University of Puerto Rico
Mayagüez Campus
Department of Chemical Engineering

Student Learning Assessment Report
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Section I: Mission and Student Learning Outcomes

Mission of the Department of Chemical Engineering:

To develop a strong Chemical Engineering program focused on research, services and on educating students coming from all socioeconomic levels to convert them in professionals competitive at a worldwide level and knowledgeable of their social responsibility.

List of Student Learning Outcomes:

The outcomes of the Chemical Engineering Undergraduate Program will provide the graduates at the time of graduation with the following knowledge and/or skills:

1. To have the ability to understand and apply knowledge of mathematics through differential equation, chemistry through basic, analytical, organic and physical chemistry, statistics: physical sciences; and engineering sciences.
2. To have the ability to design and conduct experiments, as well as to analyze and interpret data.
3. To have the ability to design a system, component, or process to meet desired needs within realistic constrains such as economic, environmental, social, ethical, health and safety.
4. To have the ability to identify, formulate, and solve engineering problems.
5. To have an understanding of professional and ethical responsibility.
6. To have the ability to communicate effectively in both English and Spanish.
7. To have a broad education and the knowledge of contemporary issues necessary to understand the impact of engineering solutions in a global and societal context.
8. To have a recognition of the need for, and an ability to engage in lifelong learning and basic leadership skills.
9. To have the ability to function in multidisciplinary teams.
10. To have the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Section II: Student Learning Assessment Report

The Deparment of Chemical Engineering (ChE) during the academic year 2006-07 enrolled an average of 687 undergraduate students of which 65% were females, and 44 graduate students (34 % MS/ME Programs and 66% PhD Program) of which 46.6 % were females. The department has 22 full time faculty members of which 68% have release time for research. The department continuously assesses its undergraduate program in a process consistent with its established vision and mission. The outcomes of the Chemical Engineering Undergraduate Program will provide the graduates at the time of graduation with the 1 to 10 knowledge and/or skills previously stated. The student learning outcomes are consistent with program educational objectives and with the mission of the institution as well as the college. They are also directly linked to the minimum learning outcomes defined by ABET Engineering Criteria 2000.

The justification for a continuous student learning assessment is part of department mission as well as to comply with the minimum learning outcomes defined by accreditation agencies. Complying with the learning outcomes will assure the students will be converted in professionals competitive at a worldwide level and knowledgeable of their social responsibility. In order to assess the effectiveness of the program, we put into place a well-defined process to ensure that the results of the assessments are used in an on-going manner, to ensure the achievement of our educational objectives and outcomes, and to improve the quality of our program.

During the academic year 2006-07 the department has been involved in a project to evaluate the teaching effectiveness and course objectives accomplishment using two evaluation instruments: Faculty Course Evaluation (FCE) (see Appendix I)and Students Course Evaluation (SCE) (see Appendix II).

By the mean of the Faculty Course Evaluation each course instructor evaluates the evaluation tools used, textbook, syllabus, class dynamics and previous background of the students as well as to give final remarks and recommendation of the class.

By the mean of the Student Course Evaluation each student evaluates two main aspects of course instruction; knowledge and skills obtained. Based on the course objectives, each student indicates how well learned the topics covered, how well can apply the knowledge's learned, the area where the instructor should spend more time, how well is grasp's essence of the chemical engineering profession at this point, areas where instructor should emphasizes, changes suggested to the course, how much like the course and final comments.

Based on the SCE results the instructor will receive feed back from previous semester evaluation to make course adjustment to attend student needs, and therefore to enhance the quality of teaching to assure the students are getting the required knowledge and skills. Complying with the learning outcomes will assure the students will be converted in professionals competitive at a worldwide level and knowledgeable of their social responsibility.
During the fall 2006 semester 80% of the faculty participated on the Faculty Course Evaluation and about 95% participated on the spring 2007 semester. We expect to reach the 100% participation next fall 2007 semester. An example of a FCE of the course InQu 4010 is shown on Appendix III. On this evaluation the name of the instructor and course sections have been

omitted to maintain confidentiality. As can be shown it presents the evaluation tools used and the grade distribution, then evaluated the textbook, syllabus, class dynamics, final remarks, recommendation and course outcomes covered. Based on this information is clearly shown that course objective were covered, students grade distribution were normal for the complexity and the previous academic preparation of students, and the instructor used the best available audiovisual techniques.

