Project 2

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https://github.com/olavkar/fys3150/tree/main/project2

PROBLEM 1

Using $\hat{x} = x/L$ means that $dx = d\hat{x}L$ and we get

$$\begin{aligned} \gamma \frac{d^2u}{dx^2} &= -Fu \\ \rightarrow \frac{\gamma}{L^2}\frac{d^2u}{d\hat{x}^2} &= -Fu \\ \rightarrow \frac{d^2u}{d\hat{x}^2} &= -\frac{FL^2}{\gamma}u = -\lambda u \end{aligned} \tag{1}$$

PROBLEM 2

Running the code related to this problem confirms that armadillo agrees with the analytical solution.

PROBLEM 3

a) & b)

See the code related to this problem. It does indeed identify that -0.7 is the biggest non-diagonal element, and it gives correct indices.

PROBLEM 4

a) & b)

See code related to this problem. When comparing the eigenvalues and eigenvectors with those found in Problem 2 (by eye, in the terminal), they are in agreement.

PROBLEM 5

a)

The number of rotations $N_{\rm rot}$ as a function of the number of steps N is shown in table I. Table I also shows how many more rotations are required from the previous N. This means as N doubles the number of rotations approximately quadruples, suggesting $N_{\rm rot}(N) \propto N^2$.

b)

We would expect to see $N_{\rm rot} = O(N^2)$ as in a), as that is approximately how many elements need to be transformed. Maybe our algorithm is about the same because non-diagonal elements, which are zero at the start, are transformed to non-zero numbers, effectively making the matrix dense.

TABLE I: Number of rotations

N	N_{rot}	Increase
10	141	-
20	655	4.65
40	2758	4.21
80	11276	4.09
160	45595	4.04

PROBLEM 6

a) & b)

Figure 1 shows the solutions to the buckling beam problem for $n = 10$ and $n = 100$ steps.

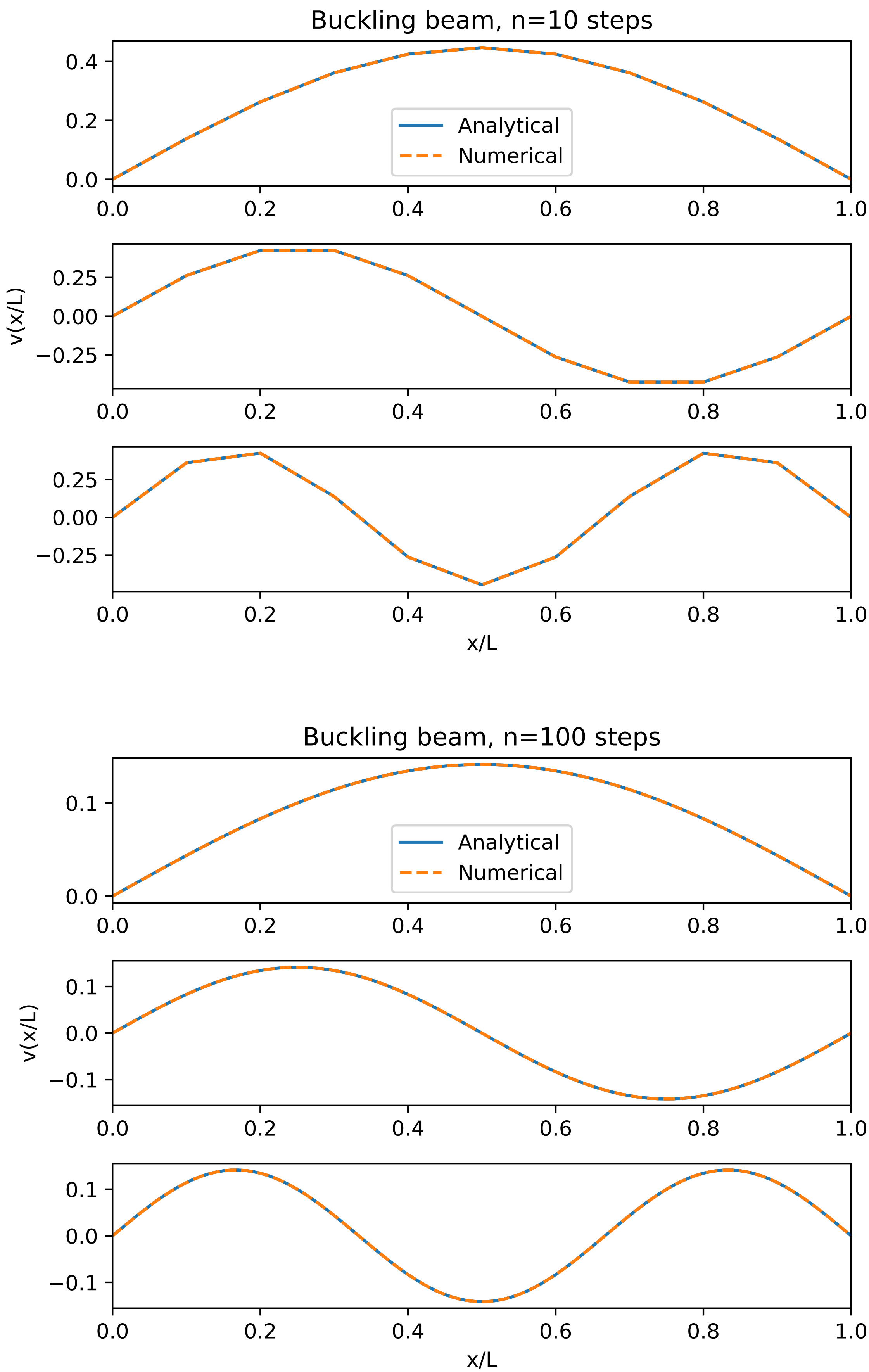

FIG. 1: The (normalised) solutions to the buckling beam problem for the 3 lowest eigenvalues.