Particle tracking velocimetry: Deliverables

ME 240: Fundamentals of Instrumentation & Measurement • D. H. Kelley and I. Mohammad • 111 points

Name: _____ Student ID: _____

Lab partners: _____

Please write the following sentence in the box below in your own handwriting and **SIGN**: ***"I affirm that I have not given or received any unauthorized help on this assignment, and that this work will be my own."***

Mixing the solution

1. (2 points) What mass of water is required for your solution? _____
2. (2 points) What mass of copper sulfate is required for your solution? _____
3. (2 points) What volume of glycerol is required for your solution? _____

Determining the fluid density

4. (2 points) What is the density of your solution? _____
5. (2 points) What volume of fluid did you use to determine that density? _____
6. (2 points) What was its mass? _____

Determining the viscosity

7. (4 points) Draw a free body diagram of a sphere falling through a fluid.

8. (4 points) Determine a formula for μ.

9. (3 points) As a sphere falls, measure its position at three different times.

   time 1: _____ position 1: _____

   time 2: _____ position 2: _____

   time 3: _____ position 3: _____

10. (2 points) Calculate the terminal velocity V for the interval from time 1 to time 2. _____

11. (2 points) Calculate the terminal velocity V for the interval from time 2 to time 3. _____

12. (2 points) Calculate the viscosity μ. _____

13. (3 points) How did you check that the sphere had reached terminal velocity?

14. (4 points) Discuss at least two potential sources of error in the viscosity measurement procedure.

Imaging the flows

15. (2 points) What is the magnet stripe width $L/2$? _____

16. (2 points) At what critical current I_c and voltage V_c do shear bands give way to vortices? _____ _____

17. (3 points) What is the size, in mm, of one pixel? _____

18. (2 points) What is the frame rate? _____

19. (2 points) List the filenames of the movies you recorded and the current applied for each in Table 1.

Measuring and analyzing flow velocities

20. (3 points) Attach the background image you calculated below.

21. (2 points) Record your values of `obj.Thr`, `obj.Max_disp`, $\langle u \rangle^{1/2}$, and Re in Table 1.

22. (4 points) Attach the illustration of your slowest movie, produced using `plot_tracks`. Write a descriptive caption for the figure.

23. (4 points) Attach the illustration of your fastest movie, produced using `plot_tracks`. Write a descriptive caption for the figure.

24. (4 points) Attach your plot of the variation of Re with applied current. Axes should be labelled with proper units. Write a descriptive caption for the figure.

25. (4 points) Attach your plot of the variation of root-mean-square horizontal velocity $\langle u^2 \rangle^{1/2}$ with Re. Axes should be labelled with proper units. Write a descriptive caption for the figure.

26. (3 points) What is the critical Reynolds number Re_c? _____

27. (20 points) Type and attach an abstract.

28. (20 points) Type and attach a description of the methods used. Explain how the lab exercise was conducted with enough detail so that an engineer could repeat your work. Begin by posing the question being addressed, and then state what data you used to answer this question, explaining why this data was appropriate to answer it. Afterwards, explain the process you used for data collection, listing tools used (including make and model for tools that aren't trivially common), materials, etc. Finally, explain how you analyzed the data. Optionally, you may use figures, tables, and equations. Feel free to paraphrase the given procedure and refer to its figures as needed. Anywhere you augmented or deviated from the given procedure, make a note.

I (mA)	Filename	`obj.Thr` (0-255)	`obj.Max_disp` (pixels)	$\langle u^2 \rangle^{1/2}$ (mm/s)	Re

Table 1: Movies and tracking results