

This is part 2 (of 2) of the homework of the second week. It is due July 9 at the beginning of class. More problems to this lecture can be found on pages 698-699 in the book.

SUMMARY:

- $x = r \cos(\theta), y = r \sin(\theta), z = z$
cylindrical coordinates
- $x = \rho \sin(\phi) \cos(\theta)$
 $y = \rho \sin(\phi) \sin(\theta)$
 $z = \rho \cos(\phi)$
spherical coordinates

EXAMPLES:

- $r = 1$ in cylindrical coordinates is a **cylinder**.
- $\rho = 1$ in spherical coordinates is a **sphere**.
- $r = z$ cylindrical coordinates is a **cone**

- 1) a) (3 points, compare Problems 5-6 in 9.7) Change from rectangular to cylindrical coordinates $(x, y, z) = (1, -1, 4)$.
b) (3 points, compare Problems 3-4 in 9.7) Change from cylindrical coordinates $(r, \theta, z) = (2, \pi/3, 4)$ to rectangular coordinates.
- 2) a) (3 points, compare Problems 9-10 in 9.7) Change from rectangular to spherical coordinates $(x, y, z) = (1, 1, 1)$.
b) (3 points, compare Problems 7-8 in 9.7) Change from spherical to rectangular coordinates $(\rho, \theta, \phi) = (2, \pi/3, \pi/2)$.
- 3) (6 points, compare Problems 11-13 in 9.7) Describe in words or draw a sketch of the surface whose equation is $\rho = \sin(\phi)$ in spherical coordinates (ρ, θ, ϕ) .
- 4) (6 points, compare Problems 11-24 in 9.7) Describe in words or draw a sketch of the surface whose equation is $\phi = \theta/2$ in spherical coordinates.
- 5) (6 points, compare Problems 21-24 in 9.7) What is the equation for the surface $x^2 + y^2 - 5 = z^2$ in cylindrical coordinates?

CHALLENGE PROBLEM:



Try to graph without computer the surface $r = f(\theta, \phi) = (2 + \sin(3\theta))(2 + \cos(2\phi))$ (It is a **graph** in spherical coordinates (r, ϕ, θ) .)

Hint. Do it in stages. First graph $r = 2$ (the sphere), then $r = (2 + \sin(3\theta))$, then draw a sketch of the final surface.

SUPER CHALLENGE PROBLEM:



How would you design analogues of spherical or cylindrical coordinates in 4 dimensions?