1. [3 pts] If $\mathbf{a} = \langle 2, -1, 2\rangle$ and $\mathbf{b} = \langle 1, -1, 2\rangle$, find a non-zero vector $\mathbf{c}$ such that $\mathbf{a}\cdot\mathbf{c} = \mathbf{b}\cdot\mathbf{c} = 0$.

2. [3 pts] Determine the projection vector $\mathsf{proj}_{\mathbf{a}}(\mathbf{b})$ of $\mathbf{b}$ onto $\mathbf{a}$ where $\mathbf{a} = \langle 1, 2, 3\rangle$ and $\mathbf{b} = \langle 1, 2, 2\rangle$.

3. [3 pts] If the scalar projection of $\mathbf{b}$ onto $\mathbf{a}$ is $\|\mathsf{proj}_{\mathbf{a}}(\mathbf{b})\| = 1$, determine the value of $\|\mathsf{proj}_{2\mathbf{a}}(3\mathbf{b})\|$.

4. True/False. If the statement is true, give an explanation why you think so. If a statement is false, provide a counter-example.

   (a) [3 pts] The cross product of two unit vectors is a unit vector.

   (b) [3 pts] If $\mathbf{u}$ is a scalar multiple of $\mathbf{v}$, then $\mathbf{u} \times \mathbf{v} = \mathbf{0}$.

   (c) [3 pts] If $\mathbf{u}$, $\mathbf{v}$, and $\mathbf{w}$ are all non-zero vectors in space and $\mathbf{u} \cdot \mathbf{v} = \mathbf{u} \cdot \mathbf{w}$, then $\mathbf{v} = \mathbf{w}$.

   (d) [3 pts] The vector equation

$$\langle x, y, z \rangle \times \langle 1, 1, 1 \rangle = \langle 0, 1, 0 \rangle$$

   has a solution in $\mathbb{R}^3$.

5. Consider the points $P(3,1,1), Q(4,1,2)$, and $R(4,4,1)$ in $\mathbb{R}^3$.
   (a) [3 pts] Find an equation for the plane containing the points P, Q, and R.

   (b) [2 pts] Find the area of the triangle with vertices P, Q, and R.

6. [4 pts] Find an equation of the plane which passes through the points $(2,2,1)$ and $(-1,1,-1)$ and is perpendicular to the plane $2x - 3y + z = 3$.

Points earned: ______
out of a possible 9 points

7. [4 pts] Find a set of parametric equations for the line of intersection of the planes:

$$\begin{cases} 6x - 3y + z = 5 \\ -x + y + 5z = 5 \end{cases}$$

8. [4 pts] Find an equation of the plane containing both the point $P(1, -1, 5)$ and the line L parametrized by:

$$\mathbf{r}(t) = \begin{cases} x(t) = 1 + 2t \\ y(t) = -1 + 3t \\ z(t) = 4 + t \end{cases}$$

Points earned: ______
out of a possible 8 points

9. Suppose that a plane P passes through the points $(4, 2, 1)$ and $(-3, 5, 7)$, and suppose that P is parallel to the z-axis. Find an equation for the plane P.