

## Chapter 05.00C

### Physical Problem of Interpolation Civil Engineering

#### Problem Statement

This is a conversation between a former instructor (Autar) and civil engineering alumni named John Q. This is just what we heard!

**Autar:** "That is interesting! You are now a professional civil engineer and love to go bass fishing."

**John Q:** "Actually, my civil engineering education is helping me in being a good bass fisherman!"

**Autar:** "How is that?"

**John Q:** "Well, if you know where the thermocline is in the lake, you can find a lot of bass there!"

**Autar:** "Glad I asked? Educate me."

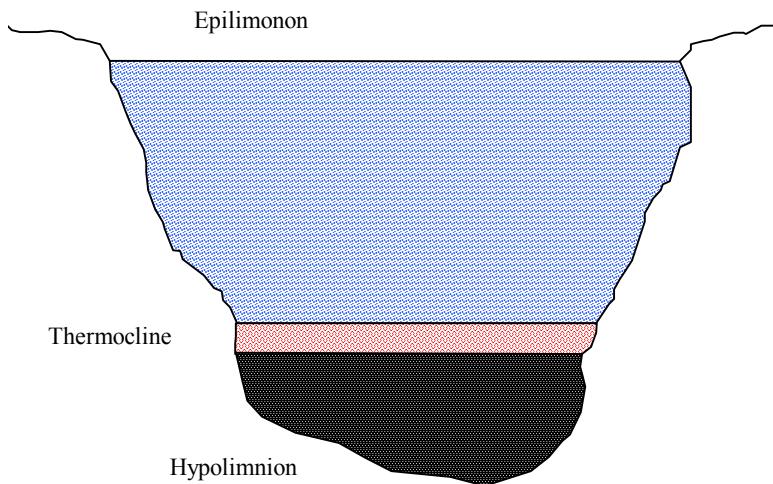
**John Q:** "Well, the water in a lake generally has three layers – epilimnon, thermocline and hypolimnion as shown in Figure 1 below. The thermocline layer is sandwiched between the epilimnon and the hypolimnion. The sun heats the water at the surface and this layer (epilimnon) of warm water floats over a layer (hypolimnion) of colder water, as the warm water is less dense than cold water. As days become hotter during the summer the layers become very distinct. Between these two layers of warm and cold water, you have a thin layer called the thermocline. Bass love the thermocline. So if you know where this thin layer of thermocline is, you can have a great catch."

**Autar:** "But why do bass fish like the thermocline?"

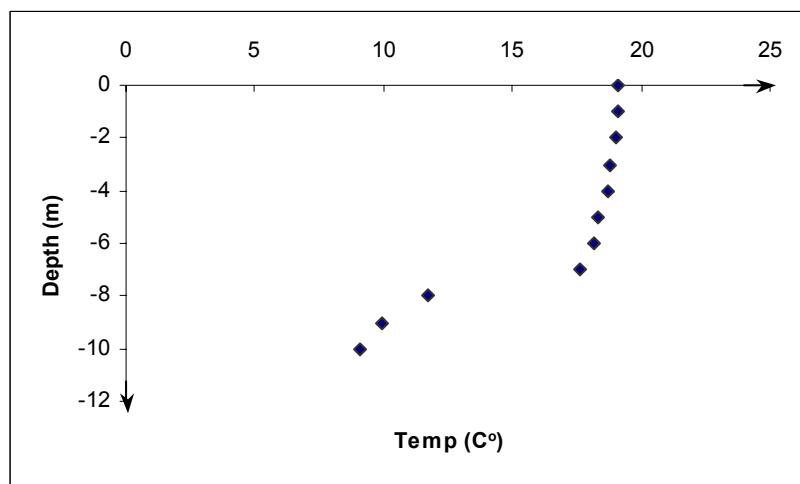
**John Q:** "Well, the upper layer (epilimnon) has too much light for the bass to be calm, while the lower layer (hypolimnion) has too little oxygen. The thermocline is also ideal for algae growth. So, it is the place of choice for the bass. You will be wasting your time if you fish below the thermocline."

**Autar:** "So how does one find where the thermocline is?"

**John Q:** "Well, you got electronic gadgets, such as depth finders, LCRs, and thermometers to do that. What some of these gadgets measure is the depth at which drastic change in temperature takes place? Just look at the data in Figure 2 taken in a lake in Pennsylvania. It shows the temperature data as a function of depth. You can see where it changes temperature suddenly. That is where the thermocline is."



**Figure 1** Three layers of lake stratification.



Temperature °C	Depth m
19.1	0
19.1	-1
19	-2
18.8	-3
18.7	-4
18.3	-5
18.2	-6
17.6	-7
11.7	-8
9.9	-9
9.1	-10

**Figure 2** Temperature as a function of depth (Data courtesy of Ms. Bartlett - <http://www.lehigh.edu/~infolios/becky/lakegraph.htm><sup>1</sup>).

**Autar:** “So what one can do is interpolate the temperature vs. depth data. The depth at which the thermocline occurs is the inflection point of the temperature-depth curve.”

**John Q:** “You are still in the habit of using jargon like inflection points. I still gives me beautiful dreams of Calculus II!”

**Autar:** “Yes, simply said, the inflection point is where the second derivative of temperature with respect to the depth becomes zero. That is  $\frac{d^2T}{dz^2} = 0$ , where  $T$  is the temperature at depth  $z$ . I think I am going to taking this problem to the classroom to teach my students about interpolation. Thanks to you.”

Topic	INTERPOLATION
Sub Topic	Physical Problem
Summary	Bass fishing never got so technical. Find how interpolation can help you to have a great catch and let you tell others a true fish story.
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Last Revised	December 23, 2009
Web Site	<a href="http://numericalmethods.eng.usf.edu">http://numericalmethods.eng.usf.edu</a>

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<sup>1</sup> This data was gathered to teach middle school biology students about lake stratification (the three layers: epilimnon, thermocline, and hypolimnion), dissolved oxygen levels, photosynthesis, and cellular respiration.”