

# Homework 2 — Multi-step Predictor/Corrector Method

## Numerical Solution for ODEs

*Due date:* December 19th, 2025

Support files for this homework can be found as a ZIP file on the webpage.

**Exercise 1.** Write a MATLAB function, with the name `pred_corr`, to implement one of the following *predictor/corrector* methods (see support files for initial template):

Algorithm	Predictor	Corrector
1. $PECE$	3-step Nyström	2-step Milne-Simpson
2. $P(EC)^4$	1-step Adams-Bashfort	3-step Adams-Moulton
3. $P(EC)^3E$	1-step Adams-Bashfort	3-step Adams-Moulton
4. $P(EC)^2E$	2-step Nyström	2-step Milne-Simpson

**Exercise 2.** Test your script on the following problems from the support files:

1. The logistic equation  $x' = (1 - x)x$  (`logistic.m`) for  $t \in [0, 3]$ ,  $x_0 = 2$ ,  $\tau = 0.1$  and plot  $t$  versus the solution  $x$ :

```
x0=2.0; h=0.1;
figure;
[t,x]=pred_corr(@logistic, 0, 3, x0, h);
plot(t,x,'-bx');
```

2. The linear oscillator (`oscillator.m`)

$$\begin{aligned}x'_1 &= x_2 \\x'_2 &= -9x_1 + 10 \cos(2.5t)\end{aligned}$$

for  $t \in [0, 10]$ ,  $\mathbf{x}_0 = (2, 1)^\top$ ,  $\tau = 0.1$  and plot  $t$  versus the solution  $x_1$ :

```
figure;
x0 = [2;1]; h = 0.1;
[t,x]=pred_corr(@oscillator, 0, 10, x0, h);
plot(t,x(:,1),'-bx');
```

3. The satellite problem (`sat_ode.m`) with  $\mu = \frac{1}{82.45}$

$$x_1' = x_3$$

$$x_2' = x_4$$

$$x_3' = 2x_4 + x_1 - (1 - \mu) \frac{x_1 + \mu}{((x_1 + \mu)^2 + x_2^2)^{1.5}} - \mu \frac{x_1 - 1 + \mu}{((x_1 - 1 + \mu)^2 + x_2^2)^{1.5}}$$

$$x_4' = -2x_3 + x_2 - (1 - \mu) \frac{x_2}{((x_1 + \mu)^2 + x_2^2)^{1.5}} - \mu \frac{x_2}{((x_1 - 1 + \mu)^2 + x_2^2)^{1.5}}$$

for  $t \in [0, 6.19216933131963970674]$ ,  $\mathbf{x}_0 = (1.2, 0, 0, -1.04935750983031990726)^\top$ ,  $\tau = 0.001$  and plot  $x_1$  versus  $x_2$ :

```
figure
x0 = [1.2; 0; 0; -1.04935750983031990726]; h = 1e-3;
[t,x] = pred_corr(@sat_ode, 0, 6.19216933131963970674, x0, h);
plot(x(:,1), x(:,2));
```

Save each of these plots as a PDF file using **Save > Save As**.

**Exercise 3.** Apply linear regression to estimate the method order. See `conv_analysis.m` for a script to perform this, when called with the `pred_corr`:

```
conv_analysis(@pred_corr);
```

## Submission

Submit the MATLAB script for the implemented method from *exercise 1*, the PDF files of the plots from *exercise 2*, and enter the order of the method deduced in *exercise 3* via the *Study Group Roster (Záznamník učitele)* in SIS before the deadline.