2nd Semester

2021/2022

Philadelphia University
Faculty of Engineering
Civil Engineering Department

HYDRAULIC LABORATORY MANUAL

Prepared by	Reviewed by
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Philadelphia University

Faculty of Engineering and Technology -
Department of Civil Engineering
Second Semester 2021/2022

Course Details:

Title: Hydraulics lab (0670442)

Prerequisite: Hydraulics of Materials (0670441)

Credit Hours: 1 credit hours (14 weeks per semester, approximately 28 contact hours)

Textbook: Laboratory manual

Fundamentals of Hydraulic Engineering Systems, Hwang & Houghtalen , 4th Edit ion, Prentice Hall, 2006.

References:

- Civil Engineering Hydraulics, by R. E. Featherstone & C. Nalluri, 3rd Edition, 1995.
- Fluid Mechanics, Douglas, Swaffield and Gasiorek. 4th Edition, 2001.

Course Description: Calibration of Bourdon Gauge, Met centric Height of Floating Bodies Osborne Reynolds Demonstration. Impact of Jet, Orifice and Free Jet Flow Determination of Coefficient of Velocity, Coefficient of Discharge for a Rectangular Notch, Hydraulic Gradient with Ground Water Flow.

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Course Outlines:

Weeks	TOPIC
1	Calibration of Bourdon Gauge
2	Metacentric Height of Floating Bodies
3	Osborne Reynolds Demonstration
4	Impact of Jet (I)
5	Impact of Jet (II)
6	Orifice and Free Jet Flow Determination of Coefficient of Velocity
7	Orifice and Free Jet Flow Determination of Coefficient of Discharge
8	Coefficient of Discharge for a Rectangular Notch
9	Coefficient of Discharge for a Triangular Notch
10	Hydraulic Gradient with Ground Water Flow

Course Learning Outcomes with reference to ABET Student Outcomes:

Upon successful completion of this course, student should:

1.	Be able to solve specific engineering problems related with Hydraulics	[1,]
2.	Identify, name, and characterize flow patterns and regimes	[1, 6]
3.	Understand basic units of measurement, convert units, and appreciate their magnitudes	[2. 6]
4.	Measure volume flow rate and relate it to flow velocity	[1 , 6]
5.	Use word and excel software in writing reports.	[6. 7]
6.	Compare the results of analytical models introduced in lecture to the actual Behavior of real fluid flows and draw correct and sustainable conclusions	[1 , 2 , 6]

Assessment Guidance:

Evaluation of the student performance during the semester (total final mark) will be conducted according to the following activities:

Lab Reports: The students will submit a report for each experiment at the beginning of each lab .No late submission will be accepted. Missing reports will result in a zero grade. Cheating is not tolerated. A student guilty of cheating will receive a zero grade. Cheating is any form of copying of another student's work, or allowing the copying of your own work.

Quizzes and lab work: (4-5) Quizzes of (10-15) minutes will be conducted during the semester. The materials of the quizzes are set by the lecturer.

Final Exam: The students will undergo a scheduled final exam (theoretical and practical) at the end of the semester covering the whole materials taught in the lab.

Grading policy:

Lab Reports	40%
Quizzes and lab work	20%
Final Exam	40%
Total:	100%

Attendance Regulation:

The semester has in total 45 credit hours. Total absence hours from classes and tutorials must not exceed 15% of the total credit hours. Exceeding this limit without a medical or emergency excuse approved by the deanship will prohibit the student from sitting the final exam and a zero mark will be recorded for the course. If the excuse is approved by the deanship the student will be considered withdrawn from the course.

List of Experiments

Experiment (1): Calibration of Bourdon Gauge

Experiment (2):Metacentric Height of Floating Bodies

Experiment (3):Osborne Reynolds Demonstration

Experiment (4):Impact of Jet (I)

Experiment (5):Impact of Jet (Ii)

Experiment (6): Orifice And Free Jet Flow Determination of Coefficient of Velocity From Jet

Experiment (7): Orifice And Free Jet Flow Determination of Coefficient of Discharge From Jet

Experiment (8): Coefficient of Discharge For A Rectangular Notch

Experiment (9): Coefficient of Discharge For A Triangular Notch

Experiment (10): Hydraulic Gradient With Ground Water Flow

HOW TO WRITE A LAB REPORT?

LAB REPORT ESSENTIALS

1. **Title Page**

   It would be a single page that states:

   a. The title of the experiment.

   b. Your name and the names of any lab partners.

   c. Your instructor's name.

   d. The date the lab was performed or the date the report was submitted.

2. **Title**

   The title says what experiment you did.

3. **Introduction / Purpose**

   Usually, the Introduction is one paragraph that explains the objectives or purpose of the lab. Sometimes an introduction may contain background information, briefly summarize how the experiment was performed, state the findings of the experiment, and list the conclusions of the investigation. Even if you don't write a whole introduction, you need to state the purpose of the experiment, or why you did it. This would be where you state your hypothesis.

