Global Dynamics and Bifurcation in SIR Model

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Abstract

Mathematical epidemiology, i.e. the building and analysis of mathematical models describing the spread and control of infectious diseases is one of the major areas of biology. In this work, we investigate the equilibrium points and bifurcation of SIRS model for epidemic diseases. Then, the stability of such points has been studied.

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1 Introduction

Mathematical epidemiology, i.e. the building and analysis of mathematical models describing the spread and control of infectious diseases is one of the major areas of biology. In many epidemic models the population can be divided intothree distinct classes, which are defined with respect to disease status. Kermack and Mckendrick [1] described the simplest SIR model which computes the theoretical number of people infected with a contagious illness in a closed population over time. Transmission of a disease is a dynamical process driven by the interaction between susceptible and infective. The behaviour of the SIR models are greatly affected by the way in which transmission between infected and susceptible individuals are modelled. Most of the models of epidemiology are based on the so-called ‘‘mass action’’ [2] assumption has faced some questions and consequently a number of realistic transmission functions have become the focus of considerable attention [3,4]. A delay differential equation has been successfully used to model varying infectious period in a range of SIR, SIS and SIRS epidemic models. Hethcote and Van den Driessche [5] have considered an SIS epidemic model with constant time delay, which accounts for duration of infectiousness. Beretta et al. [6] have studied global stability in an SIR epidemic model with distributed delay that describes the time it takes for an individual to lose infectiousness. Song and Cheng [7] have studied the effect of time delay on the stability of the endemic equilibrium. They were given some conditions for which the endemic equilibrium is asymptotically stable for all delays and also discussed the existence of orbitally asymptotically stable periodic solutions. The mathematical analysis of epidemiological modelling is often used for the assessment of the global asymptotic stability of both the disease free and endemic equilibrium. The modelling and analysis of infectious diseases have been done also by some other workers; see for example, [8–12] and the references therein.