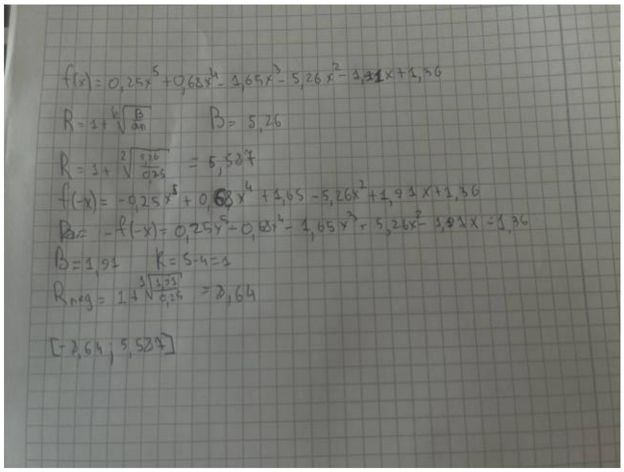
Formal part: Arsenii, Ziubin, IFU-3

Part 1

Calculation of Intervals



$f(x) = 0{,}25x^5 + 0{,}68x^4 - 1{,}65x^3 - 5{,}26x^2 - 1{,}91x + 1{,}36$

$R = 1 + \sqrt[k]{\frac{B}{a_n}}$ $\quad B = 5{,}26$

$R = 1 + \sqrt[2]{\frac{5{,}26}{0{,}25}} = 5{,}587$

$f(-x) = -0{,}25x^5 + 0{,}68x^4 + 1{,}65 - 5{,}26x^2 + 1{,}91x + 1{,}36$

$-f(-x) = 0{,}25x^5 - 0{,}68x^4 - 1{,}65x^3 + 5{,}26x^2 - 1{,}91x - 1{,}36$

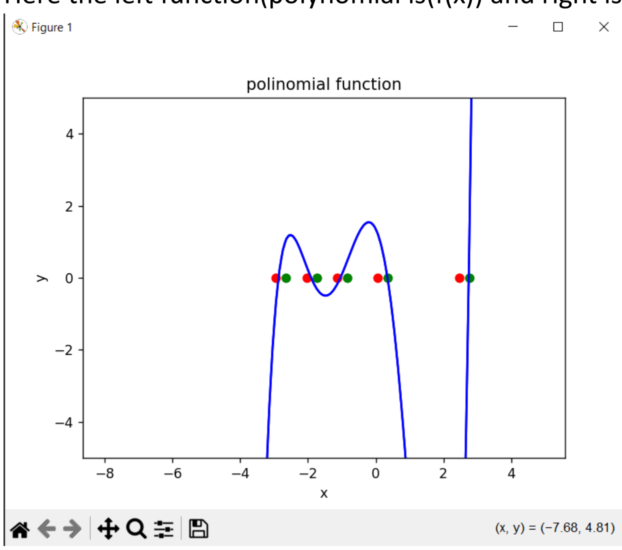
$B = 1{,}91 \quad k = 5 - 4 = 1$

$R_{neg} = 1 + \sqrt[3]{\frac{1{,}91}{0{,}25}} = 2{,}64$

$[-2{,}64;\ 5{,}587]$

[Visualization of functions f(x) and g(x)]

Here the left function(polynomial is(f(x)) and right is g(x)



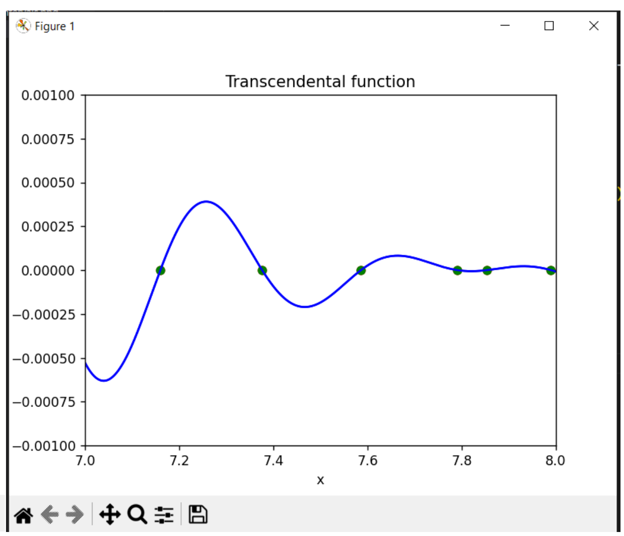
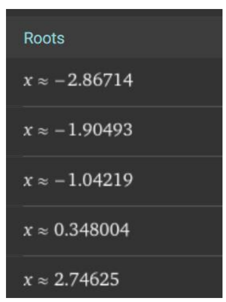


