Announcements:

1) The review session for midterm 1 is scheduled for **this Sunday, January 25, 2015, from 3PM-5PM at Center 101**.

2) I will also have extra office hours **next Thursday, January 29, 2015, from 3PM-6PM** for anyone who can'tmake it to the review sessionand for anyone with last minute questions. I still have y regular office hours on Wednesday from 5PM-6PM.

3) The practice midterm and solutions are up here:

http://www.math.ucsd.edu/~jbriones/math20c.15w/tests.html

4) About homework: **A) SHOW YOUR WORK**. In the future, the grader will mark you down for not showing any work. **B)** On the top of the firstpage of your homework, **please put your full name (FORMAT: LAST name , FIRST name), PID, Section #, and homework # (eg Homework 2)**. **C)** If you want a regrade, please hand the homework back to me BEFORE you leave the room.

Planes

What's a normal vector?

A **normal vector** to a plane is a vector that is **perpendicular** to every vector that lies in the plane. **IMPORTANT:** "A vector that lies in the plane" is **NOT** the same thing as "A position vector that points to a point on the plane".
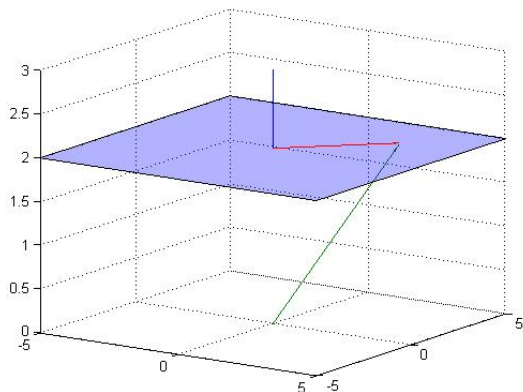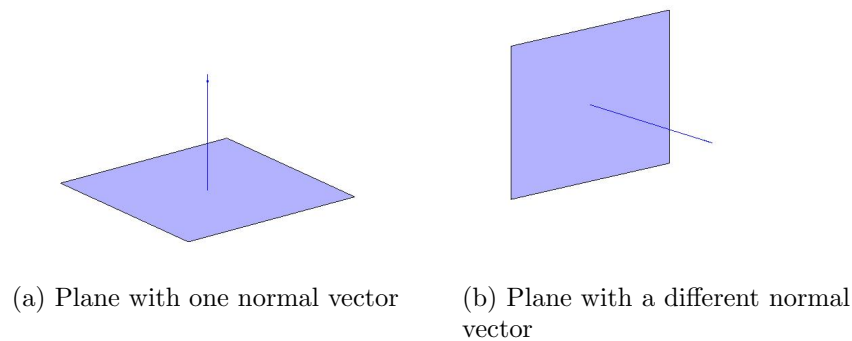

Figure 1: A plane.

A vector that lies in the plane is one that is parallel to the plane. So that if you translated the vector to the plane, it would lie flat on the plane. **You can find a vector that lies on the plane by taking the difference of the position vectors of two points on the plane. If $\vec{P}$ and $\vec{Q}$ are position vectors that point to points on the plane, then the vector $\vec{Q} - \vec{P} = \vec{PQ}$ lies in the plane.**

What's a plane?

For planes, you need 2 ingredients. You need **a point on the plane** and **a normal vector**. The direction that the **a normal vector** is pointing determines the **orientation** of the plane (example: Is it lying flat? Is it parallel to the xz-plane? Does it have a slope of some kind?). The **position vector/point** tells you where that plane is in space (so that we can tell parallel planes apart).

(a) Plane with one normal vector   (b) Plane with a different normal vector

Figure 2: The normal vector determines the **orientation** of the plane

Formulas for a plane:

The equation of a plane can be written in a few ways. The textbook lists these forms (note that $\mathbf{n} = \langle a, b, c \rangle$ is a normal vector to the plane and $\mathbf{p} = \langle x_0, y_0, z_0 \rangle$ is the position vector of some point on the plane and that $d = \mathbf{n} \cdot \mathbf{p} = ax_0 + by_0 + cz_0$):

$$\mathbf{n} \cdot \langle x, y, z \rangle = d \quad \text{(Vector form)}$$
$$ax + by + cz = d \quad \text{(Scalar form 1)}$$
$$a(x - x_0) + b(y - y_0) + c(z - z_0) = 0 \quad text(Scalar form 2)$$

How do I get a normal vector?

A normal vector is perpedicular to EVERY vector that lies on the plane. But if it is perpendicular to TWO NON-PARALLEL VECTORS IN THE PLANE, it will be perpendicular to the plane. So if you have two non-parallel vectors $\mathbf{u}$ and $\mathbf{v}$ that lie in the plane, then $\mathbf{u} \times \mathbf{v}$ is perpendicular to both of them, and $\mathbf{u} \times \mathbf{v}$ **is a normal vector for the plane**. NOTE: You normally DO NOT cross position vectors of points on the plane.

How do I find vectors on a plane?

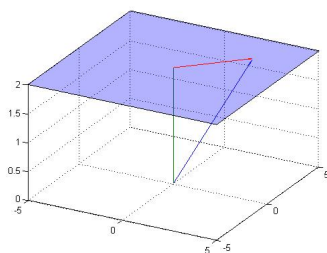Different ways to find vectors on a plane:

Figure 3: You can find a vector that lies on the plane by taking the difference of the position vectors of two points on the plane.

1. **3 points:** If you're given 3 points ON THE PLANE $\vec{P}$, $\vec{Q}$, and R that are NOT co-linnear (not on the same line), then you can take the difference of their position vectors. So $\overrightarrow{PQ}$ and $\overrightarrow{PR}$ are vectors that lie on the plane and $\overrightarrow{PQ} \times \overrightarrow{PR}$ is a normal vector.

2. **Lines:** If a plane is PARALLEL to a line, then the line's direction vector is on the plane. If a plane CONTAINS a line, then every point on that line is on the plane (use its points)