Math 53 Homework 1

Due Wednesday 8/30/17 in section

Important notes:

• Homework assignments for this class can be lengthy (this one isn't), but a lot of practice solving problems is essential for learning the material. Be organized, and don't leave things for a marathon session on Tuesday night. Instead, get a good start on the homework over the weekend (or even earlier!) so you can ask questions in discussion on Monday.

• You may check your answers to odd-numbered problems in the back of the book, but you need to turn in solutions, not just answers. You may discuss the homework problems with your classmates, but **you must write your solutions on your own**. I am aware that it is not hard to find solutions manuals on the internet. Copying said solutions on a homework assignment will result in a negative grade for that assignment. (It also won't help you learn the material).

• The problems in parentheses are for extra practice and **optional**. You only need to turn in the underlined problems.

• Page and problem numbers refer to the 8th edition of Stewart. When there is a difference, footnotes give the numbers for the 7th edition.

Wednesday 8/23 – Vectors, dot product

• **Read:** sections 12.1, 12.2, 12.3.

• **Work:** 12.1: (7), (9), (13), <u>15</u>, (23), (29), <u>37</u>, <u>45</u>.[1]

12.2: (3), (5), (17), (19), (25), (29), <u>33</u>, (35), (43), <u>45</u>, <u>51</u>.

Friday 8/25 – Dot product continued; determinant

• **Read:** section 12.3.

• **Work:** 12.3: (1), (11), (17), <u>23</u>[2], <u>25</u>, (27), (38), (39), (41), (49).

12.3: (53), <u>54</u>, <u>55</u>, (56), <u>60</u>, <u>63</u>, (64), (65).

<u>Problems 1 and 2</u> below.

Problem 1.

Let $\vec{v}_1$ and $\vec{v}_2$ be two unit vectors making angles θ_1 and θ_2 with the positive x-axis in the plane. Prove the trigonometric formula

$$\cos(\theta_1 - \theta_2) = \cos\theta_1 \cos\theta_2 + \sin\theta_1 \sin\theta_2$$

by calculating the dot product $\vec{v}_1 \cdot \vec{v}_2$ in two different ways.

[1] **7th ed:** 12.1: (5), (7), (11), <u>13</u>, (21), (27), <u>33</u>, <u>41</u>.

[2] **7th ed:** do the 8th ed problem: (a) $\mathbf{a} = \langle 9, 3\rangle$, $\mathbf{b} = \langle -2, 6\rangle$. (b) $\mathbf{a} = \langle 4, 5, -2\rangle$, $\mathbf{b} = \langle 3, -1, 5\rangle$. (c) $\mathbf{a} = -8\hat{\imath} + 12\hat{\jmath} + 4\hat{k}$, $\mathbf{b} = 6\hat{\imath} - 9\hat{\jmath} - 3\hat{k}$. (d) $\mathbf{a} = 3\hat{\imath} - \hat{\jmath} + 3\hat{k}$, $\mathbf{b} = 5\hat{\imath} + 9\hat{\jmath} - 2\hat{k}$.

Problem 2. The eight vertices of a cube centered at $(0, 0, 0)$ of side length 2 are at $(\pm 1, \pm 1, \pm 1)$.

a) Find the four vertices of the cube, starting with $(1, 1, 1)$, that form a regular tetrahedron. Confirm your answer by finding the length of an edge and explaining why all edges have the same length. (Recall: a tetrahedron is a solid with four triangular faces, like a pyramid with a triangular base; it is *regular* if all faces are equilateral triangles. Draw pictures and look at cubical objects in order to figure out how equilateral triangles fit on a cube).

b) Use dot product to find the angle between two adjacent edges (edges sharing a common vertex) of the regular tetrahedron; and the angle between two opposite edges (edges that lie on skew lines; even though they don't intersect, you can still compute the angle made by their directions). Explain your answers using symmetry.

c) A methane molecule CH_4 consists of a hydrogen atom at each of the vertices of a regular tetrahedron and a carbon atom at the center. Find the "bond angle", i.e. the angle made by vectors from the carbon atom to two hydrogen atoms (use a calculator; round your answer).