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This exam covers chapters 9.1 - 9.7.

**Directions:** Complete all question and **show all applicable work.** Partial credit will be given.

1.) [10pts] Draw a 3-dimensional axis with the positive x-axis pointing down. You may select the y- and z-axis, but they must satisfy the right-hand rule. Be sure to note which side of each axis is positive.

2.) [10pts] Let  $u = \langle 4, -2 \rangle$  and  $v = \langle 1, 2 \rangle$ . Draw a plot showing the geometry of  $u - v$ .

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3.) [5pts each] Describe the following surfaces in words. Detail the type of surface, and any special points and/or vectors that are used to describe it.

a.)  $x = 3, y = 4, z = -3$

b.)  $x^2 + y^2 + z^2 = 1 - 9x$

c.)  $x + y + z = 1 - 9x$

d.)  $z = r$

4.) [12pts] Convert the coordinates  $(x, y, z) = (3, 4, 5)$  to cylindrical coordinates.

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5.) [6pts each] Let  $P = (-5, 6, 5)$ ,  $Q = (-4, 2, 5)$  and  $R = (0, 6, 7)$ .

a.) Compute the line  $\overrightarrow{PQ}$  and  $\overrightarrow{PR}$ .

c.) Compute  $\overrightarrow{PQ} \times \overrightarrow{PR}$ .

d.) Find the area of the triangle formed by  $P$ ,  $Q$ , and  $R$ .

e.) Find a unit vector in the direction of  $\overrightarrow{PQ}$ .

f.) What is the angle between  $\overrightarrow{PQ}$  and  $\overrightarrow{PR}$ .

g.) Compute the scalar projection of  $\overrightarrow{PQ}$  onto  $\overrightarrow{PR}$ .

h.) Compute the vector projection of  $\overrightarrow{PQ}$  onto  $\overrightarrow{PR}$ .

i.) Find the equation of a line through the point  $Q$  and parallel to the line  $\overrightarrow{PR}$ .

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6.) Bonus [5pts]: Find a unit vector perpendicular to the vector  $u = \langle 4, -3, 8 \rangle$ . Show it is perpendicular.