KUWAIT UNIVERSITY

College of Engineering & Petroleum

Chemical Engineering Department

FINAL REPORT

ABET ENGINEERING CRITERIA 2000

OUTCOMES ASSESSMENT PLAN DEVELOPMENT

DECEMBER 1998

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SUMMARY

The new ABET Engineering Criteria 2000 (EC 2000) requires program educational objectives and program outcomes assessment which are new requirements by ABET. Upon recommendation from the College of Engineering, the Chemical Engineering (ChE) Department formed an Outcomes Assessment Committee (OAC) in September, 1998, to develop outcomes assessment plan for the Chemical Engineering Program at Kuwait University. This report outlines such a plan as proposed by the faculty members.

INTRODUCTION

The Accreditation Board for Engineering and Technology (ABET) is recognized in the United States as the sole agency responsible for accreditation of educational programs leading to degrees in engineering. The College of Engineering at Kuwait University has elected to adopt ABET Engineering Criteria 2000 [1] for evaluation of its various programs in the year 2001. In April 1998, the College formed the Outcomes Assessment Committee (OAC) with one faculty from each program, to design a framework for Outcomes Assessment Development for its programs. For this purpose, a schedule of events was prepared by the college OAC committee and is given in Appendix A.

The Chemical Engineering Department formed its OAC in September 1998. Prof. Al-Ansary the Vice Dean of Research and Academic Affairs and Dr. Christoforou Chairman of the college OAC gave a seminar on ABET EC 2000 and the college plan to all faculty members of Chemical Engineering on October 13, 1998. Minutes of this seminar are given in Appendix B.

The OAC of the ChE Department held several meetings in various stages from September to December 1998 to develop the Assessment Plan. The minutes of these meetings are given in Appendix C. Four different faculty teams were formed in September 1998 to work on development of the plan. Each team held several meetings to prepare their reports which are included in this report along with the minutes of teams meetings. In addition, various working teams presented and discussed their proposed plans in three departmental workshops on November 29, December 1, and December 6, 1998. Minutes of these workshops are also given in Appendix C.

The assessment plan development guides from the Rose-Hulman Institute of Technology [2], Worcester Polytechnic Institute [3], Georgia Institute of Technology [4] and Michigan State University [5] in their internet sites as well as the Report by the Mechanical and Industrial Engineering Department at Kuwait University [6] have been used in development of the ChE outcome assessment plan.

ABET ENGINEERING CRITERIA 2000

The focus of the new ABET EC 2000 for each engineering program is on educational objectives and outcomes as well as evaluation of the program to assure that objectives have been met.

The basic level accreditation criteria as stated by ABET EC 2000 [1] are given below:

1. Students
2. Program Educational Objectives
3. Program Outcomes and Assessment
4. Professional Component
5. Faculty
6. Facilities
7. Institutional Support and Financial Resources
8. Program Criteria

This work is focused on criteria 2, 3 and 8. The ABET EC 2000 statements for these criteria are given below.

Criterion 2. Program Educational Objectives

Each engineering program for which an institution seeks accreditation or re-accreditation must have in place

(a) detailed published educational objectives that are consistent with the mission of the institution and these criteria
(b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated
(c) a curriculum and process that ensures the achievement of these objectives
(d) a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program

Criterion 3. Program Outcomes and Assessment

Engineering programs must demonstrate that its graduates have:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyse and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function on multi-disciplinary 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 broad 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 life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Criterion 8. Program Criteria

Each program must satisfy applicable Program Criteria. Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set subject to two or more sets of Program Criteria, however, overlapping requirements need to be satisfied only once.

CHEMICAL ENGINEERING PROGRAM AT KUWAIT UNIVERSITY

Based on the ABET EC 2000, the Chemical Engineering Program at KU plans to have the Mission, Objectives / Goals (Criterion 2), Outcomes (Criterion 3) and Program Criteria (Criterion 8) as stated in the following parts, which were all approved by the faculty members in a departmental meeting on December 15, 1998.

CHEMICAL ENGINEERING PROGRAM MISSION

The mission of the Chemical Engineering Program at Kuwait University is to produce chemical engineers to meet the technological and societal needs of Kuwait and the Gulf region, by providing a broad curriculum in the chemical and process systems areas, process design and control and unit operations with modern experimental and computing techniques. The program concentrates on petroleum technology, environment, polymers and material sciences, water technology and biochemical engineering.

CHEMICAL ENGINEERING OBJECTIVES / GOALS (Criterion 2)

The undergraduate program in chemical engineering provides a foundation for the professional development of its students. The graduates of the program should be able to find positions as practicing chemical engineer or to continue their studies in the graduate program.

The faculty of the chemical engineering program are committed to provide an academic environment that encourages active learning and high quality student performance.

The curriculum provides a thorough base of mathematics, physical science, engineering science, laboratory experience and design experience which prepares students to apply chemical engineering principles to a variety of contemporary problems. In addition, the curriculum provides the general education necessary to identify the impact of engineering decisions in the broader societal context.

