University of Toronto
Faculty of Applied Science and Engineering
Final Examination, April 23, 2001
MIE 321S - MANUFACTURING ENGINEERING
Examiner: C. B. Park

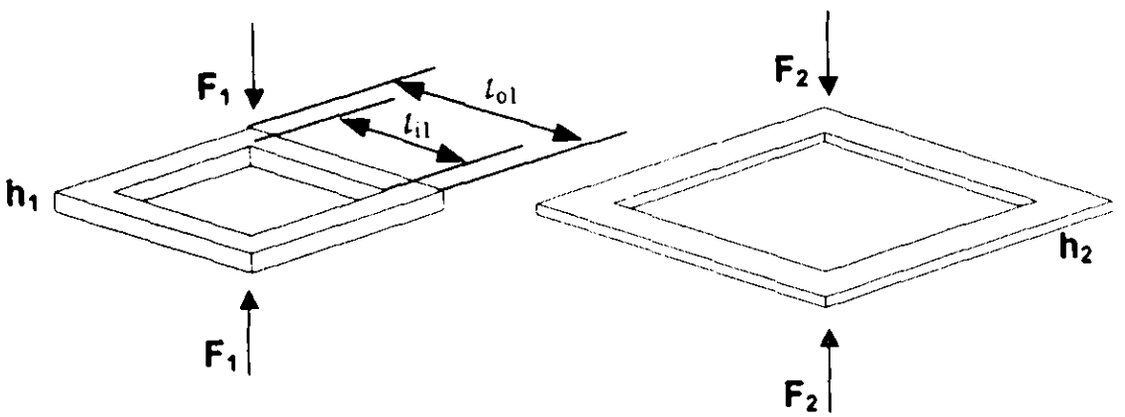
This is a closed book exam. No aids are allowed.
Only non-programmable calculators may be used.

1. (a) Describe how you would manufacture high-quality plastic lenses (which do not have any residual stresses nor molecular orientation) using injection molding only (note no machining should be involved in your proposed processing). (10 marks)

   (b) Analyze this processing using the Axiomatic Design approach. (Hint: Write the FRs, DPs, and the design equation first. Briefly explain the coupling nature of the proposed design based on your analysis.) (10 marks)

2. You would like to design a forging die to produce a metallic frame shown in Figure 1. You want to decrease the thickness from h_1 to h_2 such that $h(t) = h_1 e^{-at}$ where "a" is a given constant. The initial inner and outer side lengths of the square frames are l_{i1} and l_{o1}, respectively. Estimate the force, F(t), required for this processing as a function of time. Determine the magnitude of F_2. (15 marks)

   Hint: (i) The shear strength of the material is "k".
   (ii) Derive the inner and outer side lengths of the part, $l_i(t)$ and $l_o(t)$, as a function of l_{i1}, l_{o1}, h_1, and $h(t)$. Assume $l_{i1}, l_{o1} >> l_{o1} - l_{i1}$.
   (iii) Derive the force F(t) as a function of time.



(a) Before (b) After

Figure 1. Forging of metallic frames

3. Briefly describe the effects of the degree of crystallinity on the physical, thermodynamic, and mechanical properties of semi-crystalline polymers. (10 marks)

4. Briefly describe the "Gas Injection Technique" in injection molding. What are its advantages and disadvantages compared to the conventional injection molding process? (10 marks)

5. (a) Briefly describe the roles of the cutting speed in determining the surface quality and cost in machining. (Hint: Draw (1) the figures for the surface roughness vs. the cutting speed & (2) the cost vs. the cutting speed. Briefly explain why it affects the surface quality and cost.) (10 marks)

   (b) Briefly describe the roles of the rake angle in determining the surface quality and cost in machining. (Hint: Draw (1) the figures for the surface roughness vs. the rake angle & (2) the cost vs. the rake angle. Briefly explain why it affects the surface quality and cost.) (7 marks)

   (c) Briefly describe the roles of the depth of cut in determining the surface quality and cost in machining. (Hint: Draw (1) the figures for the surface roughness vs. the depth of cut & (2) the cost vs. the depth of cut. Briefly explain why it affects the surface quality and cost.) (7 marks)

6. Explain the difference between the redundant work and frictional work. (7 marks)

7. Briefly describe why the "force" analysis is important in stamping/forging. (7 marks)

8. Briefly describe the EDM process including its advantages and disadvantages compared to conventional machines such as a lathe and a milling machine. (7 marks)