Nuclear Thermal-Hydraulics Laboratory

Shripad T. Revankar

Instructor's Contact Information	**Course Information**
Office: NUCL 132E, Phone: 496-1782	*Course Number:* **NUCL 355**
Email: shripad@ecn.purdue.edu	Spring 2011
Office Hours: Tues, Frid, 11am-12pm	*Lecture :* Tues. 9:30-10:20am, Room GRIS 166
http://cobweb.ecn.purdue.edu/~shripad/	*Lab:* Tuesday, Thursday 1:30-3:20pm and Friday 3:30-5:20pm ECE B086
Course Web Page: Blackboard http://www.itap.purdue.edu/tlt/blackboard/index.cfm	

Teaching Assistant Contact Information : *No TA for this class*

Course Description

This course will provide students with laboratory practice on various fluid flow and heat transfer phenomena seen in nuclear reactor systems and design. The course consists of thirteen laboratory experiments with a prelab preparation assignment:

Lab 1: Basic Hydrostatic Pressure and Manometer Experiment
Lab 2: Reynolds Experiment
Lab 3: Flow Meters and DP Measurements
Lab 4: Flow around Bodies
Lab 5: Turbulence and Vortex Visualization in a Vertical Channel
Lab 6: Pipe Friction and Similarity Law
Lab 7: Drag Force on Spheres
Lab 8: Two-Phase Natural Circulation
Lab 9: Two-Phase Flow Regimes
Lab 10: Thermal Conduction
Lab 11: Natural and Forced Convection
Lab 12: Pool Boiling
Lab 13: Critical Flow and Phase Change (Blowdown Expt.)

Prerequisite: NUCL 350**, Pre/Co-requisite**: NUCL 351

Course Goals:

By the end of this course, students will be able to: (i) Perform basic fluid flow and heat transfer experiments, (ii) explain how the data relates to the physical principles, (iii) apply the basic fluid flow and heat transfer principles to nuclear reactor thermal hydraulics, and (iv)devise experiments to understand basic fluid flow and heat transfer principles.

Learning Objectives

(i) To understand the underlying principles behind experiment, (ii) prepare on how to perform experiments and analyze data, (iii) perform experiments and record observations, (iv) analyze data and write reports on the experiment, (v) apply principles behind each experiments to reactor thermal hydraulics, and (vi) demonstrate the knowledge gained through reporting and examinations

Course Requirements

Lab Reports: Students will perform 13 experiments in groups. Each student will write a full lab report for the following labs:

Lab 1
Lab 6
Lab 9
Lab 11
The report must be prepared according to the attached guidelines.

For the other labs, each person will submit a partial lab report consisting of : Short Introduction, Data (original and reduced), Sample Calculations, Analysis and Discussion, and Conclusions.

Homework: A prelab homework problem will be given with every experiment handout. The objective of the prelab homework is to acquaint the student with the concepts to be investigated during the experiment.

Due Dates*:* A prelab homework will be assigned on each Tuesday class and will be due on the following Tuesday class before laboratory experiments are conducted. The lab reports will be due on respective following lab hours.

No delay is accepted for prelab homework. A penalty of 20% per day will be deducted for each day late for lab reports, and no lab reports will not be accepted more than four days late.

Exams: Two exams, one midterm and a final will be given.

Required Texts
No Textbook is required. Class notes are available on blackboard for students download to use for this class. No distribution of the class material is allowed.

Policies
General Course Policies
(i) Regular class attendance is required. If you cannot attend a particular lab session in a week please make arrangements with the instructor in advance to attend another session that week. Each experiment is set for one week only. If you miss a laboratory for whole week no substitute experiments will be given and zero grade is counted for the missing laboratory.(ii) No use of cell phone/ computer in the class is allowed. (iii) Laboratory time should be spent in related discussion if not engaged in data acquisition.

Grading
The course grade will be based upon lab reports, homework assignments and exams. Each prelab will be worth 10 points of the lab report. All full lab reports will have two times the weight of a partial lab report. Homework assignments will be weighted equally.

Lab reports including homework (Total 13)	75%
Exam 1	10%
Final Exam	15%

The course grade will be assigned as:
A→90% or above B→80%-89% C→70%-79% D, F, I → as warranted

Academic Dishonesty
It is very important to display academic integrity in your class assignments and exams. While it is appropriate and encouraged to work together on homework assignments and lab reports,

each person must turn in homework assignments and lab reports that show original work to receive credit. Exams must be taken without the assistance of others. For definitions of academic dishonesty, the student is referred to the Dean of Student's website: http://www.purdue.edu/ODOS/administration/integrity.htm

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Attendance

Students are expected to be present for every meeting of the classes in which they are enrolled

Missed or Late Work

No delay is accepted for prelab homework. A penalty of 20% per day will be deducted for each day late for lab reports, and no lab reports will not be accepted more than four days late.
If you are sick –please bring Doctor certificate for delayed reports and inform instructor.

Students with Disabilities

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University.

It is the student's responsibility to notify the Disability Resource Center of an impairment/condition that may require accommodations and/or classroom modifications.

Health and other emergencies

Here are ways to get information about changes in this course: (i) Check on messages in for this course in Blackboard (ii) contact with my email (shripad@ecn.purdue.edu)

According to a memorandum by the Provost Office (August 11, 2009), special care has to be taken to minimize the effect of Pandemic Influenza A (H1N1). In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone.

