Modeling and Simulation, MC312
Lab-6
Due Date: October 10, 2023

October 4, 2023

This lab is an extension of Lab-5. Therefore, the reports for both labs should be submitted together. In this lab, we aim to learn and appreciate how constructing models can enable exploring different scenarios. In particular, we examine the role of lockdown in the SIR epidemic model.

1. **(Effect of lockdown in the SIR model):** Lockdown affects the rate at which contacts happen. A reduction in the number of contacts helps in reducing the spread rate. The parameter in the SIR model affected by lockdown is β_f or the transmission coefficient. We assume that the basic reproduction number R_0 is initially greater than 1. Assume that $\beta_f(t) = (1 - \theta_t)\beta_f$, where β_f is the transmission coefficient in the absence of lockdown, θ_t is the effectiveness of the lockdown (severity), and $\beta_f(t)$ is the resultant transmission coefficient because of lockdown.

   (a) **Short lockdown with immediate effect:** We first examine the role of lockdown that is short (compared to the overall time taken for the epidemic to reach its peak value). The effect of the lockdown starts immediately. We assume it to be a constant A for the duration of the lockdown.

   $$\theta_t = \begin{cases} A, & \text{if } t_1 \leq t \leq t_2 \\ 0, & \text{otherwise} \end{cases}$$

   Discuss through your numerical analysis the effect of introducing such a lockdown. Your analysis should properly capture the effect of parameters A, t_1, andt_2.

   (b) **(Extra Credit: Including human behavior)** If we want to include people's behavior in the lockdown model above, one may argue that lockdown does not immediately reduce the number of contacts. Assuming the following function for the effectiveness of lockdown. Initially, θ_t is at a low value (people do not take it seriously) but slowly increases. It remains at the higher value for some time, beyond which the unlock is initiated. When the unlock is announced, people's behavior changes in the same way. In the initial stages, people are cautious, so θ_t is at its higher value. In time, other important factors take over, and they venture out and become more relaxed. This leads to a decrease in θ_t. Accommodate these two effects in the model and discuss your findings.