# VE230: Electromagnetics I

## Homework I

## Due: May 25, 11.59pm

**P.2–17** A field is expressed in spherical coordinates by $\mathbf{E} = \mathbf{a}_R(25/R^2)$.

**a)** Find $|\mathbf{E}|$ and $E_x$ at the point $P(-3, 4, -5)$.

**b)** Find the angle that $\mathbf{E}$ makes with the vector $\mathbf{B} = \mathbf{a}_x 2 - \mathbf{a}_y 2 + \mathbf{a}_z$ at point $P$.

**P.2–18** Express the base vectors $\mathbf{a}_R$, $\mathbf{a}_\theta$, and $\mathbf{a}_\phi$ of a spherical coordinate system in Cartesian coordinates.

**P.2–19** Determine the values of the following products of base vectors:

| | | |
|---|---|---|
| **a)** $\mathbf{a}_x \cdot \mathbf{a}_\phi$ | **b)** $\mathbf{a}_\theta \cdot \mathbf{a}_y$ | **c)** $\mathbf{a}_r \times \mathbf{a}_x$ |
| **d)** $\mathbf{a}_R \cdot \mathbf{a}_r$ | **e)** $\mathbf{a}_y \cdot \mathbf{a}_R$ | **f)** $\mathbf{a}_R \cdot \mathbf{a}_z$ |
| **g)** $\mathbf{a}_R \times \mathbf{a}_z$ | **h)** $\mathbf{a}_\theta \cdot \mathbf{a}_z$ | **i)** $\mathbf{a}_z \times \mathbf{a}_\theta$. |

**P.2–21** Given a vector function $\mathbf{E} = \mathbf{a}_x y + \mathbf{a}_y x$, evaluate the scalar line integral $\int \mathbf{E} \cdot d\boldsymbol{\ell}$ from $P_1(2, 1, -1)$ to $P_2(8, 2, -1)$

**a)** along the parabola $x = 2y^2$,

**b)** along the straight line joining the two points.

Is this $\mathbf{E}$ a conservative field?

**P.2–22** For the $\mathbf{E}$ of Problem P.2–21, evaluate $\int \mathbf{E} \cdot d\boldsymbol{\ell}$ from $P_3(3, 4, -1)$ to $P_4(4, -3, -1)$ by converting both $\mathbf{E}$ and the positions of $P_3$ and $P_4$ into cylindrical coordinates.

**P.2–26** Find the divergence of the following radial vector fields:

**a)** $f_1(\mathbf{R}) = \mathbf{a}_R R^n$,

**b)** $f_2(\mathbf{R}) = \mathbf{a}_R \dfrac{k}{R^2}$.

**P.2–28** For a scalar function $f$ and a vector function $\mathbf{A}$, prove that

$$\nabla \cdot (f\mathbf{A}) = f\nabla \cdot \mathbf{A} + \mathbf{A} \cdot \nabla f$$

in Cartesian coordinates.

**P.2–34** Assume the vector function $\mathbf{A} = \mathbf{a}_x 3x^2y^3 - \mathbf{a}_y x^3y^2$.

**a)** Find $\oint \mathbf{A} \cdot d\boldsymbol{\ell}$ around the triangular contour shown in Fig. 2–36.

**b)** Evaluate $\int (\nabla \times \mathbf{A}) \cdot d\mathbf{s}$ over the triangular area.

**c)** Can $\mathbf{A}$ be expressed as the gradient of a scalar? Explain.

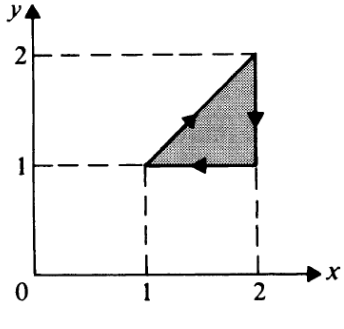


**FIGURE 2–36**
Graph for Problem P.2–34.