Class Schedule

Please see attached sheet of class schedule

NUCL 355
Thermal Hydraulics Laboratory
Grading scale for full lab reports
Spring 2011

	SECTION	POINTS
1.	PRE-LAB PROBLEM	10
2.	EXECUTIVE SUMMARY	5
3.	INTRODUCTION	5
4.	EXPERIMENTAL APPARATUS	3
5.	DATA ACQUISITION + APPENDIX A-1: RAW DATA	10
6.	ANALYSIS AND DISCUSSION	
	THEORY	10
	RESULTS & DISCUSSION	15
7.	UNUSUAL OBSERVATIONS	5
8.	CONCLUSIONS	10
9.	REFERENCES	1
10.	APPENDIX A-2: REDUCED DATA	5
11.	APPENDIX A-3: SAMPLE CALCULATIONS	6
12.	APPENDIX A-4: ERROR ANALYSIS	5
QUALITY AND OVERALL PRESENTATION		10
	TOTAL	100

Partial lab reports

Prelab	10
Short introduction	5
Data (original and reduced)	15
Analysis and discussion	40
Sample calculations	10
Conclusions	20
Total	100

School of Nuclear Engineering
Purdue University
West Lafayette, IN 47907

NUCL 355
Spring 2011

GUIDELINES ON THE PREPARATION OF THE FULL LABORATORY REPORT

Instructions:

1. Reports should be typed or word-processed. A legible hand written report is also acceptable in case typing or word-processing cannot be done. In the latter case, use a medium hardness pencil and a good eraser to facilitate writing

2. Use good English (*see Additional Remarks and Cautions*)

3. Graphs and figures should be clearly drawn with appropriate legends for axes and lines and they should be provided with complete figure captions.

4. Reports found deficient will need to be resubmitted with some loss of credit.

The front page will contain the following information:

School of Nuclear Engineering
Purdue University

Title of the Experiment

A Report of the Experiment Conducted by
(Names of the members in the group)

Written by (name of the author)

Date

NUCL 355
Prof. S. T. Revankar

The report will contain the following sections, with each section beginning on a new page.

1. Executive Summary

In this section an extended abstract will state the nature of the experiment, the purpose of the experiment, the major findings and the main conclusions derived from the experiment. This part should be self-contained without reference to the body of text. It could contain an equation or two if necessary but no figures. *(approximately 500 words)*

2. Introduction and Theoretical Considerations

Start out by stating in simple words the motivation for this particular experiment. Continue by stating what is expected to be demonstrated, discovered or to be proven. Give subsequently the theoretical background on whose premises the experimental results will be tested and compared with. To a limited extent, make an effort to present what other relevant information is available in the literature, both experimental and theoretical. *(2-3 pages)*

3. Description of the Experiment

Include a schematic figure to illustrate the set-up. Number various components so that you can describe the apparatus. Make sure that you can identify in detail all the instruments you use, including the name of manufacturer and instrument serial number as appropriate. Expand portions of the apparatus in separate drawings if necessary to show important details. The figure should contain self-explanatory captions. (*1-2 pages*)

4. Data Acquisition

In this section describe the procedure used to collect the data in systematic order. Enter this raw data in Appendix A-1 under the title Original Data. This section should be concise such that other person would be able to use the data for analysis. (*1-2 pages*)

5. Analysis and Discussion of the Experimental Data

In this section you will include Reduced Data in the form required to analyze and discuss them under the premises set forth in the Introduction. These tables will normally be an abbreviated version of those appearing in Appendix A-2.

Use self-explanatory figures/illustrations to compare your data with other available theoretical or experimental results. Critically examine your data and explain any deviations observed from your expectations under the light of Error Analysis included in the Appendix A-4. For each figure and table, use separate pages in the order they are referred to in the body of the text. (*2-5 pages*)

6. Unusual Observations and Unexpected Findings

In this section record any observation made that you cannot explain from first principles. You should make an effort to offer tentative explanation. (*1 page*)

7. Conclusions, Recommendations and Comments

In this section cite the conclusions drawn from the experiment. What was shown or failed to be shown, or any new finding, should be stated in a concise way. Conclude this section by

providing recommendations such as alternative methods of performing the experiment to make it more successful. Also feel free to make comments on what you liked best or least in this particular experiment *(1-2 pages)*

8. List of References

The references will be numbered in order they appear in the text, e.g.,
3. Pitts, Donald R. and Leighton E. Sissom, "Heat Transfer", Schaum's Outline Series In Engineering, McGraw-Hill Book Company, 1977.

4. Giedt W.H., "Investigation of Variation of Point Unit-Heat-Transfer Coefficient Around a Cylinder Normal to an Air Stream", Trans. ASME vol. 71, 1949, pp 375-381.

Appendices

A-1 Original Data

Here you will copy from your lab book all data and pertinent notes recorded during the experiment either by you or your group member. Make sure to include the names of team members that provided the data information.

A-2 Reduced Data

Most of the time you will have original data in the form of voltages currents or length (such as manometer level), which need to be reduced to the physical quantities such as pressure, temperature or some non-dimensional number. In this appendix, tabulate the required reduced data.

A-3 Sample Calculations

Here you should enter sample calculations you performed to reduce your data to the form needed for comparison/discussion as described above.

A-4 Error Analysis

In this section you should analyze all your data statistically, so that you can estimate the error and reliability of your data. Make sure to identify systematic and random errors and error propagation while reducing data. Do not reject any data without sound explanation. Be critical and conservative in your error estimations.

Additional Remarks and Cautions

All reports should be typed/word processed or hand-written in pencil with clear legible handwriting without crossing-out or sloppy appearance. The quality of your English will be carefully evaluated. Unacceptable reports will be given back for revision with some loss of credit. It is to the best of your interest to submit a good report the first time.