# Exam 2

**P208 Fall 2009,**
**Instructor: Prof. Abanov**

**10/12/09**

Name_____ Section_____

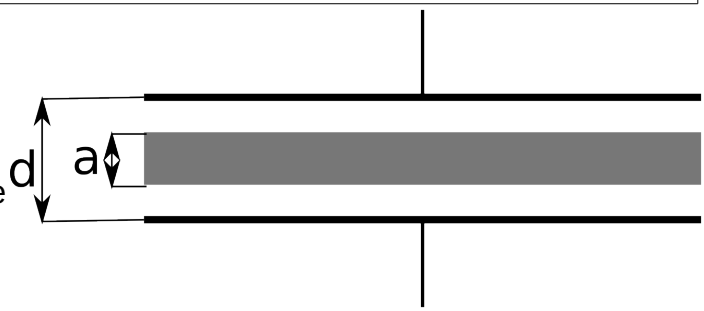
(print)

| | | | |
|---|---|---|---|
| **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** |

Your grade:

**Problem 1.**

A parallel plate air capacitor is made using square $L$ by $L$ plates. The distance between the plates is $d$. A metal slab having thickness $a$ ( $a<d$ ) and the same shape as the plates is inserted in the middle between the plates as shown on the figure.




**What is the capacitance of this capacitor without the slab?**_____

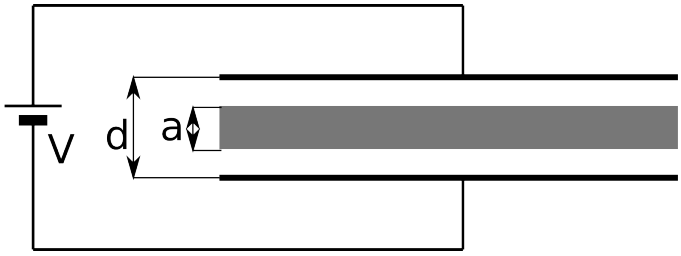
**What is the capacitance of this arrangement with the slab?**_____

**How will the capacitance change if we move the slab up or down (without touching the plates)?**_____

**How will the capacitance change if we move the slab a distance $x$ to the right?**
_____

**Or to the left?**_____

## Problem 2.




A parallel plate air capacitor is made using square $L$ by $L$ plates. The distance between the plates is $d$. A metal slab having thickness $a$ ( $a<d$ ) and the same shape as the plates is inserted in the middle between the plates as shown on the figure. The capacitor is connected to the battery with emf $V$.

**What is the charge on the capacitor without the slab?_____**

**What is the charge on the plates when the slab is inserted?_____**

**What will the charge on the plates be if you move the slab the distance $x$ to the right?_____**

**What is the total work done by the battery after you have moved the slab?_____**

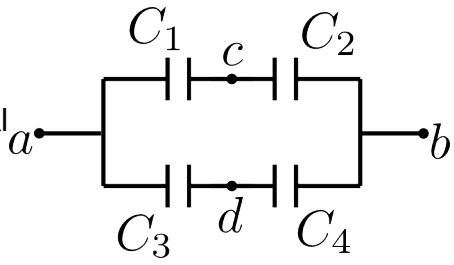
**What is the change of the energy stored in the capacitor?_____**

**What is the total work done by YOU after you have moved the slab?**
**_____**

**What is the minimal force you have to apply to the slab in order move it?**
**_____**

## Problem 3.

In the figure $C_1=C_4=6\mu F$ and $C_2=C_3=3\mu F$ . The potential difference between points $a$ and $b$ is kept $V_{ab}=3\text{V}$ by a battery.




