REVIEW - INITIAL VALUE PROBLEM (Ch.9)

True or false:

- In solving an ODE numerically, the roundoff error and the truncation error are independent of each other.
- In solving an IVP for an ODE numerically, the global error is always at least as large as the sum of the local errors.
- A numerical solution method can be unstable even if applied to a stable ODE.
- In approximating a stable solution of an ODE numerically, an implicit method is always stable.

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True or false:

- Implicit methods are better than explicit methods for solving stiff ODEs numerically.
- The simplest numerical method that is stable for integrating a stiff ODE is backward Euler's method.
- In using a multistep method to solve an ODE numerically, one might still need to have a single-step method available.

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9.11. Which of the following types of first-order ODEs have stable solutions?

(a) An ODE whose solutions converge toward each other, (b) An ODE whose Jacobian matrix has only eigenvalues with negative real parts, (c) A stiff ODE,

(d) An ODE with exponentially decaying solutions.

9.12. Classify each of the following ODEs as having unstable (U), stable (S), or asymptotically stable (A) solutions: (a) $y' = y + t$ (b) $y' = y - t$

(c) $y' = t - y$ (d) $y' = 1$.

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9.22. What does it mean for the accuracy of a numerical method for solving ODEs to be of order *p*?

9.24. Give the stability regions for a) the Euler's and b) backward Euler methods for solving a scalar ODE $y'=\lambda*y$! c) For the backward Euler method, which factor places a stronger restriction on the choice of stepsize: stability or accuracy?

Calculate stepsize h for a) explicit Euler's method to be stable in solving a scalar ODE $y'=\lambda*y$ and for b) achieving local error smaller than tol. c) Which stepsize should be used in the numerical solution?

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9.39. a) Is a predictor-corrector method for solving an ODE an implicit method?

b) If implemented as a PECE scheme, does the second evaluation affect the value obtained for the solution at the point being computed?

c) If so, what is the effect, and if not, then why is the second evaluation done?

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9.41. For each of the following properties, state which type of ODE method, multistep (M) or classical Runge-Kutta (R), more accurately fits the description:

(a) Self starting,

(b) More efficient in attaining high accuracy,

(c) Can be efficient for stiff problems,

(d) Easier to program,

(e) Easier to change stepsize,

(f) Easier to obtain a local error estimate,

(g) Easier to produce output at arbitrary intermediate points within each step.

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Name methods for numerical solution of ODE $y'=f(t,y)$ as listed below:

a) $y_{(k+1)} = y_k + h*f(t_k,y_k)$,

b) $y_{(k+1)} = y_k + h/2*(f(t_k,y_k) + f(t_{(k+1)},y_{(k+1)}))$,

c) $y_{(k+1)} = y_k + h/2*(f(t_k,y_k) + f(t_{(k+1)}, y_k+f(t_k,y_k)))$,

d) $y_{(k+1)} = y_k + h*f(t_{(k+1)},y_{(k+1)})$.