McGill University
Faculty of Engineering

CLASS TEST 1
OCTOBER 2002

COURSE ECSE 353
ELECTROMAGNETIC FIELDS AND WAVES

Examiner:	J. P. Webb	Co-Examiner:	None
Signature:	_____	Signature:	_____
Date:	October 11, 2002	Time:	10:35-11:25

- 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-546) 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] What is the unit of electric polarization?
   - A Cm
   - B Cm^{-1}
   - C Cm^{-2}
   - D Cm^{-3}

2. [4] A positive charge Q is placed on an isolated conductor. In equilibrium, when all current flow has stopped, which of the following statements is NOT true:
   - A The electric field just outside the conductor is perpendicular to the surface
   - B There is a layer of surface charge over the surface
   - C The electric potential throughout the conductor is zero
   - D The volume charge density inside the conductor is zero

3. [6] Two large, flat, parallel, conducting plates are 1 mm apart. Between them is an insulating material with dielectric constant equal to 2. Half way between the plates, well away from the edges, the electric field strength is 10 kV/m. What is the potential difference between the plates?
   - A 5 V
   - B 10 V
   - C 20 V
   - D 40 V

4. [6] Throughout a solid dielectric material, the electrostatic potential is $V = \cos\phi$ (cylindrical coordinates r, ϕ, z). Assuming there is *no* free charge in the material, find the volume polarization charge density.
   - A 0
   - B $\dfrac{\varepsilon_0 \cos\phi}{r}$
   - C $\dfrac{\varepsilon_0 \sin\phi}{r}$
   - D $\dfrac{\varepsilon_0 \cos\phi}{r^2}$

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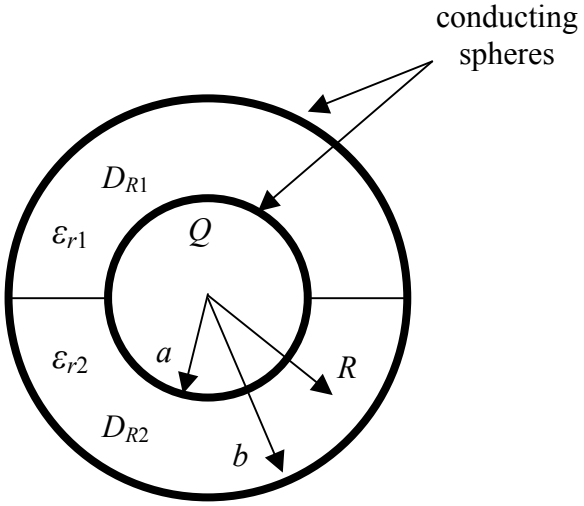
PART B

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

5. [30] A capacitor is formed of two concentric conducting spheres, as shown, separated by dielectric. The dielectric in the upper half has a uniform relative permittivity, ε_{r1}, that is different from the uniform relative permittivity, ε_{r2}, of the lower half. A total charge Q is placed on the inner sphere. Assume that the electric flux density **D** is purely radial and that its radial component in the upper region, D_{R1}, varies only with the distance, R, from the centre of the spheres; similarly for D_{R2}. Find:

   (a) D_{R1} and D_{R2} [hint: use Gauss's Law *and* the interface condition between the dielectrics];
   (b) the electric field everywhere between the spheres;
   (c) the capacitance between the spheres.



END OF QUESTIONS **FORMULAS FOLLOW**