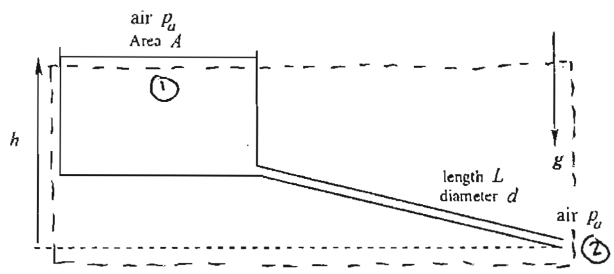
# of Exams: 139
Mean: 148.7
Standard Deviation: 26.3

UNIVERSITY OF CALIFORNIA, BERKELEY
MECHANICAL ENGINEERING
ME106 Fluid Mechanics
2nd Test, S08 *Prof S. Morris*

NAME SOLUTIONS

**1.(60)** The large reservoir drains through a long cylindrical pipe in which the power loss is given by $\frac{1}{2}\dot{m}fV^2\frac{L}{d}$. Derive the differential equation giving $dh/dt$ in terms of $h$, the friction factor $f$, and the constants shown in the figure. (You are not asked to solve the differential equation.)

Question 1
Mean: 46.5 / 60
Standard Dev: 14.2



Question 2
Mean: 49.5 / 60
Standard Dev: 16.4

2. (60) An aircraft cruises subsonically at an elevation where the atmospheric temperature and pressure are respectively $T_a$ and $p_a$. Assuming the Bernoulli equation in either of the two forms given in the lecture notes, and a suitable isentropic relation, *derive* an expression giving the speed $V$ of the aircraft in terms of $p_a$, $T_a$, the measured stagnation pressure $p_0$ and the constants $\gamma$ and $c_p$. (You will not receive credit for simply writing down the answer.)

Question 3
Mean: 52.6 / 80
Standard Dev: 20

**3. (80)** The large tank is draining through a small hole of area $A_e$. The smaller figure shows the detail near the exit hole. Specifically, below the exit, the streamlines contract to form a jet with area $cA_e$, where $c < 1$ is the contraction coefficient; the speed $V_e$ within that jet is given by the Torricelli theorem as $V_e = \sqrt{2gh}$. By balancing vertical momentum on the control volume shown, show that

$$c = \tfrac{1}{2} + \frac{1}{2\rho g h A_e} \int_{A'} (\rho g h + p_a - p)\, \mathrm{d}A. \qquad (A)$$

The integral is calculated over the area $A' = A - A_e$ of the tank bottom, excluding the exit hole; the liquid pressure on that area is $p$.

**Hints.** (a) The liquid weight is significant. (b) At the upper surface, the liquid has negligible momentum. (c) To express the result of the momentum balance in the form (A), you may find it useful at the end to note that $\rho g h A = \rho g h A_e + \rho g h (A - A_e)$.