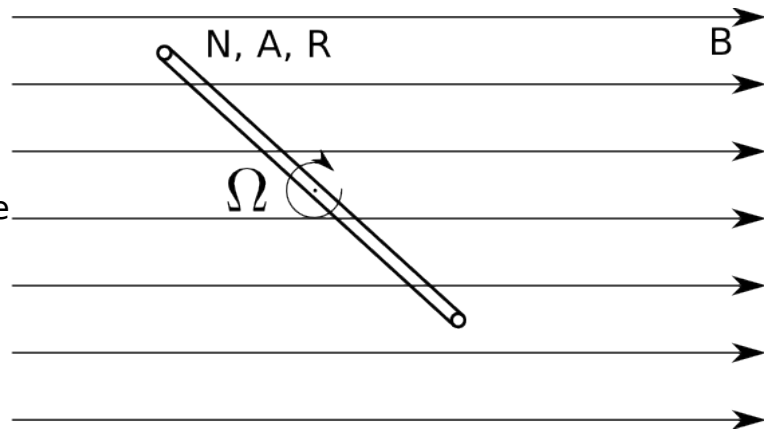
What is magnetic moment of the loop?_____

What is the magnetic force acting on the loop?_____

What torque should be applied to the loop in order to keep it at rest? _____

What torque would be needed if the loop had 100 turns?_____

Problem 5.

A planar loop of area A with N turns is placed in the uniform magnetic field B . The resistance of the loop is R . Initially the plane of the loop is perpendicular to the magnetic field. At time $t=0$ a student starts to rotate the loop with the angular velocity Ω .

N, A, R

Ω

B

What is the emf in the loop at arbitrary time t ?_____

What is the current in the loop at arbitrary time t ?_____

**What power is being dissipated in the loop at arbitrary time t ?_____**

What is the magnetic moment of the loop at arbitrary time t ?_____

What is the torque which the student needs to apply to the keep the constant angular velocity at arbitrary time t ?_____

What power does the student need to supply to the keep the constant angular velocity at arbitrary time t ?_____

Problem 6.

A wire with a current $I=2\text{mA}$ is in the $x-y$ plane and has the form shown in the figure with dimensions $R=10\text{cm}$ and $h=10\text{cm}$. The magnetic field $B=0.5\text{T}$ is in the $y-z$ plane at the angle $\Theta=30°$ to the z axes.
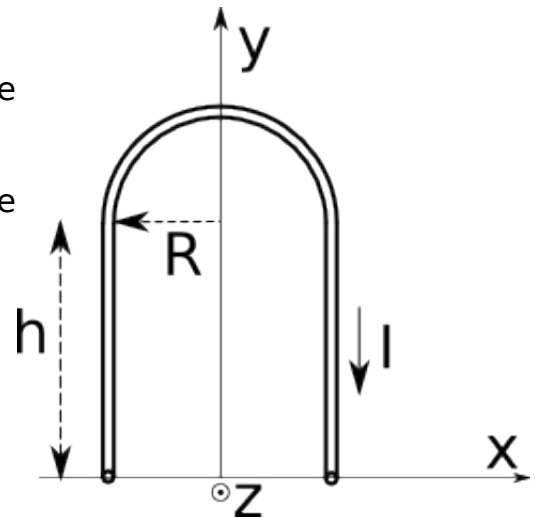
What are the x , y and z components of the magnetic force acting on the wire?_____

What is the torque of the magnetic force with respect to the x axis? _____

Problem 7.

A metal bar of mass $m=10\text{kg}$ can move along two vertical straight rails which are $L=1\text{m}$ apart from one another. The total friction force between the bar and the rails is proportional to the velocity $F_f=kv$, where $k=0.25\text{Ns}/m$. The resistor $R=3\Omega$ connects the rails. Magnetic field is $B=0.5\text{T}$ After a long time the bar falls with constant velocity.
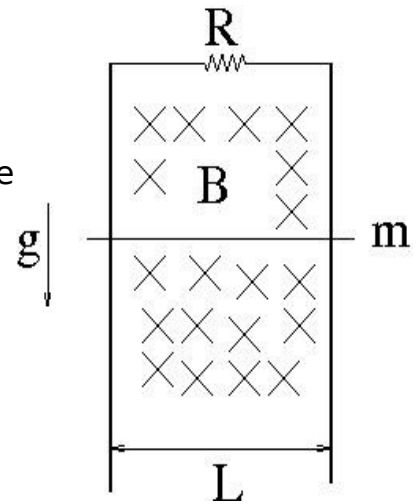
What is the direction of electric current induced by the motion?(show on the figure)

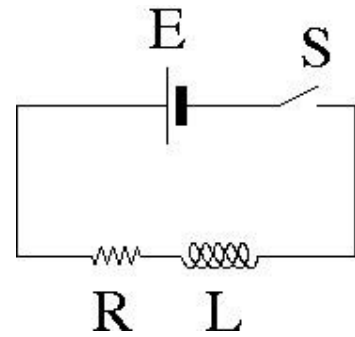**What is the direction of the magnetic force acting on the bar?(show on the figure)**

What is the velocity of the bar?_____

What will be the velocity if we triple the magnetic field?_____

Problem 8.

A circuit show on the figure has $E=20\text{V}$, $R=2\text{k}\Omega$, $L=10\text{mH}$.

