

Teaching in Cambodia – Real Analysis

March 3 to March 22, 2008

Instructor: John Lamperti (Dartmouth College, NH)

Outline

- Class 1: The real number system, especially the completeness axiom.
- Class 2: Sets. Countable and non-countable sets; transcendental numbers.
- Class 3: Sequences and series; definition and properties of limits.
- Class 4: Existence of limits; Cauchy criterion; Bolzano-Weierstrass theorem. Convergence of infinite series.
- Class 5: Functions. Limits and continuity. First (short) exam.
- Class 6: Continuous functions on compact intervals; max/min and intermediate value theorems.
- Class 7: Interchanging limit operations (examples). Derivatives. Chain rule; mean value theorem; consequences.
- Class 8: The Riemann Integral. Upper and lower sums; definition of integral. Existence for bounded monotonic functions.
- Class 9: Riemann sums; properties of integral. Fundamental theorem.
- Class 10: Integrability and fundamental theorem. Uniform continuity; prove existence of integral for continuous functions. Second exam.
- Class 11: Sequences of functions; uniform convergence including the Cauchy criterion. The Peano space-filling curve.
- Class 12: The Weierstrass approximation theorem; proof using Bernstein polynomials. Brief review of series. The exponential and log functions.
- Class 13: Series of functions; uniform convergence; properties of limit. Power series: radius of convergence; derivatives and integrals.
- Class 14: Taylor series: two forms of remainder; series for sine and cosine. Cauchy's example where Taylor series doesn't equal the function.
- Class 15. Irrationality of e . Brief review; final exam.

Discussion

The conditions for the course were far from ideal. In particular, language was a major problem. I tried to always speak as clearly and simply as possible, although no doubt I sometimes forgot. While I'm not sure how well the students understood me, I know that *I* had difficulty understanding *them*. As a result the possibility of questions and discussion was limited, and I spent more time simply lecturing than I'd prefer.

It would help a lot if the class members had a good textbook. I distributed xeroxed sections from books I had brought with me; this helped, but a book we could follow would have been much better. Perhaps this could be done another time, although of course buying books at even a fraction of US prices would be difficult or impossible for the Cambodian students. The previous instructor sent books from Japan for the class – pirated copies, I think. Unfortunately they arrived after his course was over.

These two problems have implications for teaching style. A professor giving clear, complete, formal lectures would come across better under these conditions than one with a more informal, chatty style. I recall a beautiful lecture course I attended in graduate school; we had a textbook but made little use of it. That professor (H. P. Bohnenblust) would have succeeded very well at RUPP. My own teaching style leans more toward informal discussion, which did not work so well in this case.

I think the structure of the course – 3 1/2 hours of class (with a break!) daily, five days per week – is unfortunate; these ideas are much better absorbed in smaller doses, with time to think them over and allow them to sink in and mature. However, I and doubtless others would not volunteer to spend ten weeks or so in order to teach the course at a more leisurely pace, so the intensive schedule is no doubt a necessary evil.

Despite all that, we tried! The material is beautiful, and I hope some of my own enthusiasm for it did get across. I know that even good students in the US do not master these ideas the first time they see them, nor did I do so as a student – yet in time these concepts do take root and (sometimes) even grow. I hope that will happen in this case! and that some seeds were planted for the future. -- JL