Simulation Results

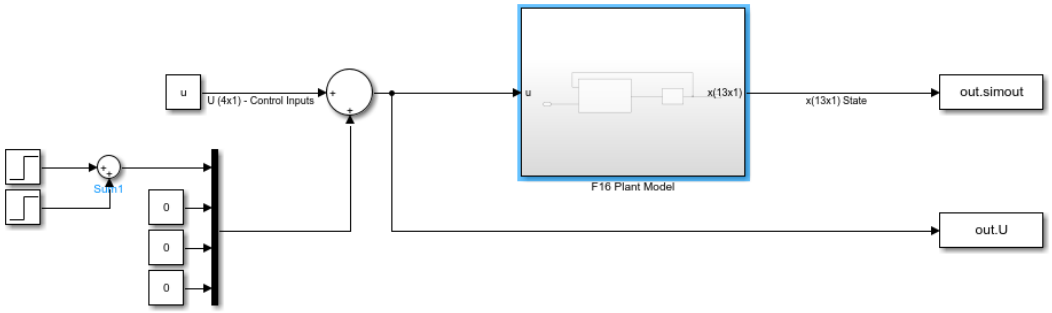


Figure 1: Full Scale F16 Plant Model With Impulse Responses on the Inputs

First, the Simulink model was ran with initial state variable conditions of: Freestream Airspeed = 500 ft/s, Alpha=Beta=Phi=Theta=Psi=P=Q=R=0, North Displacement = 1000 ft, East Displacement = 1000 ft, Altitude = 1000 ft, and Engine Power = 100. The control input conditions were all set equal to 0 as well for steady state flight.

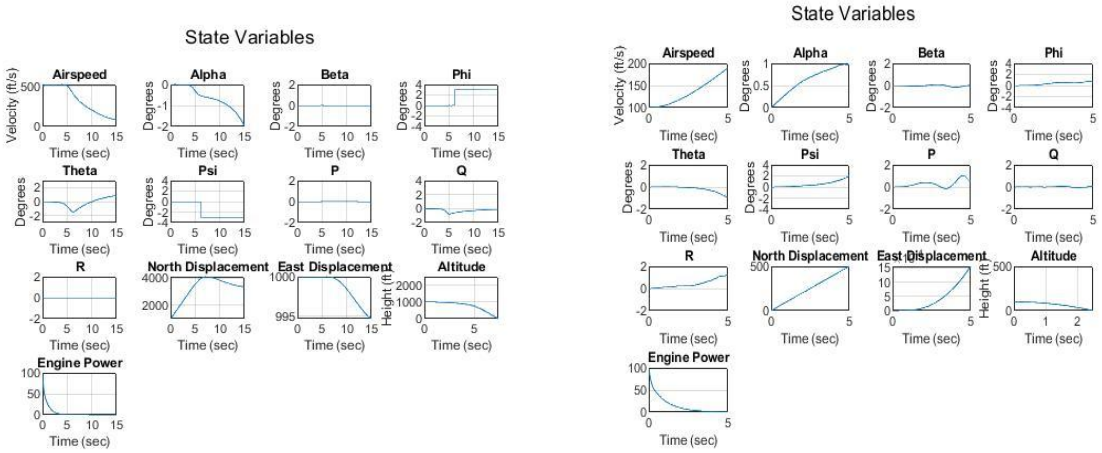


Figure 2 Steady State - State Variables - Full scale F16 (Left) Small Scale (Right)

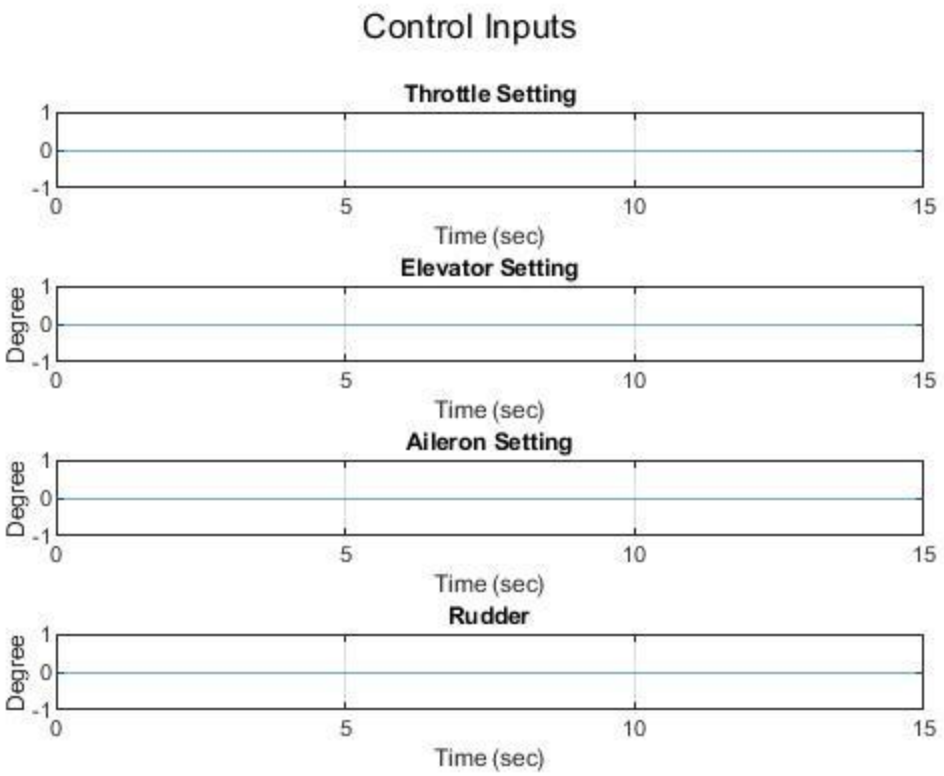
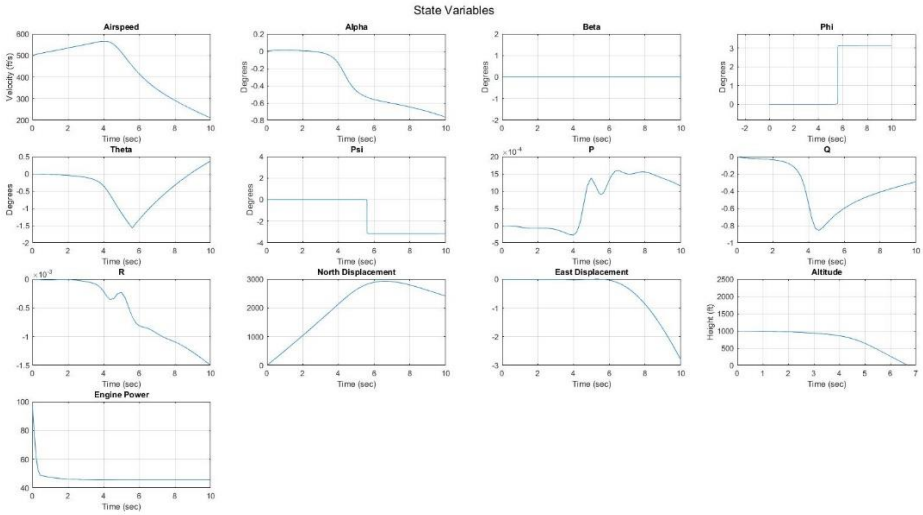


