ESO204A: Fluid Mechanics and Rate Processes
TUTORIAL 6 PROBLEMS

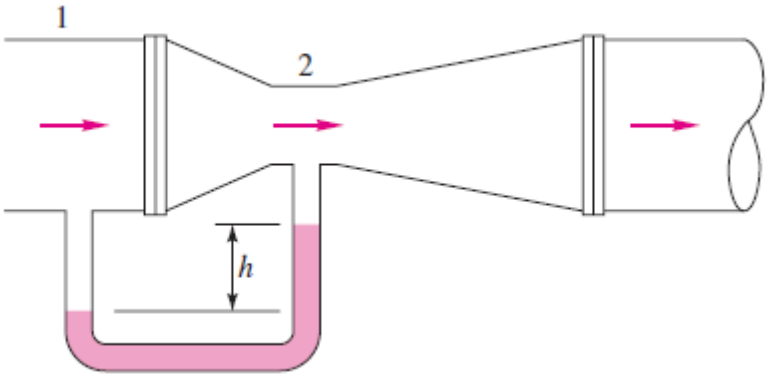
August-November 2017

1. Review of Tutorial-5

2. A *venturi meter*, shown in Fig. P3.128, is a carefully designed constriction whose pressure difference is a measure of the flow rate in a pipe. Using Bernoulli's equation for steady incompressible flow with no losses, show that the flow rate Q is related to the manometer reading h by

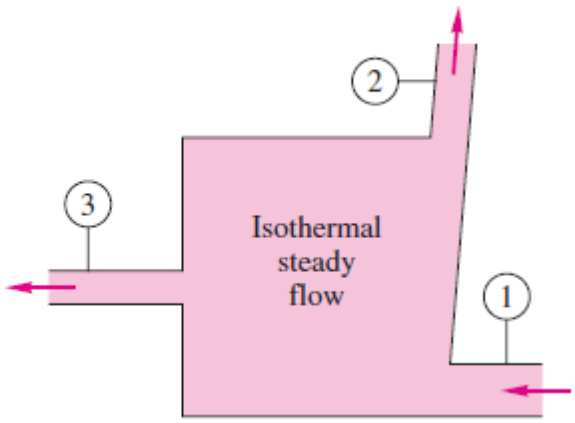
$$Q = \frac{A_2}{\sqrt{1-\left(D_2/D_1\right)^4}}\sqrt{\frac{2gh\left(\rho_M-\rho\right)}{\rho}}$$

where ρ_M is the density of the manometer fluid.



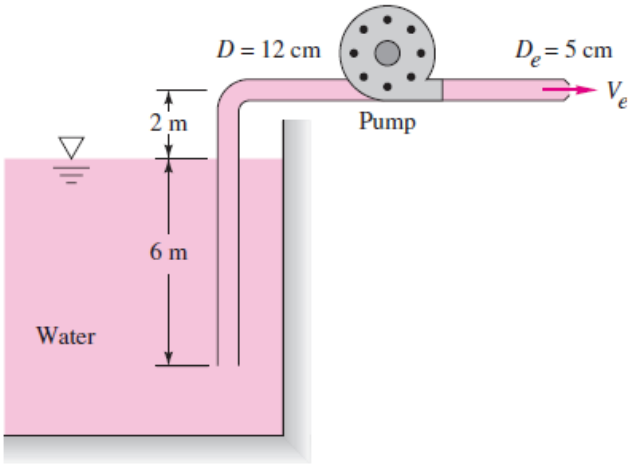
P3.128

3. There is a steady isothermal flow of water at 20°C through the device in Fig. P3.165. Heat-transfer, gravity, and temperature effects are negligible. Known data are: $D_1 = 9\,\text{cm}$, $Q_1 = 220\,\text{m}^3/\text{h}$, $p_1 = 150$ kPa, $D_2 = 7\,\text{cm}$, $Q_2 = 100\,\text{m}^3/\text{h}$, $p_2 = 225$ kPa, $D_3 = 4\,\text{cm}$ and $p_3 = 265$ kPa. Compute the rate of shaft work done for this device and its direction.



P3.165

4. When the pump in Fig P3.169 draws 220 m^3/h of water at 20°C from the reservoir, the total friction head loss is 5 m. The flow discharges through a nozzle to the atmosphere. Estimate the pump power in kW delivered to the water.



