Homework Assignment 10

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Problem 1. Determine the number of subintervals N such that the error for the IVP $u'(t) = -150u(t) + 49 - 150t$ with initial condition $u(0) = \frac{1}{3} + \epsilon$ is 0.1, 0.01, and 0.001 for $\epsilon = 0.1$ for the following schemes:

- Forward Euler's method
- Backward Euler's method
- Heun's method
- Trapezoidal method
- Fourth-order Runge-Kutta method.
- `ode23`
- `ode45`

Solution. See below for a table detailing the number of subintervals needed for each scheme such that the error is the value in the column header.

Scheme	**Error 0.1**	**Error 0.01**	**Error 0.001**
Forward Euler's method	74	82	345
Backward Euler's method	1	1	1
Heun's method	74	76	166
Trapezoidal method	1	1	90
Fourth-order Runge-Kutta method	54	54	87
`ode23`*	2	2	2
`ode45`*	2	2	2

Table 1: Number of subintervals N to achieve various errors.

Note that due to the stability of the Implicit Euler's method, the number of subintervals required to attain each error is much, much lower compared to the other numerical schemes. I was unable to compute `ode23` and `ode45` with only one subinterval, but I suspect if done, that the number of subintervals would be 1 for norms within error of the true solution. □