McGill University
Faculty of Engineering

CLASS TEST 1
OCTOBER 2005

COURSE ECSE 353
ELECTROMAGNETIC FIELDS AND WAVES

Examiner:	J. P. Webb	Co-Examiner:	None
Signature:	_____________	Signature:	_____________
Date:	October 14, 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] In general, charge on a conductor under static conditions is distributed:
   - A uniformly through the volume of the conductor.
   - B non-uniformly through the volume of the conductor.
   - C uniformly over the surface of the conductor.
   - D non-uniformly over the surface of the conductor.

2. [4] The tangential part of the electric flux density is continuous across a surface, *S*. Which one of the following statements must be true?
   - A The surface charge density on *S* is zero.
   - B The surface charge density on *S* is non-zero.
   - C The dielectric constant is the same on both sides of *S*.
   - D The dielectric constant is the same on both sides of *S* and the surface charge density on *S* is zero.

3. [6] Two equal charges *q* are distance *d* apart in air. The point *O* is exactly half way between them, and the point *P* is exactly half way between *O* and one of the charges. Find the potential at *P* relative to *O*.
   - A $\frac{1}{3}\frac{q}{\pi\varepsilon_o d}$
   - B $\frac{2}{3}\frac{q}{\pi\varepsilon_o d}$
   - C $\frac{q}{\pi\varepsilon_o d}$
   - D $\frac{4}{3}\frac{q}{\pi\varepsilon_o d}$

4. [6] A point charge *q* sits at the centre of a sphere of solid dielectric, with radius *a* and relative permittivity ε_r. Find the polarization surface charge density at the surface of the sphere.
   - A 0
   - B $\frac{q}{4\pi\varepsilon_r a^2}$
   - C $-\frac{q}{4\pi\varepsilon_r a^2}$
   - D $\frac{q(\varepsilon_r - 1)}{4\pi\varepsilon_r a^2}$

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PART B

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

5. [30]

(a) Two infinitely-long conducting wires run parallel to one another. One wire is at potential $V=+V_0$ and the other wire is at potential $V=-V_0$. A diagram of the cross-section of the wires is given in the answer sheet. Mark on this diagram the equipotential line $V=0$.

(b) Hence solve the following problem. A long wire of radius 1 cm runs parallel to the earth's surface at a height of 4 m. The earth's surface can be taken to be an infinite conducting plane at potential $V=0$. The wire is at $V=+1$ kV (DC). Find the electrostatic energy stored for each 1m length of the wire.

[Hint: the stored energy of the configuration in part (a) is $\frac{1}{2}CV_{12}^2$, where C is the capacitance between the wires and V_{12} is the potential difference between the wires.]

END OF QUESTIONS **FORMULAS FOLLOW**