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**AM3911B/9670B – Mathematical Modelling. Winter 2009**

*Instructor: Dr. M. Karttunen*

Assignment 5. Due: Mon. Mar. 16, 2009 by 9:30pm.

See the lecture notes for instructions on plotting, presentation of results and programs.

Each problem is of equal value unless otherwise stated.

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**Problem 1.** Write a Monte Carlo program that computes

$$\left\langle \left( \sum_{i=1}^{50} x_i^2 \right)^y \right\rangle$$

with

$$P(\{x\}) = \exp \left( - \sum_{i=1}^{50} x_i^2 / 2 \right)$$

and estimate the error for your calculation.

**Problem 2.** Write a Monte Carlo code for simulated annealing of the travelling salesman problem for 42 cities located randomly in 2-dimensions.

**Problem 3.** Use your MD program (Lennard-Jones particles) as a starting and modify it so that it uses Metropolis Monte Carlo. Notice: instead of forces, you have to use energies. Tune the program so that it reaches about 50% acceptance ratio. Use the same densities as in the MD problems, plot the time development of the total energy and 3-5 snapshots of the system during the simulation.