Figure 3 Steady State Control inputs (Same for Both)

With the Control Inputs and State Variables set to steady state flight conditions, the initial velocity at 500 ft/s increases to 522 ft/s then drops off parabolically towards 0 ft/s. At about 6.23 sec, when there is no engine power (throttle is set to 0), there is an increase in roll angle from 0 to 3.13 degrees, a negative yaw angle of -3.13 degrees, and the pitch angle reaches its most negative heading at -1.56 degrees before increasing back to 1 degree above level flight. Finally, when there is about 1% of engine power left, the altitude starts to decrease at a steep rate.



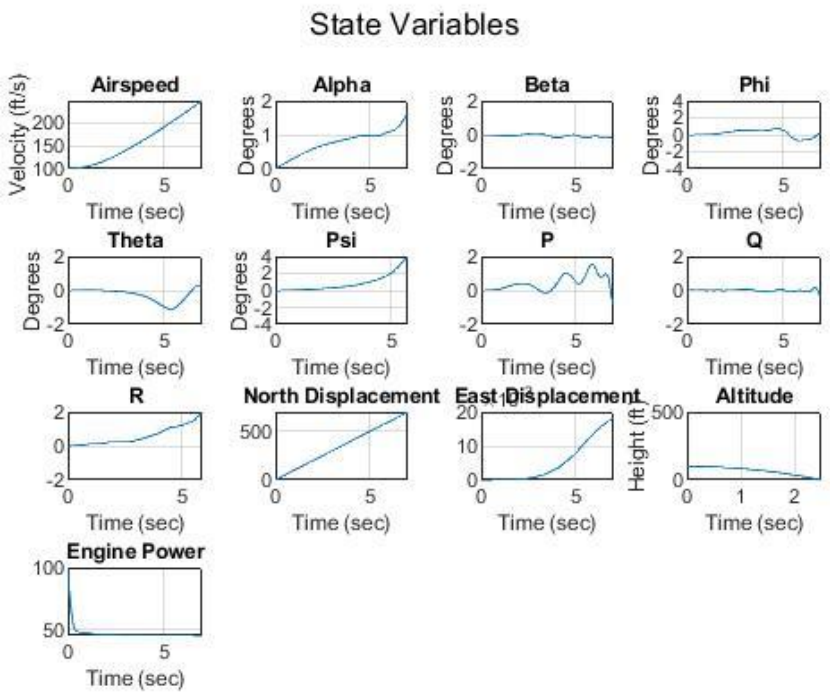
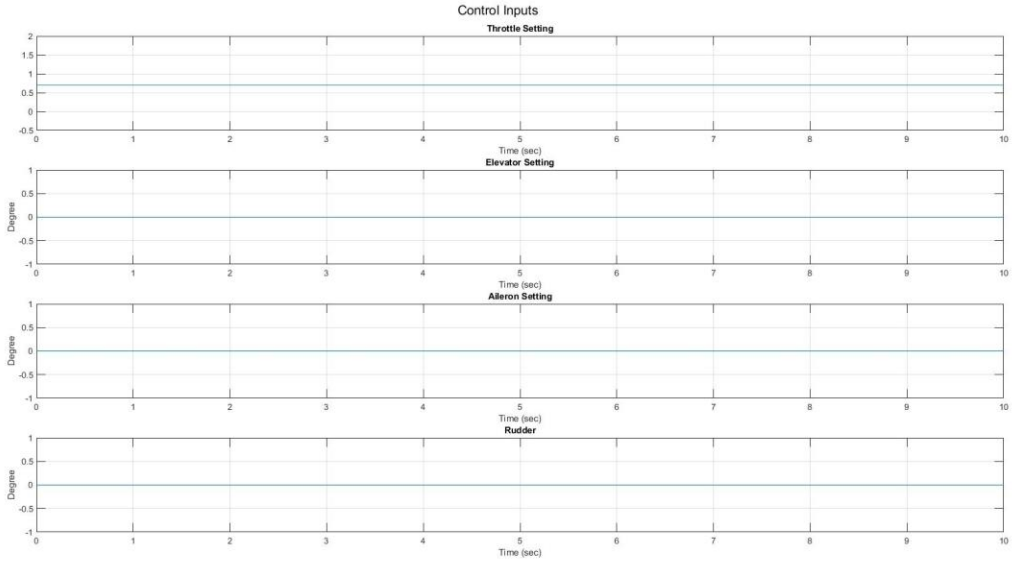


