ELECTROMAGNETICS THEORY
BEKP3553
1-2006/2007

Tutorial 1:

A. Vector Algebra

1. Vector **A** starts at point (1,-1,-2) and ends at point (2,-1,0). Find a unit vector in the direction of **A**.

2. Given vectors
$$\mathbf{A} = \hat{\mathbf{x}}2 - \hat{\mathbf{y}}3 + \hat{\mathbf{z}}$$
$$\mathbf{B} = \hat{\mathbf{x}}2 - \hat{\mathbf{y}} + \hat{\mathbf{z}}3$$
$$\mathbf{C} = \hat{\mathbf{x}}4 + \hat{\mathbf{y}}2 - \hat{\mathbf{z}}2$$

   show that **C** is perpendicular to both **A** and **B**.

3. In Cartesian coordinates, the three corners of a triangle are $P_1(0,2,2)$, $P_2(2,-2,2)$ and $P_3(1,1,-2)$. Find the area of the triangle.

4. Given
$$\mathbf{A} = \hat{\mathbf{x}}2 - \hat{\mathbf{y}}3 + \hat{\mathbf{z}}$$
$$\mathbf{B} = \hat{\mathbf{x}}B_x + \hat{\mathbf{y}}2 + \hat{\mathbf{z}}B_z$$

   (a) Find B_x and B_z if **A** is parallel to **B**.
   (b) Find a relation between B_x and B_z if **A** is perpendicular to **B**.

5. Given vectors
$$\mathbf{A} = \hat{\mathbf{x}} + \hat{\mathbf{y}}2 - \hat{\mathbf{z}}3$$
$$\mathbf{B} = -\hat{\mathbf{x}}3 - \hat{\mathbf{y}}4$$
$$\mathbf{C} = \hat{\mathbf{y}}3 - \hat{\mathbf{z}}4$$
   find the following

   (a) A and $\hat{\mathbf{a}}$
   (b) The component of **B** along **C**
   (c) θ_{AC}
   (d) $\mathbf{A} \times \mathbf{C}$
   (e) $\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C})$
   (f) $\mathbf{A} \times (\mathbf{B} \times \mathbf{C})$
   (g) $\hat{\mathbf{x}} \times \mathbf{B}$
   (h) $(\mathbf{A} \times \hat{\mathbf{y}}) \cdot \hat{\mathbf{z}}$

6. **E** and **F** are vector fields given by

$$\mathbf{E} = \hat{\mathbf{x}}\, 2x + \hat{\mathbf{y}} + \hat{\mathbf{z}}\, yz$$
$$\mathbf{F} = \hat{\mathbf{x}}\, xy - \hat{\mathbf{y}}\, y^2 + \hat{\mathbf{z}}\, xyz$$

Determine:

(a) |**E**| at (1,2,3)
(b) The component of **E** along **F** at (1,2,3)

B. Coordinate System

1. Express the following points in Cartesian coordinates:

(a) $P(1, 60^o, 2)$
(b) $Q(2, 90^o, -4)$
(c) $R(3, 45^o, 210^o)$
(d) $T(4, \pi/2, \pi/6)$

2. Express the following points in cylindrical and spherical coordinates:

(a) $P(1, -4, -3)$
(b) $Q(3, 0, 5)$
(c) $R(-2, 6, 0)$

3. Using the appropriate expression for the differential surface area $d\mathbf{s}$ to determine the area of each of the following surfaces:

(a) $r = 3;\ 0 \le \phi \le \pi/3\ ;\ -2 \le z \le 2$
(b) $0 \le R \le 5;\ \theta = \pi/3\ ;\ 0 \le \phi \le 2\pi$
Also sketch the outline of each surface

4. Find the volumes described by the following:

(a) $2 \le r \le 5\ ;\ \pi/2 \le \phi \le \pi\ ;\ 0 \le z \le 2$
(b) $0 \le R \le 5;\ 0 \le \theta \le \pi/3\ ;\ 0 \le \phi \le 2\pi$
Also sketch the outline of each volume

5. At a given point in space, vectors **A** and **B** are given in spherical coordinates by

$$\mathbf{A} = \hat{\mathbf{R}}4 + \hat{\boldsymbol{\theta}}2 - \hat{\phi}$$
$$\mathbf{B} = -\hat{\mathbf{R}}2 + \hat{\phi}3$$

Find: (a) the scalar component, or projection of **B** in the direction of **A**
(b) the vector component of **B** in the direction of **A**
(c) the vector component of **B** perpendicular to **A**

Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia