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**General Physics II, Midterm 4**
PHYS10400, Class year 98
05-20-2010

SN:_____, Name:_____

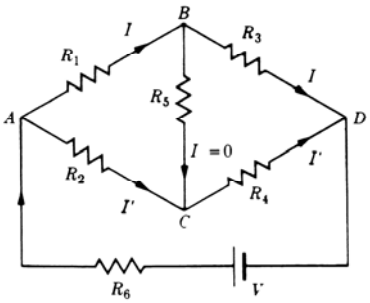
***This is an open-book examine. You are allowed to use any material you brought, but not others.* ABSOLUTELY NO CHEATING!**

## Problems (5 Problems, total 100 points)

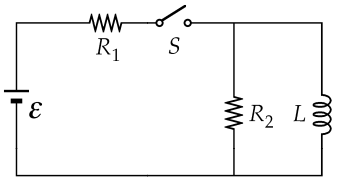
1. (a) Qualitatively explain what the working mechanism of an induction stove is. (10%), (b) Write down Maxwell's 4 Equations, and explain them (10%).

2. **Bohr Theory** (30%): Assume, for simplicity, the electron (charge ***e***) of hydrogen atom moves around the nucleus (with charge ***Ze***) in a circular orbit, (a) derive the orbital angular momentum of the electron according to classical model. (b) What is the total classical energy of this electron in the system? (c) What is the total energy in terms of charge and angular momentum? (d) However, experimentally, angular momentum was observed, "quantized" as $L = n\hbar$, where $\hbar = \frac{h}{2\pi}$ =1.0545×10$^{-34}$Js and ***n*** is a positive integer. What is the "quantized" energy obtained in (c)? When n=1, we said the electron is in its "ground state", that means the electron is closest to the nucleus possible. The radius of the electron can be expressed as $r = \frac{a_0}{Z}n^2$, where $a_0$ is called **Bohr radius**. (e) What is the Bohr radius of the hydrogen electron? Note 1: $m_e$ = the electron mass = 9.1×10$^{-31}$ ***Kg***; $\varepsilon_0$ = vacuum permittivity = 8.85×10$^{-12}$***N$^{-1}$m$^{-2}$C$^2$***; ***e*** = the charge of the electron = 1.6×10$^{-19}$ ***C***. Note 2: However, it should be emphasized that the value of r obtained in (d) must not be taken too literally. According to quantum mechanics it should be considered only as an indication of the order of magnitude of the region in which the electron is most likely to be found.

3. **Wheatstone bridge**: The circuit on the right is called Wheatstone bridge. This circuit is often used to measure resistance for it is a very sensitive measuring device. Determine the conditions under which the current through $R_5$ in the circuit is zero; i. e. what is the relation between $R_1$, $R_2$, $R_3$ and $R_4$? (20%)




4. ***RL* circuit** (20%): At $t$ = 0, the open switch in the right figure is closed. By using Kirchhoff's rules for the instantaneous currents and voltages in this two-loop circuit, show that the current in the inductor at time $t > 0$ is $I(t) = \frac{\mathcal{E}}{R_1}\left[1 - e^{-(R'/L)t}\right]$ where $R' = R_1R_2/(R_1 + R_2)$. (20%)




5. **Earth's magnetic field** (10%): In an experiment designed to measure the Earth's magnetic field (**B**) using the Hall effect, a copper bar 0.500 cm thick is positioned along an east–west direction. If a current of 8.00 A in the conductor results in a Hall voltage of 5.10×10$^{-12}$ V, what is the magnitude of the Earth's magnetic field? (Assume $n$ = 8.46×10$^{28}$ electrons/m$^3$ and the plane of the bar is rotated to be perpendicular to the direction of **B**.)