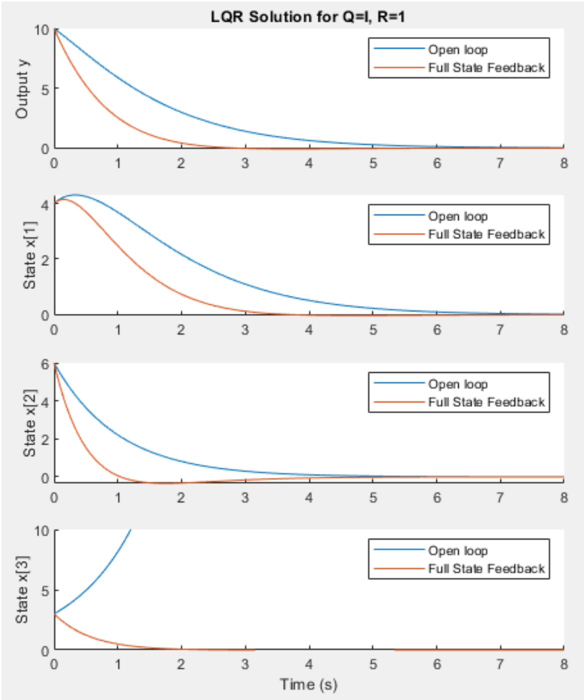
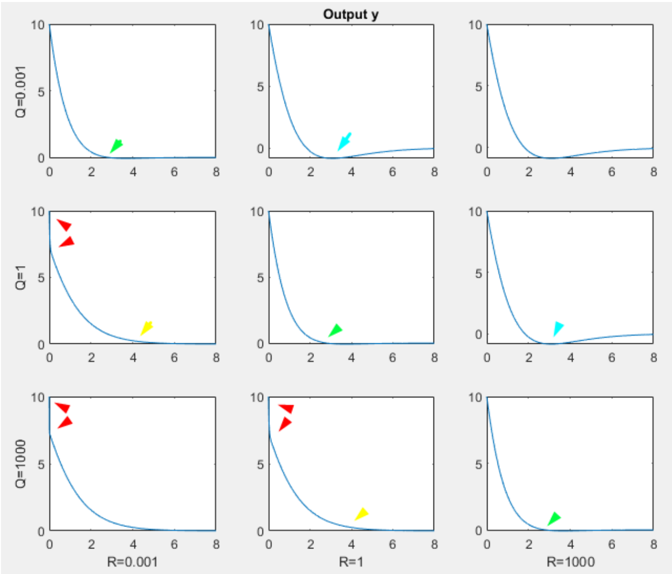
Q4 Part D



We can see the x[3] is bounded with feedback control, which is previously unbounded.

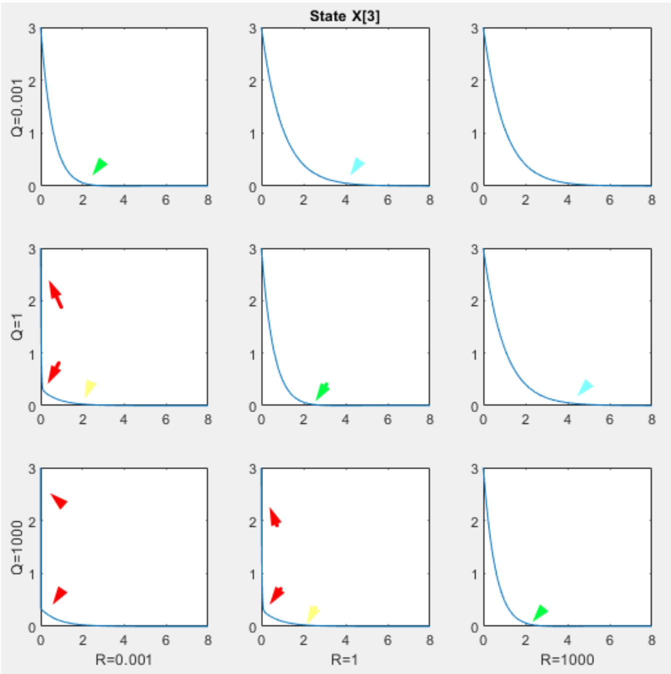
Q4 Part E



When the Q/R ratio is the same, the response is the same, as indicated by yellow/ cyan/ green colors.

- When R>>Q, cyan arrows, we can observe a more rapid response and an overshoot of the output value before decaying to zero. R>>Q, meaning the weighting of LQR equation is mainly put on to control signal u. So, the control signal u is limited and compromised, u<<y. Making the system behave more like an open loop system, where the decay of the states is slow.
- When Q>>R, the decay is flatter and slower. Also, when Q is much larger than R, a very sharp instant response is observed at the beginning, red arrows. This is because when Q>>R, the weight on control signal is small, the control signal can be large to compromise the states, that is, u>>y, making the control more effective and a quick decay in the states.

The same description can be applied to both x[1] and x[2]. But in x[3], some strange behavior is seen:



The sharp drop of output value at the beginning of simulation comes from x[3]. But it is strange since C=[1,1,0], where x[3] is not directly fed into the output.