Figure 4 State Vector Throttle at 70% no impulse



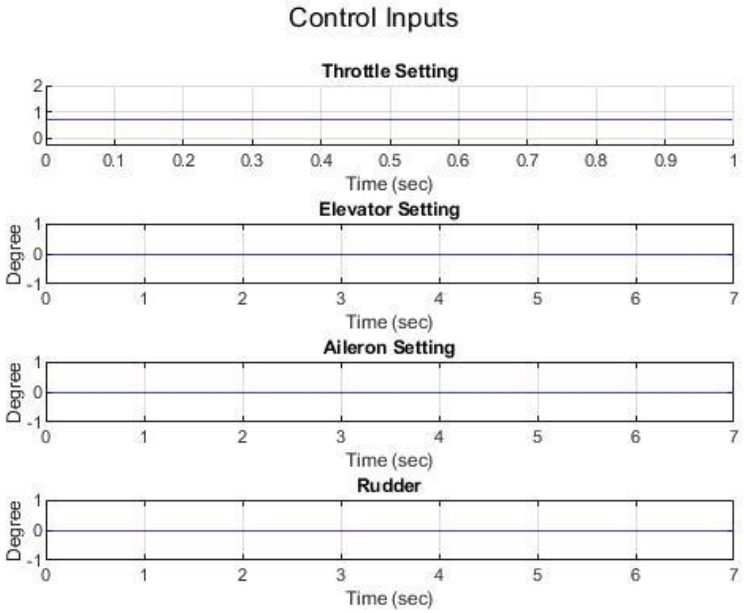
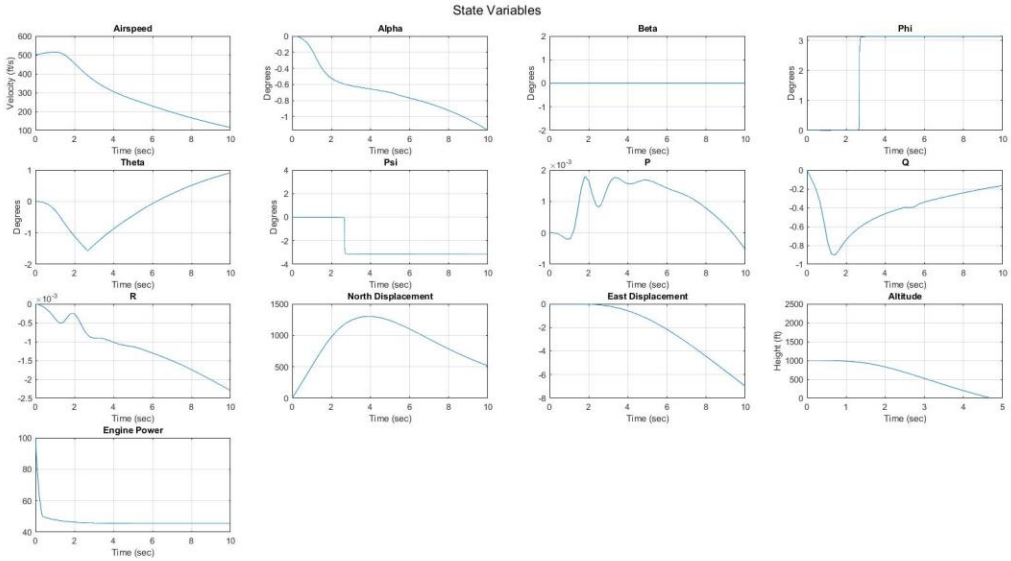


Figure 5 Control Inputs Throttle At 70%

Control: Thtrl 70

State alt 100 vt 500 power 100



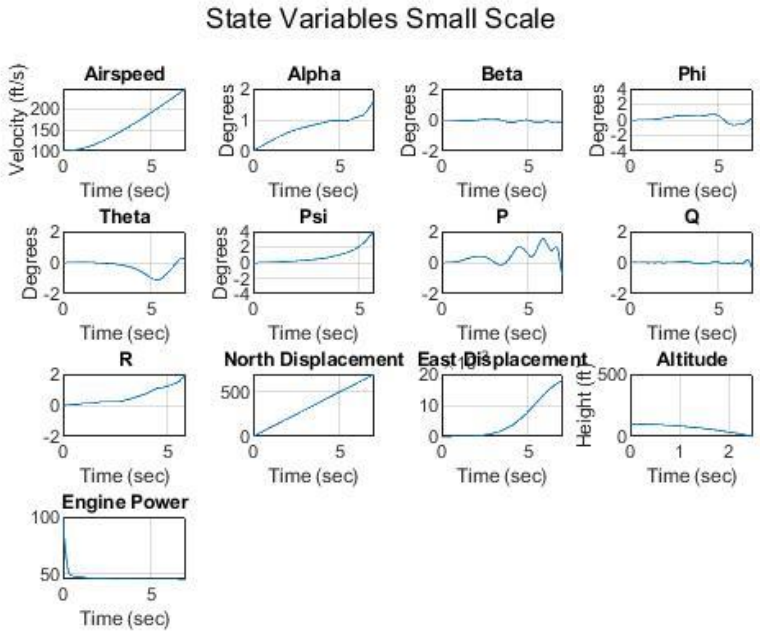
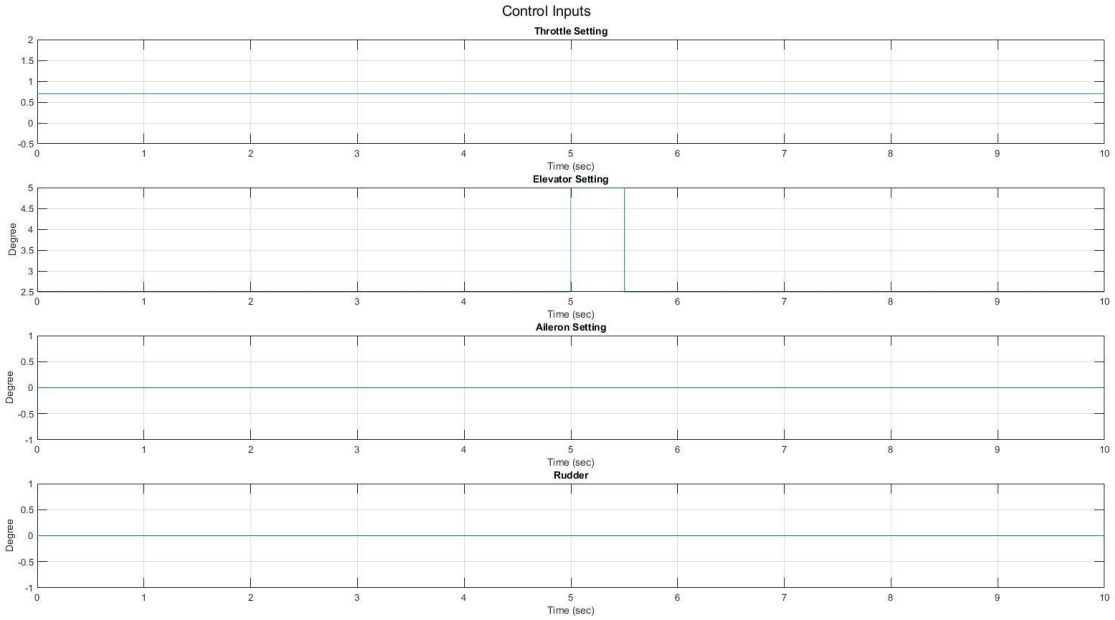


