Math 254N ASSIGNMENT 10, SPRING 2018 **Due at 5 PM Monday, May 7th**

Give units with all answers!

In some location the temperature T in degrees Fahrenheit of the ground at a depth of d feet and at time t days from some zero date is modeled by

$$T(d,t) = 30e^{-0.2d}\cos(0.0172t - 0.2d) + 60\,.$$

You will recognize this from a recent assignment.

1. Graph the temperature as a function of time at depths 0 feet, 2 feet and 5 feet (all on one graph) using *www.desmos.com*). Click the little wrench and set the viewing window for $-10 \le x \le 50$, $20 \le y \le 100$. Sketch what you see, **using the following guidelines:**

   - Your graph should occupy the full width of your page (with margins), and both axes should be drawn using some sort of straightedge.
   - Each axis should be labeled with its variable, the units used for that variable, and a numerical scale with important values noted.
   - Put a dashed horizontal line at the horizontal "center line" of the three graphs. Again, use a straightedge.
   - Label each graph with the depth it represents.
   - **You may do all of this with some other computer software and print the results if you wish. Or you can print from Desmos if you can figure out how to do that. Be sure each curve is labeled with its value of d.**

2. Give the period and amplitude at each of the three depths from Exercise 1, in some organized way that I can tell which is which. (A table might be a nice way to do this.) You should notice something special about the period - state it in a brief sentence. Write another sentence describing what you see in the amplitudes as the depth increases.

3. Give the phase shift ("lag time") at depths of 2 feet and 5 feet.

4. What time of year do you think is represented by time zero? Explain.

5. Given that

   $$T_d(d,t) = 6e^{-0.2d}\big[\sin(0.0172t - 0.2d) - \cos(0.0172t - 0.2d)\big], \qquad T_t(d,t) = -0.516e^{-0.2d}\sin(0.0172t - 0.2d),$$

   find and **interpret** the meanings of $T(5,100)$, $T_d(5,100)$, $T_t(5,100)$. Give each answer like this: "$T(5,100) = number\ with\ units$ At ..." Use either *increasing* or *decreasing* in your answer, and say "rate of change" rather than derivative. Specify location, time, and which variable is changing.

6. Find the average rate of change of temperature with respect to time at a depth of 4 feet, from $t = 0$ days to $t = 50$ days. Indicate clearly how your answer is obtained, and give units with your answer.

7. What does $\dfrac{T(10,200) - T(8,200)}{2}$ represent, and what units will it have?

8. The function $T(x,y,z)$ gives temperature, in degrees Celsius, at the point (x,y,z) in a solid object. x, y and z are in meters, and we know that

   $$T(5,8,3) = 41, \qquad T_x(5,8,3) = 1.7, \qquad T_y(5,8,3) = -2.1, \qquad T_z(5,8,3) = 1.5$$

   (a) Write a sentence interpreting $T(5,8,3) = 41$.

   (b) What are the units for $T_z(5,8,3) = 1.5$? Write a sentence interpreting $T_z(5,8,3) = 1.5$.

   (c) Using the given information, approximate the value of $T(7,9,6)$.

   (d) Use the same method to approximate $P(7,7,6)$.