Fig. f(x) visualization and start and end of each root interval represented in different color. If points overlap, different marker size may be used. Scanning step size indicated in description.	Root : [-2.940 ; -2.640] Root : [-2.040 ; -1.740] Root : [-1.140 ; -0.840] Root : [0.060 ; 0.360] Root : [2.460 ; 2.760] Step size is 0,3

Fig. f(x) visualization and start and end of each root interval represented in different colors. If points overlap, different marker size may be used. Scanning step size indicated in description.	Root : [7.150 ; 7.200] Root : [7.350 ; 7.400] Root : [7.550 ; 7.600] Root : [7.750 ; 7.800] Root : [7.850 ; 7.900] Root : [7.950 ; 8.000] Step size is 0.05



Defined roots by the wolfram alpha for the Polynomial equation

Here Fx represents a very small number that shows us that x is our root.

[chords]	Initial guess	defined root	Iterations count	Validation	Value of the function in calculated root
f(x)	-2.940	-2.86714	10	correct	Fx = 6.099010851912112e-09
	-2.040	-1.90493	7	correct	Fx = -9.384185206684492e-09
	-1.140	-1.04219	8	correct	Fx = -2.2547015365859124e-09

	0.060	0.34800	5	correct	Fx = 7.390201783863404e-10
	2.460	2.74625	6	correct	Fx = -2.0526980115675997e-10
g(f)	7.15	7.15999	3	correct	Fx = 3.0589692765336706e-09
	7.35	7.37612	4	correct	Fx = -8.050906634320769e-10
	7.55	7.58609	4	correct	Fx = 3.7231461117618403e-09
	7.75	7.79041	7	correct	Fx = -4.5927400893715745e-09
	7.85	7.85397	3	correct	Fx = -2.273719506233726e-09
	7.95	7.98948	4	correct	Fx = 6.104890158295009e-10

[newton]	Initial guess	defined root	Iterations count	Validation	Value of the function in calculated root
f(x)	-2.940	-2.867	4	correct	Fx = -0.000
	-2.040	-1.905	3	correct	Fx = 0.000
	-1.140	-1.042	3	correct	Fx = 0.000
	0.060	0.348	5	correct	Fx = -0.000
	2.460	2.746	5	correct	Fx = 0.000
g(f)	7.15	X = 7.160	2	correct	Fx = -0.000
	7.35	x = 7.376	2	correct	Fx = 0.000
	7.55	x = 7.586	3	correct	Fx = -0.000
	7.75	x = 7.790	3	correct	Fx = 0.000
	7.85	X = 7.854	2	correct	Fx = 0.000
	7.95	x = 7.989	4	correct	Fx = -0.000

[Quasi-Newton]	Initial guess	defined root	Iterations count	Validation	Value of the function in calculated root
f(x)	-2.940	-2.867	4	correct	Fx = -1.0438316877525722e-12
	-2.040	-1.905	3	correct	Fx = 2.7602082841582387e-09
	-1.140	-1.042	3	correct	Fx = 7.463486051406676e-09
	0.060	0.348	5	correct	Fx = 1.5127898933542383e-12
	2.460	2.746	5	correct	Fx = -8.063993917062362e-12
g(f)	7.15	7.1599	2	correct	Fx = -2.9936772688812957e-10
	7.35	7.376	2	correct	Fx = 3.782644552786599e-09
	7.55	7.586	3	correct	Fx = -1.403313179776122e-12
	7.75	7.79	3	correct	Fx = 6.868197839231533e-09
	7.85	7.85	2	correct	Fx = 9.199100201494893e-11
	7.95	7.989	4	correct	Fx = -1.399173477500979e-12