**What is the charge on each capacitor?** $C_1$ _____, $C_2$ _____, $C_3$ _____, $C_4$ _____,

**What is the potential difference between points** $a$ **and** $c$ **,** $V_{ac}$ **?**

_____

**What is the potential difference between points** $a$ **and** $d$ **,** $V_{ad}$ **?**

_____

**What is the potential difference between points** $c$ **and** $d$ **,** $V_{cd}$ **?**

_____

## Problem 4.

A current $I = 1.6\text{A}$ is in a copper wire (resistivity $\rho = 1.7\times10^{-8}\Omega\cdot m$ ) with cross section area $A = 5.88\times10^{-7}m^2$ and length $L = 100\text{m}$ .

**What is the resistance of the wire?_____**

**How many electrons are crossing a cross section of the wire each second?_____**

**What is the current density in the wire?_____**

**What is the magnitude of the electric field in the wire?_____**

**What is the potential difference between the ends of the wire?_____**

## Problem 5.

A battery with $E = 12\text{V}$ and internal resistance $r = 3\text{k}\Omega$ is connected to a simple circuit with a total resistance of $R = 9\text{k}\Omega$ .

**What is the current through the battery?_____**

**What is the potential difference between the battery's terminals?_____**

**How much power does the battery supply to the simple circuit?_____**

**How much power dissipates inside the battery?_____**

## Problem 6.

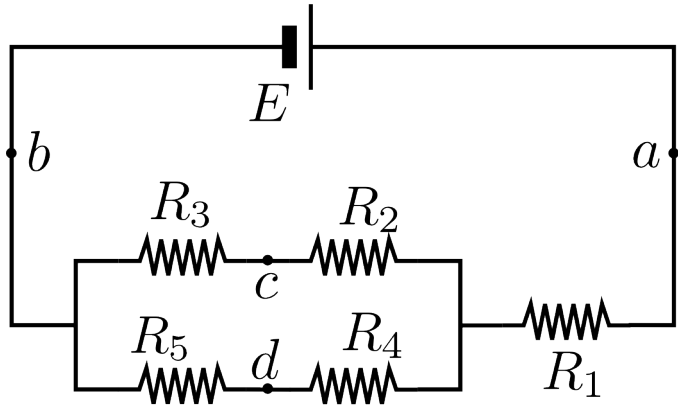
You have a meter with resistance $30\,\Omega$ and full-scale current $I_{fs}$=1mA .

**Design an ammeter with a range $0$ to $50\text{mA}$ (draw schematics and calculate the resistance of the shunt resistor).**

**What is the total resistance of your ammeter?_____**

## Problem 7.

In the circuit shown in the picture
$E = 12\text{V}$ , $R_1 = 2\text{k}\,\Omega$ , $R_2 = 1\text{k}\,\Omega$ ,
$R_3 = 2\text{k}\,\Omega$ , $R_4 = 2\text{k}\,\Omega$ , $R_5 = 4\text{k}\,\Omega$ .




**What is the potential difference between points $a$ and $b$ ?_____**

**What is the current at point $a$ of the circuit?_____**

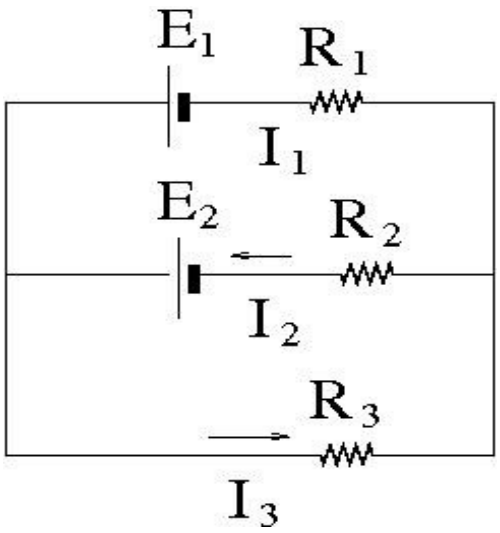
**What is the the current at point $c$ ?_____**

