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Time Delayed Susceptible-Vaccinated-Infected-Recovered-Susceptible Epidemic Model along with Nonlinear Incidence and Nonlinear Treatment

Authors : Kanica Goel, Nilam

Abstract : Infectious diseases are a leading cause of death worldwide and hence a great challenge for every nation. Thus, it becomes utmost essential to prevent and reduce the spread of infectious disease among humans. Mathematical models help to better understand the transmission dynamics and spread of infections. For this purpose, in the present article, we have proposed a nonlinear time-delayed SVIRS (Susceptible-Vaccinated-Infected-Recovered-Susceptible) mathematical model with nonlinear type incidence rate and nonlinear type treatment rate. Analytical study of the model shows that model exhibits two types of equilibrium points, namely, disease-free equilibrium and endemic equilibrium. Further, for the long-term behavior of the model, stability of the model is discussed with the help of basic reproduction number R_0 and we showed that disease-free equilibrium is locally asymptotically stable if the basic reproduction number R_0 is less than one and unstable if the basic reproduction number R_0 is greater than one for the time lag $\tau \geq 0$. Furthermore, when basic reproduction number R_0 is one, using center manifold theory and Casillo-Chavez and Song theorem, we showed that the model undergoes transcritical bifurcation. Moreover, numerical simulations are being carried out using MATLAB 2012b to illustrate the theoretical results.

Keywords : nonlinear incidence rate, nonlinear treatment rate, stability, time delayed SVIRS epidemic model
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