McGill University
Faculty of Engineering

CLASS TEST 2
NOVEMBER 2006

COURSE ECSE 353
ELECTROMAGNETIC FIELDS AND WAVES

Examiner:	J. P. Webb	Co-Examiner:	None
Signature:	_____	Signature:	_____
Date:	November 3, 2006	Time:	11:35-12:25

- This is a closed book examination. No books or notes are permitted, except for the Formula Sheet attached.
- The Faculty Standard Calculator (Casio fx-991 or Sharp EL-546L or R or V (VB) or G) only is permitted.
- All units are SI unless otherwise stated
- Unless otherwise stated: *x*,*y*,*z* are rectangular (Cartesian) coordinates; r, ϕ , *z* are cylindrical coordinates; and R, θ, ϕ are spherical coordinates.
- This is a 50 minute exam
- The marks indicated in square brackets at the start of each question are out of 50.

INSTRUCTIONS:

- Answer all questions.
- Put your name and student ID also on the Answer Sheet provided.
- **Part A** is multiple choice. There is one correct answer for each question. Mark your answers on the Answer Sheet, not on this examination paper. Only the answers on the Answer Sheet will be considered.
- **Part B**: Put your answers in the spaces provided on the Answer Sheet.

WHEN INSTRUCTED, TURN TO NEXT PAGE AND START THE EXAM

PART A

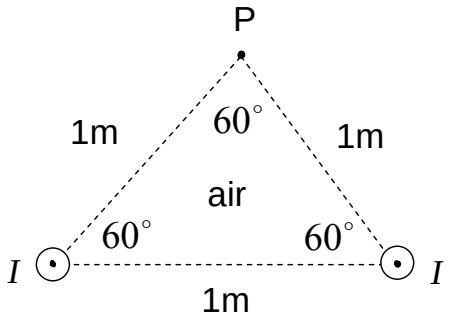
Part A is multiple choice. There is one correct answer for each question. Mark your final answers on the Answer Sheet. Only the answers on the Answer Sheet will be considered.

1. [4] In general, the electric field inside a conductor with steady current flowing in it is:
   A zero
   B non-zero, but uniform throughout the volume of the conductor
   C non-uniform, but not varying in time
   D non-uniform and varying in time

2. [4] Which quantity has the unit with standard abbreviation Wb?
   A magnetic flux density
   B magnetic flux
   C magnetic field intensity
   D magnetic flux linkage

3. [6] Inside a battery, the impressed electric field is $x^2\mathbf{a}_x$ and this is driving a current through the battery. The conductivity, σ, and the permittivity, ε, are both finite and uniform. Find the volume charge density inside the battery.
   A 0 B $x^2\varepsilon$
   C $x^2\sigma$ D $-2x\varepsilon$

4. [6] Two infinitely long, straight, parallel wires are 1m apart and each carries a current I=1 A. Find the *magnitude* of the magnetic flux density at the point P which is 1m from each wire, as shown.

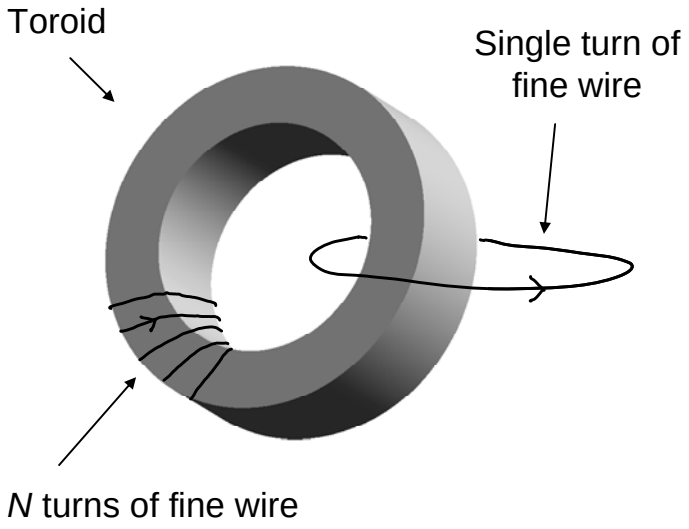


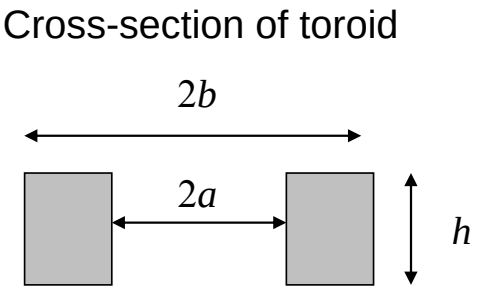
   A 0 B 0.200 μT
   C 0.346 μT D 0.400 μT

PART B

In Part B, put your answer in the spaces provided on the Answer Sheet.

5. [30] The figure shows a toroid of rectangular cross section, made of a material with permeability μ. A coil of N turns of fine wire is wrapped all the way around the toroid (just a few turns are shown on the figure). Another coil, consisting of a single turn of wire, passes through the hole in the toroid, as shown. Find the mutual inductance between the two coils, taking into account the positive direction for each coil, indicated by the arrows. [Hint: the shape of the single turn of wire does not matter.]





END OF QUESTIONS **FORMULAS FOLLOW**