ME 310 Fundamentals of Fluid Dynamics

Homework Assignment 2

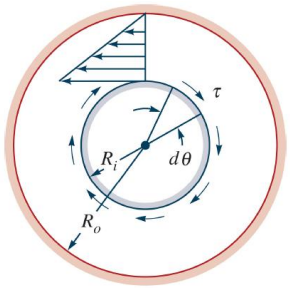
Instructions and Guidelines:

- Homework must be submitted to our course website in an electronic format as a single PDF file. Each page must be clean, legible, and in an upright orientation. The PDF can be created by using your preferred app or generated from scanned pages.
- Unlimited submissions may be made, however, only the final submission will be graded.
- Your homework submission must represent your own understanding. You are encouraged to attempt homework problems individually at first, followed by discussions with your peers, but do not duplicate anyone's work. Any duplication identified during the grading process will result in sanctions according to the Academic Integrity Policy in the Student Code.
- Homework will be graded on correctness. Your work must be neat and complete to receive full credit. "Complete" means (1) all the steps showing how you reach your final answer need to be presented; (2) if a free body diagram (FBD) or a control volume (CV) is involved in your analysis, the FBD and CV must be presented in your work; (3) the steps of plugging the given numbers with units into the equations must be presented in your work and the units must be presented for the numbers of results; (4) words must be used to explain your thoughts, not just equations.

Assignment:

Solve the following problems from the textbook, Fundamentals of Fluid Mechanics, 9th Ed., by Munson et al.

1.2.13, 1.2.26, 1.6.21 (Viscosity of ethylene glycol $\mu_{eg} = 1.99 \times 10^{-2}\,\mathrm{N \cdot s/m^2}$. Look up the propoties of water in Tables B.1 and B.2 of text Appendix B.), 1.6.34 (Hint: see the figure below. The slope of the dependence of T on ω from data fitting will be used to determine the viscosity.), and 1.9.3.



Top view

And also solve the following problem.

Problem 1.A (Interdisciplinarity): Blood viscosity plays a critical role in diagnosing and managing diseases like hypertension or anemia, attracting the interest of scientists in biomedical research and applications. The viscosity (μ) of human blood at 37 °C is shown in the table below, and its density (ρ) is 1.05 g/cm^3. (a)

Plot the viscosity against the shear rate (i.e. rate of shear strain). Determine whether blood is a Newtonian or non-Newtonian fluid, and explain your conclusion. (b) Calculate the specific gravity and specific weight of the blood. (c) Kinematic viscosity is defined as $\nu = \mu/\rho$. Determine the kinematic viscosity of the blood at the shear rate of 25 s^{-1}.

Shear Rate [s^{-1}]	Viscosity [mPa·s]
2	12
25	6
100	4.5
200	4

Problem 1.B: Calculate the pressure difference between the inside and outside of a spherical soap water bubble with a diameter of 50 mm. The surface tension of soap water is 0.025 N/m.

10 points for each of the above HW problems.

For 5 Extra HW Credit Points (Optional):

Float a metal paperclip on water. Observe the effect of surface tension which helps the paperclip to float. Take a photo of the floating paperclip and submit the photo with your HW for 5 extra HW credit points. This is optional.