This chemical engineering program integrates the knowledge and skills acquired in a rigorous set of courses, the extra curricular experiences, and the faculty expertise needed to enable the graduates of the program to:

- understand fundamentals of physics, chemistry, mathematics and chemical engineering; (a)
- design and perform laboratory experiments to gather data and test theories; (b)
- understand, analyze and design chemical processes; (c)
- participate effectively in same-discipline and cross-disciplinary groups; (d)

- identify and solve chemical engineering problems; (e)
- conduct themselves in accordance with the highest professional and ethical standards. (f)
- be proficient in the oral and written communication of their work and ideas; (g)
- understand the global and societal impact of engineering problems and solutions; (h)
- be prepared for a lifetime of continuing education; (i)
- understand the safety and environmental consequences of their work as chemical engineers; (j)
- be proficient in the use of modern engineering tools; (k)
- learn and work independently.

Goals specified by a, b, c, d, e, f, g, h, i, j, k correspond to desired program outcomes specified by ABET EC 2000.

CHEMICAL ENGINEERING PROGRAM CRITERIA (Criterion 8)

Chemical engineering program graduates at KU must have demonstrated

1. knowledge of mathematics, physics and chemistry as applied to engineering problems.
2. working knowledge of advanced chemistry such as organic, inorganic, physical and biochemistry
3. working knowledge of safety and environmental aspects, material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and stage-wise

separation operations; process dynamics and control; and process design

4. ability to use appropriate modern experimental and computing techniques
5. familiarity with one of the following specialties as selected by the student

   i) petroleum technology
   ii) polymers and materials sciences
   iii) water technology
   iv) environmental engineering
   v) biochemical engineering

PROGRAM OUTCOMES & ASSESSMENT (Criterion 3)

The Department of Chemical Engineering at Kuwait University has adopted the outcome requirements of Criterion 3 of the ABET EC 2000. Their achievement by the graduates of our program plays a major role in accomplishing our Program Education Objectives and supportive of the mission of our program.

The following document describes, for each of the eleven outcomes,

1) the performance criteria which are used to gauge achievement of program outcomes, and
2) the practices and strategies in place to accomplish the required outcomes
3) the assessment methods, tools and conduct

The focus of following pages is on program outcomes via the program curriculum. The desired outcomes are

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

WORKING TEAMS

The following working teams were involved in development of 11 program outcomes:

1. A.R. Khan, H.T. Al-Dessouky and H.M. Ettouney (outcomes: a, d, e, k)
2. C.G.J. Baker, K. Al-Shaiji and M.A. Fahim, (outcomes: b, c)
3. H.M.S. Lababidi and Y. Al-Roomi (outcomes: g)
4. M.R. Riazi, A. Elkamel and E. Alper (outcomes: f, h, i, j)

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(a)

Chemical engineering program at Kuwait University will graduate engineers who have

> *"an ability to apply knowledge of mathematics, science, and engineering"*

1. PERFORMANCE OBJECTIVES

Objective A: Learning formulation of any physical situation and solution of mathematical problems.

Objective B: Understand underlying principles of physics, chemistry, general engineering, and core chemical engineering.

Objective C: Apply acquired knowledge and developed skills to formulate mathematical models, design experiments, and to interpret results and experimental data.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Learning formulation and solution of mathematical problems.

Learn elements, fundamentals, and applications of

1. Calculus.

2. Linear algebra.
3. Differential equations.
4. Numerical techniques.
5. Statistical analysis.
6. Optimization methods.
7. Modeling and mathematical analysis.

Objective B: Understand underlying principles of physics, chemistry, general engineering, and core chemical engineering.

Learn elements, fundamentals, and applications of

1. General physics.
2. General, inorganic, organic, physical, and analytical chemistry.
3. General engineering, which includes statistics, materials, thermodynamics, economy, engineering drawing, and workshop.
4. Core chemical engineering, which includes principles, fluid mechanics, thermodynamics, heat transfer, mass transfer, reactor design, process control, and unit operations.

Objective C: Apply acquired knowledge and developed skills to formulate mathematical models, design experiments, and to interpret results and experimental data.

Applications are found in the following courses:

1. Plant and process design.
2. Desalination and petroleum refining.
3. Chemical engineering laboratories.
4. Interaction of theory with experimentation.
5. Interpretation of experimental data.
6. Several of the core chemical engineering includes applications of knowledge gained in physics, mathematics, and engineering. These courses include fluid mechanics, heat transfer, mass transfer, reactor design, process control, and unit operations.

7. Several of the elective chemical engineering course, which includes senior project, field training, wastewater treatment, air pollution, safety.

3. PRACTICES TO BE USED TO ACHIEVE OBJECTIVES

The chemical engineering curriculum includes 31 credits of basic science courses, 25 credits of core engineering courses, and 67 credits of chemical engineering courses. Theses courses include the following:

Objective A: Learning formulation and solution of mathematical problems.

The following courses focus on formulation and solution of mathematical problems

MATH 101 Calculus I
MATH 102 Calculus II
MATH 111 Linear Algebra
MATH 211 Calculus III
MATH 240 Ordinary Differential Equations
ENGR 202 Statistics
ENGR 304 Engineering Probability and Statistics

ENGR 308 Numerical Methods in Engineering

Objective B: Understand underlying principles of physics, chemistry, general engineering, and core chemical engineering.

The following courses include principles of physics, chemistry, general engineering, and core chemical engineering.

