EN400

LAB #1 PRELAB

NUMERICAL INTEGRATION

Instructions:

1. The prelab covers theories that will be examined experimentally in this lab.

2. The prelab is to be completed and handed in to your instructor at the beginning of the lab period.

3. If you can, answer the questions without referring to your notes. Only refer to your notes if you are confused or fail to understand a concept. This will greatly improve your understanding of the concepts this lab is designed to reinforce.

4. By conscientiously completing this prelab, you will have a thorough understanding of what the lab is trying to show. Your lab performance will be maximized.

5. For full credit, all work must be shown. Show generalized equations, substitution of numbers, units, and final answers. Engineering is communication. Work that is neat and shows logical progression is much easier to grade.

Student Information

Name(s): ______________________________________________________

Section: __________

Date: ____________
Figure 1 YP Body Plan

DWL = 6 ft \quad \text{Lpp} = 101.7 \text{ ft} \quad \text{Half-breadths in feet from the centerline}

STATION NUMBERS – Station 0 is the FP, Station 10 is the AP

<table>
<thead>
<tr>
<th>Draft (ft)</th>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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Table 1 YP Table of Offsets
Verifying the Table of Offsets

1. Determine the half-breadths for the 6-foot waterline (DWL) by pulling the appropriate values from Table 1. Then verify the values by measuring them on the body plan in Figure 1. Show that you know how to find these points by circling them on the body plan in Figure 1. Insert the measured offsets and table values in the table below.

<table>
<thead>
<tr>
<th>Station</th>
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<th>9</th>
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</thead>
<tbody>
<tr>
<td>Half-breadths from Table of Offsets (ft)</td>
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<tr>
<td>Half-breadths from Body Plan (ft)</td>
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</tbody>
</table>

Hull Definitions

2. Indicate the following items, on each diagram it is found in Figure 2:

- Waterline
- Waterplane
- Section area
- Forward perpendicular
- Aft perpendicular
- Centerline
- Baseline
- Midships
- Center of flotation

Figure 2 Diagram for hull form definitions
Sectional Area

3. Using the table of offsets and Simpson’s first rule, follow the steps below to find the sectional area of station number 5 up to the 6-foot waterline.
   
a. Sketch the section you are integrating, properly labeling axes and dimensions.

b. Write the general Simpson’s rule for the section above.

c. Substitute the relevant numbers and calculate the sectional area of station 5.
Submerged Volume

4. Using the following steps, show how the submerged volume of a ship is calculated using Simpson’s first rule.

a. Sketch a 2-D graph of the volume you are integrating, labeling the axes and dimensions.

b. Applying Simpson’s first rule, give the generalized equation for determining the underwater volume.

Waterplane Area

5. Using the table of offsets and Simpson’s first rule, follow the steps below to find the waterplane area at the 6-foot waterline.

a. Sketch the waterplane you are integrating, labeling the axes and dimensions.
b. Write the general Simpson’s first rule as it applies to the waterplane area.

c. Substitute the relevant numbers and calculate the area of the 6-foot waterplane.

Longitudinal Center of Flotation (LCF)

6. Using the table of offsets and Simpson’s first rule, calculate the position of the LCF at the 6-foot waterline (referenced to the YP’s forward perpendicular).

a. Write the general equation for the longitudinal center of flotation of the 6-foot waterplane using Simpson’s first rule.

b. Substitute the relevant numbers and calculate the LCF of the 6-foot waterplane.
EN400
LAB #1
NUMERICAL INTEGRATION

Instructions:

1. This lab is conducted in the classroom.

2. Prior to arriving, read through the lab procedure so that you are familiar with the steps necessary to complete the lab.

3. Bring this handout, the completed prelab, and a calculator to the lab.

4. The lab is to be performed in small groups of 2 or 3. Your instructor will specify whether the group or each individual must submit the completed lab.

5. Follow the stages of the lab in consecutive order. The lab follows a logical thought pattern and jumping ahead without completing the intervening theory questions will limit your understanding of the concepts covered.

6. For full credit, all work must be shown on the lab. Show generalized equations, substitution of numbers, units, and final answers.

