HW4
due February 19, 2026

Show all your work and indicate your reasoning in order to receive the full credit.

Name: _____

Date: _____

Collaborators: _____

(Collaborators submit their individually written assignments together, in class, in person)

Question:	1	2	Total
Points:	10	35	45
Score:			

Instructor/grader comments:

Gravity waves

1. (10 points) In fluid dynamics, *gravity waves* (not to be confused with gravitational waves) are surface waves for which gravity acting as the primary restoring force when the fluid is displaced from its equilibrium position.

   Use dimensional analysis to determine the propagation velocity, v, of gravity waves in deep water. Assume that v depends on the acceleration of gravity, g, the fluid density, ρ, and the wavelength λ.

   (a) Do waves with longer wavelengths travel faster or slower than those with shorter wavelengths?

   (b) How does the velocity of a gravity wave change if the fluid density is doubled while all other parameters remain unchanged?

Uniform settling

2. (35 points) During emergency repairs in zero gravity, a swimming pool on the starliner Axiom was filled to the brim with a material of density ρ, Young's modulus E, and Poisson's ratio ν. The pool has a depth h and perfectly rigid vertical sides. When normal gravity (acceleration g) was restored, the material deformed under its own weight, creating a depression at the surface. See the sketch in Fig. 1.

   (a) Solve the equations for equilibrium and find all non-zero components of the stress and strain tensors and the deformation of the material

   (b) Estimate the depth of the resulting recess for a material with $E = 2$ GPa, $\nu = 0.2$, $\rho = 5 \times 10^3$ kg/m^3, and for a pool with $h = 10$ m. Assume that $g \approx 10$ m/s^2.

   (c) Calculate the ratio of the total forces acting on the bottom and on the side of a pool of cubic shape. Express the answer as a function of ν only.

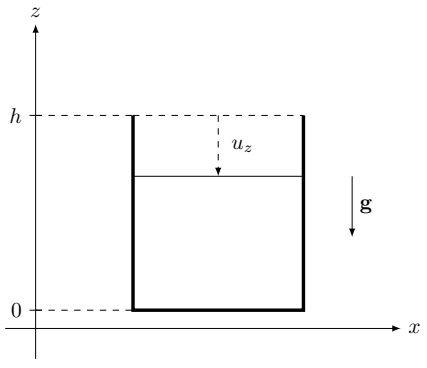

Figure 1: Elastic material undergoing a downwards displacement because of gravity. The pool has fixed, vertical side walls.