Numerical Methods Project

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- Ran
- Michael

```
matlab_set_up
```

Constatnts

```
basic_const_set_up
```

```
Create 'basic_const.mat' file in /Users/michaelpoliakov/Library/Mobile Documents/com~apple~CloudDocs/Technion/084135 Numerical Methods/FinalProject2023/פונקציות עם הסברים
```

Section B

```
disp ' '
disp("SECTION B:")
section_b_print_specific_continuous_value_Mach
```

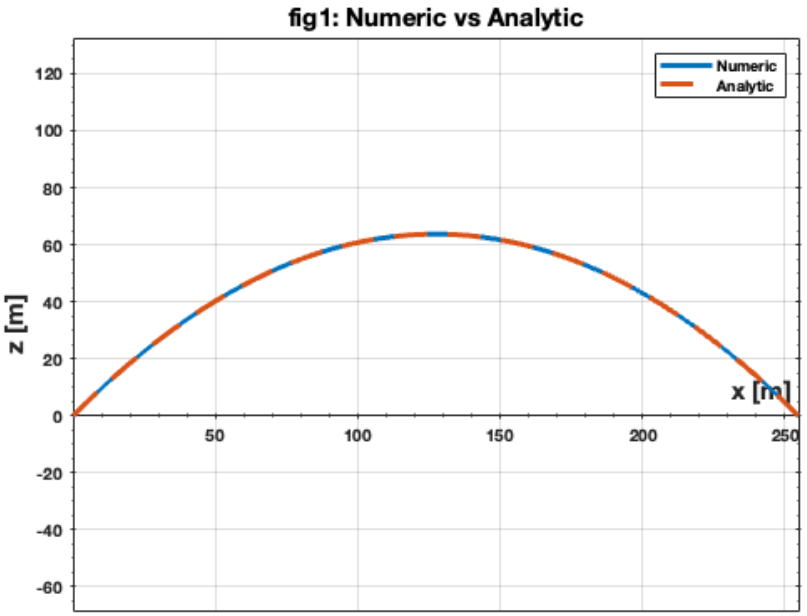
```
SECTION B:
Drag Coefficent at Mach 0.82 is:
 CD(Mach=0.82) = 0.352
Save CD(Mach) to New file: section_e_well_defined_functions.mat
```

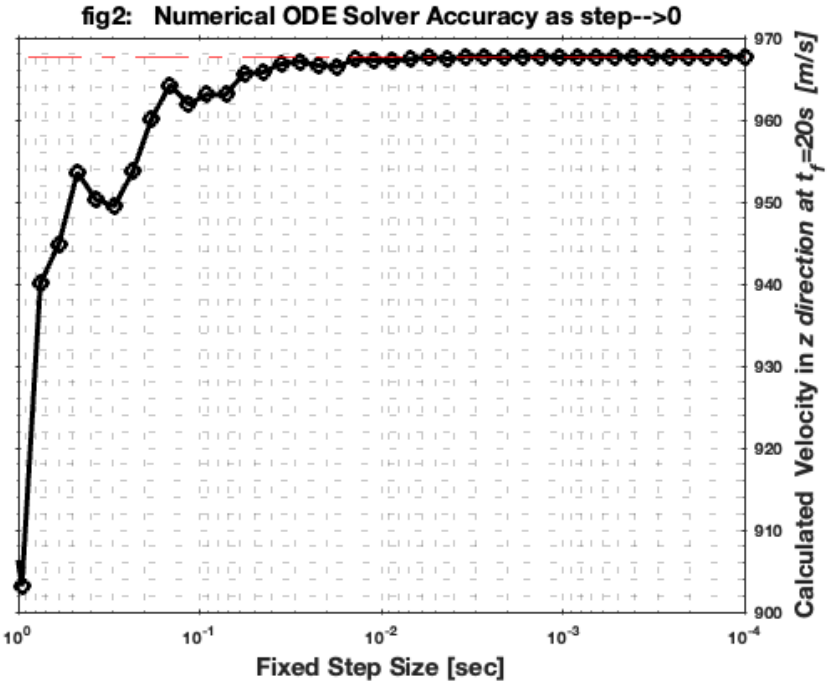
Section D

```
disp ' '
disp("SECTION D:")

% (D1)
```

```
section_d1_first_degenerated_problem

% (D2)
dydt = section_d2_second_degenerated_problem;

% (D3)
section_d3_convergence_test(dydt);
```

```
SECTION D:
vzEndAnalytic =
       967.73
vzEndNumeric =
       967.73
|V_{Analytical}-V_{Numerical}| = 4.2064e-12
```





