McGill University **CLASS TEST 2**
Faculty of Engineering **NOVEMBER 2005**

COURSE ECSE 353
ELECTROMAGNETIC FIELDS AND WAVES

Examiner:	J. P. Webb	Co-Examiner:	None
Signature:	_____	Signature:	_____
Date:	November 7, 2005	Time:	13:35-14:25

- 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
- 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

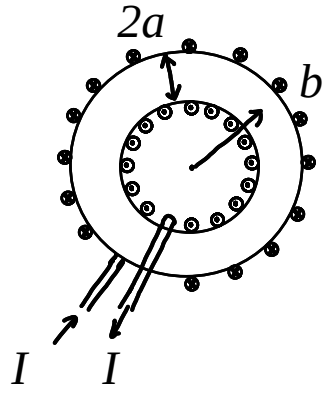
PART A

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] The unit of electromotive force is:
   A V B Vm^{-1} C N D Nm^{-1}

2. [4] In general, in a ferromagnetic material:
   A The magnetization is uniform.
   B The magnitude of the magnetization is directly proportional to the magnitude of the magnetic field, **H**.
   C The magnitude of the magnetization is directly proportional to the magnitude of the magnetic flux density, **B**.
   D The magnitude of the magnetization is never greater than a certain value, no matter how large **B** or **H** is.

3. [6] The toroidal coil shown consists of N turns of fine wire carrying current I. Since N is large, the wire can be replaced by an equivalent surface current. What is the approximate magnitude of the surface current density? (N=1000, a=0.1cm, b=1cm, I=1mA).



(Picture is not to scale)

   A 16 Am^{-1} B 160 Am^{-1}
   C 1.6 kAm^{-1} D 160 kAm^{-1}

4. [6] A straight wire is made of a poor conductor coated with a thin layer of a much better conductor. The poor conductor has a circular cross section of radius a. The coating has conductivity σ and thickness $\delta << a$. When current passes down the wire, it flows almost entirely in the thin layer. Which of the following expressions is the best approximation to the resistance per unit length of the wire?
   A $\dfrac{\delta}{\sigma 2\pi a}$ B $\dfrac{\delta}{\sigma \pi a^2}$
   C $\dfrac{1}{\sigma 2\pi a\delta}$ D $\dfrac{1}{\sigma \pi a\delta}$

TURN TO NEXT PAGE

PART B

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

5. [30]

(a) A steady current I flows down the wire described in question 4. Assume that current flows *entirely* in the coating. Find the magnetic flux density inside the thin coating, as a function of distance r from the wire axis. The coating has a permeability equal to that of free space.

(b) Find the internal inductance per metre associated with the current flowing in the coating.

END OF QUESTIONS **FORMULAS FOLLOW**