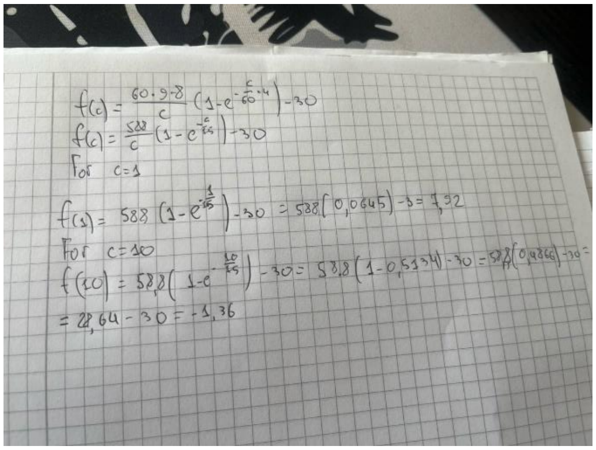
[secant]	Initial guess	defined root	Iterations count	Validation	Value of the function in calculated root
f(x)	-2.940	-2.867	5	correct	Fx = -2.2909896202349955e-11
	-2.040	-1.905	4	correct	Fx = 2.9087952047035515e-09

	-1.140	-1.042	4	correct	Fx = 7.726557393894495e-09
	0.060	0.348	7	correct	Fx = -5.362377208939506e-13
	2.460	2.746	7	correct	Fx = 2.3070434451710753e-13
g(f)	7.15	7.1599	3	correct	Fx = -5.233640753919259e-12
	7.35	7.376	3	correct	Fx = 1.7783441119903404e-10
	7.55	7.586	3	correct	Fx = -2.4016507108484072e-09
	7.75	7.79	4	correct	Fx = 7.1251004349230665e-09
	7.85	7.8539	2	correct	Fx = -2.3043657377328464e-09
	7.95	7.989	5	correct	Fx = 1.0799680576093684e-09

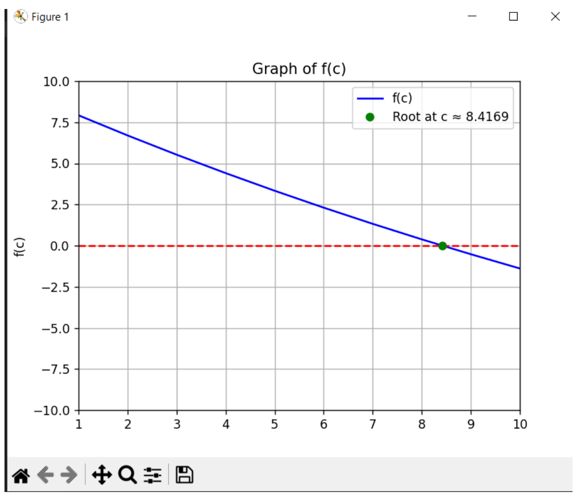
Part 2

Velocity of the parachutist is obtained by law $v(t) = \frac{mg}{c}\left(1 - e^{-\left(\frac{c}{m}\right)t}\right)$, here $g = 9{,}8\ \mathrm{m/s^2}$, m – mass of the parachutist and t - time. What is the coefficient of resistance c, if it is known that after time t_1 free fall, velocity of the parachutist is v_1?

(m * g / c) * (1 - np.exp(-(c / m) * t1)) - v1



Since the function value is positive at c=1 and negative at c=10, there must be a root within the range [1, 10].



This graph shows us function f(c) and the root which is shown by green dot,

Red line represents the line where y = 0.

I have used Newton method for calculating the root approximately 8.417

Conclusion

Based on the data of the analysis I have found the roots of a polynomial function f(x), and a transcendental function g(x). The roots were first isolated using a scanning method with a step size of 0.3 for f(x) and 0.05 for g(x).

I have applied few numerical methods like:

Chords, Newton's, Quasi-Newton, and Secant—to find the exact roots. All methods were successful, with the calculated function values. Newton's and Quasi-Newton methods based on my analysis required fewer iterations to converge. Finally, the Newton's method was used to solve a Task2, finding the coefficient of resistance, c, for a parachutist. The root of the defined function f(c) was determined to be approximately 8.4169, which was confirmed in calculation to be within the initial interval of [1, 10].