During the fall 2006 semester 85% of the course were evaluated using the SCE instrument and almost 100% on the spring 2007 semester. An example of a SCE is shown on Appendix IV. This demonstrates that the students learned the topics covered on the course and know how to apply them from well to extremely well. There are some topics that the students asked the instructor to spend more time due to the complexity and student background. Once the instructor receives the feedback of this evaluation he or she will make course adjustment to attend student needs, and therefore to enhance the quality of teaching to assure the students are getting the required knowledge and skills.

This process of faculty and student course evaluation has been approved by the Deparment of Chemical Engineering Faculty as part of the each semester academic program.

APPENDIX I

UNIVERSITY OF PUERTO RICO
MAYAGUEZ CAMUS
CHEMICAL ENGINEERING DEPARTMENT

FACULTY UNDERGRADUATE COURSE EVALUATION

Academic Year:
Semester:
Curse:_____

Instructor Name:

Course Number: Session:

Enrollment:

Final Grade Distribution:

A. EVALUATION TOOLS: (Exams, Quizzes, Special Project, Final Exam, Reports, Oral Presentation, etc.)

Tools	Max. Grade	Min. Grade	Mean	Content

Include pdf copy of each evaluation tool. Student name might delete to maintain confidentiality.

B. TEXTBOOK AND TOOLS

C. SYLLABUS

D. CLASS DYNAMICS AND PREVIOUS BACKGOUND

E. FINAL REMARKS AND RECOMMEDATIONS

F. PLEASE CICLE ALL THE COURSE LEARNING OUTCOMES COVERED

a. an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design and conduct experiments, as well as to analyze and interpret data.
c. an ability to design a system, component, or process to meet desired needs.
d. an ability to function in multidisciplinary teams.
e. an ability to identify, formulate, and solve engineering problems.
f. an understanding of professional and ethical responsibility.
g. an ability to communicate effectively.
h. the education necessary to understand the impact of engineering solutions in a global and societal context.
i. a recognition of the need for, and an ability to engage in lifelong learning.
j. a knowledge of contemporary issues.
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
l. a recognition of basic leadership skills.

Please find attached two course evaluation samples as reference

APPENDIX II

Student Course Evaluation
InQu 4005
Semester:_____, Year:_____

KNOWDLEDGE

1. **I learned the following topics**

	Extremely well (4)	Very well (3)	Well (2)	Not well (1)	Not at all (0)
Units and Dimensions					
Hydrostatic pressure					
Temperature					
Stoichiometric					
Mass balance without reaction in simple units					
Mass balance without reaction in multiple units					
Recycle, Purge, and By-pass					
Vapor pressure					
Saturation					
Mass balance with and without reaction with saturation					
Cp mean and enthalpy					
Heat and Work					
Energy balance without reaction					
Energy balance with reaction					
Humidity charts					

SKILLS

2. **At the end of the course, I am able to do**

	Extremely well (4)	Very well (3)	Well (2)	Not well (1)	Not at all (0)
Mass balance for single units without reaction					
Mass balance for multiple units without reaction					
Mass balance for single units with reaction					
Mass balance for multiple units with reaction					
Mass balance for units with recycles, by-pass, and purge.					
Compute concentration					
Compute hydrostatic pressure					
Calculations involving saturation and vapor pressure					
Energy balances for single units without reaction					
Energy balances for multiple units without reaction					
Energy balances for single units with reaction					
Energy balances for multiple units with reaction					

3. I would have appreciated if the instructor spent more time on

_ Compute concentration
_ Compute hydrostatic pressure
_ Mass balance for single units without reaction
_ Mass balance for multiple units without reaction
_ Mass balance for single units with reaction
_ Mass balance for multiple units with reaction
_ Mass balance for units with recycles, by-pass, and purge.
_ Calculations involving saturation and vapor pressure
_ Energy balances for single units with out reaction
_ Energy balances for multiple units with out reaction
_ Energy balances for single units with reaction
_ Energy balances for multiple units with reaction
_ Humidity charts

4. I grasp the essence of the chemical engineering profession.

Extremely well (4)	Very well (3)	Well (2)	Not well (1)	Not at all (0)

5. Instructor should emphasize

_____

_____

6. I would do the following changes to the courses.

_____

_____

_____

7. Overall I liked the course

Very much (3)	A lot (2)	A little (1)	Not at all (0)

8. **Comments:**

_____

_____

APPENDIX III

UNIVERSITY OF PUERTO RICO
MAYAGUEZ CAMUS
CHEMICAL ENGINEERING DEPARTMENT

FACULTY UNDERGRADUATE COURSE EVALUATION
Second Semester 2006-07

Instructor Name:

