Lecture F13 Mud: Bernoulli Equation
(25 respondents)

1. **How is $\rho u \, du/dx = \frac{1}{2}\rho \, d(u^2)/dx$?** (2 students)
   You can see this easily just by differentiating $d(u^2)/dx$ via the product rule.

2. **How is $\rho u \, du = \frac{1}{2}\rho \, d(u^2)$?** (2 students)
   Take the differential $d(u^2)$ using the product rule. This is essentially the same operation as in mud 1 above.

3. **How did you go from $\frac{1}{2}\rho \, d(u^2)/dx + dp/dx = 0$ to $\frac{1}{2}\rho \, u^2 + p = C$?** (1 student)
   Via an indefinite integration in x:
   $$\int \left(\frac{1}{2}\rho \, d(u^2)/dx + dp/dx = 0 \right) dx$$

4. **How did you know you can multiply x-momentum by dx?** (1 student)
   You can always multiply equations by anything you want, whether it's useful or not to do so. Bernoulli in the 1700's figured out that multiplying by dx actually gets you somewhere.

5. **What form of $\vec{V}$ should you use in Bernoulli? $\nabla\phi$?** (1 student)
   In aerodynamic flows, the velocity used in Bernoulli is usually defined via $\phi(x, y, z)$. There are exceptions, however, such as when a pitot probe is used inside a boundary layer to actually measure the varying $p_o(y)$. In this case, $\vec{V}$ is <u>not</u> obtained from any $\phi(x, y, z)$.

6. **Is p_o the same as p_∞?** (1 student)
   No. In aerodynamic flows, p_o is usually p_{o_∞}, which is the total pressure far away, while p_∞ is the static pressure far away. They are related to the far-away speed V_∞, via Bernoulli:
   $$p_{o_\infty} = p_\infty + \frac{1}{2}\rho V_\infty^2$$

7. **Is p_o constant for all streamlines outside the boundary layer?** (1 student)
   Yep.

8. **What is Anderson's term "quasi-1-dimensional" on page 185?** (1 student)
   There is a slight variation in the flow velocity direction across the width of a pipe which varies in cross-section, so this flow is not strictly 1-D. But we neglect this slight transverse variation, and call the flow "quasi-1-D". Note that the only "truly-1-D" flow is a uniform flow, which isn't particularly interesting.

9. **Why does the air speed up over a wing?** (1 student)
   That's the velocity field which is needed to satisfy the equations of mass and momentum conservation for the moving fluid. A somewhat similar question is "Why does a mass accelerate when you apply a force to it?" It just does. That's physical reality as described by Newton's Laws.

10. **If we can't say that high velocity causes low pressure, what's a good layman's interpretation of Bernoulli's Equation?** (1 student)
    I really don't know a good way to do this. Anderson on page 183 makes an energy interpretation, but I don't think that would convince most laymen.

11. **A venturi must narrow down and expand again fairly gently, correct?** (1 student)
    Yes. If the area changes are rapid, then the boundary layers on the inside surface will separate (like on a stalled airfoil), and the effective areas will change drastically. The pressures inside the venturi will then differ a great deal from what's predicted from the geometric areas.

12. **No mud** (15 students)