Section E

Note that $\frac{P_e}{P_0}$ is constant. We will derive it, by Newton Raphson's method. Once we have this ratio, we esealy may use it for deriving P_e by multiplication with P_0.

Newton Raphson's method:

$$x_{n+1} := x_n - \frac{f(x_n)}{f'(x_n)}$$

```
disp ' '
disp("SECTION E:")
% (E1)
%
% Full problem Constants:
close all;
derive_Pe

% Initial Condition:
x0 =    0;
vx0 =   0;
z0 =    0;
vz0 =   0;

IC = [x0 vx0 z0 vz0];

% Time sampling
t = 0:1.6:45;

dydt = @main_ode;

[Y,~] = RK5solver(dydt,t,IC);
save
```

```
SECTION E:
Saves Pe(t) to section_e_well_defined_functions.mat

Saving to: /Users/michaelpoliakov/Library/Mobile Documents/com~apple~CloudDocs/Technion/084135 Numerical Methods/FinalProject2023/פונקציות עם הסברים/matlab.mat
```

```
[t,Y] = section_e1_cut_fly_at_final(t,Y);

section_e1_plot_xz_as_function_of_time(t,Y);

% (E.2)
section_e2_plot_vx_vz_as_function_of_time(t,Y);

% (E.3)
plot5 = section_e3_plot_path_of_the_rocket(Y);

% (E.4)
section_e4_acceleration_maximum(t,Y);

% (E.5)
```

```
section_e5_find_maximum_hight(Y);

% (E.6)
section_e6_rocket_fly_fime(t);

% (E.7)
section_e7_rocket_harizontal_Delta_x(Y);
```

```
Maximus Acceleration Magnitude is: 54.01[m·sec^-2]
Happen to be at: 20.8[sec]
Maximum hight rocket reaches:
  2.1116[km] =  6927.6932[feet].
Rocket fly time: 0.72 [minute]
|X2-X1| = 11.3482[km]
```

