

Fabrication and Testing of a Centrifugal Pump

ME 199A

Teams of two students are to fabricate a small centrifugal pump driven by a DC motor. Two teams of two will then combine to evaluate pump performance and to present their findings to the class as a formal technical presentation. The project will involve the following components:

- Draw the pump impeller using SolidWorks (individual, but select only one to be printed for your team of 2)
- Draw the pump body and face plate using SolidWorks (individual)
- Draw an assembled model of the pump, including body, face plate, o-rings, screws and motor (teams of 2)
- Lay out the dimensions on your raw materials to prepare for fabrication (teams of 2)
- Fabricate and assemble the pump (teams of 2)
- Characterize the performance of the pump by completing a series of flow experiments (teams of 2)
- Generate plots of pump head versus flow rate and pump efficiency versus head (individual, teams of 2)
- Present the results of your work to the class as a formal PowerPoint presentation (teams of 2)

Determine the dimensions of the pump body by viewing the *pump fabrication PowerPoint presentation*. You will need to go all the way through the presentation to get all dimensions since a step-by-step fabrication procedure is provided. Draw the pump impeller using the drawings provided below.

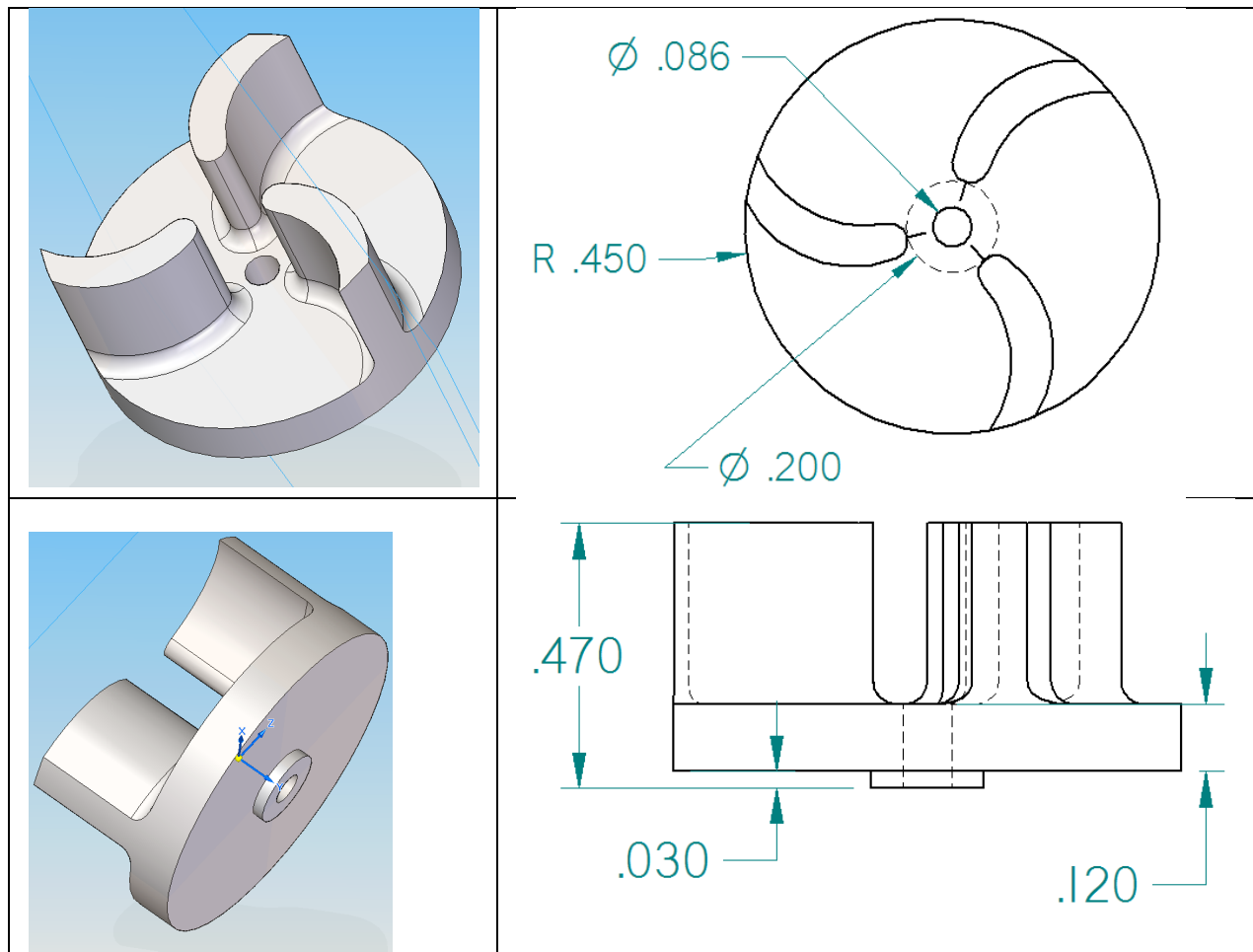


Figure 1 – Drawings of impeller to be drawing for centrifugal pump.

