Applications of Water Wave Theory in Oceanography and Coastal Engineering

Jerry L. Bona

Department of Mathematics, Statistics, and Computer Science
The University of Illinois at Chicago

After a review of salient parts of surface water wave theory and some indication of recent rigorous results pertaining to it, the lecture will turn to some applications of these theories. This will include tsunami propagation, rogue wave formation, beach protection strategy and pulmonary hypertension, as time allows.

Critical Point Theory and Multiplicity of Solutions to Elliptic Boundary Value Problems

Alfonso Castro

Department of Mathematics
Harvey Mudd College

We will review critical point theory techniques and combine them to establish the existence of multiple solutions to boundary value problems of the form $\Delta u + g(u) = 0$ in Ω and $u = 0$ on the boundary of Ω, where Ω is a smooth bounded region in R^N. In particular, sufficient conditions for this problem to have seven solutions for g *sublinear* in the absence of symmetries will be discussed.

Modeling Infectious Diseases with Environmental Transmission

Suzanne Lenhart

Department of Mathematics
University of Tennessee Knoxville

Modeling infectious diseases that have an indirect transmission route through pathogens in the environment is a research area with growing interest. Whether to use this approach may depend on how long the pathogen stays viable in the environment. The appropriate types of transmission terms to include may vary depending on the disease. Examples of models representing Johne's Disease in dairy cattle and Clostridium Difficile in hospital-acquired infections will be discussed.

Mathematical Models for Infectious Diseases with Nonlocal State Structures

Michael Li

Department of Mathematical and Statistical Sciences
University of Alberta, Canada

In this talk, I will discuss state structures in mathematical models for infectious diseases. The state is a measure of infectivity of an infected individual in epidemic models or the intensity of viral replications in an infected cell for in-host models. In modelling, a state structure can be either discrete or continuous.

In a discrete state structure, a model is described by a large system of coupled ODEs. The complexity of the system often poses a serious challenge for the analysis of the system dynamics. I will show how such a complex system can be viewed as a dynamical system defined on a transmission-transfer network (digraph), and how a graph-theoretic approach to Lyapunov functions developed by Guo-Li-Shuai can be applied to rigorously establish the global dynamics.

In a continuous state structure, the model gives rise to a system of nonlinear integro-differential equations with a nonlocal term. The mathematical challenges for such a system include a lack of compactness of the associated nonlinear semigroup. The well-posedness and dissipativity of the semigroup is established by directly verifying the asymptotic smoothness. An equivalent principal spectral condition between the next-generation operator and the linearized operator allows us to link the basic reproduction number R_0 to a threshold condition for the stability of the disease-free equilibrium. The proof of the global stability of the endemic equilibrium utilizes a Lyapunov function whose construction is informed by the graph-theoretic approach in the discrete case.