Electrical & Computer Engineering Department
National University of Singapore

EE2011 Engineering Electromagnetics

Tutorial 3: Field Operators

(for week beginning 13 February 2012)

The tutorial discussion will focus on Questions 3 and 4 (which are marked by asterisks *).

1. **BASICS**

(a) Determine the spherical coordinates of the location P specified by (4, 120°, 3) in the cylindrical coordinate system.

(b) Determine the angle between the vectors $\vec{E}$ and $\vec{B}$ at the point P where

$\vec{E} = \frac{25}{R^2}\hat{u}_R$ expressed in spherical coordinates

$\vec{B} = 2\hat{u}_x - 2\hat{u}_y + \hat{u}_z$ expressed in Cartesian coordinates

$\overrightarrow{OP} = -3\hat{u}_x + 4\hat{u}_y - 5\hat{u}_z$ expressed in Cartesian coordinates.

(c) For the vector function $\vec{E} = y\hat{u}_x + x\hat{u}_y$, evaluate the scalar line integral $\int_P^Q \vec{E} \bullet d\vec{s}$ from P (2, 1, –1) to Q (8, 2, –1) along the parabolic contour $x = 2y^2$ on the $z = -1$ plane.

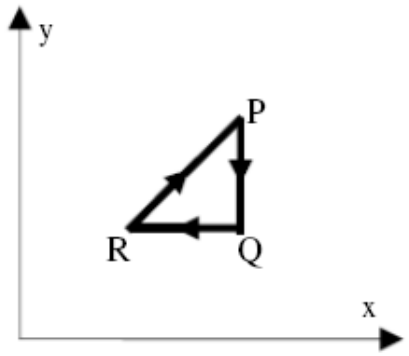
2. Determine the following for the scalar function $V = \sin\left(\frac{\pi}{2}x\right)\sin\left(\frac{\pi}{3}y\right)e^{-z}$:

(a) grad V at the point P (1, 2, 3)

(b) rate of increase of V at P in the direction of $\overrightarrow{PO}$ (*i.e.* towards the origin).

3. * For the vector function $\vec{E} = y^2 z\hat{u}_x + y^3\hat{u}_y + xz\hat{u}_z$, verify that the Divergence Theorem holds for the cube enclosed by the plane surfaces S_1 (where x = 1), S_2 (where x = –1), S_3 (where y = 1), S_4 (where y = –1), S_5 (where z = 2) and S_6 (where z = 0).

4. * For the vector function $\vec{B} = 3x^2y^3\hat{u}_x - x^3y^2\hat{u}_y$, verify that Stoke's Theorem holds for the triangular contour PQR where the Cartesian coordinates of the three vertices are given by P (2, 2, 0), Q (2, 1, 0) and R (1, 1, 0).



Answers:

1(a) $(5, 53.1^o, 120^o)$

1(b) 153.6^o

1(c) 14

2(a) $-0.026\,\hat{u}_x - 0.043\,\hat{u}_y$

2(b) 0.0485