fig3: *x, z as function of Time*

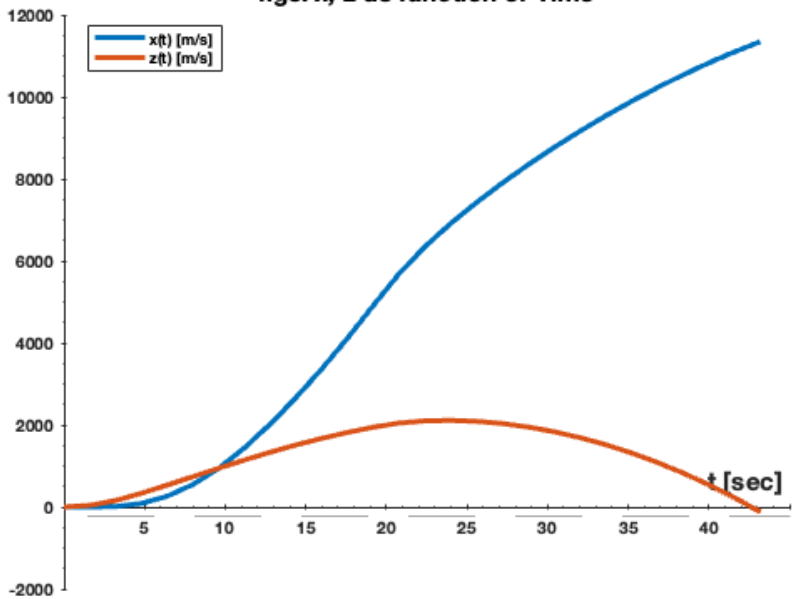


fig4: v_x & v_z

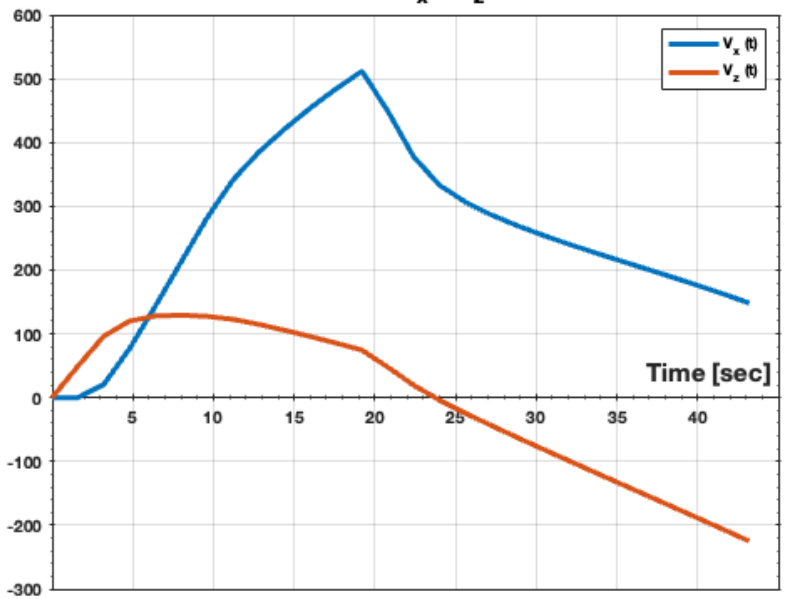
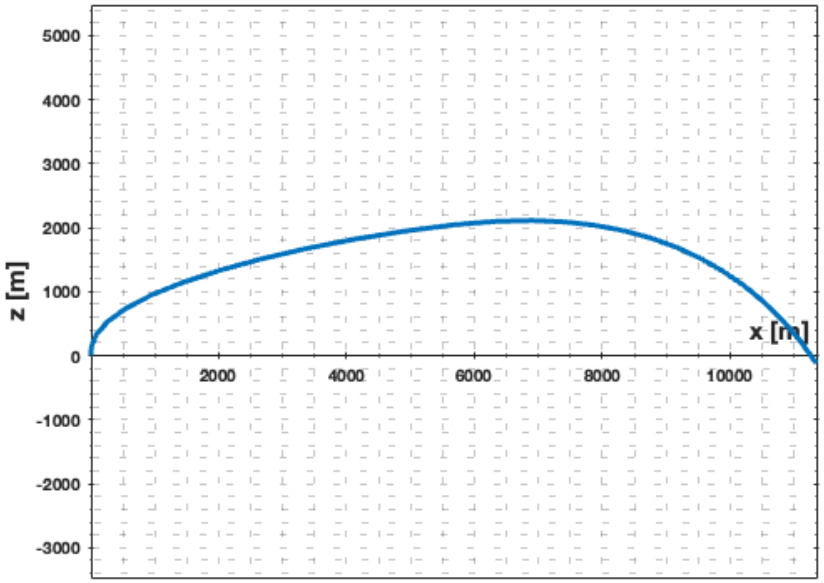


