

# Numerical Methods and Scientific Computing

## Case Study 6

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### Overview

Nonlinear boundary-value problems arise in many areas of science and engineering. In this case study you will apply your tri-diagonal solver and Newton's method solver in order to compute the solution to a nonlinear BVP using continuation.

### Nonlinear BVP

Consider the nonlinear BVP

$$U_{xx} - 3U - 10U^3 = x^2, U(0) = 0, U(1) = 0$$

In the absence of the nonlinear term ( $10U^3$ ), the BVP has an exact solution which can be used for validation of your basic technique. If we replace the nonlinear term with  $\alpha U^3$  then we can compute a solution to the full nonlinear BVP using finite-difference approximations and continuation from  $\alpha = 0$  to  $\alpha = 10$ . You will need to use your tri-diagonal solver in order to compute the updates to Newton's methods on the nonlinear BVP.

### Report

Prepare a report in which you review the tri-diagonal solver developed in case study 4, and Newton's method for systems of nonlinear equations in case study 5. Include the key figures developed in these case studies. Include a review of your method to solve this nonlinear BVP, and present the key results.