CHEM 101 General Chemistry I
CHEM 105 General Chemistry I Laboratory
CHEM 102 General Chemistry II
CHEM 106 General Chemistry II Laboratory
CHEM 234 Analytical Chemistry
CHEM 269 Organic Chemistry
ME 241 Material Science and Metallurgy

PHYS 101 Physics I
PHYS 105 Physics I Laboratory
PHYS 102 Physics II
PHYS 107 Physics II Laboratory

ENGR 202 Statistics
ENGR 206 Electrical Engineering Fundamentals
ENGR 208 Engineering Thermodynamics
ChE 211 Chemical Engineering Principles I
ChE 212 Chemical Engineering Principles II
ChE 215 Physical Chemistry
ChE 241 Fluid Mechanics
ChE 242 Fluid Mechanics Laboratory
ChE 321 Chemical Engineering Thermodynamics
ChE 324 Kinetics and Reactor Design (A)
ChE 343 Heat Transfer
ChE 344 Heat Transfer Laboratory
ChE 345 Mass Transfer
ChE 351 Process Dynamics and Control
ChE 352 Process Control Laboratory
ChE 427 Kinetics and Reactor Design (B)
ChE 440 Mass Transfer Operations
ChE 442 Unit Operations Laboratory

Objective C: Apply acquired knowledge and developed skills to formulate mathematical models, design experiments, and to interpret results and experimental data.

ChE 461 Water Desalination
ChE 472 Petroleum Refining Engineering
ChE 491 Plant Design

Students choose 12 credits from the list of departmental electives. A maximum of 3 credits may be substituted, with the approval of the Department, by a suitable selection from Science or Engineering offerings with minimum 200 level. Common elective courses include, senior project, field training, safety, optimization, fundamentals of petroleum processes, air pollution, wastewater treatment, modeling and simulation, and gas engineering.

4. ASSESSMENT CRITERIA

1. Have a strong and comprehensive background in fundamentals of mathematics, chemistry, and physics.
2. Learn fundamentals of general engineering and core chemical engineering courses.
3. Simple logistic approach to conceptual understanding the problem, breaking down into simple mathematical expressions and solving in correct and in right order.
4. Apply knowledge to formulate physical and mathematical models for engineering systems.
5. Develop skills to solve, analyze, and interpret results of physical and mathematical models as well as interpretation of experimental data.

5. CONDUCT ASSESSMENT

Examine the course materials by evaluating the following:

1. Course contents and text book.
2. Problems, quizzes, examinations and reports.

Assess the student performance by evaluating the following:

1. Student transcript.
2. Details of course grades, which includes homework, examinations, and other class assignments.

6. DETERMINATION OF FEED BACK CHANNELS

1. Evaluation of course contents and textbook by the departmental curriculum committee.
2. Evaluation of the students performance by the departmental student affairs committee.

3. Examination of the student evaluation forms.
4. Self assessment of instructor.
5. Self assessment of students.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

The departmental curriculum committee together with course instructors are responsible for revaluation of the course contents and textbook to achieve program objectives.

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(b)

The Chemical Engineering program at Kuwait University will graduate engineers who have

> ***"an ability to design and conduct experiments, as well as to analyze and interpret data."***

1. PERFORMANCE OBJECTIVES

Objective A: Students will be capable of conducting experiments safely, with a full knowledge of the hazards involved.

Objective B: Students will be capable of collecting accurate experimental data. They will be able to select appropriate ranges for each experimental variable.

Objective C: Students will apply their knowledge of mathematics, physics, and engineering to interpret the results.

Objective D: Students will be able to prepare an accurate and clear report on the experiment.

Objective E: Students will be able to design and construct experimental rigs.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Students graduating in Chemical Engineering will be able to:

1. Identify possible hazards involved in performing the experiment and develop safe procedures for making the measurements.
2. Identify the startup period, the establishment of steady state conditions, and the procedure for terminating the experiment.
3. Prepare a data-collection sheet, and use a data logger or on-line computer to collect the experimental data.

Objective B: Students graduating in Chemical Engineering will be able to:

1. Determine which variables need to be measured and their ranges.
2. Select appropriate instrumentation based on a knowledge of each experimental variable and its range.
3. Select the measurement interval for each variable.

Objective C: Students graduating in Chemical Engineering will be able to:

1. Develop mathematical models based on their knowledge of mathematics, physics, and engineering sciences and the application of computer software.
2. Apply statistical methods for data fitting and presentation, and error analysis.

Objective D: Students graduating in Chemical Engineering will be able to:

1. Prepare a report describing the problem, the background, why it is necessary to carry out the experiment, the experimental procedure, the measurements made, and the analysis and interpretation of the data.

2. Set out in a concise and readable format the following elements of the report: summary, introduction, experimental, data, model, sample calculation, analysis, conclusions and recommendations, and citations.

Objective E: Students graduating in Chemical Engineering will be able to:

1. Define the problem
2. Collect relevant information relating to the problem from the library, texts, and the Internet.
3. Prepare a preliminary rig design that meets the objectives of the experiment and discuss this with the instructor. Special emphasis is placed on safety issues (e.g. possible chemical, mechanical and electrical hazards).
4. Obtain from the laboratories and workshop the components needed to construct the rig.
5. Modify the rig design on the basis of the availability of components.
6. Construct the rig and perform preliminary measurements.

