King Fahd University of Petroleum and Minerals
Electrical Engineering Department

Appendix B: PROBLEM SESSIONS

PROBLEM SESSION I

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

Describe the following surfaces separately:

a) x=-5, z=2.
b) ρ=3, Φ=3π/2.
c) $\rho = \sqrt{5}$, z=-2.
d) r=5, Φ= π/3.
e) θ = π/2, Φ=π/2.
f) r=2, Φ=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)
Φ=45	z=5
x=-2	z=3
ρ=5	Φ=45
r=1	θ=60

Part (3): Vector Algebra

Problems 1.5 and 1.10 from the text book.

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) $P_1\ (5, 120^\circ, 0)$

(b) $P_2\ (1, 30^\circ, -10)$

(c) $P_3\ (10, 3\pi/4, \pi/2)$

(d) $P_4\ (3, 30^\circ, 240^\circ)$

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) $\mathbf{T} = \left[\dfrac{x^2}{x^2 + y^2} - y^2\right]\boldsymbol{a}_x + \left[\dfrac{xy}{x^2 + y^2} + xy\right]\boldsymbol{a}_y + \boldsymbol{a}_z$

(d) $\mathbf{S} = \dfrac{y}{x^2 + y^2}\boldsymbol{a}_x - \dfrac{x}{x^2 + y^2}\boldsymbol{a}_y + 10\boldsymbol{a}_z$

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

(a) Parallel to $\mathbf{a_z}$.

(b) Normal to the surface $\Phi = 3\pi/2$.

(c) Tangential to the spherical surface $r = 2$.

(d) Parallel to the line $y = -2$, $z = 0$.