
Instructions:

- No calculators, tablets, phones, or other electronic devices are allowed during this exam.
 - You may use one handwritten sheet of notes (8.5"×11" double-sided), but no books or other aids.
 - Fill in your Name and PID on this page.
 - Read each question carefully and answer each question completely.
 - Write your solutions clearly and legibly.
 - Show all of your work; no credit will be given for unsupported answers.
 - Circle your final answers.
 - Exams must be turned in promptly when time is called.
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0. (1 point) Carefully read and complete the instructions on this exam and any additional instructions announced during the exam.
1. (6 points) Consider the vectors $\vec{v} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{w} = \hat{i} + 2\hat{j} + 2\hat{k}$.
 - (a) Compute $\vec{v} \times \vec{w}$.
 - (b) Determine the area of the parallelogram spanned by $\vec{v}$ and $\vec{w}$.
 - (c) Find a vector that is orthogonal to both $\vec{v}$ and $\vec{v} \times \vec{w}$.
2. (6 points) Let $P = (0, 2, -1)$ and $Q = (-3, 1, 0)$ be two points in $\mathbb{R}^3$.
 - (a) Find a vector parameterization for the line that passes through P and Q .
 - (b) Find an equation for the plane orthogonal to the line passing through P and Q that passes through the point Q .
3. (6 points) Evaluate $\lim_{(x,y) \rightarrow (0,0)} \frac{2xy}{x^2 + y^2}$ or explain why the limit does not exist.
4. (6 points) Let $\vec{u}$ and $\vec{v}$ be two unit vectors such that $\|\vec{u} + \vec{v}\| = \frac{2}{3}$. Find $\|\vec{u} - \vec{v}\|$.
5. (6 points) Determine if the lines given by these vector parameteric formulas intersect. If so, find the point where they intersect.

$$\vec{r}_1(t) = \langle -9, 6, -8 \rangle + t \langle 4, -1, 3 \rangle \quad \text{and} \quad \vec{r}_2(t) = \langle 7, 0, 2 \rangle + t \langle 2, -1, 1 \rangle$$