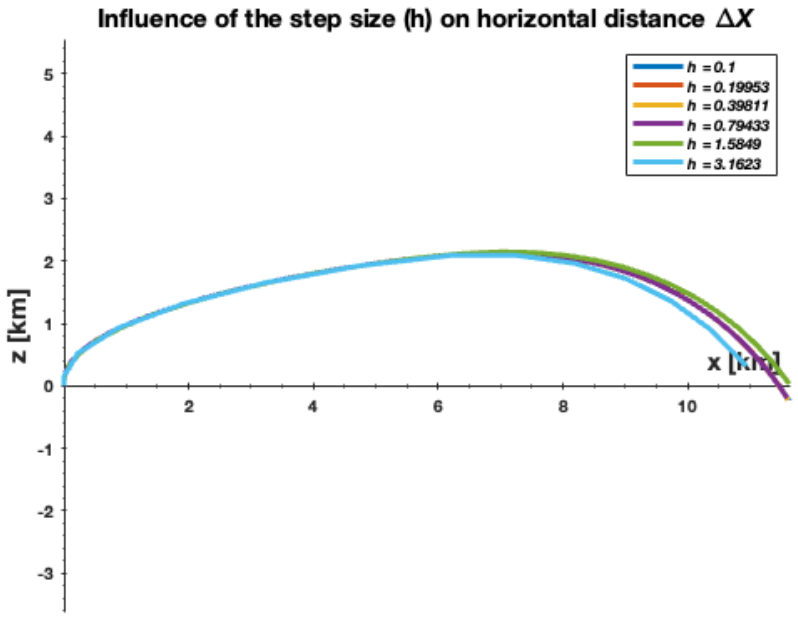
fig 5: Rocket Path in XZ-Plane

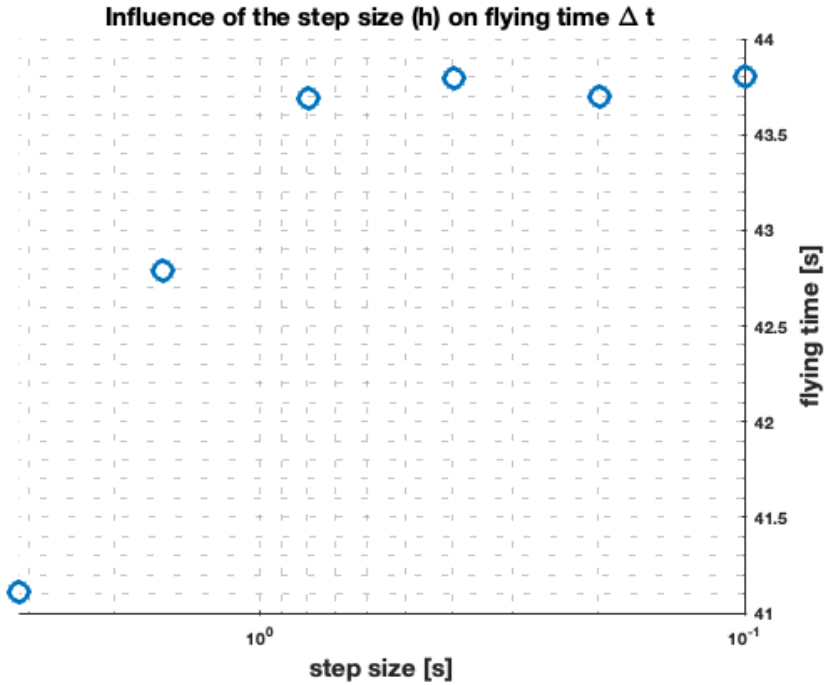


Convergence tests for Section E:

```
[steps, fly_time, delta_x] = section_e_convergence_tests(dydt,IC,45)
```

```
SECTION E TESTS:
step-h V resulted delta x:
h = 0.1
|X2-X1| = 11.6224[km]

h = 0.19953
|X2-X1| = 11.6012[km]

h = 0.39811
|X2-X1| = 11.6093[km]

h = 0.79433
|X2-X1| = 11.5931[km]

h = 1.5849
|X2-X1| = 11.6299[km]

h = 3.1623
|X2-X1| = 10.9395[km]

step-h V resulted flying time:
steps =
          0.1      0.19953      0.39811      0.79433       1.5849       3.1623
fly_time =
         43.8       43.696       43.792       43.688       42.792        41.11
delta_x =
        11622        11601        11609        11593        11630        10940
```





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