**REPORT**

1. Theory:
   1. Linearization: It is achieved by differentiating (Jacobian) around the equilibrium points since nonlinear systems act like linear systems near the equilibrium points.
   2. State Feedback Control: SFC relies on current states to decide the input to the system. It can be achieved by:
2. Step Results:
   1. 
   2. linear\_A = 4×4  
       0 1.0000 0 0  
       12.5769 0 -11.9611 0  
       0 0 0 1.0000  
       -16.9227 0 46.1565 0

linear\_B = 4×2  
 0 0  
 1.7250 -4.4345  
 0 0  
 -4.4345 14.8902

* 1. System is unstable
  2. C = 4×8  
      0 0 1.7250 -4.4345 0 0 74.7378 -233.8759  
      1.7250 -4.4345 0 0 74.7378 -233.8759 0 0  
      0 0 -4.4345 14.8902 0 0 -233.8759 762.3251  
      -4.4345 14.8902 0 0 -233.8759 762.3251 0 0  
     System is controllable
  3. poles = 1×4 complex  
      -1.0000 + 0.0000i -2.0000 + 0.0000i -1.0000 - 1.0000i -1.0000 + 1.0000i  
     K = 2×4  
      23.9371 6.4042 5.2636 0.1559  
      6.0097 1.8868 4.7955 0.2022  
     A\_SF = 4×4  
      0 1.0000 0 0  
      -2.0655 -2.6804 0.2250 0.6277  
      0 0 0 1.0000  
      -0.2582 0.3049 -1.9085 -2.3196

1. Trajectory Plots

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|  | MATLAB | Gazebo |
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1. From Gazebo results I found that due to absence of friction, the torque on motor is significantly different and much smoother in MATLAB simulations than Gazebo Simulation.
2. 