Course Number: INQU 4010 - Sections

Enrollment: 24

Final Grade Distribution: 7A, 2B, 6C, 3D, 2F, 4W

A. EVALUATION TOOLS: (Exams, Quizzes, Special Project, Final Exam, Reports, Oral Presentation, etc.)

Tools	Max. Grade	Min. Grade	Mean ± St Dev	Content
Exam #1	72	19	41.4 ± 14.0	• **Introduction to Fluid Mechanics** - properties of fluids, stresses, Newton's law of viscosity • **Fluid Statics and Pressure Forces** - the concept of pressure, the hydrostatic equation, pressure forces in fluids manometers • **Shell Momentum Balances and Velocity Distributions in Laminar Flow:** shell balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through an annulus, creeping flow around a sphere
Exam #2	100	3	58.3 ± 27.2	• **Finite Control Volume Analysis (Macroscopic Balances)** - conservation of mass, linear momentum, angular momentum, and energy • **Similitude, Dimensional Analysis, and Modeling** - Buckingham Pi theorem, common dimensionless groups
Exam #3	89	39	68.4 ± 18.1	• **Viscous Flow in Pipes** - characteristics of pipe flow, fully developed laminar and turbulent flow, dimensional analysis, pipe flow calculations • **Flow in Packed Beds/Porous Media:** fluid friction and pressure drop in packed beds • **Flow Over Immersed Bodies:** lift and drag concepts, boundary layer characteristics, drag calculations for immersed spheres
Problem Sets	1.1	9.5	6.2 ± 2.6	
Project	100	90	98.9 ± 3.2	
Final Exam	45	90	62.5 ± 13.0	All material mentioned above plus, • **Pump Design and Selection** • **Polymeric and Non-Newtonian Liquids**

Include pdf copy of each evaluation tool. Student name might delete to maintain confidentiality.

B. TEXTBOOK AND TOOLS

Textbook:

B. R. Munson, D. F. Young, and T. H. Okiishi, *Fundamentals of Fluid Mechanics*, Fifth ed., New York, NY: John Wiley & Sons, Inc., 2002.

The textbook is appropriate for the basic course content, but the professor has to complement the material to make it more relevant to chemical engineering. Additional electronic material, such as files with all drawings in Power Point format, videos, solution manual and additional problems are available through the publisher's webpage.

References:

G. K. Batchelor, *An Introduction to Fluid Dynamics*. Cambridge, UK: Cambridge University Press, 1967.

R. B. Bird, W. E. Stewart, and E. N. Lightfoot, *Transport Phenomena*, Second ed. New York, NY: Wiley, 2001.

S. Middleman, *An Introduction to Fluid Dynamics*, New York, NY, John Wiley & Sons, 1998.

N. de Nevers, *Fluid Mechanics for Chemical Engineers*, Second ed. New York, NY: McGraw-Hill, Inc., 1991.

G. M. Homsy, H. Aref, K. Breuer, S. Hocqreb, and J. R. Koseff, *Multi-Media Fluid Mechanics CD-ROM*. Cambridge, UK: Cambridge University Press, 2000.

R. W. Fox and A. T. McDonald, *Introduction to Fluid Mechanics*. New York, NY: Wiley, 2004.

Internet Site:

The course has a site in webct.uprm.edu where registered students may find copies of old problem sets with their solution, copies of old exams with their solutions, current problem sets, additional classroom notes from other textbooks, pdf versions of the Power Point presentations discussed in the classroom, and handouts.

C. SYLLABUS

Course Content: The schedule proposed at the beginning of the semester was followed with no major adjustments.

Exams:	All exams were given at the time and dates proposed. All students with a valid excuse were granted with make-up exams.
Problems Sets:	Weekly problem sets were assigned, with the exception of exam weeks.

D. CLASS DYNAMICS AND PREVIOUS BACKGOUND

- All examination tools were given in conjunction with section 070 taught by

- Both sections had teaching assistants. Problem set preparation was done by the TAs, with the supervision of the professors.
- TAs scheduled help sessions every week.
- Only a minimum of students made use of the professor's office hours.
- Attendance to class and exams was normal.
- A higher student participation was noted when videos and/or demonstrations were done in the classroom.
- Final grades were segregated as evidenced by the small amounts of Bs compared to As and Cs, suggesting a marked difference in their previous academic preparation. Nevertheless, distributions showed improvement towards the end of the semester. However, they maybe attributed to withdrawals.
- A project was added to the course since last semester. This project involved the evaluation of a problem in a pharmaceutical production line and draw recommendations not only on the engineering calculation, but also on the ethical impact of their suggestions.

