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*Last Name, First Name*

*Student No.*

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**University of Toronto**  
**Department of Electrical & Computer Engineering**  
**ECE110S – Electrical Fundamentals**  
**Quiz 1 – January 26, 2005, 4:30-5:00 PM**

**Instructions:** Non-programmable calculators allowed. No other aids. Answer in the space provided on these sheets. The back sides of these sheets can be used as well. For full marks you must show methods, state UNITS and compute numerical answers when requested. **Please write in PEN, not pencil.**

**Useful constants:**  $\epsilon_0 = 8.8542 \times 10^{-12}$  F/m,  $\mu_0 = 4\pi \times 10^{-7}$  H/m,  $g = 9.81$  m/s<sup>2</sup>.

1. **Electrostatics.** A parallel-plate capacitor consists of two square metal plates with sides 2 m, oriented horizontally, one in the  $x$ - $y$ -plane of a Cartesian coordinate system, the other one parallel to the first one at  $z = 1$  cm. The potential difference between the plates is 60V.
  - (a) Calculate the capacitance. **(2 marks)**
  - (b) Calculate the charge on each plate. **(2 marks)**
  - (c) Calculate the energy stored in the capacitor. **(2 marks)**
  - (d) A small, non-conducting sphere with a mass of 1 g and carrying a negative charge  $-Q$ , is placed between the plates at  $z = 0.5$  cm where it remains in equilibrium. Determine the magnitude of the charge. **(3 marks)**
  - (e) In part (d), which plate has to be at the higher potential? Explain your answer. **(1 mark)**

2. **Magnetic Field.** Two long, thin, parallel wires are located 2m apart in an external magnetic field  $B_0 = 0.5 \mu T \hat{j}$  (into the plane) and oriented parallel to the z-axis of a Cartesian coordinate system as shown below. Wires 1 and 2 carry currents  $i_1 = 5A$  and  $i_2 = 2A$ , respectively, in the directions indicated.
- Calculate the magnitude of the magnetic field due to wire 2 at point  $P_1$  and the magnitude of the magnetic field due to wire 1 at point  $P_2$ . (2 marks)
  - Determine the total magnetic field at  $P_1$  and  $P_2$  (magnitude and direction). (3 marks)
  - Calculate the magnitudes of the total forces per unit length for both wires and indicate their directions. (3 marks)
  - Determine a current  $i_2$  for which the force on wire 1 is zero. (2 marks)

