

Graphing calculators are allowed during this exam, **except TI-89's and TI-92's**. There is no penalty for guessing on the true-false and multiple choice questions. Indicate your answers CLEARLY and NEATLY.

1. True-False (10 pts)

- (a) **T**    **F**    The vectors  $\langle 2, -1, 3 \rangle$  and  $\langle 4, -2, 1 \rangle$  are parallel.
- (b) **T**    **F**    The vectors  $\langle 2, -1, 3 \rangle$  and  $\langle 1, 5, 1 \rangle$  are orthogonal.
- (c) **T**    **F**    The vectors  $\langle 8, -1, 2 \rangle$  and  $\langle -2, 4, 7 \rangle$  have the same length.
- (d) **T**    **F**    The vector  $\langle \frac{3}{5}, \frac{-4}{5} \rangle$  is a unit vector.
- (e) **T**    **F**    The vector  $\langle -1, -1, 1 \rangle$  is perpendicular to the plane  $x + y - z = 3$ .

2. The area of the parallelogram formed by the vectors  $\mathbf{v} = 2\mathbf{i} + \mathbf{j}$  and  $\mathbf{u} = -4\mathbf{i} + 5\mathbf{j}$  is (5 pts)

- (a) 14            (b) 6            (c) 5            (d) 3            (e) 1

3. The cosine of the angle between the two vectors  $\mathbf{v} = \langle -7, 4, -4 \rangle$  and  $\mathbf{u} = \langle 4, 8, -1 \rangle$  is (5 pts)

- (a)  $\frac{64}{49}$             (b) 0            (c)  $\frac{-7}{12}$             (d)  $\frac{8}{63}$             (e)  $\frac{8}{81}$

4. The surface whose equation in *cylindrical* coordinates is given by  $\theta = \frac{\pi}{6}$  is (5 pts)

- (a) a cone            (b) a cylinder            (c) a sphere            (d) a plane            (e) two straight lines

5. Find the point of intersection of the line given by  $\frac{x+2}{2} = \frac{y-7}{8} = z+2$  and the  $xy$ -plane. (5 pts)

your answer:

6. Let  $P(2,4,6)$ ,  $Q(0,-1,5)$ ,  $R(3,1,2)$  be three points in  $\mathbf{R}^3$ .

(25 pts)

(a) Find the vector (in component form) from  $P$  to  $Q$ .

your answer:

(b) Find the symmetric equations for the line in space through points  $P$  and  $Q$ .

your answer:

(c) Find a vector (in component form) that is orthogonal to  $\overrightarrow{PQ}$  and  $\overrightarrow{PR}$ .

your answer:

(d) Find an equation for the plane determined by the points  $P, Q$ , and  $R$ .

your answer:

(e) Find the projection of  $\overrightarrow{PQ}$  in the direction of  $\overrightarrow{PR}$ .

your answer:

7. Consider the surface defined by  $y - \frac{x^2}{4} - z^2 = 0$ . (20 pts)

(a) Sketch and describe the trace of the surface in the  $xy$ -plane.

(b) Sketch and describe the trace of the surface in the  $yz$ -plane.

(c) Sketch and describe the trace of the surface in the  $xz$ -plane.

(d) Sketch and describe the trace of the surface in the plane  $y = 4$ .

(e) Sketch and describe the surface in 3-space.

8. Consider the vector  $\mathbf{u}$  in the  $yz$ -plane of length 4 making an angle of  $30^\circ$  with the positive  $y$ -axis.

(10 pts)

(a) Write the vector  $\mathbf{u}$  in standard unit vector notation (as a linear combination of  $\mathbf{i}$ ,  $\mathbf{j}$  and  $\mathbf{k}$ ).

your answer:

(b) Write the vector in component form.

your answer:

(c) Sketch the vector  $\mathbf{u}$ .

9. Consider the surface in 3-space defined by the equation  $x^2 + y^2 = 4y$ .

(15 pts)

(a) Sketch and describe the surface in 3-space.

(b) Convert the equation into cylindrical coordinates.

your answer:

10. **Bonus** Find the point  $(x_1, y_1, z_1)$  that results when the point  $(x_o, y_o, z_o)$  is projected onto the plane  $ax + by + cz + d = 0$ .