Figure 6 State Variable - Impulse Elevator



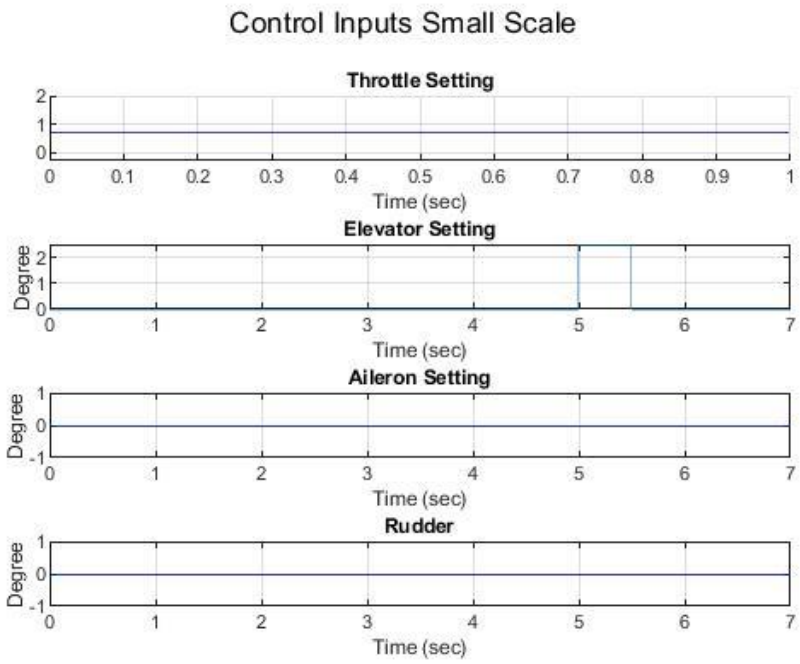
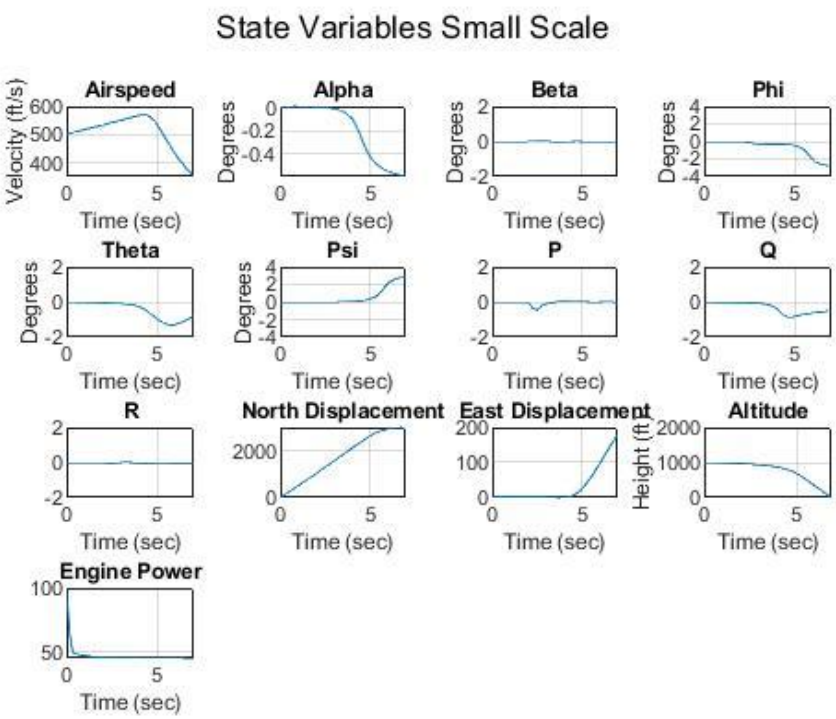


