

Follow the instructions for each question and show enough of your work so that I can follow your thought process. If I can't read your work, answer or there is no justification to a solution, you will receive little or no credit!

1. Let  $\mathbf{a}$  and  $\mathbf{b}$  be nonzero vectors. Under what conditions is  $\text{comp}_{\mathbf{a}}\mathbf{b} = \text{comp}_{\mathbf{b}}\mathbf{a}$ ?
2. Let  $\mathbf{a}$  and  $\mathbf{b}$  be nonzero vectors. Under what conditions is  $\text{proj}_{\mathbf{a}}\mathbf{b} = \text{proj}_{\mathbf{b}}\mathbf{a}$ ?
3. Find an equation of the plane through the points  $(3, 0, -1)$ ,  $(-2, -2, 3)$ , and  $(7, 1, -4)$ .
4. Find an equation of the plane that passes through the point  $(3, 5, -1)$  and contains the line  $x = 4 - t$ ,  $y = 2t - 1$ , and  $z = -3t$ .
5. Reduce the following equation to one of the standard forms, classify the surface, and sketch it:

$$x^2 + y^2 - 2x - 6y - z + 10 = 0$$

6. Reduce the following equation to one of the standard forms, classify the surface, and sketch it:

$$x^2 - y^2 + z^2 - 4x - 2z = 0$$

For problems 7 and 8, compute the following limits.

$$7. \lim_{t \rightarrow 1} \left( \frac{t^2 - t}{t - 1} \mathbf{i} + \sqrt{t + 8} \mathbf{j} + \frac{\sin(\pi t)}{\ln t} \mathbf{k} \right)$$

$$8. \lim_{t \rightarrow \infty} \left\langle te^{-t}, \frac{t^3 + t}{2t^3 - 1}, t \sin \left( \frac{1}{t} \right) \right\rangle$$

For problems 9 and 10, compute the unit tangent vector  $\mathbf{T}(t)$  of  $r(t)$  and the indicated point.

$$9. r(t) = \langle t^2 - 2t, 1 + 3t, \sin(2t) \rangle \text{ at the point } t = 2.$$

$$10. r(t) = \langle \sin^2 t, \cos^2 t, \tan^2 t \rangle \text{ at the point } t = \frac{\pi}{4}.$$

For problems 11 and 12, find the unit tangent vector, unit normal vector and the binormal vector; that is  $\mathbf{T}(t)$ ,  $\mathbf{N}(t)$ , and  $\mathbf{B}(t)$  of the vector  $\mathbf{r}(t)$ .

11.  $\mathbf{r}(t) = \langle \cos t, \sin t, t \rangle$ .

12.  $\mathbf{r}(t) = \left\langle t^2, \frac{2}{3}t^3, t \right\rangle$  at the point  $\left(1, \frac{2}{3}, 1\right)$ .

13. Find the curvature of the twisted cube  $\mathbf{r}(t) = \langle t, t^2, t^3 \rangle$ .