P3.169

5. (Self-study) The pump-turbine system in Fig.3.182 draws water from the upper reservoir in the daytime to produce power for a city. At night, it pumps water from lower to upper reservoir to restore the situation. For a design flow rate of 60 m^3/min in either direction, the friction head loss is 5 m. Estimate the power in kW (*a*) extracted by the turbine and (*b*) delivered by the pump.

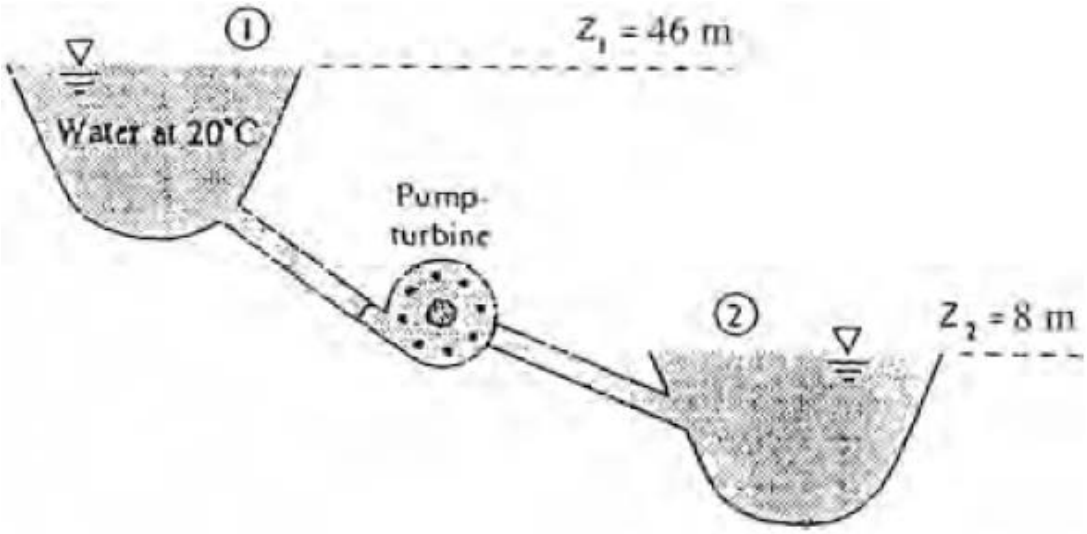
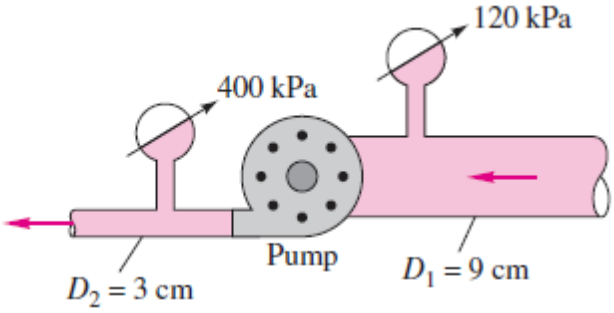


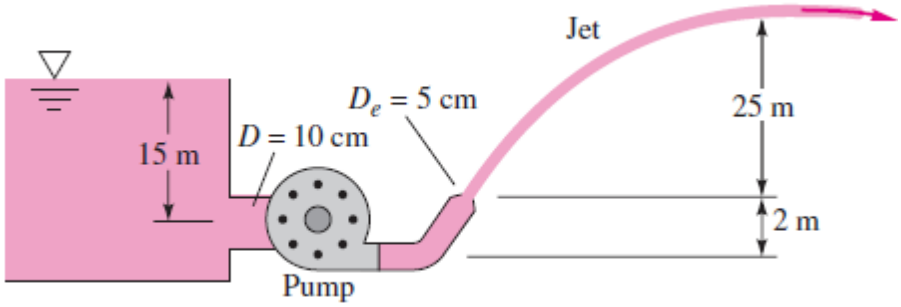
Fig. P3.182

6. The horizontal pump in Fig. P3.178 discharges 20°C water at 57 m^3/h. Neglecting losses, what power in kW is delivered to the water by the pump?



P3.178

7. The pump in Fig. P3.183 creates a 20°C water jet oriented to travel a maximum horizontal distance. System friction head loses are 6.5 m. The jet may be approximated by the trajectory of frictionless particles. What power must be delivered by the pump?



P3.183