Summary of Topics

1. Error Analysis
   (a) Roundoff errors (floating point arithmetic).
   (b) Condition number and stability.
2. Interpolation
   (a) Polynomial interpolation
      i. Power form.
      ii. Lagrange form.
      iii. Newton divided difference form.
      iv. **Difference tables**.
      v. **Gregory–Newton formula**.
   (b) **Error (next term rule)**.
   (c) Polynomial wiggle problem.
   (d) Spline interpolation (linear splines, cubic splines).
3. Numerical differentiation and integration
   (a) **Order notation.**
   (b) **Numerical differentiation (forward, central and backward finite difference approximations).**
   (c) Numerical integration.
      i. **Newton–Cotes rules: (Composite) Trapezoid Rule, (Composite) Simpson's rule.**
      ii. **Gaussian quadrature.**
      iii. **Richardson extrapolation.**
      iv. **Singular integrals.**
4. Ordinary Differential Equations
   (a) Initial Value Problems
      i. **Euler's methods, $\theta-$method.**
      ii. Runge–Kutta methods
      iii. Multi-step methods.
      iv. Predictor–corrector methods.
      v. **Explicit versus implicit methods, truncation error analysis, stability analysis.**
      vi. Stiff equations.

(b) Boundary Value Problems

i. **Iterative methods: Newton's, Jacobi, Gauss-Seidel, SOR, convergence rate.**

ii. **Method of weighted residuals: collocation, moment method, Galerkin method, finite element method.**

5. Partial Differential Equations

(a) Classification of PDE's.

(b) Classification of boundary conditions.

(c) Error analysis.

i. **Consistency.**

ii. **Convergence.**

iii. **Lax's equivalence theorem.**

iv. **Stability (von Neumann's stability analysis method).**

v. **Truncation error.**

vi. Complexity (computational cost).

(d) **Method of lines (semi-discretization) for Heat Equation.**

(e) Finite difference methods.

i. **FTCS method for Heat Equation.**

ii. Richardson's method for Heat Equation.

iii. Dufort–Frankel method for Heat Equation.

iv. Classical implicit method for Heat Equation.

v. **Crank–Nicolson method for Heat Equation.**

vi. **Finite difference method for one-dimensional wave equation.**

The Exam

The exam consists of four questions. The items in bold on the preceding list should be emphasized in preparing for the exam, but the other items should not be ignored. As in the midterm test, questions will deal with theory (not programming), however some simple calculations will be required. Please bring the McMaster standard calculator (Casio FX-991). No notes shall be taken into the examination.

Office hours

After classes end my office hours will be Monday April 10 13h30-15h30, Tuesday April 11 9h30-10h30. I will also be available by appointment.