APPENDIX B

PROBLEM SESSION I

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
Electrical Engineering Department
EE 340: Introduction to Electromagnetics

Part (1): Visualization of surfaces in *3D* coordinate systems

Describe the following surfaces:

a) $x=-5$, $z=2$.
b) $\rho=3$, $\Phi=3\pi/2$.
c) $\rho=\sqrt{5}$, $z=-2$.
d) $r=5$, $\Phi=\pi/3$.
e) $\theta=\pi/2$, $\Phi=\pi/2$.
f) $r=2$, $\Phi=0$.
g) $y=5$.

Part (2): Visualization of surfaces in 3D coordinate systems

Describe the intersection of surfaces (1) and (2):

Surface (1)	Surface (2)
$\Phi=45$	$z=5$
$x=-2$	$z=3$
$\rho=5$	$\Phi=45$
$r=1$	$\theta=60$

Part (3): Vector Algebra

Problems 1.5 and 1.10 from the text.

1.5 For $\mathbf{U} = U_x\,\mathbf{a_x} + 5\,\mathbf{a_y} - \mathbf{a_z}$, $\mathbf{V} = 2\,\mathbf{a_x} - V_y\,\mathbf{a_y} + 3\,\mathbf{a_z}$, and $\mathbf{W} = 6\,\mathbf{a_x} + \mathbf{a_y} + W_z\,\mathbf{a_z}$, obtain U_x, V_y, and W_z such that **U**, **V**, and **W** are mutually orthogonal.

1.10 Verify that

(a) $\mathbf{A}\cdot(\mathbf{A}\times\mathbf{B}) = 0 = \mathbf{B}\cdot(\mathbf{A}\times\mathbf{B})$

(b) $(\mathbf{A}\cdot\mathbf{B})^2 = |\mathbf{A}\cdot\mathbf{B}|^2 = (AB)^2$

(c) If $\mathbf{A} = (A_x, A_y, A_z)$, then $\mathbf{A} = (\mathbf{A}\cdot\mathbf{a}_x)\,\mathbf{a}_x + (\mathbf{A}\cdot\mathbf{a}_y)\,\mathbf{a}_y + (\mathbf{A}\cdot\mathbf{a}_z)\,\mathbf{a}_z$.

Part (4): Coordinate transformations

Problems 2.1, 2.2 , 2.3 and 2.15 from the text.

2.1 Convert the following points to Cartesian coordinates:

(a) P_1 (5, 120°, 0)
(b) P_2 (1, 30°, -10)
(c) P_3 (10, 3π/4, π/2)
(d) P_4 (3, 30°, 240°)

2.2 Express the following points in Cylindrical and Spherical coordinates:

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

2.3 Express the following points in Cylindrical and Spherical coordinates:

(a) $\mathbf{P} = (y + z)\, \mathbf{a_x}$
(b) $\mathbf{Q} = y\, \mathbf{a_x} + x z\, \mathbf{a_y} + (x + y)\, \mathbf{a_z}$
(c) $\mathbf{T} = \left[\frac{x^2}{x^2 + y^2} - y^2\right]\mathbf{a}_x + \left[\frac{xy}{x^2 + y^2} + xy\right]\mathbf{a}_y + \mathbf{a}_z$
(d) $\mathbf{S} = \frac{y}{x^2 + y^2}\mathbf{a}_x - \frac{x}{x^2 + y^2}\mathbf{a}_y + 10\mathbf{a}_z$

2.15 If $\mathbf{J} = r \sin\theta \cos\phi\, \mathbf{a}_r - \cos 2\theta \sin\phi\, \mathbf{a}_\theta + \tan\frac{\theta}{2} \ln r\, \mathbf{a}_\phi$ at *T* (2, π/2, 3π/2), determine the vector component of **J** that is

(a) Parallel to $\mathbf{a_z}$.
(b) Normal to surface $\Phi = 3\pi/2$.
(c) Tangential to the spherical surface $r = 2$.
(d) Parallel to the line $y = -2$, $z = 0$.