GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - FALL Semester 2001

Tribology
EXAM AREA

Assigned Number **(DO NOT SIGN YOUR NAME)**

- **Please sign your name on the back of this page—**

Question #1

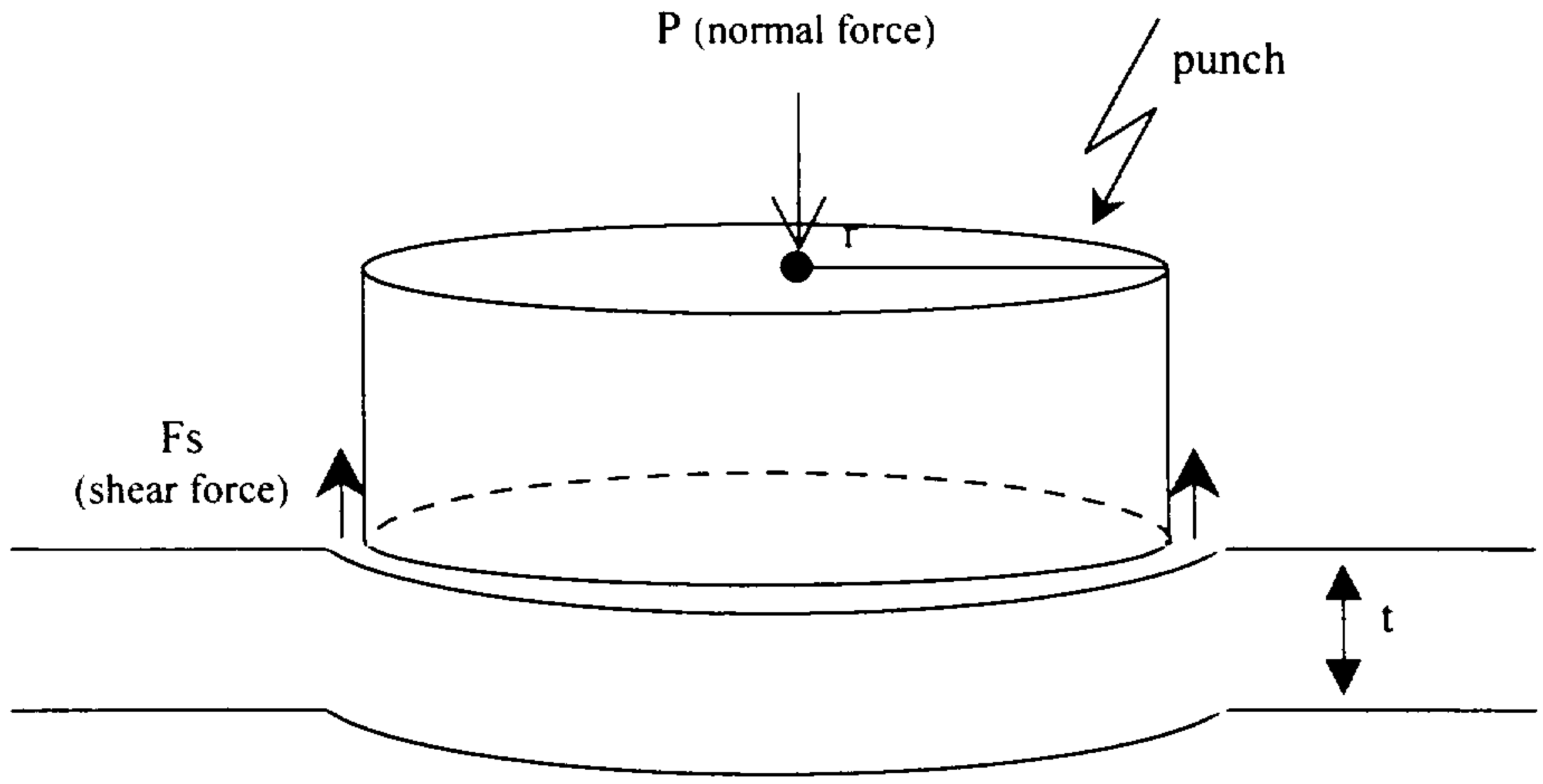
Consider an automobile disk brake with a pair of pads that come into contact with a rotor. Suppose a particular disk brake must provide 25% of a car's stopping force.

a) Derive an equation relating the mean pad pressure to the rate of deceleration of the car. Define any parameters that you introduce.

