# Dynamics and Impact of Quarantine Compartments in the Control of COVID-19 Spread

**Rohith G.*** and K. B. Devika*

*Department of Engineering Design, Indian Institute of Technology, Madras, Chennai, India, 600036

**Abstract.** In this work, an attempt is made to analyse the dynamics of COVID-19 outbreak mathematically using a modified SEIR model with additional compartments and a nonlinear incidence rate with the help of bifurcation theory. The significance of having two additional compartments, viz., protective and hospital quarantine compartments, is then illustrated via numerical simulations. From the analysis and results, it is observed that, by properly selecting transfer functions to place exposed and infected individuals in protective and hospital quarantine compartments, respectively, and with apt governmental action, it is possible to contain the COVID-19 spread effectively.

## Introduction

Mathematical modeling based on dynamical equations has received relatively less attention compared to statistical methods even though they can provide more detailed mechanism for the epidemic dynamics. Ever since the introduction of compartmental models [1], researchers widely used it to model epidemics dynamics. Susceptible-Exposed-Infectious-Recovered (SEIR) model [2] is widely used in literature to understand the dynamics of various epidemics, including the early dynamics of COVID-19 [3]. The addition of extra compartments to address the isolation/quarantine stage could serve as a better alternative. In this regard, this work attempts to model the COVID-19 dynamics by including two additional quarantine compartments to forcibly curb the disease spread. Effect of one more additional control parameter, added through the selection of a nonlinear incidence rate function, is also considered.

## Results and Discussion

The basic SEIR model is modified by adding two new additional compartments, representing the fraction of exposed population placed in protective quarantine ($Q^P$), the fraction of infected individuals placed in hospital quarantine ($Q^I$).

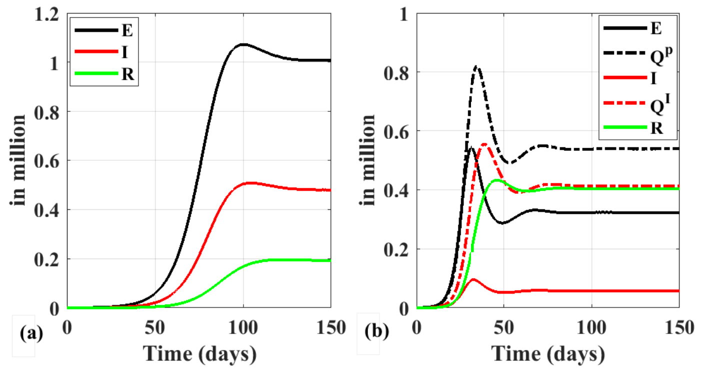


Figure 1: Numerical simulation results at $R_0 = 2$ for with and without quarantine compartments (a). without quarantine compartments (b). with quarantine compartments.

Figures 1(a) and 1(b) presents numerical results for $R_0 = 2$ using the classical SEIR model and the proposed model with additional quarantine compartments, respectively. For a city with total population of 5 million Without any quarantine measures, the number of exposed, infected and recovered cases are 1 million, 0.5 million and 0.2 million, respectively. Now, assuming the government could successfully track down and place 50% of the total exposed population in protective quarantine, could hospitalize only 50% of the total number of infected persons, and assuming a best case scenario of only 10% of total number of people in protective quarantine become infected, the number of exposed and infected cases come down to 0.32 million and 0.057 million, respectively. Number of recovered cases doubles to 0.4 million. There are 0.54 million people in protective quarantine and 0.41 million people in hospital quarantine, which reduced the disease spread considerably. Thus,by including the protective and hospital quarantine compartments, the proposed model could be utilized for the prediction and performance evaluation of actual governmental quarantine efforts and could serve as a viable alternative to statistical methods in predicting and controlling the COVID-19 transmission.

## References

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