ARIZONA STATE UNIVERSITY

COLLEGE OF LIBERAL ARTS AND SCIENCES
Department of Mathematics and Statistics

COURSE ANNOUNCEMENT

SPRING 2006

MAT 598

MODELS OF NEURONS AND NEURAL NETS

Instructors: **Steve Baer, Karl Hadeler, Priscilla Greenwood**

Time: **3:15 – 4:30 Tuesdays & Thursdays**

Location: **AG 246**

Schedule Line #: **75801**

Credit Hours: **3.0**

Course Description*:* Neurons are the basic units of nervous systems, and neurons form neural nets in the bodies of humans and all animals with some higher level of organization. Neural networks perform special tasks in physiology, information processing, etc. Mathematical models of such networks are *biological* neural networks. The underlying concepts like threshold behavior, inhibition and excitation, layer structure, input and output, stochasticity have been incorporated into a class of dynamical systems which are called *mathematical* or *computational* neural networks. The latter have been used to solve various design and optimization problems from within mathematics and from applications.

Steve Baer will begin, in the first 3 1/2 weeks of lectures, with an overview of cable theory, dendritic spines, gap junctions and chemical synapses, and then proceed to biological networks. Elecrical activity in the syncitium of horizontal cells in the retina serves as an example of a biological network involving interaction between rods, cones and horizontal cells. Karl Hadeler will continue with the Hartline-Ratliff model for an invertebrate retina, and then proceed to general networks with inhibitory and excitatory connections, then introduce Hopfield networks as examples of networks which solve certain problems, establish the connection to cellular automata and other discrete dynamical systems with determinisctic or stochastic action, finally enter the field of truly computational networks, networks which can solve concrete problems, i.e., extract information on cleaving rates from output in protease dynamics, or produce prescribed patterns on sea shells. In the final part of the course Priscilla Greenwood will talk about the role of noise in the nervous system. There is irregularity in the electrical activity of neurons. Some models of this use the integrate-and-fire idea. A statistical framework for spike train analysis, the phenomenon of stochastic resonance, and possibly stochastic neural networks will be discussed.