4. **Materials**

   List everything needed to complete your experiment.

5. **Methods or procedure**

   Describe the steps you completed during your investigation. This is your procedure. Be sufficiently detailed that anyone could read this section and duplicate your experiment. Write it as if you were giving direction for someone else to do the lab. It may be helpful to provide a Figure to diagram your experimental setup.

6. **Data and Results**

   Numerical data obtained from your procedure usually is presented as a table. Data encompasses what you recorded when you conducted the experiment. It's just the facts, not any interpretation of what they mean.

7. **Discussion or Analysis**

   The Analysis section contains any calculations you made based on those numbers. This is where you interpret the data and determine whether or not a hypothesis was accepted. This is also where you would discuss any mistakes you might have made while conducting the investigation. You may wish to describe ways the study might have been improved.

8. **Conclusions**

   Most of the time the conclusion is a single paragraph that sums up what happened in the experiment, whether your hypothesis was accepted or rejected, and what this means.

9. **Figures & Graphs**

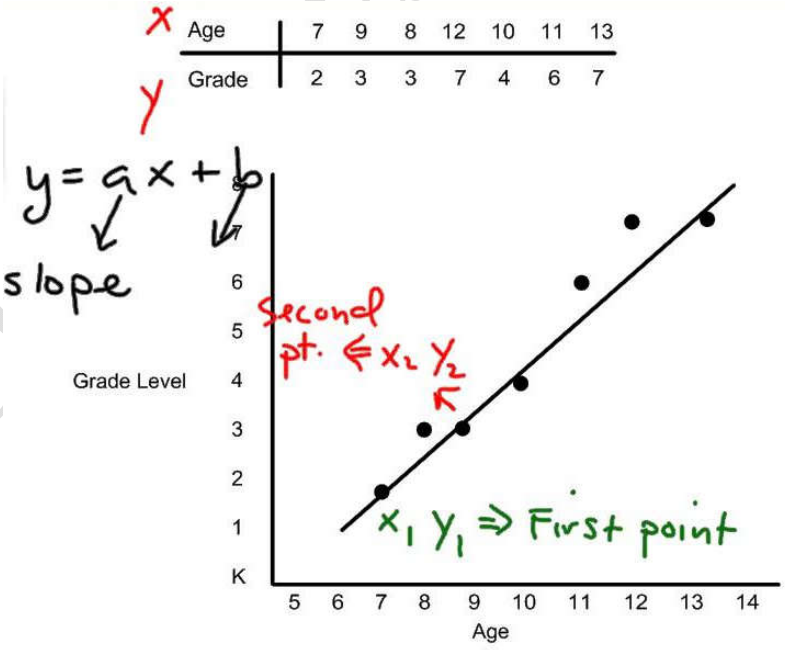
   Graphs and figures must both be labeled with a descriptive title. Label the axes on a graph, being sure to include units of measurement.

10. **References**

    If your research was based on someone else's work or if you cite facts that require documentation, then you should list these references.

WHAT IS A SCATTER PLOT?

A scatter plot is a chart with points that show the relationship between two or more sets of data. The data is plotted on the graph as Cartesian coordinates, also known as data on an X-Y scale.



FLOW RATE FORMULAS:

- **Volume flow rate:**

The flow rate of a liquid is a measure of the volume of liquid that moves in a certain amount of time.

The flow rate depends on:

- The area of the pipe or channel that the liquid is moving through
- The velocity of the liquid

Note:

1 m^3/s = 1000 L/s.

$$\mathbf{Q = Av = \frac{V}{t}}$$

- Q = Volume flow rate (m^3/s or L/s)
- A = area of the pipe or channel (m^2)
- v = velocity of the liquid (m/s)
- V=volume that passes through an area(m^3 or L)
- T=time(sec)

- **Mass flow rate:**

Mass Flow Rate is defined as the transfer of a mass of substance per unit of time. Mass flow rate can be calculated from the density of the liquid (or gas), its velocity, and the cross sectional area of flow.

$$\mathbf{\dot{m} = Q_m = \rho * Q = \rho * v * A}$$

Where,

- $\dot{m} = Q_m$ = mass flow rate(Kg/s),
- Q = Volume flow rate (m^3/s or L/s)
- A = area of the pipe or channel (m^2)
- v = velocity of the liquid (m/s)
- ρ = fluid density (Kg/m^3