Figure 7 Control Inputs - impulse at 5.5 sec on Elevator

Control thtrl 70, imp el

State alt 100 vt 500 power 100



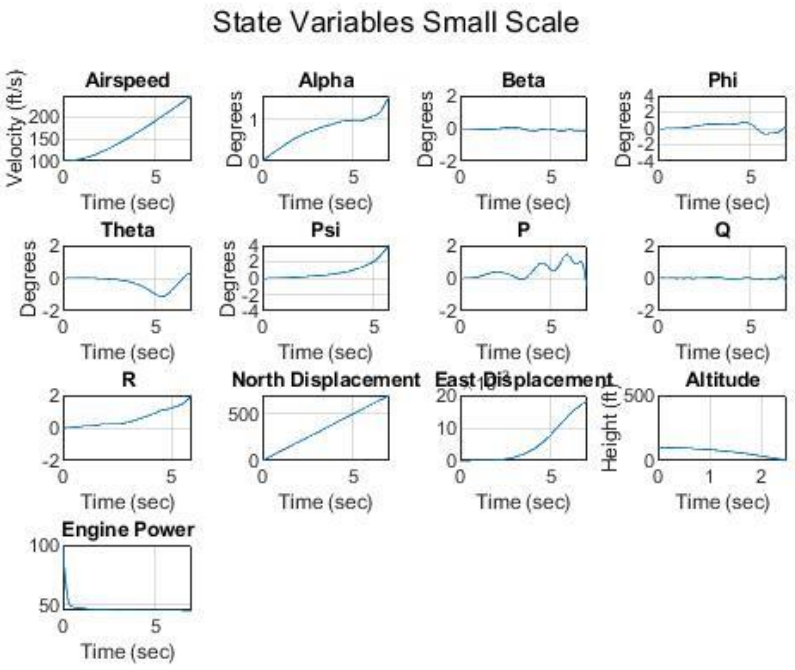
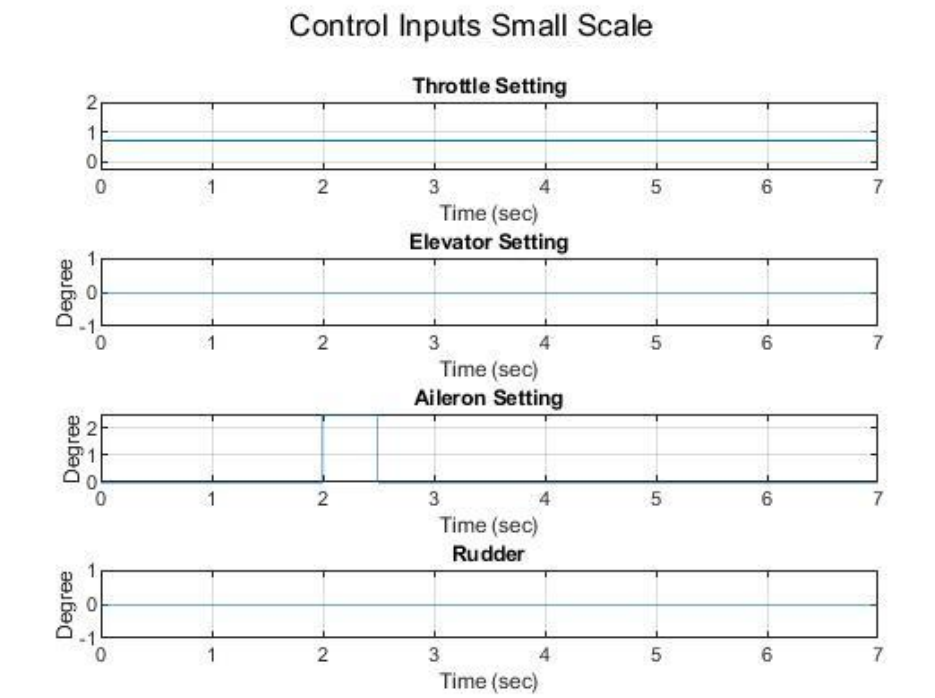


