DIRECTIONS: Submit solutions to 4 problems only. To obtain full credit, please show ALL work. Good luck!

1. (a) What is the angle between the vectors \( \mathbf{a} = \mathbf{i} - \mathbf{j} + \mathbf{k} \) and \( \mathbf{b} = -\mathbf{i} + \mathbf{j} + 2\mathbf{k} \).
   (b) Find a unit vector orthogonal to both \( \mathbf{a} \) and \( \mathbf{b} \).

2. (a) Determine the line through the point \((6, 5, -2)\) parallel to the line \(x = 1 + t, y = 2 - t, z = 3t\).
   (b) Using the cross product, find the area of the triangle whose vertices are \(A(0, 0), B(-2, 3), C(3, 1)\).

3. Given the plane \(3x + 2y + 6z = 6\)
   (a) Determine any point \(P_0\) on this plane and a vector \(\mathbf{n}\) perpendicular to this plane.
   (c) Determine the distance from the origin to this plane.

4. Given \(\rho \sin \phi = 2 \cos \theta\) in spherical coordinates, translate it into rectangular coordinates and describe (or sketch) the resulting surface.

5. A space curve is described by \(\mathbf{r}(t) = 4t \mathbf{i} + (t - 2)^2 \mathbf{j} + 3t \mathbf{k}\).
   (a) Find the unit tangent vector at \(t = 2\).
   (b) Determine the curvature \(\kappa\) at \(t = 2\).
   (c) Set up, but do not evaluate, the integral which gives the length of the curve between the points \((4, 1, 3)\) and \((12, 1, 9)\).