

## 530.327 - Introduction to Fluid Mechanics - Su

## Quiz 7 - 12 November

10 pts. Closed book.

Name SOLUTIONS

Consider a very long horizontal pipe with inner diameter  $D$ . Point 2 on the pipe lies a distance  $L$  downstream of point 1. An incompressible, viscous fluid flows through the pipe. The flow is steady and fully developed. The energy equation between points 1 and 2 is

$$\left[ \frac{p_1}{\rho} + \alpha_1 \frac{\bar{V}_1^2}{2} + gz_1 \right] - \left[ \frac{p_2}{\rho} + \alpha_2 \frac{\bar{V}_2^2}{2} + gz_2 \right] = (u_2 - u_1) - \frac{\dot{Q}}{\dot{m}}$$

Now answer the following questions:

- If there is no change in the internal energy of the fluid, what happens to the terms on the right side of the equation? Specifically, which terms go to zero, and what can you say about the sign(s) of the term(s) that remain? Explain briefly, using physical arguments.
- Now suppose again that there's no change in the internal energy of the fluid, and that you keep point 1 where it is, but now you move point 2 so that it lies  $2L$  away from point 1. Do any of the terms on either side of the equation change, and if so, do they get more positive or more negative? Explain briefly, using physical arguments.

(i) NO INTERNAL ENERGY CHANGE  $\rightarrow$   $u_2 - u_1 = 0$  (2)

LHS  $> 0$  SINCE MECHANICAL ENERGY IS CONVERTED TO HEAT AS THE FLOW

MOVES DOWNSTREAM  $\rightarrow -\frac{\dot{Q}}{\dot{m}} > 0$ ; know  $\dot{m} > 0$ , so

(2)  $\dot{Q} < 0$   $\Rightarrow$  FLUID TRANSFERS HEAT TO SURROUNDINGS (2)

(ii) LONGER PIPE LENGTH  $\Rightarrow$  MORE PRESSURE DROP | MORE HEAT TRANSFER TO SURROUNDINGS (2)

$P_2 \downarrow$  (MORE NEGATIVE  $\leftrightarrow$  LESS POSITIVE)

$\dot{Q} \downarrow$  (MORE NEGATIVE)