What is the current right after the switch is closed? _____

How fast is the current changing right after the switch is closed?_____

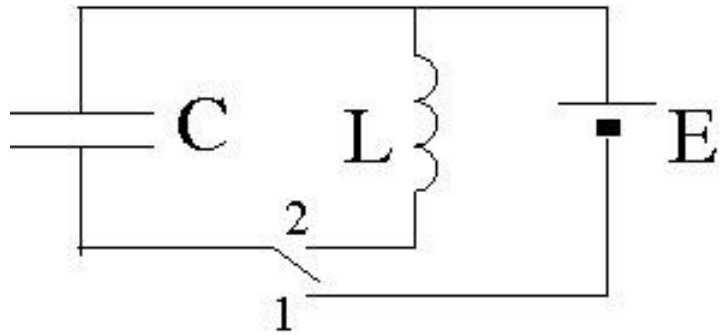**What is the current a long time after the switch is closed?**_____

What is the time constant of this circuit?_____

Problem 9.

After the switch had been in the position 1 for a very long time, it was switched to the position 2. If
$C=45$mF , $L=5$mH , $E=20$V find:

**What is the time derivative of the current right after the switch was switched?_____**

What is the frequency of oscillation?_____

What is the amplitude of the current oscillations?_____

What is the total energy in the system?_____

Problem 10.

$+\infty$

An infinitely long vertical thin solenoid with the cross-section area A goes at angle ϕ through the center of the rectangular horizontal loop of wire with sides a and b. The density of turns in the solenoid is n. There is a time dependent current $I(t)$ in the wire loop.

φ

b

a

R

$I(t)$

$-\infty$
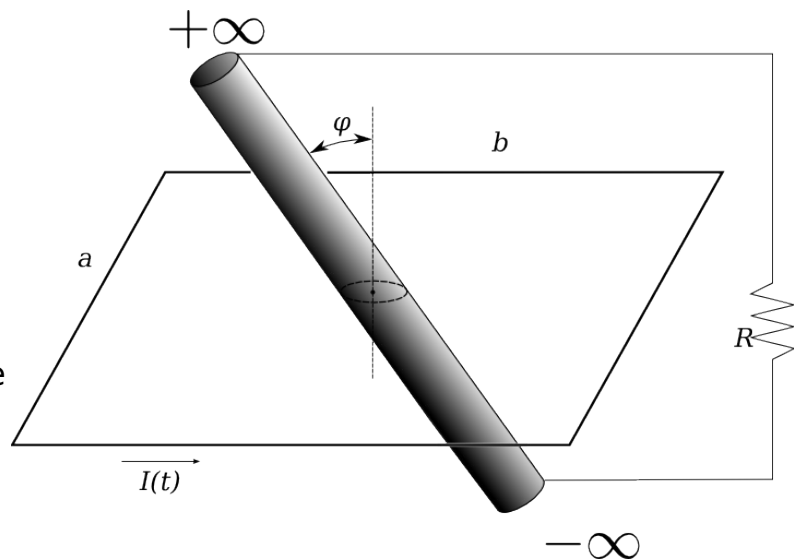
What is the *emf* between the ends of the solenoid?_____

How would this *emf* change if we double the side a ?_____

How would this *emf* change if we double the tilt angle ϕ ?_____

What charge would go through the resistor R , if the current in the wire loop was changed from I_i to I_f during the experiment?_____
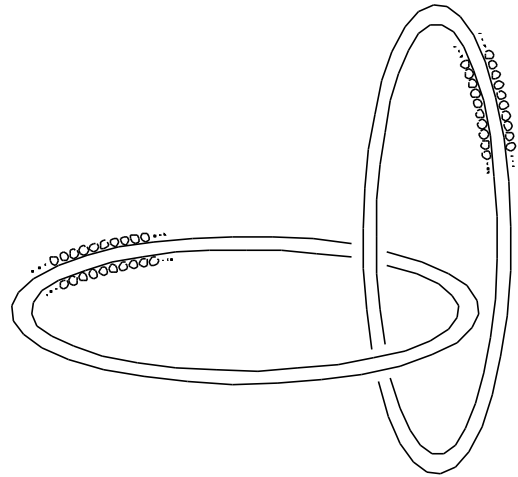
Extra Problems.

You have until the Final Exam to solve these problems. The first student who solves any gets 10 extra points for this exam. Please, take this sheet with you.

Extra Problem 1.

Find the mutual inductance of two entangled solenoids (see figure).

The cross-section areas of the solenoids are A_1 and A_2, and the densities of turns are n_1 and n_2.

Extra Problem 2.

A particle of charge q and mass m is moving with large velocity v and impact parameter d with respect to a small planar loop of wire of resistance R.

The area of the loop is A and the loop and the vector of velocity $\vec{v}$ lay in the same plane.
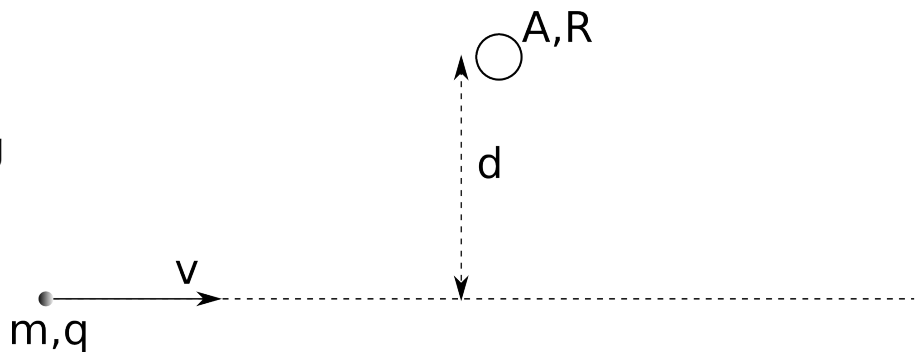
Find the final velocity of the charge.

Find direction of the final velocity.

Find the final impact parameter.