McGill University
Faculty of Engineering

CLASS TEST 1
OCTOBER 2007

COURSE ECSE 353
ELECTROMAGNETIC FIELDS AND WAVES

Examiner:	J. P. Webb	Co-Examiner:	None
Signature:	_____	Signature:	_____
Date:	October 12, 2007	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-115, Casio fx-991, Casio fx-570ms, Sharp EL-520, or Sharp EL-546) 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] Which of these statements about the electric potential difference between two points is *not* true?
   - A It is the path integral of electric field from one point to the other.
   - B It is the work done per unit charge in moving a charge from one point to another.
   - C Its units are volts per metre.
   - D It is zero if both points are in the same conductor, under static conditions.

2. [4] "Polarization" means
   - A volume density of electric dipole moment
   - B volume density of electric charge
   - C surface density of electric dipole moment
   - D surface density of electric charge

3. [6] The spherical surface $R=a$ is covered with a uniform layer of surface charge, ρ_s. No materials are present, just free space. Find the electric potential of the origin (R=0), relative to infinity.
   - A $\frac{\rho_s a}{\varepsilon_0}$
   - B 0
   - C $\frac{\rho_s}{4\pi\varepsilon_0 a}$
   - D $\frac{\rho_s}{4\pi\varepsilon_0 a^2}$

4. [6] An infinite flat conducting plate sits at y=0. Above the plate (y>0) is an infinite dielectric material with dielectric constant 2(1+y). On the upper surface of the plate is a uniform layer of surface charge, 1 pC m^{-2}. Find the electric field strength at y=0.2 m.
   - A 41.7 mV m^{-1}
   - B 47.1 mV m^{-1}
   - C 56.5 mV m^{-1}
   - D 113 mV m^{-1}

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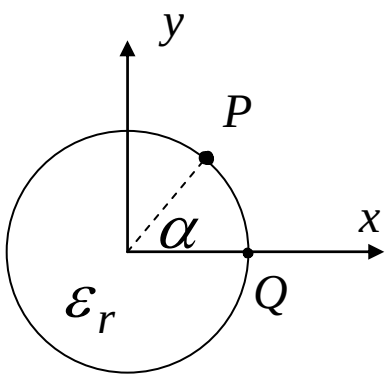
PART B

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

5. [30] An infinitely long cylinder of dielectric is surrounded by infinite free space. The cylinder has a circular cross-section of radius *b*. The dielectric constant is ε_r. The field inside the cylinder is uniform and *x*-directed:

$$\mathbf{E} = E_0 \mathbf{a}_x$$



Point P is a point on the surface of the cylinder with angle $\phi = \alpha$, as shown. Point Q is a point on the surface of the cylinder with angle $\phi = 0$.

(a) Find the cylindrical (*r* and ϕ) components of the electric field at a point (*r*, ϕ) inside the cylinder.

(b) Find the potential difference $V_P - V_Q$.

(c) Find the *x* and *y* components of electric field at the point P, just *outside* the cylinder.

END OF QUESTIONS **FORMULAS FOLLOW**