Math 53 Homework 3

Due Wednesday 2/10/16 in section

(The problems in parentheses are for extra practice and optional. Only turn in the underlined problems.)

Monday 2/1 – Cross product

- **Read:** section 12.4.
- **Work:** 12.4: (3), (9), (13), 16, (19), (27), 31, 36, (37), (45), 46, 53.[1]

  p. 823 "The geometry of a tetrahedron", parts 1† and 3.[2]

† Hint: for part 1, don't introduce coordinates; instead, express everything in terms of the vectors $\vec{a} = \overrightarrow{SP}$, $\vec{b} = \overrightarrow{SQ}$, and $\vec{c} = \overrightarrow{SR}$ and use the properties of cross-product.

Wednesday 2/3 – Equations of lines and planes

- **Read:** section 12.5.
- **Work:** 12.5: (1), 5, (9), (19), (25), 33[3], (37).

  12.5: (45), 48[4], (51), 58, 63, (65), (71), 77.[5]

  Problem 1 (next page).

(Hint for 12.5 # 77: even though we are given symmetric equations rather than parametric ones, this is similar to examples 3 and 10 in the book.)

Friday 2/5 – Parametric equations and vector functions

- **Read:** sections 13.1 to middle of p. 851; 13.2 to top of p. 858.[6]
- **Work:** 13.1: (9), 14, (21), (25), (27), (31), (49).[7]

  13.2: (1), (3), 5[8], (9), (19), 25, 33[9], (34)[9].

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[1] **6th ed:** 12.4: (3), (9), (13), 16, (19), (27), 31, 36, (37), (43), 44, 49; **7th ed:** same as 8th ed.
[2] **6th ed:** p. 794, **7th ed:** p. 816.
[3] **6th and 7th eds:** do the 8th ed problem: plane through points (2,1,2), (3,-8,6), and (-2,-3,1).
[4] **6th and 7th eds:** do the 8th ed problem: line through (-3,1,0) and (-1,5,6), plane $2x+y-z=-2$.
[5] **6th ed:** 12.5: (43), 46 (modified, see above), (49), 56, 61, (63), (69), 75. **7th ed:** same as 8th.
[6] **6th and 7th eds:** 13.1 to middle of p. 820 / p. 843; 13.2 to middle of p. 826 / top of p. 850.
[7] **6th ed:** 13.1: (9), 14, (22), (23), (25), (27), (41). **7th:** 13.1: (9), 14, (21), (25), (27), (29), (47).
[8] **6th and 7th eds:** do the 8th ed problem: $\vec{r}(t) = e^{2t}\hat{\imath} + e^{t}\hat{\jmath}$, $t = 0$.
[9] **6th ed:** 13.2: 31, (32). **7th ed:** same as 8th ed.

Problem 1. In 3D computer graphics, one needs to represent 3-dimensional objects on a plane screen, by drawing a given point P at the place where the line from P to the eye meets the screen. Suppose that the screen is the yz-plane, and the eye is at $E : (2, 0, 0)$.

a) At what point $Q : (y, z)$ in the yz-plane should one represent the point $P : (x_0, y_0, z_0)$? (Express y and z in terms of the coordinates of P. Assume that $x_0 < 2$. Why is this assumption legitimate?)

b) What does the image on the screen of a line segment in space look like? (Justify your answer.)

c) A line segment connects $P_0 : (-1, -3, 1)$ to $P_1 : (-2, 4, 6)$. What is drawn on the screen?

d) A bird leaves from P_0 at time $t = 0$, and flies in a straight line at constant speed in such a way that it passes through P_1 at time $t = 1$.

What does the trajectory of the bird (for $t \geq 0$) look like on the screen? Show that, as t tends to infinity, the trajectory on the screen tends to a limit point (the "vanishing point"), and give its coordinates.

e) In fact, part of the trajectory of the bird is hidden by a vertical fence erected in front of the observer. The fence lies in the plane $x = 1$, and its top is at the altitude $z = 1$. What portion of the trajectory is hidden? (*Hint:* the points hidden by the fence are exactly those which lie below a certain plane passing through E.)