**ESO212 Fluid Mechanics & Rate Processes** **July-Nov 2010**

**I Mid-semester Exam** **1 hour; 15 points**

- Use $g = 9.8$ m/s$^2$, density of water = $10^3$ kg/m$^3$.
- Clearly state all the assumptions you make.

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1. Consider the gate HA shown in figure 1 which is hinged at H. The gate is 10 m wide normal to the plane of the paper. Calculate the force $F$ required at A to hold the gate closed. [6 points]

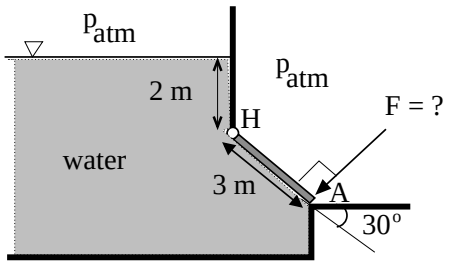


Figure 1: **Problem 1**

2. A pipe of 12 cm diameter containing water flowing at 20 kg/s is capped by an orifice plate (as shown in figure 2) with flange bolts. The water jet exits to the atmosphere, and jet diameter reaches a constant value of 25 mm as shown in the figure. The pressure in the pipe at section 1 is 800 kPa (gage). Assume flow to be uniform both at section 1 and in the jet, and neglect viscous friction at the pipe walls. Calculate the force provided by the flange bolts to hold the orifice plate fixed. [5 points]

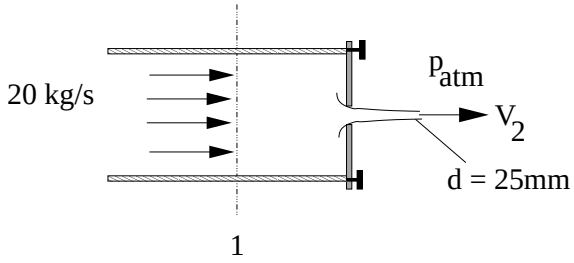


Figure 2: **Problem 2**

3. A turbine (shown next page in figure 3) is supplied with $0.6\,\mathrm{m}^3/\mathrm{s}$ of water from a 0.3 m diameter pipe; the outlet pipe has 0.4 m diameter. Assume flow to be steady, incompressible, and non-viscous. Determine the pressure drop across the turbine if the rate at which work is produced by the turbine is $60\,\mathrm{kJ/s}$. [4 points]

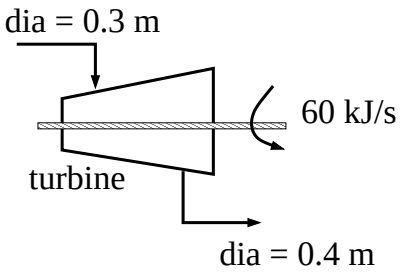


Figure 3: **Problem 3**