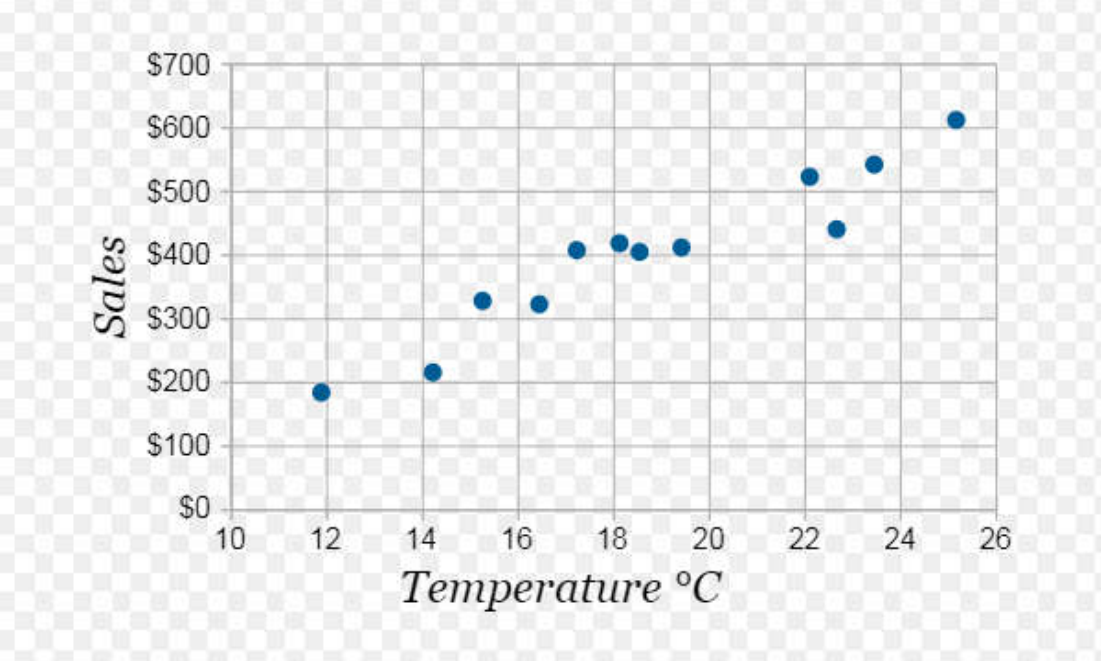
Assignment:

1) Water is flowing through a circular pipe that has a radius of 0.0800 m. The velocity of the water is 3.30 m/s. What is the flow rate of the water in liters per second (L/s)?

2) Water is flowing down an open rectangular chute. The chute is 1.20 m wide, and the depth of water flowing in it is 0.200 m. The velocity of the water is 5.00 m/s. What is the flow rate of the water through the chute in liters per second (L/s)?

3) Calculate the mass flow rate of liquid or gas by the given details.
Density of the liquid or gas (kg/m^3) = 25
Velocity of the liquid or gas (m/s) = 20
Flow Area of the Liquid or gas (cm^2) = 15

4) For the following plot draw the trend line and calculate its slope:



Laboratory Safety Requirements

اجراءات السلامة العامة في مختبر الهيدروليكا

يجب التقيد بمبادئ السلامة العامة التالية من قبل الطلبة ومشرفي المختبرات:

(1) ضرورة الزام الطلبة بارتداء ارواب العمل لتأمين السلامة للجسم واليدين والملابس.

(2) يمنع استخدام الهواتف النقالة داخل المختبر.

(3) يمنع التواجد داخل المختبر لمن ليس له عمل رسمي

(4) يجب الحفاظ على نظافة المختبر والادوات والارضيات وضمان جاهزية المختبر للعمل في اي وقت.

(5) يمنع المزاح او الركض داخل المختبر منعا لوقوع اية حوادث ناتجة عن عدم الانتباه.

(6) يمنع العمل في حالة التعب او المرض.

(7) يمنع تنظيف الاجهزة وهي في حالة العمل.

(8) يجب المحافظة على نظافة الارضيات والاجهزة وطاولات العمل.

(9) التاكد من اطفاء المضخات في الاجهزة التي يتطلب فيها تشغيل المضخات بعد الانتهاء من التجارب وذلك لتامين سلامة الاجهزة.

وعلى المشرف او مهندس المختبر مراعاة ما يلي:

(1) التاكد من فصل التيار الكهربائي عن سخانات المياه قبل مغادرة المختبر.

(2) التاكد من اطفاء الكهرباء والماء قبل المغادرة.

(3) يجب التحضير المسبق للاجهزة والتجارب المنوي اجراؤها والتاكد من صلاحية الاجهزة مسبقا.

(4) يجب توفر صندوق للاسعاف الاولي في المختبر.

(5) يجب توفر طفاية حريق مناسبة في المختبر ووضعها في مكان قريب من الباب الرئيسي للمختبر لتسهيل الوصول اليها. وابعادها عن مصادر الحرارة والطاقة واسطوانات الغاز.