Figure 8 State Variable - Impulse Aileron



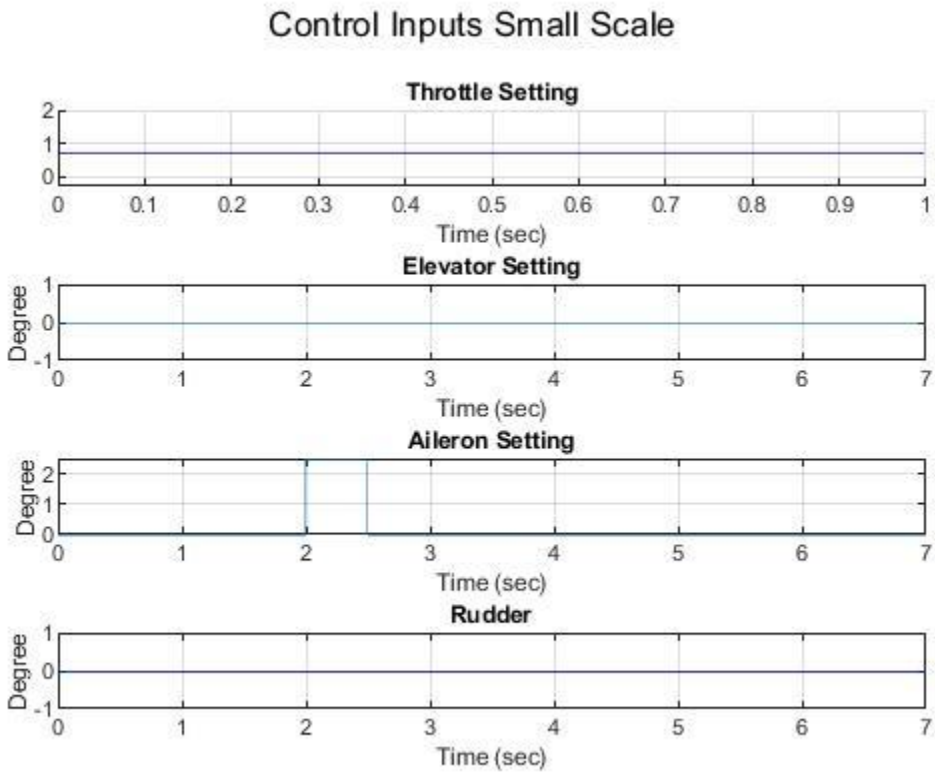


Figure 9 Control Inputs - impulse at 2 sec on Aileron

Control thrtl 70, imp al

State alt 100 vt 500 power 100

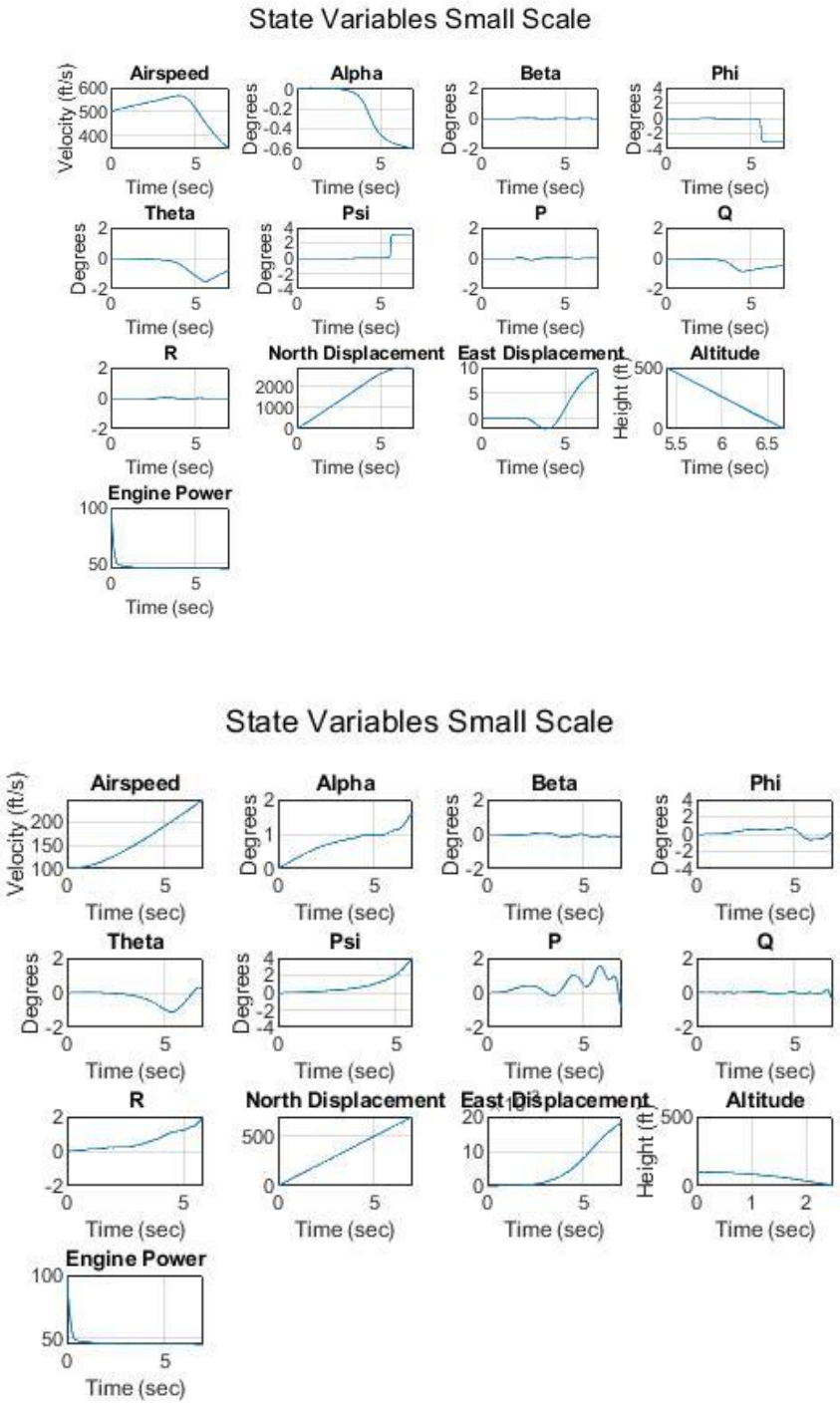


Figure 10 State Variable - Impulse Rudder

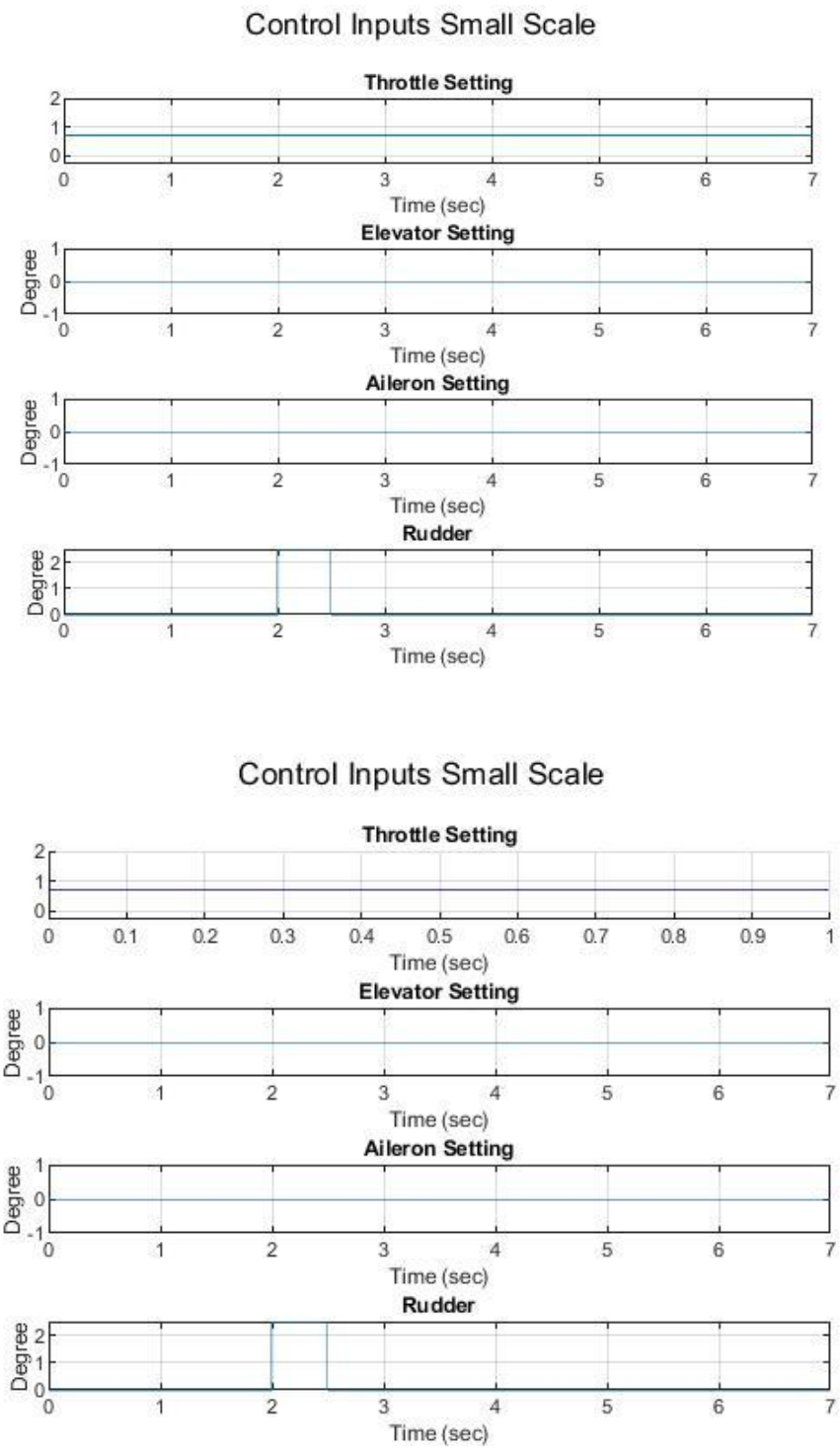


Figure 11 Control Inputs - impulse at 2 sec on Rudder

Control thrl 70, imp rud

State alt 100 vt 500 power 100

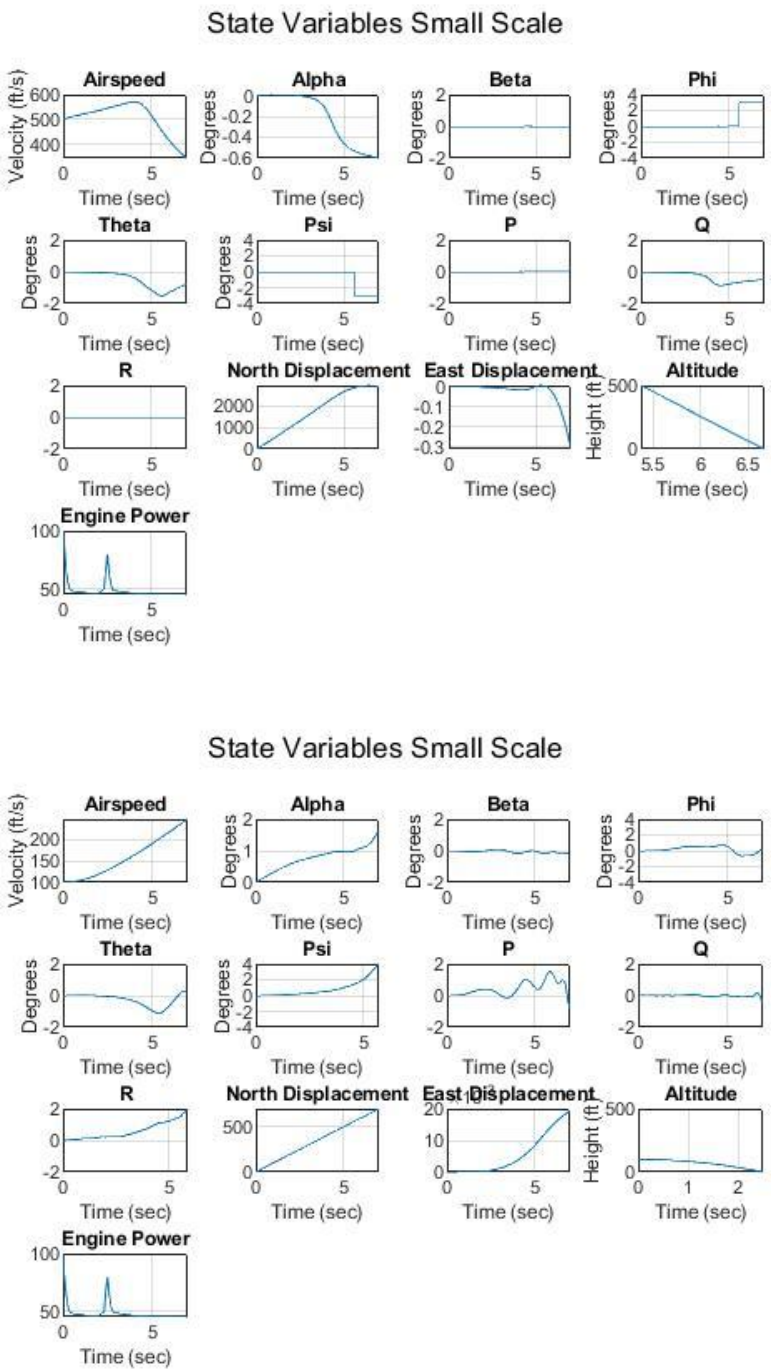
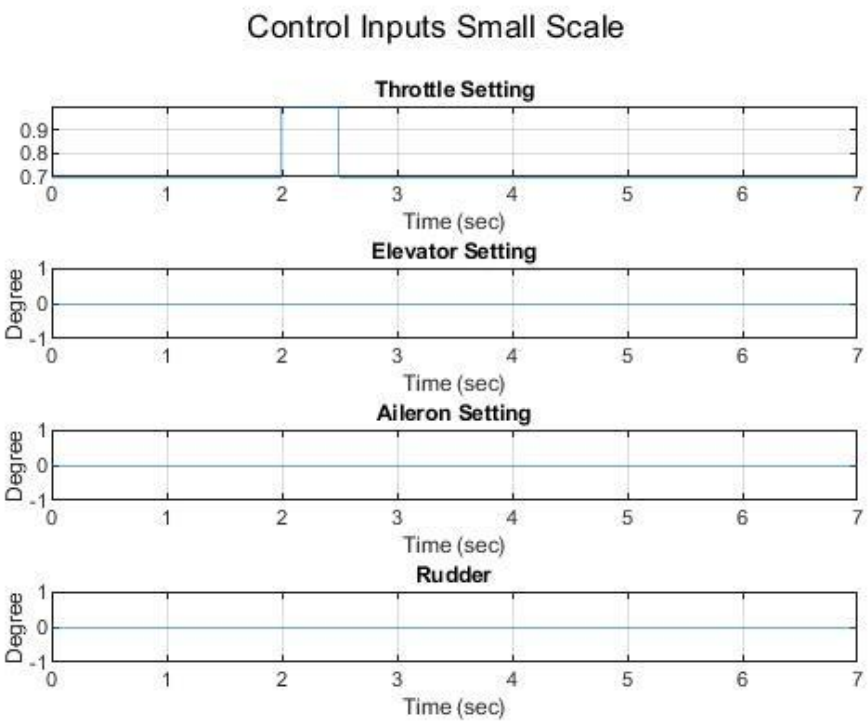


Figure 12 State Variable - Impulse Throttle



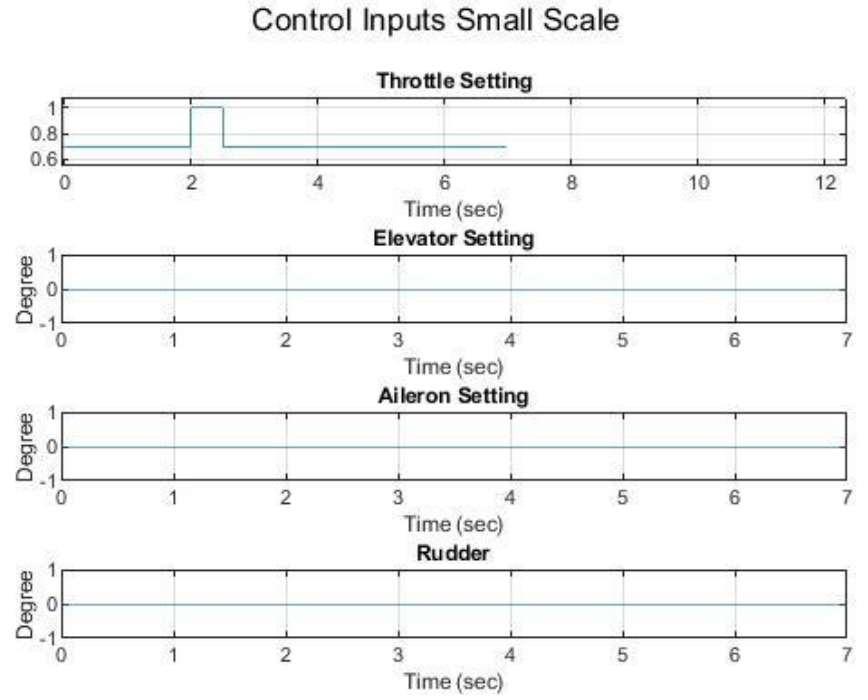


Figure 13 Control Inputs - impulse at 2 sec on Throttle

Control thrtl 70, imp thtl

State alt 100 vt 500 power 100

Response	Notes
Steady State: Figure 2	• Steeper drop off of engine power in full scale model • Airspeed is continually increasing in small scale model and decreases in full scale • Positive angle of attack in small scale, negative angle of attack in full scale • Almost no sideslip in either model • Increase in bank and yaw angles of small scale, no change in full scale • Small scale has an increase in angular velocity of bank and yaw components • Similar altitude responses With the overall steady state response being similar, I suspect the changes in yaw and bank angles and velocities are due to the incorrect measurements of the moments of inertia
Throttle at 70%: Figure 4	• Airspeed is continually increasing in small scale model and decreases in full scale • Positive angle of attack in small scale, negative angle of attack in full scale • Almost no sideslip in either model • Without an impulse on any control surfaces there is a major bank and yaw angle change around 6 seconds • Similar altitude responses
Elevator Impulse: Figure 6	• Airspeed is continually increasing in small scale model and decreases in full scale at 1.5 sec • Positive angle of attack in small scale, negative angle of attack in full scale – less roll off rate in full scale AOA due to the elevator impulse • Almost no sideslip in either model

	• Without an impulse on any control surfaces there is a major bank and yaw angle change around 6 seconds Similar altitude responses
Aileron Impulse: Figure 8	Same response as the elevator impulse because we are not modeling the ailerons as left or right, but as one. If we pulse the ailerons, it acts as an elevator because they are pulsed in the same direction. UPDATE – After thinking about this more carefully, I do not think this is the case. I still can't explain why the aileron has the same state response as the elevator.
Rudder Impulse: Figure 10	• Similar drop off of engine power in full scale model • Airspeed is continually increasing in small scale model and decreases in full scale • Positive angle of attack in small scale, negative angle of attack in full scale • Small changes in sideslip (I expected more, but maybe the magnitude of impulse needs to increase) • Increase in bank and yaw angles (smoother change in small scale model) • Small scale has an increase in angular velocity of bank and yaw components compared to Full Scale • Similar altitude responses
Throttle Impulse Figure 12	• Visible change in engine power at 2.5 sec • Airspeed is continually increasing in small scale model and decreases in full scale • Positive angle of attack in small scale, negative angle of attack in full scale • No yaw angular velocity response in full scale, increasing angle in small scale • Unstable angular bank velocity in small scale