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

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

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

(b) Normal to the surface Φ = 3π/2.

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

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