3. PRACTICES USED TO ACHIEVE OBJECTIVES

As noted above, two types of experimental design are used to achieve the above objectives. The first involves making measurements in the safest possible way and analyzing the results. The second involves the design and construction of an experimental rig (one only).

Experiments are performed in four laboratory courses.

A. Fluid Mechanics (ChE 244)

1. Friction losses in pipes, elbows, and valves.
2. Rating of mechanical pumps.

3. Drag, buoyancy, and gravity forces on an object.
4. Measurements of static and dynamic pressures.

B. Heat Transfer Laboratory (ChE 344)

1. Temperature measurements and error analysis.
2. Determination of heat transfer rates in double pipe heat exchangers.
3. Boiling and condensation.
4. Different modes of heat transfer.

C. Unit Operations Laboratory (ChE 444)

1. Liquid-Liquid extraction.
2. Distillation.
3. Evaporation.
4. Drying.
5. Vapor-Liquid Equilibrium.
6. Plug flow reactor.
7. Fluidization.

D. Process Measurement and Control Laboratory (ChE 352)

1. Modeling of a Process Task
2. Components of a Control Loop
3. Feedback and Feedforward Control Loops
4. Root Locus Using MATLAB
5. Controller Tuning Using MATLAB

4. ASSESSMENT CRITERIA

1. Students should have learnt the basics of experimental design and practice (including safety issues), and methods for selecting appropriate measurement ranges for each variable.
2. They will have learnt how to apply science and engineering fundamentals to experimental design and analysis.
3. They should have learnt how to use of software and library material in the preparation of their laboratory reports.
4. They should have developed the ability to write clear and concise laboratory reports.
5. Students should have developed the skills necessary to design, construct, modify, and operate experimental rigs, in a manner consistent with all safety requirements.

5. ASSESSMENT METHODS

The evaluation team consists of two instructors. The first instructor is responsible for overseeing the students' work on a day-to-day basis. His tasks include the following:

1. He devises a work plan with the students to achieve the desired goals.
2. He holds weekly meetings to evaluate progress.
3. He initiates progress reports and the preliminary draft of the final report.

The second instructor acts as an independent evaluator, and ensures that the work is properly executed and the desired goals are achieved.

The assessment is based on the following elements:

1. Progress and final reports.
2. Oral presentation.
3. Inspection and evaluation of the experimental rig.

6. FEEDBACK CHANNELS

Feed back channels for evaluating the students' ability to design and conduct experiments, and to analyze and interpret data, include.

1. Self-assessment by the instructor and support staff.
2. Student evaluation forms.
3. Assessment by the departmental Curriculum Development Committee.

7. Evaluation of Whether or Not the Performance criteria were met and the Objectives Were Achieved

The departmental Curriculum Development Committee, the course instructor, and the department Council are responsible for revaluation of the teamwork practices necessary to achieve program objectives.

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(c)

The chemical engineering program at Kuwait University will graduate engineers who have

"an ability to design a system, component, or process to meet desired needs."

1. PERFORMANCE OBJECTIVES

Objective A: Students will be able to identify, formulate and solve engineering problems using the techniques, skills and modern engineering tools applicable to current engineering practice.

Objective B: Students will successfully complete a major process design study. This should require them to innovate and to apply fundamental engineering and economic principles in order to devise a feasible manufacturing route for a specific product.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Students graduating in Chemical Engineering will:

1. Be able to analyze and synthesize individual unit operations.

2. Be capable of handling open-ended design problems

Objective B: Students graduating in Chemical Engineering will:

1. Be able to design a process or plant consisting of multiple unit operations, including chemical reactors.
2. Be capable of handling open-ended design problems and producing innovative solutions.
3. Be able to apply constraints resulting from considerations related to health and safety, economic criteria, environmental impact, and ethical and societal considerations.

3. PRACTICES USED TO ACHIEVE OBJECTIVES

Objective A: Students are progressively introduced to the fundamentals of design throughout their chemical engineering program. Many of the 'fundamental' engineering courses include a design element. Initially, students are set problems in which they have to apply the principles they have been taught to the design of relatively simple equipment for which the required data are supplied and the design constraints relatively rigid. In more senior level courses, these constraints are progressively relaxed as students tackle more open-ended problems and have to research their own design data.

The design content of these 'fundamental' courses is as follows:

1. *Engineering Economy (ENG 209)*

   Students should be able to undertake capital and manufacturing cost estimates and analyze the financial viability of engineering projects.

2. *Materials Science and Metallurgy (ME 241)*

   Students should develop an understanding of materials selection and corrosion.

3. *Chemical Engineering Principles I/II (ChE 211/ChE 212)*

   Students must demonstrate an ability to construct and analyze process flowsheets and to undertake material and energy balances. They should gain experience in the use of flowsheet simulators.

4. *Fluid Mechanics (ChE 241)*

   Students gain knowledge of the different types of pumps and compressors, and their applications. They should be capable of specifying both these devices.

5. *Kinetics & Reactor Design A/B (ChE 324/ChE 427)*

   Students are required to design a continuous stirred tank reactor, a plug flow reactor and a fixed bed reactor.

6. *Heat Transfer (ChE 343)*

   Students should be capable of designing heat exchangers, condensers and reboilers, and furnaces.

