<u>Curriculum Topic</u> :
Electrostatic Fields

<u>ESF4</u> : Gauss's Law in Differential Form

Module Outline:	
Prerequisite Skills	Competencies
Supplemental Reading and Resources	Assessments
Power Point Slides and Notes	

Prerequisite Skills

Prerequisites / Requirements:
ESF3 Gauss's Law in Integral Form

Competencies

Competency ESF.4: **Apply Gauss's Law in differential form to electrostatic problems.**

Competency Builders:
ESF.4.1 Understand the geometrical meaning of divergence
ESF.4.2 Write the divergence theorem in mathematical form
ESF.4.3 Calculate charge from an arbitrary field distribution in space

Supplemental Reading and Resources

Supplemental Reading Materials:

Prof. Andrew Peterson's Lecture Notes (Fields and Waves Lecture 7)

Assessments

The following questions and exercises may serve as either pre-assessment or post-assessment tests to evaluate student knowledge.

Question: ESF.4.1 *Competency:* ESF.4.1

If a vector field appears to be emanating from a small region in space, then the divergence of the vector field at that region in space is likely _____ .

Answer:

positive

Question: ESF.4.2 *Competency:* ESF.4.2

Explain why you cannot take the divergence of a vector in spherical coordinates by straight-summing the partial derivatives of each component:

$$\textbf{Wrong: } \nabla \cdot \vec{D} = \frac{\partial D_\rho}{\partial \rho} + \frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_\theta}{\partial \theta}$$

Answer:

Operators in Other Coordinate Systems: In the spherical coordinate system, the unit vectors used to decompose the field components change direction as a function of observation point. The gradient, curl, and divergence formulas differ from their simpler Cartesian operators (since the Cartesian unit vectors do not change orientation depending on observation point).

Question: ESF.4.3 *Competency:* ESF.4.3

Electrostatic Charge Distributions: All of the field distributions in this problem are free-space and may be written in the following form:

$$\vec{E}(r, \phi, \theta) = E_r(r)\hat{r}$$

Make a rough sketch in the graph provided of $E_r(r)$ for the following charge distributions.

Answer: