HW2 Problem 4



Figures 1: Thrust, acceleration, velocity, and distance traveled by a jet-ski with relative jet velocity of 21 m/s; timestep of 0.001s

Appendix A: MATLAB Code

%Short program to simulate operation of a jet-ski with constant relative

%jet velocity

%Josh Bevan Sept 2013

%22.581 HW#2, Problem 4

clc

close all

clear all

%Physical constants

g =9.8; %m/s^2

RhoW =1000; %kg/m^3

%Problem ICs at t=0

x\_ski=0; %m/s Distance travelled by jet-ski

v\_ski=0; %m/s Velocity of jet-ski

%Inputs

CDA =6.87E-3; %m^2 Drag-area

u\_rel =21; %m/s Relative jet velocity

AOut =pi\*(0.075^2); %m^2 Area of jet outlet

mass\_ski =450; %kg Mass of jet-ski

%

del\_t =0.001; %s Timestep for iterative time marching

max\_t =2.5; %s Maximum time to simulate for

steps =floor(max\_t/del\_t +1);

%Main loop

%Initialization

Thrust =RhoW\*AOut\*(u\_rel^2 + u\_rel\*v\_ski); %Newtons Thrust of jet-ski

a\_ski =-(RhoW/mass\_ski)\*(AOut\*(u\_rel^2 + u\_rel\*v\_ski) - (CDA\*v\_ski^2)/2); %m/s^2 Acceleration of jet-ski

%Preallocate save structures

step=1;

saved\_Thrust=zeros(steps,1);

saved\_Accel=zeros(steps,1);

saved\_Velocity=zeros(steps,1);

saved\_Dist=zeros(steps,1);

saved\_Thrust(step)=Thrust;

saved\_Accel(step)=a\_ski;

saved\_Velocity(step)=v\_ski;

saved\_Dist(step)=x\_ski;

for t=0:del\_t:max\_t;

step =step+1;

if abs(v\_ski)<=16 %If ski hasn't reached desired speed

x\_ski = x\_ski - v\_ski\*del\_t;

v\_ski = v\_ski + a\_ski\*del\_t;

Thrust =RhoW\*AOut\*(u\_rel^2 + u\_rel\*v\_ski); %Newtons Thrust of jet-ski

a\_ski =-(RhoW/mass\_ski)\*(AOut\*(u\_rel^2 + u\_rel\*v\_ski) - (CDA\*v\_ski^2)/2); %m/s^2 Acceleration of jet-ski

%Save data

saved\_Thrust(step)=Thrust;

saved\_Accel(step)=a\_ski;

saved\_Velocity(step)=v\_ski;

saved\_Dist(step)=x\_ski;

else %Plot when empty

PlotResults(0:del\_t:t,1:step-1, saved\_Thrust, saved\_Accel, saved\_Velocity, saved\_Dist);

return

end

end

%If sim hasn't run to conclusion, plot what we have

PlotResults(0:del\_t:max\_t+del\_t,1:steps+1, saved\_Thrust, saved\_Accel, saved\_Velocity, saved\_Dist);

%For the purposes of printing, function files:

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% function [p1,p2,p3,p4] = PlotResults(time, data, saved\_Thrust, saved\_Accel, saved\_Velocity, saved\_Dist)

% p1=subplot(221);plot(time, saved\_Thrust(data));xlabel('time (s)');ylabel('Thrust of jet-ski (N)');

% p2=subplot(222);plot(time, saved\_Accel(data));xlabel('time (s)');ylabel('Acceleration of jet-ski (m/s^2)');

% p3=subplot(223);plot(time, saved\_Velocity(data));xlabel('time (s)');ylabel('Velocity of jet-ski (m/s)');

% p4=subplot(224);plot(time, saved\_Dist(data));xlabel('time (s)');ylabel('Distance travelled by jet-ski (m)');

% end