7. *Process Dynamics & Control (ChE 351)*

   Students are taught how to design control systems and specify process instrumentation and control hardware. They learn how to construct PI diagrams.

8. *Mass Transfer Courses (ChE 317/440)*

   Students should know how to design the following separation equipment: distillation columns (including trays), absorption columns, extractors, cooling towers, and adsorption columns.

Objective B: The ABET accreditation criteria require that "Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints

> that include most of the following considerations: economic, environmental, sustainability, manufactur-ability; ethical; health and safety; social; and political".
>
> Students participate in a major chemical engineering design project towards the end of their course. They are set an open-ended design problem and, working in small groups, are required to research their own background information and data prior to undertaking the design.

The design project (Plant Design, ChE 491) requires the student to complete the following activities:

1. A literature survey relating to the specified product is first carried out. The topics covered include industrial uses, manufacturing methods, world production/sales, physical properties. The students are required to recommend a specific manufacturing process.
2. A flowsheet is constructed and mass and energy balances calculated. The students are encouraged to innovate during this phase and to develop strategies to minimize energy and cooling water usage. Most of the calculations are performed on a process simulator, currently HYSIS; however, hand calculations are also undertaken.
3. Detailed designs of the principal items of equipment (e.g. reactors, separators, heat transfer equipment, etc.) are undertaken. These include specification of the principal dimensions, materials of construction, wall thickness of vessels, and instrumentation and control systems.
4. Capital cost of the plant is estimated. The purchase cost of the principal items of equipment are determined using standard

methods. Installation costs and the costs of piping, instrumentation, etc., are estimated using appropriate factors.

5. Manufacturing costs are estimated from a knowledge of the cost of the raw materials and the capital investment.

The profitability of the plant is determined by calculating the Return On Investment (ROI) or Discounted Cash Flow (DCF) rate of return.

The effectiveness of the design project could be further improved by the following:

1. Introduction of a senior core course on Safety. This would include exercises in HAZOP, etc.
2. The introduction of an elective course on Environmental Impact Assessment.
3. The possible extension of the course from one semester to two semesters. This would enable many of the design aspects to be covered in greater detail.

4. ASSESSMENT CRITERIA

The criteria for assessing the design element of the core courses are set by the individual instructors responsible for these courses.

In the Plant Design course (ChE 491), student performance is judged using the following criteria:

1. They must have a good working knowledge of the fundamentals and should know how to apply them in their designs.
2. They should have developed an understanding of the limitations of design techniques based on both theory and empiricism.
3. They should be competent in the use of all appropriate design aids – e.g. the library (including on-line searching), software, and the internet.

4. They should be capable of constructing flowsheets and performing materials and energy balances.
5. They should understand the constraints imposed by health, safety, environmental and societal considerations.
6. Where appropriate, they should be familiar with the selection of materials of construction, with equipment standards, and with design codes.
7. They should be capable of estimating the cost of process equipment and calculating the profitability of manufacturing processes.
8. They should have gained experience in the optimization of relatively simple processes.

5. ASSESSMENT METHODS

The design element in the core courses is assessed using the methods specified by the individual instructors responsible for these courses.

In the case of the Plant design course, the following assessment methods are used:

1. Written Reports – two interim reports (Literature Survey, Mass and Heat Balances), and the Final Report.
2. An oral presentation, which takes place at the end of the 'literature survey' phase of the project.
3. Two oral examinations – one after completion of the mass and energy balances and one towards the end of the project.

Student performance is assessed on the basis of the following aspects:

Technical Ability

Students are assessed on the basis of their ability to apply core knowledge and modern engineering techniques in formulating the design.

They are evaluated on the magnitude and quality of their contribution to the group effort, as judged by ongoing reviews by the instructors, oral examinations, and written reports.

Communication Skills

Students present their work in written, well-documented progress and final reports. These are evaluated in terms of technical content, clarity and presentation. The final report includes, general background, descriptions of the process flowsheet, mass and energy balances, detailed equipment design, costings, economic analyses and conclusions. Detailed calculations are included in appendices.

The students are also required to make an oral presentation of their work. This is judged on the basis of organization, clarity and the effective use of visual aids.

The idea of instituting an award for the best design project is currently under consideration. If this is successful, an attempt may be made to extend it to other Universities in the GCC countries.

6. FEEDBACK CHANNELS

1. An assessment on the success of the core courses in fulfilling their design objectives is made by the instructor responsible for the Plant Design course. This information is fed back to the Chairman of the Curriculum Development Committee for evaluation and action.
2. Feedback on the value and success of the ChE 491 Plant Design course is obtained by polling a cross-section of graduates and employers. This information is again fed back to the Chairman of the Curriculum Development Committee for evaluation and action.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

This evaluation is made by the Curriculum Development Committee based on the information obtained in Section 6 above.

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(d)

Chemical engineering program at Kuwait University will graduate engineers who have

"an ability to function in multi-disciplinary teams"

1. PERFORMANCE OBJECTIVES

Objective A: Learning requirements for successful execution of teamwork duties.

Objective B: Developing capabilities to perform efficiently within a team.

Objective C: Learning to perform and complete assignments for the success of the team main task, learning cooperative skills.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Learning requirements for successful execution of teamwork duties.

