# Midterm Examination, ECED 3300

**Instructor:** Sergey A. Ponomarenko.

**Place, Date & Time:** Sexton Gym; November 2, 2017, 8:35 to 10:35 am

**Closed Books:** Formula sheets are provided; no calculators are allowed.

**Hint:** Make sure to justify all your answers to get full credit.

## Problem 1 (15pts)

Given the electric flux density distribution, $\mathbf{D} = \rho\cos(2\phi)\,\mathbf{a}_\rho + \rho\sin(2\phi)\,\mathbf{a}_\phi + e^{-\rho}\mathbf{a}_z$ C/m$^2$, in a region of space, determine:

(a) the volume charge density there,

(b) the total charge inside a sphere of radius $R$ centered at the origin.

## Problem 2 (25pts)

The potential distribution of the electric field outside a conducting sphere of radius $R$, centered at the origin, is given by

$$V(r) = \frac{V_0 R^2}{r^2},$$

where $V_0$ is a given constant. The dielectric permittivity of the medium outside the sphere is $\epsilon$.

a) Find the electric field everywhere.

b) Determine the surface charge density induced on the sphere.

c) Determine the energy stored in the field.

## Problem 3 (30pts)

A point charge $Q$ is located at the point $A(0, 0, h)$ **above** an infinite, grounded conducting plane $z = z_0$. Answer the following questions:

(a) **Justify** your choice of the magnitude(s), sign(s), and locations(s) of all image charge(s);

(b) Find the magnitude and direction of the force experienced by the charge $Q$;

(c) How much work is needed to move the charge $Q$ to the point $B(0, 0, 2h)$. The plane remains grounded during the entire process.

## Problem 4 (30pts)

A ring of radius $a$ is located in the $xy$-plane and centered at the origin. The ring carries a uniform charge with the line charge density $\rho_l$.

a) Determine the electrostatic potential at a point $P(0, 0, z)$ on the axis of the ring;

b) Find the amount of work required to move a point charge $Q$ to the center of the ring from far away.