**What is the the current at point $d$ ?_____**

**What is the potential difference between points $c$ and $d$ ?_____**

## Problem 8.

In the circuit shown in the figure $R_1$=1k$\Omega$ , $R_2$=4k$\Omega$ , $R_3$=3k$\Omega$ , $I_2$=4mA , and $I_3$=6mA (directions of $I_2$ and $I_3$ are shown)



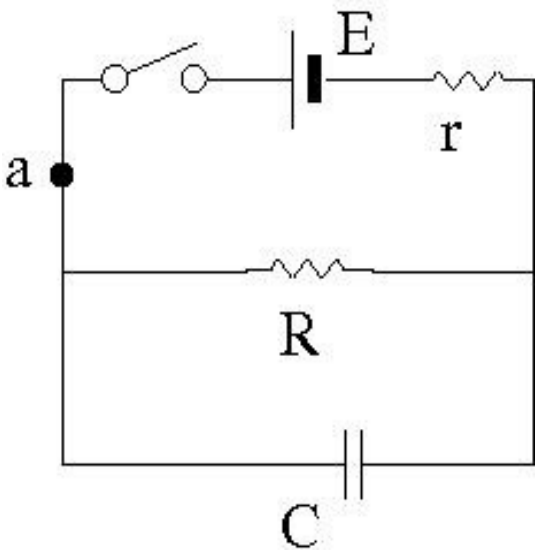

**What is the magnitude and direction (show in the figure) of the current $I_1$ ?_____**

**What is the value of the emf $E_1$ ?_____**

**What is $E_2$ ?_____**

## Problem 9.

In the circuit shown in the figure $E=12\,V$ , $r=2\mathrm{k}\,\Omega$ , $R=4\mathrm{k}\,\Omega$ , and $C=4\,\mu F$ . Initially the capacitor is uncharged. The switch is closed at moment $t_0$ .



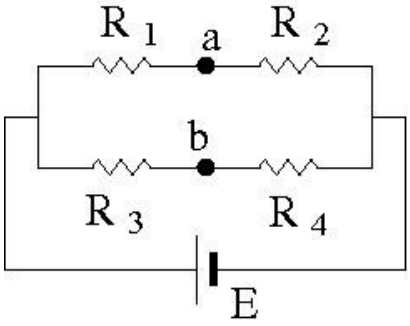

**What is the current in point "a" immediately after $t_0$ ?_____**

**What is the current in point "a" after a very long time?_____**

**What is the charge on the capacitor $C$ long after time $t_0$ ?_____**

## Problem 10.

In the circuit shown on the figure $R_1 = 3\text{k}\,\Omega$ , $R_2 = 9\text{k}\,\Omega$ , and $R_3 = 5\text{k}\,\Omega$ .




**What is the necessary value of $R_4$ such that the potential difference between points $a$ and $b$ is $0$ ?**_____

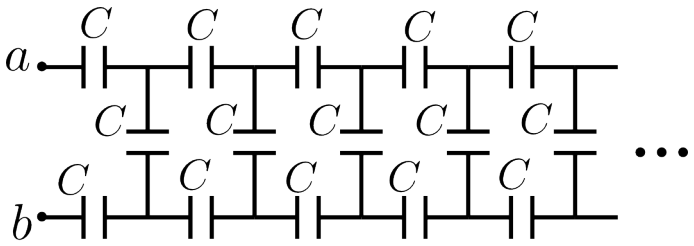
**For $R_4$ which you calculated before what will be the current through a $12\text{k}\,\Omega$ resistor placed between the points $a$ and $b$ ?**_____

# Extra Problems.

Please take this page with you. You have all the time till the final exam to solve these problems. The first student who solves one of the problems will get 5 bonus points for this exam.

**Extra Problem 1.**

The capacitance of each capacitor of the **infinite** series shown in the picture is $C=1\mu F$ . Find the total capacitance between points $a$ and $b$ .




**Extra Problem 2.**

An **infinite** square lattice is made of identical capacitors of capacitance $C=1\mu F$ .

Find the capacitance between nearest neighbor vertices $a$ and $b$ .