Name (last, first): _____

Student ID: _____

☐ **Write your name and PID on the top of EVERY PAGE.**

☐ Write the solutions to each problem on separate pages. **CLEARLY INDICATE** on the top of each page the number of the corresponding problem. Different parts of the same problem can be written on the same page (for example, part (a) and part (b)).

☐ The exam consists of 4 questions. Your answers must be carefully justified to receive credit.

☐ This exam will be scanned. Make sure you write **ALL SOLUTIONS** on the paper provided. **DO NOT REMOVE ANY OF THE PAGES.**

☐ No calculators, phones, or other electronic devices are allowed.

☐ Remember this exam is graded by a human being. Write your solutions **NEATLY AND COHERENTLY**, or they risk not receiving full credit.

☐ You are allowed to use one 8.5 by 11 inch sheet of paper with hand-written notes (on both sides); no other notes (or books) are allowed.

1. (20 points) Find *two* unit vectors orthogonal to the plane that contains the points

$$P = (0, 1, 2), \quad Q = (2, -1, 2), \quad R = (-1, 0, 1).$$

Also, find an equation for this plane.

(ADDITIONAL SPACE FOR WORK, clearly INDICATE the problem you are working on)

2. (20 points) Is the triangle with vertices

$$P = (0, 1, 2), \quad Q = (2, -1, 2), \quad R = (-1, 0, 1)$$

right-angled?

(ADDITIONAL SPACE FOR WORK, clearly INDICATE the problem you are working on)

3. (20 points) Compute the volume of the parallelepiped determined by the vectors

$$\mathbf{u} = \langle 1, -1, 2 \rangle, \quad \mathbf{v} = \langle 2, 0, 3 \rangle, \quad \mathbf{w} = \langle 3, -1, 5 \rangle.$$

(ADDITIONAL SPACE FOR WORK, clearly INDICATE the problem you are working on)

4. (20 points) Consider the planes

$$-x - 3y + 2z + 4 = 0$$

and

$$2x + 6y - 2z + 4 = 0.$$

Determine whether these planes are equal, parallel but not equal or intersecting. If they intersect, find the line of intersection between them.

(ADDITIONAL SPACE FOR WORK, clearly INDICATE the problem you are working on)