Part 1: Brownian Diffusion in Micro-Channel

a) Point Source: Consider a laminar flow between two parallel plates. Assume that a point source located at different locations emit particles in the size range of 0.01 to 10 micron. Simulate the motion of particles under the action of Brownian force in the presence and absence of gravity. Assume that the mean air velocity is $V=0.01$ m/s, the channel is width is $h=1$ mm, with a length of about 10 mm, and particle-to-air density ratio is $S=2000$. Use an ensemble of $N=50$ to 200 trajectories and evaluate the mean, variance and other statistics for particle position. Verify your results for dispersion for the source near the duct centerline by comparison with the exact solution. Discuss the importance of gravity and Brownian forces for different size particles. Also evaluate the deposition rate of panicles for point sources, which are very near the wall (about $a=1$ mm). (Use FLUENT as well as your own program and compare the results.)

b) Uniform Inlet Concentration: For a uniform inlet concentration of particles in size range of 0.01 to 10 micron, evaluated the deposition rate for laminar flows between two parallel plates. Plot the results in term of Schmidt number. (Use FLUENT as well as your own program and compare the results with those obtained from the diffusion analysis.)

c) Electromagnetic Forces: For the cases studied in parts a) and b) assume that the particles carry the average of the Botlzmann charge distribution. When an electric field is acting perpendicular to the flow direction, evaluate the dispersion and deposition of particles that are emitted from the point sources and/or enter the duct with a uniform concentration. Repeat the simulation when a magnetic field in the flow direction is present.

Part 2: Particle Detachment

Develop a computer program for evaluating the critical velocity needed to remove particles in the size range of 0.1 to 100 micron from a flat surface in a laminar duct flow. Assume that the duct is two mm wide and use JKR, DMT and Maguis-Pollock models for two materials of your choice.

Part 3: Applications

Select three industrial/environmental examples and perform two and three-dimensional analysis of the flow and particle transport analysis.

Report and Due Dates: The reports should include hard copies and electronic copies of the programs including FLUENT files, figures, and discussion of the results. The due dates for Parts 1 and 2 are October 16 and November 13, 2002, and for Part 3 is December 4, 2006.