Abstract of the Thesis

This thesis showcases studies on certain aspects of spectral stability of nonlinear waves in a class of dynamical systems. We are interested to study the linearized operator that can be obtained from the resulting small perturbations in the initial condition of the wave solutions for all positive times. The spectrum of the linearized operator would provide clues to the stability of solution of the unperturbed nonlinear systems.

In the past decades, a number of methods have been introduced to construct analytical wave solutions for nonlinear partial differential equations. However, the analysis and physical interpretation of the solutions are few (such as interaction of solutions, superposition, stability of the obtained solutions, etc.). We analyze some of the special class of solutions which are known analytically, constant at infinity and the derivatives vanishes at infinity. Our focus is to use the Evans function to find the spectral stability of wave solutions numerically. First two chapters of this thesis are devoted to studying the one-dimensional reaction-diffusion equation and reaction-diffusion-advection equation. Analysis of the solutions for different parameters reflect some specific characters of the nonlinear wave solutions such as, stationary to traveling, both kink and antikink solutions having same wave speed, etc.

In the next two chapters, we consider the biological phenomenon of aneurysm, and study the onset of bifurcation and the spectral stability of nonlinear wave solution. We model a perivascular supported arterial tube and derived the bifurcation criterion. This model has relevance to the study of an aneurysm in blood vessels. It is observed that the surrounding soft tissues can substantially delay the onset of bifurcation through a subcritical jump in circular distension at bifurcation with increasing tissue stiffness. The presence of subcritical and supercritical jumps in solution bifurcation with variation of tissue stiffness and anisotropy has been pointed out. A study of the effect perivascular stiffness on the solution of evolution equation of perturbations using the Evans function has been carried out. In summary, the work in this thesis, is an attempt towards exploring some of the features of the spectral stability of solutions in a class of continuous dynamical models.

Keywords: Dynamical systems, linear operator, spectral stability, wave solutions, Evans function, stiffness, exterior algebra.