University of Toronto

Faculty of Applied Science and Engineering

FINAL EXAMINATION, April 24, 2001

MIE 418 - FLUID MECHANICS II

Examiner: D.F. James

Duration: 2 1/2 hours

NOTES:

1. Allowed aids are a textbook, personal notes, homework solutions, handouts, and a hand calculator.
2. An examination is an exercise in communication.

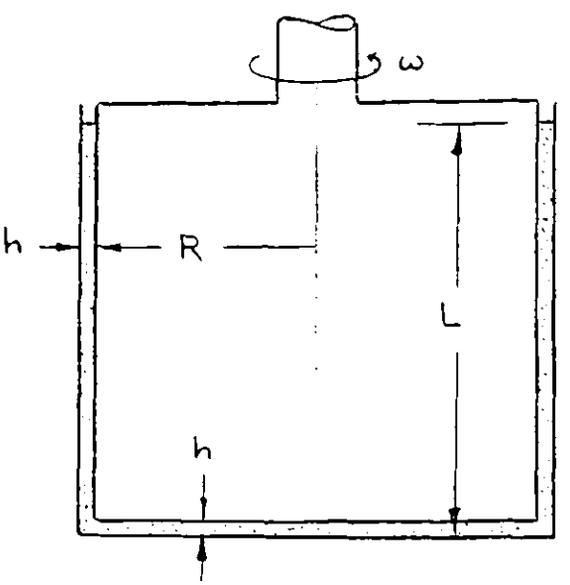
Question 1 (10%)

(a) Explain the purpose of ailerons on aircraft wings.

(b) Explain the purpose of flaps.

Question 2 (25%)

A shaft is positioned to be concentric with a circular housing. The gap distance is everywhere h, as indicated in the diagram, where h is much much smaller than the shaft radius R. The shaft end is flat, as is the cylinder bottom. In the space between the shaft and cylinder is a liquid of viscosity μ, which fills the space to a depth L. The shaft rotates at a steady angular speed ω.



(a) What is the torque T on the shaft, in terms of the given parameters?

(b) If the bottom of the shaft were cone-shaped instead of flat, with the vertex just touching the cylinder bottom and with a maximum gap of h, what would be the torque T in this case?

(c) Which shape is preferable for rheometry, and why?

(d) To use the preferred shape for rheometry, what conditions and assumptions are necessary?

Question 3 (20%)

A parachutist jumps from an airplane at 8000 ft. (2420 m), where the air density is 0.960 kg/m^3. The parachute has a diameter of 28 ft. and the weight of the chute and person is 185 lbf.

(a) Estimate the person's terminal velocity at this height.

(b) Estimate the time to reach the ground, at 100 m above sea level, in minutes.

Question 4 (15%)

A tube has an inner diameter D_1 and an outer diameter D_2, and the tube wall is porous with permeability k. A liquid of viscosity μ flows from inside to outside at a flow rate q per unit length of tube. The pressure drop across the wall is Δp.

If the flow were from outside to inside instead, would the pressure drop Δp be the same? Justify your answer.

If particles are suspended in the liquid, is the time for transport of a particle across the wall the same for both directions, for the same q?

Question 5 (30%)

A rectangular channel 60 ft. wide carries a discharge of 2700 ft^3/sec. The slope of the bottom is 0.0081 and the depth of uniform flow is 2.50 ft.

(a) What is the upstream Froude number?

(b) What is the uniform flow depth downstream of the transition, to 2 significant figures?

(c) What is the downstream Froude number?

(d) Sketch the transition in depth, showing how and where the transition takes place. Justify your answer by qualitative arguments.