1. Given the points $A(1,1,3)$, $B(2,-3,1)$, and $C(0,4,4)$,
   (a) Determine if the three points $A$, $B$, and $C$ lie on the same line.
   (b) Find a unit vector in the direction of $\vec{AC}$ and a unit vector in the direction opposite of $\vec{AC}$.

2. Forces with magnitudes of 500 pounds and 200 pounds act on a machine part at angles of $\pi/6$ and $-\pi/4$ with the $x$-axis. Find the resultant force vector.

3. Given the vectors $\vec{a} = \langle 1, -4, \xi \rangle$, $\vec{b} = \langle -3, 12, 6 \rangle$, and $\vec{c} = -4\hat{i} + 3\hat{j} + 3\hat{k}$:
   (a) Find $\xi$ so that $\vec{a}$ is parallel to $\vec{b}$:
   (b) Find $\xi$ so that $\vec{a}$ is orthogonal to $\vec{c}$:
   (c) Evaluate $-3\vec{a} + 2\vec{b}$

4. Given the vectors $\vec{u} = \langle 4, 3, 0 \rangle$ and $\vec{v} = \langle 2, -1, 2 \rangle$,
   (a) find the scalar projection of $\vec{u}$ onto $\vec{v}$, $\text{comp}_\vec{v}\vec{u}$:
   (b) find the vector projection of $\vec{u}$ onto $\vec{v}$, $\text{proj}_\vec{v}\vec{u}$:

5. Find the cosine of the angle between the vectors $\vec{r} = \langle 3, 2, -1 \rangle$ and $\vec{s} = \langle 1, 2, 2 \rangle$:

6. Find the direction cosines for the vector $\vec{r} = \langle 3, 2, -1 \rangle$:

7. An object is pulled 25 feet across a floor using a force of 40 lbs. Find the work done if the direction of the force is 45 degrees above the horizontal.

8. Find the area of the triangle defined by the three points $P(1,1,3)$, $Q(2,-3,1)$ and $R(0,4,4)$:

9. Find the area of the parallelogram defined by the vectors $\vec{r} = \langle 3, 2, -1 \rangle$ onto $\vec{s} = \langle 1, 2, 2 \rangle$:

10. Find two unit vectors that are orthogonal to both vectors given, $\vec{u} = \langle 2, 1, 3 \rangle$, and $\vec{v} = \langle 3, -2, 0 \rangle$.

11. A child applies breaks on a bicycle by applying downward force of 20 lbs on a pedal when the crank shaft is at a 30 degree angle with horizontal. Find torque at $P$ if the crank is 1/2 foot in length.

12. Find the volume of the parallelepiped defined by the vectors $\vec{u} = \langle 4, 3, 0 \rangle$, $\vec{v} = \langle 2, -1, 2 \rangle$ and $\vec{w} = \langle 3, 2, 1 \rangle$:

13. Write the equation in parametric and symmetric form for the line that passes through the point $(1,0,-4)$ and is parallel to $\vec{u} = \langle 4, 2, 3 \rangle$ in the space below:
14. Find the vector equation of the line containing the points $A(1,1,3)$ and $B(2,-3,1)$.

15. Find the equation of the plane that contains the three points $P(1,1,3)$, $Q(2,-3,1)$ and $R(0,4,4)$:

16. The two lines given below intersect when $t = 1$ and $s = -1$. Write down the point of intersection and the cosine of the angle of intersection.
   Line 1: $x = 1 - 2t$  $y = -2 + t$  $z = 2 + 4t$
   Line 2: $x = -3 - 2s$  $y = 1 + 2s$  $z = 3 - 3s$

17. Find the distance from the point $Q(-6,2,1)$ to the plane $3x - 3y + z = 9$. You must include a sketch (not an exact graph) illustrating how you solved this problem. It should include the point $Q$, the plane and the distance you are trying to find.

18. The lines $x - 2t = y - 2 + t = z - 3 = 3 = 1$ intersect at the point $(6,-4,5)$. Find an equation of the plane that contains both lines.

19. Given the surface $4x^2 - y^2 + 4z^2 = -16$, Transform the equation of the surface to a cylindrical equation and a spherical equation.

20. Transform the cylindrical equation $\sin \theta = r \cos^2 \theta$ to a rectangular equation and identify the surface.

21. Transform the spherical equation $1 = 4 \cos \phi$ to a rectangular equation.

22. Given the vector valued functions $\vec{r}(t) = \langle \sqrt{t^2 - 25}, \frac{t}{t^2 - 1}, 2t^2 \rangle$

   (a) Where is the vector $\vec{r}(t)$ continuous?
   (b) Evaluate the $\lim_{t \to 1} \vec{r}(t)$.
   (c) Find $||\vec{r}(t)||$

23. Given the vectors $\vec{u}(t) = \sqrt{4 - t} \hat{i} + \sin 2t \hat{j} + \ln t \hat{k}$

   (a) What is the domain of $\vec{u}(t)$?
(b) Evaluate, if possible, $\vec{u}(\frac{\pi}{6})$.

30. Find the rectangular equation for the parametric surface given by $\vec{r}(u, v) = 2u \cos (v)\hat{i} + 2u \sin (v)\hat{j} + u^2\hat{k}$. Identify the surface.

31. Find the rectangular equation for the parametric surface $\vec{r}(u, v) = (1 + 2u, 3v, 2 + 4u + 2v)$ and identify the surface.

32. Find a vector valued function whose graph is the indicated surface. The cylinder $x^2 + 6y^2 = 12$.

33. You may also be asked to match an equation with either a space curve from 13.1 problems 19 - 24 or a surface from 16.6 problems 11 - 16.

Exam # 3 Formulas

\[ \vec{a} \cdot \vec{b} = ||\vec{a}|| ||\vec{b}|| \cos \theta \]

\[ ||\vec{a} \times \vec{b}|| = ||\vec{a}|| ||\vec{b}|| \sin \theta \]