Data Collection. After the pumps have been fabricated, their performance will be quantified by performing a series of flow experiments at different heads (different elevations that the water is pumped). You should use the data sheet provided in Table 1 as a template for collecting your data.

Table 1 – Data collection sheet for pump performance testing.

Group Members:				
Bucket depth =				
Container weight =				
Tube inner diameter =				
height above water in supply bucket (in)	I to pump (amps)	V across pump leads (volts)	mass collected in 20 seconds (g)	time (s)
6				20
12				20
18				20
24				20
30				20
36				20
42				20
48				20
54				20
60				20
66				20
72				20

If your pump will not pump the full height of 72 inches, then choose lesser heights so that you get at least ten data points defining your pump's performance. You should take one set of data with increasing heights (going up) and another set of data coming down. Collect data for at least 20 seconds each time. You will collect your data in the lab in EB 365. A signup sheet will be provided closer to the data collection time to provide your team with a one-hour slot for collecting data.

Presentation. Your final presentation for your group of two students should be seven minutes long and should include the following content:

Title Page: Title of Presentation, Names, Course, Date, Location (Portland State University)

Introduction: Provide a very brief overview of your presentation.

Background: Briefly discuss centrifugal pumps.

Pump Design: Provide SolidWorks drawings of your pump body and impeller along with your completed assembly of the pump components.

Pump Fabrication: Show and discuss a few of the steps that you think were most important. This should be brief.

Pump Performance: This is where you should focus your efforts. Discuss the experimental setup and the objectives of the experimental work. Provide the equations used to quantify the performance of your pump, show sample calculations for a given pump head using Mathcad, and give plots of head (meters) versus flow rate (L/min) and pump efficiency (%) versus head (meters) using Excel. Explain why you think the plots have the shape shown (if there are irregularities, then why do you think they occurred, discuss the trends, . . .)

Suggestions for Improvement: Provide suggestions for how you think the pump could be improved. What went right, what went wrong?

Questions: End the presentation by fielding questions from the audience.

Please arrive at the presentation dressed professionally. There may be visitors in the audience. All group members must significantly participate in the presentation.

WHAT TO TURN IN: On presentation day, turn in the following items in the order requested.

1. Email your presentation to the instructor at least two hours prior to class.
2. Turn in a copy of your presentation in handout form (six slides to the page).
3. Turn in your Excel spreadsheet showing all of your calculations.
4. Turn in your Excel plots showing the two pump curves.
5. Provide a detailed hand calculation showing how everything was calculated for one of your data points (for a given voltage, current, time, head, mass) using Mathcad. The number should match one of the rows in your spreadsheet. Make sure you use all relevant units in these calculations.

Each of the physical items turned in should be neatly formatted and properly labeled with:

- The course number
- The date
- Names of the group members
- A brief, descriptive title, e.g. "Analysis of Pump Performance Measurements", or "Pump Performance Measurement"

Presenters: _____

ENGR 120 - Presentation Grades

Organization and Clarity **10 points maximum**

Score = (0 1 2 3 4 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10) X 1 = _____

Does the presentation include an introduction and a conclusion?
Is the presentation organized in a logical manner?

Technical Content..... **50 points maximum**

Score = (0 1 2 3 4 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10) X 5 = _____

Do all plots contain axis labels and units?
Are both of the required plots provided?
Are sample calculations provided for a single data point, and are the calculations easy to follow?
How much understanding of the project does the team demonstrate?
Plot of head (meters) versus flow rate (L/min)?
Plot of pump efficiency (%) versus head (meters)?

Timing..... **10 points maximum**

Score = $(7 - \text{_____}) / 7 \times 10 = \text{_____}$

Plus two or minus one *minute grace period* (allowable time with no deductions is from 6 to 9 minutes). If you go over 10 minutes, you will lose all 10 timing points.

Visual Aids **20 points maximum**

Score = (0 1 2 3 4 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10) X 2 = _____

Does the presentation begin with an overhead with the presenters name and topic?
Does the presenter have at least 7 overheads (title page + 2)?
Do the overheads contain graphics (pictures, plots, other)?
Does the presentation have an attractive background / scheme?
Is the font large enough to read from the back of the room?

Delivery..... **10 points maximum**

Score = (0 1 2 3 4 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10) X 1 = _____

Do the presenters make eye contact with the audience?
Are the presenters expressive, and do they show appropriate posture and movement.
Did all group members participate by speaking?
Are the presenters professionally dressed?

OVERALL SCORE _____

Group Members:
 Bucket depth =
 Container weight =
 Tube inner diameter =

height above water in supply bucket (in)	I to pump (amps)	V across pump leads (volts)	mass collected in 20 seconds (g)	time (s)
6				20
12				20
18				20
24				20
30				20
36				20
42				20
48				20
54				20
60				20
66				20
72				20
72				20
66				20
60				20
54				20
48				20
42				20
36				20
30				20
24				20
18				20
12				20
6				20