5.1.10 Exam: Implementing two-step implicit methods

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Exams due Aug 30, 2023 05:00 IST Completed

In this problem, you will implement the calculation of the residual and the Jacobian for the following implicit, two-step numerical methods (Method A and Method B). A two-step numerical method is one in which the calculation of $\underline{v}^{n+1}$ depends on the previous two timesteps ($\underline{v}^{n}$ and $\underline{v}^{n-1}$). Below, we give the methods and their corresponding residuals:

Method A

$$\underline{v}^{n+1} = \frac{4}{3}\underline{v}^{n} - \frac{1}{3}\underline{v}^{n-1} + \frac{2}{3}\Delta t \underline{f}\left(\underline{v}^{n+1}, t^{n+1}\right) \tag{5.22}$$

$$\underline{r}\left(\underline{v}\right) = \frac{1}{\Delta t}\left(\underline{v} - \frac{4}{3}\underline{v}^{n} + \frac{1}{3}\underline{v}^{n-1}\right) - \frac{2}{3}\underline{f}\left(\underline{v}, t^{n+1}\right) \tag{5.23}$$

Method B

$$\underline{v}^{n+1} = \underline{v}^{n} + \Delta t\left[\frac{5}{12}\underline{f}\left(\underline{v}^{n+1}, t^{n+1}\right) + \frac{8}{12}\underline{f}\left(\underline{v}^{n}, t^{n}\right) - \frac{1}{12}\underline{f}\left(\underline{v}^{n-1}, t^{n-1}\right)\right] \tag{5.24}$$

$$\underline{r}\left(\underline{v}\right) = \frac{1}{\Delta t}\left(\underline{v} - \underline{v}^{n}\right) - \left[\frac{5}{12}\underline{f}\left(\underline{v}, t^{n+1}\right) + \frac{8}{12}\underline{f}\left(\underline{v}^{n}, t^{n}\right) - \frac{1}{12}\underline{f}\left(\underline{v}^{n-1}, t^{n-1}\right)\right] \tag{5.25}$$

In the code provided on the grading site at the link below, implement the calculation of the residual $\underline{r}$ and the Jacobian $\partial\underline{r}/\partial\underline{v}$ for these two methods.

Problem: Implementation of two-step implicit methods (External resource) (2.84 / 4.0 points)

This will launch an external site that will require forwarding of your username.

Launch external site for submission and grading of Python code

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