Student Information:

Name(s): ______________________________________________________

Section: __________

Date: __________
Download File Template

Access the EN400 course website and download the Excel template of Lab #1.

If you have difficulty with Excel at any stage of this lab, use the “HELP” capability of the program to assist. If you are still confused, ask a neighbor or the instructor.

Sectional Area

Go to the “Sectional Area and Submerged Volume” tab on the spreadsheet.

Program the sectional area calculation into the spreadsheet and calculate the sectional area for each of the 11 stations up to the 6-foot waterline by following the steps below.

Input the Simpson multipliers and waterline spacing (dz) into the appropriate spreadsheet cells. Use the function SUMPRODUCT to calculate the sectional areas.

1. Check your spreadsheet results by comparing the sectional area of station 5 with that calculated in the prelab.

<table>
<thead>
<tr>
<th>Area of Station 5 up to the 6-ft waterline (spreadsheet calculation) (ft²)</th>
<th>Area of Station 5 up to the 6-ft waterline (hand calculation) (ft²)</th>
</tr>
</thead>
</table>

2. Comment on any differences between the two values.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Repeat the procedures in Step 1, to reprogram the spreadsheet to calculate the sectional areas for each of the 11 stations up to the 2 ft, 4 ft, 8 ft, and 10 ft waterlines. Use of the spreadsheet’s “copy” and “paste” functions, as well as locking some cells with “$” may prove useful here.

Using the spreadsheet’s graphing capabilities, plot the sectional area curves at each draft on the same axes. As a reminder, the sectional area curve shows sectional (station) areas on the vertical-axis and FP-to-AP length on the horizontal-axis.

- Use the “X-Y Scatter” graph as the graph type
- Ensure each draft is its own series or curve on the graph
- Ensure the graph is correctly titled, each curve is properly labeled, and that the axes are labeled with the appropriate name, symbol, and units.

3. Print your graph on a separate sheet of paper or submit electronically, as directed.
4. What does the area under the curve of sectional areas represent? ________________

________________________________________________________________________

5. What is the naval architecture symbol for the area under the curve of sectional areas? ___

Submerged Volume

Program the submerged volume calculation into the spreadsheet and calculate the submerged volumes of the YP at drafts of 2 ft, 4 ft, 6 ft, 8 ft, and 10 ft in the appropriate cells of the spreadsheet.

In the appropriate cells on the spreadsheet, calculate the YP’s displacement in salt water at each draft.

6. Print the spreadsheet page or submit electronically, as directed.

Waterplane Area

Click on the “Waterplane Area” tab. A new table of offsets should be revealed.

Program the waterplane area calculation into the spreadsheet and calculate the area of the 2-foot through 10-foot waterplanes by following the general steps below.

Input the Simpson multipliers and section spacing (dx) into the appropriate spreadsheet cells.

Use the function SUMPRODUCT to calculate the waterplane areas. Place the waterplane areas in the appropriate cells.

7. Check your spreadsheet calculations by comparing the waterplane area of the 6-ft waterline with that calculated in the prelab.

<table>
<thead>
<tr>
<th>Waterplane area of 6-ft waterline (spreadsheet calculation) (ft²)</th>
<th>Waterplane area of 6-ft waterline (hand calculation) (ft²)</th>
</tr>
</thead>
</table>

8. Comment on any differences between the two values.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
**Longitudinal Center of Flotation (LCF)**

Program the LCF calculation into the spreadsheet and determine the position of LCF, as referenced to the forward perpendicular, for the 2, 4, 6, 8, and 10 foot waterlines in the appropriate cells of the spreadsheet.

9. Check your spreadsheet calculations by comparing your result for the 6-foot waterline with that calculated in the prelab.

<table>
<thead>
<tr>
<th>LCF of the 6-foot waterline (spreadsheet calculation) (ft aft of FP)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LCF of the 6-foot waterline (hand calculation) (ft aft of FP)</td>
<td></td>
</tr>
</tbody>
</table>

10. Comment on any difference between the two values.

________________________________________________________________________
________________________________________________________________________

11. **Print** the spreadsheet page or submit electronically, as directed.

**Submitting the Lab**

Your instructor will provide guidance on how to submit the printed lab and/or electronic spreadsheet file.