University of California at Berkeley
College of Engineering
Mechanical Engineering Department

ME119, Fall 2002 **Liwei Lin**

Quiz I (80 minutes)

Close book, close notes, open one page formula sheet

Please answer questions as concise as possible

Problem 1, Movable Micromechanical Structure Paper (20 points)

Draw the cross sectional view of a *self-constrained pin joint* by using the MUMPs process (figure illustrations on the left and brief process details on the right) – you can ignore the layers that you don't plan to use. (10 points) Indicate the various layer (or material) names of each layer. Please also indicate in your process sequence where masks should be used and if the mask should be a clear or a dark mask. (10 points) You may have to etch the nitride layer in this process.

Problem 2, Comb-Shape Resonator Paper (20 points)

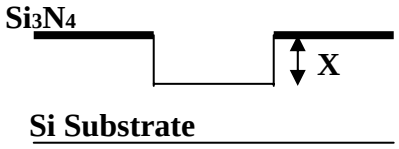
a. What are the energy dissipation mechanisms of the comb drive? What is Couette flow? What is Stokes flow? What are the way(s) to increase the quality factor? (10 points)
b. List any difference in the manufacturing process of this paper as compared with the standard MUMPs process? (10 points)

Problem 3, Surface-Micromachining (30 points)

The MUMPs process has been a popular process by using the foundry service. Both microfluidics and Bio-MEMS have also become interesting topics. How can one use MUMPs process to make micro channels? (These channels can have multiple holes on the side for release etching purpose and the holes could be left open. The surface tension force of the fluids inside the channel may prevent liquid to leak outside through these holes). Please draw the process sequences for the following two processes using cross sectional views and brief descriptions.

(a) Design a process that will have polysilicon on top of the microchannel? (15 points)
(b) Design a process that will have PSG on top of the microchannel such that the channel is transparent? (15 points)

Problem 4, Oxidation (30points)



a. For a final silicon dioxide thickness of 0.5μm, find the required etched silicon thickness X (10 points)
b. Design an oxidation process, including processing temperature and time to get "flat" silicon dioxide growth (10 points)
c. Draw the final cross sectional view (showing any non-perfect effects you may expect to see) (10 points)