8a. Airy Function

- **`airy.cpp`**: Solve the *Airy* equation as a boundary value problem

$$\frac{d^2y}{dx^2} - xy = 0, \qquad \text{subject to} \qquad y(x_L) = 1, \quad y(x_R) = 0$$

where x_L = `-10`, x_R = `+10`.

- Solve the problem using two different algorithms:
  1. Shooting method, by integrating the previous ODE with the 4th order Runge-Kutta algorithm and `NSTEPS = 800` (*Hint*: $10 < y'(x_L) < 40$). Use a root-finder of your choice (`xtol=1.e-8`). Report, in the comments at the beginning of the C++ code, the value of $y'(0)$ that you obtain.

  2. Finite difference method, with a grid of (`NSTEPS+1`) points (inclusive of boundary values). *Hint*: write the tridiagonal system resulting from a finite difference discretization of the 2nd derivative and obtain the coefficients `a[], b[], c[] and r[]`.

- Upload two files (or – alternatively – a single pdf file*):
  1. a plot** of the Airy functions obtained with the two methods overlapped;
  2. the C++ code including relevant library functions (e.g. RK4, root finder, tridiag).

- *You may use the LaTex template if you wish (next page).

- **Here's a Gnuplot script to produce the plot (in case you need one):

```
reset
set title "Solution of the BVP y'' - xy = 0  with yL = 1, yR = 0" font ",18"

set label 1 at -1, -12 font ",18"

set xlabel "x"    font ",18"
set ylabel "y(x)" font ",18"
set key           font ",18" spacing 2
  plot "airy.dat" index 0 u 1:2  title "RK4"
replot "airy.dat" index 1 u 1:2  title "FD"
```

8a. LaTex Template

```
\documentclass[10pt]{article}
\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{anysize}
\usepackage{listings}
\usepackage{graphicx}
\usepackage{xcolor}

\definecolor{Blue}{rgb}{0.2,0.2,0.9}
\definecolor{Green}{rgb}{0,0.6,0}
\definecolor{Gray}{rgb}{0.5,0.5,0.5}
\definecolor{Purple}{rgb}{0.58,0,0.82}
\definecolor{background}{rgb}{0.98,0.98,0.95}

\lstdefinestyle{mystyle}{
    backgroundcolor=\color{background},
    commentstyle=\color{Green},
    keywordstyle=\color{Blue},
    numberstyle=\tiny\color{Gray},
    stringstyle=\color{Purple},
    basicstyle=\ttfamily\footnotesize,
    breakatwhitespace=false,
    breaklines=true,
    captionpos=b,
    keepspaces=true,
    numbers=left,
    numbersep=5pt,
    showspaces=false,
    showstringspaces=false,
    showtabs=false,
    tabsize=2
}
\lstset{style=mystyle}


\title{Classwork:  xxx}
\author{Student: Name}
\date{\today}

%%%%%% DOCUMENT BEGINS HERE %%%%%%

\begin{document}
\maketitle

\begin{figure}[!ht]
  \centering
  \includegraphics[width=0.7\textwidth]{airy.png}
  \caption{\footnotesize This is an example on how to place a figure.
  }
  \label{fig:single}
\end{figure}
%

Insert your code using the \texttt{lstlisting} environment included at the
beginning of this document.
Example:

\lstinputlisting[language=C++]{airy.cpp}

\end{document}
```