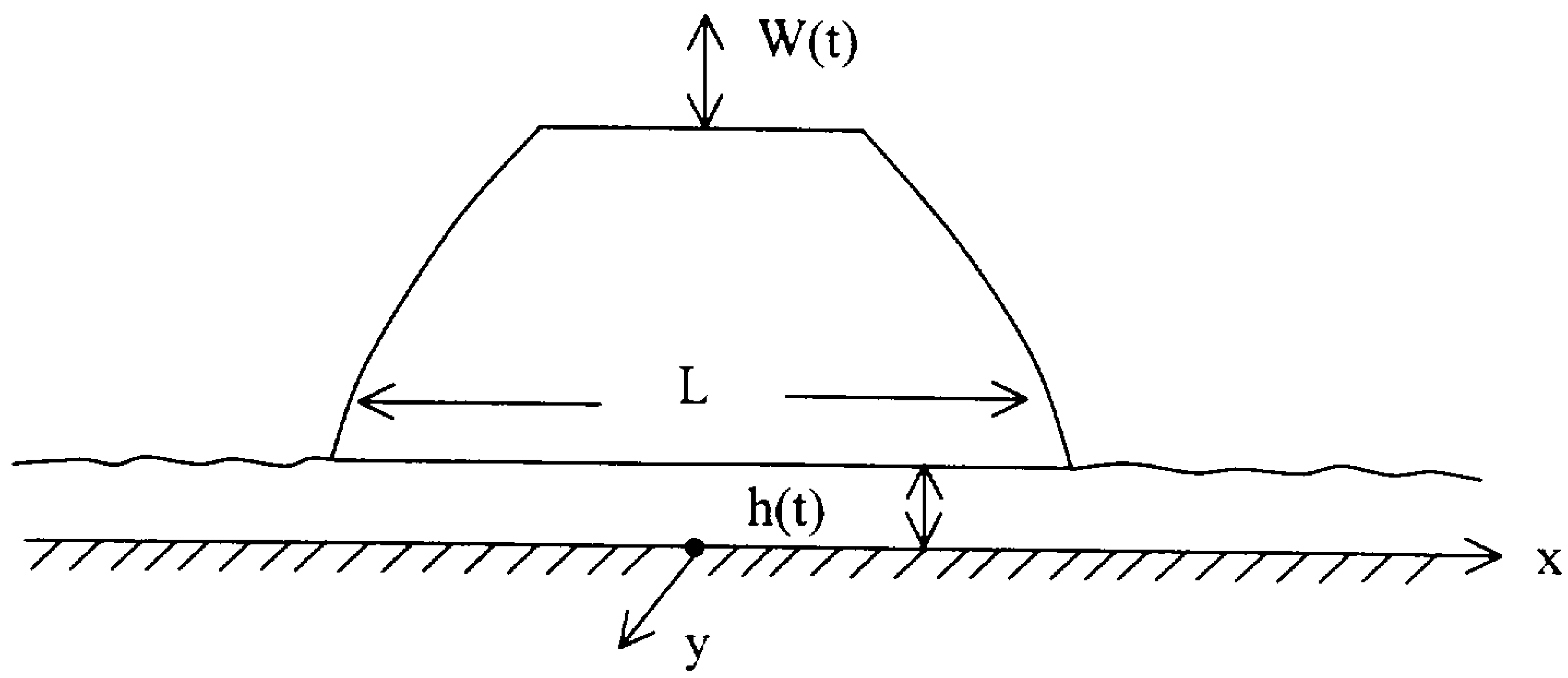
b) Based on the Archard Wear Law and the results above, derive an expression for the reduction in pad thickness during one stopping of the car from an initial speed V_0 in time t.

Question #2

Friction is very important in metal deformation processes. In some cases such as punching, the frictional (shear) force can limit the size and thickness of the material to be punched. This problem asks you to analyze the forces used in punching circular holes in a thin sheet of metal, including the frictional (shear) force. Derive an expression for the normal force in terms of the radius, thickness and yield strength of the material. The figure below is a schematic diagram of the punching process.



Question #3



Consider a two-dimensional thrust bearing (very long in the y-direction) that is supported by an oil film of thickness h, as shown above. The load on the bearing oscillates such that the film thickness is given by

$$h = h_0 + h_1 \cos(\omega t)$$

i) Find the pressure distribution in the film in terms of the parameters of the problem: μ (viscosity), ω, h_0, h_1, L, x, t.

ii) Find the load per unit length in the y-direction, W, in terms of the parameters of the problem.

iii) Find the volumetric flow rate, per unit length in the y-direction, at the edge of the bearing (x=L/2), Q, in terms of the parameters of the problem.