

Quiz II

This is a 50 minute closed-book exam. Please put your name on the top sheet. Answer all three questions. Explain your working and state any assumptions you have made.

1 (3 points) Circle the correct answer.

1. The First Law of thermodynamics in fluids mechanics

- can be viewed as generalizing Bernoulli's equation.
- is Newton's Second Law times velocity.
- ignores gravity.
- requires no shaft work.
- is a vector equation.

2. Circulation

- is zero for viscous flows.
- is a vector.
- is not defined for unsteady flows.
- can be calculated by integrating the pressure.
- is the integral of vorticity over a bounding surface.

3. Being able to scale up from model to full-size requires

- luck.
- the same density fluid.
- dynamic and geometric similarity.
- knowing the torque acting on the model.
- incompressible flow.

2 (7 points) Ships generate waves in their wake and this is one of the mechanisms that induces drag. Derive a nondimensional parameter relating drag D (a force) for a ship of length L moving at velocity V when the acceleration due to gravity is g . It is easiest to obtain a number proportional to L (the Froude number). What is its value for a Nimitz class aircraft carrier (length at waterline 317 m, speed 30 knots)? What about for a duck (estimate L and U)? [One nautical mile = 1,852 m.]

3 (10 points) Oil (SG = 0.92) flows in an inclined pipe at a rate of $4 \text{ ft}^3/\text{s}$ as shown in the figure below. If the differential reading in the mercury manometer is 3 ft, calculate the power that the pump supplies to the oil if head losses are negligible.

