Sample Questions from Past Qualifying Exams

This list may give the impression that the exams consist of a series of questions fired at the student one after another. In fact most exams have more the character of a conversation with considerable give and take. Hence this list cannot be expected to indicate accurately the difficulties involved.

The list indicates the professor associated to each question where available. Some have been in the MGSA files for a while, and this information has been lost (if it was ever there).

The listing by section is approximate, since some questions may fit under more than one heading.

Numerical ODE's and Numerical PDE's

- State precisely the root condition for $\sum(a_j y_{n+j}) = h\sum f(x_{n+j}, y_{n+j})$.
- Consider $\frac{d}{dt}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} -10^6 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix}$. Would Runge-Kutta be reasonable to use? Do you anticipate any problems?
- Define stability for the general scheme $u^{n+1} = Qu^n$. Define consistency and convergence.
- Consider the PDE $v_t = v_x$, $v(x,0)$ given, and the numerical scheme $\frac{u_j^{n+1}-u_j^n}{k} = \frac{u_{j+1}^n - u_j}{h}$. Is this scheme consistent? Stabe? What is the CFL condition and what does it say about k and h?
- Prove the Fourier transform of D_+u^n is $\frac{1}{h}(e^{-i\xi}-1)\hat{u^n}$.
- Given a scheme $u_j^{n+1} = \alpha u_j^n - 2u_{j+1}^n + u_{j+1}^n$, describe how you would find values of α for which it is stable.
- Assume $\hat{u^{n+1}} = \rho(\xi)\hat{u^n}$ and $|\rho(\xi)| \leq 1$. Show that his implies stability.
- What is the advantege/disadvantage of RK methods comparing to multi-step methods?