E. FINAL REMARKS AND RECOMMEDATIONS

- All students with a passing grade are able to apply the principles of conservation of mass, energy, and momentum to the solution of static and dynamic fluid problems, with particular emphasis on chemical engineering applications.

F. PLEASE CICLE ALL THE COURSE LEARNING OUTCOMES COVERED

(a.) an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design and conduct experiments, as well as to analyze and interpret data.
(c.) an ability to design a system, component, or process to meet desired needs.
d. an ability to function in multidisciplinary teams.
(e.) an ability to identify, formulate, and solve engineering problems.
f. an understanding of professional and ethical responsibility.
g. an ability to communicate effectively.
h. the education necessary to understand the impact of engineering solutions in a global and societal context.
i. a recognition of the need for, and an ability to engage in lifelong learning.
j. a knowledge of contemporary issues.
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
l. a recognition of basic leadership skills.

APPENDIX IV

Student Course Evaluation
InQu 4001
Second Semester 2006-07

KNOWDLEDGE

1. I learned the following topics

	Extremely well (4)	Very well (3)	Well (2)	Not well (1)	Not at all (0)
Heat transfer modes (conduction, convection, radiation)	67%	33%	0%	0 %	0
Conservation of energy requirement	67 %	22%	11 %	0 %	0
Conduction rate equation	61%	22%	17 %	0 %	0
Heat diffusion equation	28%	33%	39 %	0 %	0
One-dimensional steady-state conduction	67%	22%	0 %	0 %	0
Application of thermal resistance concepts	44%	50 %	6 %	0 %	0
Heat transfer from extended surfaces (fins)	17%	50%	28 %	6 %	0
Conduction with thermal energy generation	56%	28%	17 %	0 %	0
Two-dimensional steady-state conduction	17%	39%	17 %	28 %	0
Transient conduction: separation of variables	11%	33%	44 %	11 %	0
Convection boundary layers: convection coefficient	22%	56%	22 %	0 %	0
Convection correlations for external flows: flat plates and tube banks	17%	56 %	28%	0 %	0
Convection correlations for internal flows	22%	50 %	22 %	6 %	0
Laminar and turbulent flows in circular tubes	28 %	56%	17%	0 %	0
Heat exchanger types	33%	56%	11%	0 %	0
Overall heat transfer coefficients	28%	56%	17 %	0 %	0
Heat exchanger analysis: use of LMTD	33%	33%	33%	0 %	0
Heat exchanger analysis: use of effectiveness-NTU	50%	33 %	17%	0 %	0

SKILLS

2. At the end of the course, I am able to do

	Extremely well (4)	Very well (3)	Well (2)	Not well (1)	Not at all (0)
Calculate one-dimensional conduction heat fluxes	50%	44%	6 %	0 %	0
Calculate two-dimensional conduction heat fluxes	33 %	56 %	6 %	6 %	0
Calculate transient conduction heat fluxes	17 %	56 %	28 %	0	0
Estimate heat transfer coefficients over flat plates	44 %	50 %	6 %	0	0
Estimate heat transfer coefficients across tube banks	22 %	56 %	22 %	0	0
Estimate heat transfer coefficients inside circular tubes	28 %	39 %	33 %	0	0
Heat transfer coefficients inside noncircular tubes	11 %	78 %	11 %	0	0
Calculate convection heat transfer fluxes	28 %	56 %	17 %	0	0
Calculate radiation heat transfer fluxes	33 %	33 %	33 %	0	0
Identify the different types of heat exchangers	44 %	33 %	22 %	0	0
Design heat exchangers using the LMTD approach	17 %	44 %	33 %	6 %	0
Design heat exchangers using the ε-NTU approach	33 %	28 %	22 %	11 %	6 %

3. I would have appreciated if the instructor spent more time on

17% Radiation heat transfer
11% Extended surfaces (fins)
39% Separation of variables for two-dimensional conduction
11% Finite difference equations
6% Lumped capacitance method for transient conduction
17% Separation of variables for transient conduction
11% Finite difference method for transient conduction.

44% Boundary layer theory
6% Physical significance of dimensionless numbers
0 Cylinder in cross flow
39% Packed beds
6% The effectiveness-NTU method
17% Compact heat exchangers

4. I grasp the essence of the chemical engineering profession.

Extremely well (4)	Very well (3)	Well (2)	Not well (1)	Not at all (0)
28 %	67 %	6 %	0	0

5. Instructor should emphasize

6. I would do the following changes to the courses.

7. Overall I liked the course

Very much (3)	A lot (2)	A little (1)	Not at all (0)
50 %	44 %	6 %	0

8. Comments: