

Midterm Examination, ECED 3300

Instructor: Sergey A. Ponomarenko.

Place, Date and Time: Sexton Campus; Wed., Nov. 4, 2009, 10:35-12:35 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)

A straight cylinder of radius R and height H is placed along the z -axis of a coordinate system. Determine a flux of the field $\mathbf{F} = 3\rho z^2 \mathbf{a}_\rho + (\rho^2 + z^2) \mathbf{a}_\phi + \rho^3 \mathbf{a}_z$ through the surface of the cylinder.

Problem 2 (15pts)

A point charge Q is located at the center of a sphere of radius a , filled with a dielectric material of permittivity ϵ_1 . The sphere is surrounded by a concentric spherical dielectric shell of the inner and outer radii b and c , respectively, $a < b < c$. The dielectric permittivity of the shell material is ϵ_2 . Find the electric field \mathbf{E} , flux density \mathbf{D} , and polarization \mathbf{P} everywhere. The free space permittivity is ϵ_0 .

Problem 3 (25pts)

A conducting interface $z = 0$ separates a perfect conductor in the lower half-space, $z < 0$ and a dielectric medium with permittivity ϵ , filling the upper half-space, $z > 0$. The electrostatic potential distribution in the dielectric is given in spherical coordinates, $V(r, \theta, \phi) = \frac{V_0 r \cos \theta}{\sqrt{r^2 + a^2}}$, where V_0 and a are positive constants. Determine:

- The electric field \mathbf{E} everywhere;
- The surface charge density induced on the interface.

Problem 4 (25pts)

A point charge Q is located a distance h above an infinite grounded conducting plane $z = 0$. Find:

- The magnitude(s), sign(s), and location(s) of image charge(s);
- The force – magnitude and direction – experienced by the charge;
- The work done to carry the charge from point A(0, 0, h) to point B(0, 0, $2h$);
- The work done to move the charge from point A(0, 0, h) to point C($2h$, 0, h).