

# Exam 3

**P208 Fall 2008,  
Instructor: Prof. Abanov**

**11/03/08**

Name\_\_\_\_\_

Section\_\_\_\_\_

(print)

Your grade:

**Problem 1.**

Two high current transmission lines carry currents of  $25\text{A}$  and  $75\text{A}$  in the same direction. And are suspended parallel to each other  $35\text{cm}$  apart. The vertical posts supporting these wires divide the lines into straight  $15\text{m}$  segments.

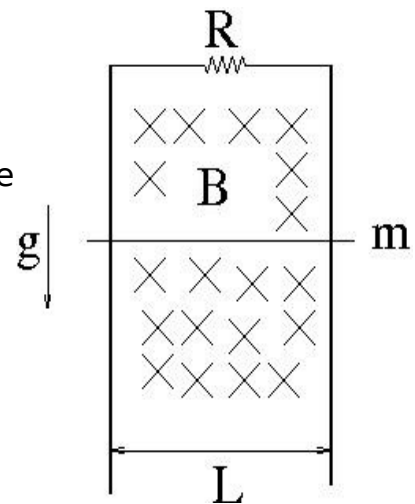
**What magnetic force does each segment exert on the other? \_\_\_\_\_**

**Is this force attractive or repulsive? \_\_\_\_\_**

**What would happen to the force if we double each current? \_\_\_\_\_**

## Problem 2.

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  $F_f=50\text{N}$ . The resistor  $R=2\Omega$  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)**

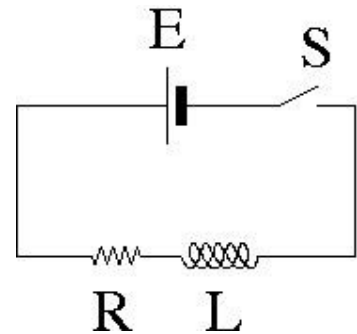
**What is the direction of the magnetic force acting on the bar?(show on the figure)**

**What is the velocity of the bar? \_\_\_\_\_**

**What will be the velocity if we double the magnetic field? \_\_\_\_\_**

### Problem 3.

A circuit shown on the figure has  $E=10\text{V}$  ,  $R=1\text{k}\Omega$  ,  
 $L=5\text{mH}$  .



**What is the current right after the switch is closed?**  
\_\_\_\_\_

**How fast the current is changing right after the switch is closed?**\_\_\_\_\_

**What is the current long time after the switch is closed?**\_\_\_\_\_

**What is the time constant of this circuit?**\_\_\_\_\_

### Problem 4.

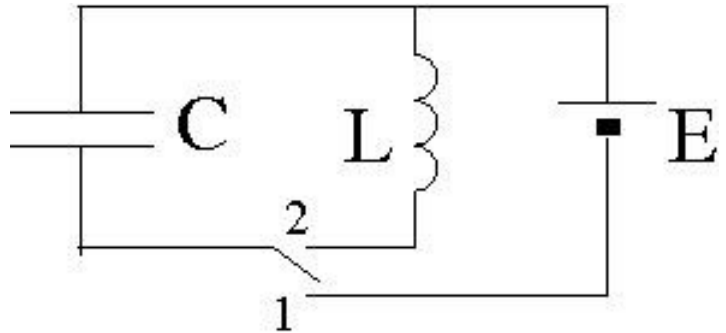
After the switch had been in the position 1 for a very long time, it was switched to the position 2. If  $C=20\text{mF}$  ,  $L=5\text{mH}$  ,  $E=10\text{V}$  find:

What is the time derivative of the current right after the switch was switched? \_\_\_\_\_

What is the frequency of oscillations? \_\_\_\_\_

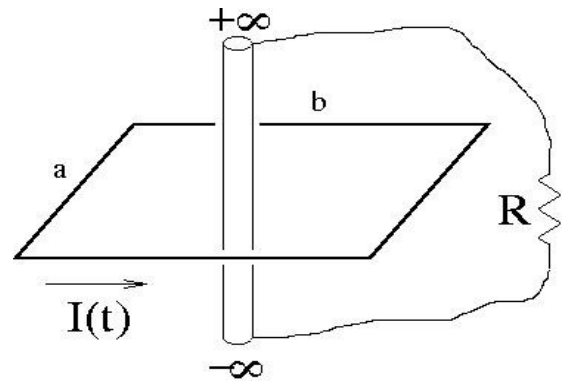
What is the amplitude of the current oscillations? \_\_\_\_\_

What is the total energy in the contour? \_\_\_\_\_



## Problem 5.

An infinitely long vertical thin solenoid with the cross-section area  $A$  goes 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.



**What Electro Motive Force is between the ends of the solenoid?\_\_\_\_\_**

**How would this EMF change if we double the side  $a$  ?\_\_\_\_\_**

**How would this EMF change if we tilt the solenoid to the angle  $\phi$  with respect to the vertical?\_\_\_\_\_**

**What charge went through the resistor  $R$ , if the current in the wire loop had changed from  $I_i$  to  $I_f$  during the experiment.?\_\_\_\_\_**

# Extra Problem.

You have all the time till the end of the semester to solve this problem. The first student who solves it gets 10 extra points for this exam. Please, take this sheet with you.

## Extra Problem.

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  $n_2$  .