1. Selection of team leader and members.
2. Development of work plan.
3. Assignment of duties among team members, comment and cooperation.

Objective B: Developing capabilities to perform efficiently within a team.

1. Train to be a team leader.
2. Accept different points of view for problem solving.
3. Learn to receive and give trust to other team members.
4. Learn that success of the team is the joint effort of all members.

Objective C: Learning to perform and complete assignments for the success of the team main task.

1. Learn to divide assigned duties into sub-tasks.
2. Exchange information with other team members.
3. Report problems to team leader and members.
4. Prepare and present progress and final reports on assigned duties in the specified time.

3. PRACTICES USED TO ACHIEVE OBJECTIVES

Teamwork experience is found in the following courses:

A. Laboratory courses which include the following:
Basic Science and Chemistry Laboratories

Physics I Laboratory (PHYS 105, 1 Credit)
Physics II Laboratory (PHYS 107, 1 Credit)
General Chemistry I Laboratory (CHEM 105, 1 Credit)
General Chemistry II Laboratory (CHEM 106, 1 Credit)

Laboratories in Chemistry and Engineering Courses

Organic Chemistry (CHEM 269, 4 Credits)
Analytical Chemistry (CHEM 234, 3 Credits)
Physical Chemistry (ChE 215, 4 Credits)
Electrical Engineering Fundamentals (ENGR 206, 4 Credits)

Chemical Engineering Laboratories

Fluid Mechanics Laboratory(ChE 242, 1 Credit)
Heat Transfer Laboratory (ChE 344, 1 Credit)
Mass Transfer Operations Laboratory (ChE 443, 1 Credit)
Process Control Laboratory (ChE 352, 1 Credit)

All laboratories are taught in the afternoon over a period of three hours. Teams of two to three students are formed in each laboratory and each team executes the following tasks to conduct the laboratory experimental work:

- Prepare and study the experimental elements, which includes objectives, applications, theory, procedure, equipment, instrumentation, chemicals, safety.
- Discuss the experimental content with the instructor.
- Answer the instructor questions concerning various elements of the experiment.
- Prepare the experimental system for operation and measurements.
- Conduct the experimental work and record measurements.
- Perform proper termination of the experiments (shut down, storing elements, cleaning).
- Perform data analysis and prepare graphs, correlations, and laboratory report.

Teamwork is manifested in all of the above tasks, where

- The students may share textbook material and other references during preparation for the experiments.
- Before the start of the experimental work and during the discussion and question period, the instructor insures participation of all

students. Part of the grade of the experimental work is given to the student performance in discussing and answering the instructor queries.

- The instructor and the team coordinate the experimental duties to facilitate and insure efficient performance.
- The students share the experimental results to prepare for their final report.
- During report preparation the students may share textbook material and other materials, however, each student prepares his/her own report.

B. Engineering Training Course (ChE 395)

The engineering training course is one of the elective courses, which are offered every semester. On average, the course is attended by more than 20% of the graduating students. During the semester, the students attend a field training program at one of the approved institutions engaged in chemical engineering practice. The main objective of the course is to gain practical experience in real engineering applications. The teamwork element in this course are manifested in following points:

- Upon joining the training program in a specific plant, the training engineer divides the students body in a number of groups.
- The groups are trained in various departments of the plant.
- During the training period, all students follow the regulations and internal rules of the plant.
- During the training period, each group collects plant data and other material for preparation of their final report. This material includes process description, unit operations, instrumentation, maintenance and repairs, shutdown procedures, chemicals, raw materials, product, storing facilities, transportation, power supply, inspection, safety, security, labor body, and management.

- The student share the collected information for preparation of their final report and presentation.
- The training program is conducted over a period of 5 weeks with a total of 200 hours.

C. Plant Design Course (ChE 491)

The plant design is a compulsory course and is offered in the senior year. The course involves teamwork for design and analysis of the assigned process flow diagram. Each team is normally formed of 3 students. Lecture time is limited to 9 hours, while group meetings with the instructor are conducted on weekly basis. The teams perform the following tasks:

- Discuss problem elements with the instructor.
- Collect material and information required for performing all necessary calculations.
- Prepare reports on:
  - Process material and energy balance
  - Equipment sizing and design
  - Process economics
  - Flow chart computer simulation.
- Discuss reports with the instructor.
- Prepare a final report on the assigned problem.

During the course, the students share in performing various duties, which includes

- Collecting data and reference material.
- Extracting information from textbooks, internet and references through library.
- Executing calculations.
- Conducting computer work.
- Layout of final presentation and report.

– Preparation of final presentation and report.

Irrespective of this, each student prepares his/her own reports. Also, the final grade is based on the student performance during the course and quality of his/her final presentation and report.

D. Senior Project Course (ChE 495)

The senior project is an elective course, with a prerequisite of 90 credit hours and a GPA of 3.00/4.00. The course is offered every term and on average is joined by 20% of the graduating students. The course involves teamwork of 2-4 students. During the course, the student conducts investigative research supervised by the instructor and assistance (graduate students, technicians, or research assistants). The project team conducts the following tasks:

– Literature survey and collection of material from various references.
– Experimental investigation.
– Data analysis and preparation of graphs, correlations, and tables.
– Preparation of final report.
– Formal presentation.

The students cooperate to execute various tasks, since the experimental work involves lengthy hours of measurements and require repetition of measurements to insure reproducibility of data. Also, preparation of the final report involves lengthy calculations and intensive use of the computer to generate the necessary schematics, graphs, tables, and report. Students develop initiative thinking and innovative ideas to incorporate in the research.

4. ASSESSMENT METHODS

1. Develop abilities to act as a team leader or a member in a multidisciplinary team.
2. As a leader or a member learn methods for development of work plan, break down of tasks, assignment of duties among team members.
3. Learn to accept different points of view for problem solution.
4. Learn to meet deadlines for execution of assigned tasks.
5. Enhance skills for report preparation and oral presentation.
6. Assess the ability of individuals and contribution in the team.

5. CONDUCT ASSESSMENT

The evaluation team consists of two instructors. The first is responsible for supervision of students' work. His tasks include the following:

1. Supervise team formation and allow for a period of selecting the team members.
2. Discuss work plan with team members.
3. Perform weekly meetings to evaluate work progress.
4. Request progress reports that include executed tasks.
5. Request a preliminary draft of the final report.
6. Suggest alternate solution to the problem faced by any perticular member.

The second instructor acts as independent evaluator and ensures that the work is properly executed and the desired goals are achieved.

The assessment is based on the following elements:

1. Team performance during meetings and laboratory hours.
2. Progress and final report.
3. Oral presentation of the team.

6. DETERMINATION OF FEEDBACK CHANNELS

1. Evaluation of teamwork by two instructors. The first instructor is the one who have conducted and executed the work with the students and the second instructor acts as an independent evaluator or examiner to insure proper execution of the proposed work and achievement of the desired goals.
2. Self-assessment by team members and leader.
3. Self-assessment by instructor and supporting staff.
4. Assessment by the examiner.
5. Assessment by the departmental curriculum committee.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

The departmental curriculum committee, the course instructor, the examiner, and the department council are responsible for revaluation of the teamwork practices to achieve program objectives.

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(e)

Chemical engineering program at Kuwait University will graduate engineers who have

> ***"an ability to identify, formulate, and solve engineering problems"***

1. PROGRAM OBJECTIVES

Objective A: Learning fundamentals of physics, chemistry, mathematics, and engineering.

Objective B: Develop skills for computer programming and experimental investigation.

Objective C: Apply knowledge and skills for formulation and solution of engineering problems.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Learning fundamentals of physics, chemistry, mathematics, and engineering.

1. Learn fundamentals of calculus, algebra, differential equations, numerical analysis, statistical analysis, optimization, and computer programming.
2. Learn fundamentals of general engineering and chemical engineering.

Objective B: Develop skills for computer programming and experimental investigation.

1. Develop programming skills for coding and solution of algebraic and differential equations, statistical analysis, and optimization.
2. Develop skills for use of standard computer programs, packages, textbook routines, and Internet download programs.

Objective C: Apply knowledge and skills for formulation and solution of engineering problems.

1. Apply knowledge to perform experimental design, measurements, analysis, and data interpretation.
2. Apply knowledge to perform unit/process design, simulation, and performance evaluation.

3. PRACTICES USED TO ACHIEVE OBJECTIVES

Objective A: Learning fundamentals of physics, chemistry, mathematics, and engineering.

Extensive evaluation for learning fundamentals of physics, chemistry, mathematics, and engineering is found Criteria 3, part a. The chemical engineering curriculum includes 31 credits of basic since courses (mathematics, physics, and chemistry), 25 credits of core engineering courses, and 67 credits of chemical engineering courses.

Objective B: Develop skills for computer programming and experimental investigation.

Computer programming and use of packages is found in several of the several courses in the chemical engineering curriculum. Programming language is instructed the computer programming course (Eng. 200). Use of simulation packages is found in the chemical engineering principles II (ChE 212), where PDPlus is used and in the plant design course (ChE 491), where HYSIS is used. Other routines extracted from textbooks or downloaded from the Internet are used in several of the core chemical engineering courses (Reactor design, process control, heat transfer, and unit operations).

Skills in experimental investigation are developed in the chemical engineering laboratories, the senior project, and field training. Skills include definition of experimental range, selection of instrumentation and unit processes, data collection, analysis, and interpretation of results.

Objective C: Apply knowledge and skills for formulation and solution of engineering problems.

Formulation and solution of engineering problems is practiced throughout the chemical engineering core courses. Special focus on problem formulation and solution is made in the senior classes of plant design, petroleum refining, and desalination. Formulation and solution includes selection of unit processes, operating range, selection of models, and solution method. The elective courses of wastewater treatment, air pollution, gas

engineering, and safety includes a number of specialized problems, which require formulation and solution by the student.

4. ASSESSMENT CRITERIA

1. Develop programming skills and abilities to use standard computer programs, packages, and other simulation routines.
2. Develop skills in performing experimental investigation, data collection, analysis, and interpretation of results.
3. Formulate and solve problems for design of unit processes.

5. ASSESSMENT METHODS

Student performance in several of the core chemical engineering courses, the senior courses of plant design, desalination, and petroleum refining, and the elective courses is evaluated by the course instructor and an independent examiner.

The evaluation insure execution of the following:

1. Selection and assignment of engineering problems related to the local and regional industries that includes various elements of the engineering practice, i.e., process design, safety, environmental protection, and process economics.
2. Development and formulation of the engineering problem.
3. Problem solution through experimental investigation and/or mathematical modeling. Solution of the developed models by appropriate techniques or use of computer packages.

Assessment of student performance is based on the following elements:

1. Selection of the formulation method and solution technique.

2. Progress and final reports.
3. Oral presentation of the team.

6. DETERMINATION OF FEED BACK CHANNELS

This made by evaluation of the following elements:

1. Self-assessment by student.
2. Self-assessment by instructor and supporting staff.
3. Assessment by the examiner.
4. Assessment by the departmental curriculum committee.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

The departmental curriculum committee, the course instructor, the examiner, and the department council are responsible for revaluation of practices in formulation and solution of engineering problems in various chemical engineering course.

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(f)

The Chemical Engineering program at Kuwait University will graduate engineers who have

"An understanding of professional and ethical responsibility."

1. PERFORMANCE OBJECTIVES

Objective A: Identify sources of ethical standards and codes, and demonstrate an understanding of the ethical aspects of the profession.

Objective B: Demonstrate professional excellence and be determined to produce high-quality technical work, be able to make realistic commitments and deliver on time.

Objective C: Understand personal responsibility and the impact of the profession on society.

Objective D: Be able to implement strategies in dealing with unethical situations.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Identify sources of ethical standards and codes, and demonstrate an understanding of the ethical aspects of the profession.

Students will:

1. Understand rules and commitments of the engineering practice.
2. Know how to issue public statements.
3. Adhere to any commitments they make to their colleges or their employer.

Objective B: Demonstrate professional excellence and be determined to produce high-quality technical work, be able to make realistic commitments and deliver on time.

Students will:

1. Be objective and truthful in statements they make to their employer, coworkers, or to the public.
2. Accept their own errors when proven wrong and refrain from distorting the facts in an attempt to justify their wrong behavior.
3. Avoid any act tending to promote their own interest at the expense of their firm or the profession.
4. Not engage in any business with firms believed to have dishonest practices.
5. Issue public statements and reports only in an objective and truthful manner.
6. Not be engaged in any action believed to be of conflicting interest with their firm.
7. Give credit for work to those to whom credit is due.

Objective C: Understand personal responsibility and the impact of the profession on society.

Students will:

1. Recognize that their primary responsibility is to protect the safety, health, and welfare of the public.
2. Approve only those practices that conforms to safety standards and that are not damaging to the environment.
3. Undertake assignments only when qualified by their education or prior experience.

Objective D: Be able to implement strategies in dealing with unethical situations.

Students will:

1. Understand the code of ethics and adhere to it.
2. Be able to issue public statements.
3. Make corrective actions for any unethical behavior that has been made by them or their firm.

3. PRACTICES TO BE USED TO ACHIEVE OBJECTIVES

1. Students will be introduced to the rules of ethical behavior and the Code of Ethics for Engineers. The first chapter of the introductory course for chemical engineering (Basic Principles A, CHE211) can serve for this purpose. In addition one or two lectures about ethics and ethical standards can be given during the design course. Moreover, one or two lectures of the introductory courses on the

college level (EN 102, Workshop, EN209, Engineering Economy) can be used to introduce the subject of ethics and ethical standards.

2. Safety measures, appropriate waste disposal, and precautions against health hazards will be discussed in all laboratory courses and workshops (Fluid Mechanics Lab CHE242, Physical Chemistry Lab CHE215, Heat Transfer Lab CHE344, and Mass Transfer Lab CHE443). In addition, safety measures will also be introduced in the chemistry lab courses in collaboration with the chemistry department. Such courses include: CH105, General Chemistry laboratory, and CH106 General chemistry II laboratory.
3. Faculty discuss the impact of chemical engineering on society. This will be addressed in the introductory courses (Basic Principles A and Basic Principles B).
4. In one or two laboratory experiments or during their senior project course, the students are required to assess the impact of the product, process, or work experience on society and should analyze the relevant health, safety, and environmental regulations.
5. Student work is graded for neatness, completeness, and punctuality throughout the curriculum.
6. Students are encouraged to join professional organizations (the AIChE and the Kuwaiti Society of Engineering) and to participate in service activities.

4. ASSESSMENT CRITERIA

The criteria for assessing the ethical issues of students are set by the individual instructors throughout the program.

In laboratories, student performance is juded using the following criteria.

1. Acceptance of responsibility for safety of themselves and other students
2. Acceptance of responsibility for safely use of equipments
3. Acceptance of responsibility for safely use of chemicals
4. Considering environmental aspects when working in a laboratory
5. Economical use of expensive materials
6. Responsibility in sharing the equipments in laboratories
7. Responsibility in conducting the experiments as accurate as possible
8. Responsibility in preparing his/her own report as accurate as possible

In all courses, the criteria for assessment of ethical issues are

- students behavior in classes
- on time attending to class rooms
- students cooperation with the instructor
- students behavior in preparing their homeworks and take-home assignments
- students behavior during exam periods
- students behavior outside classrooms
- students responsibility in returning borrowed books or other items from libraries, instructors, friends etc.

5. ASSESMENT METHODS

1. During each of the introductory courses mentioned above, one homework assignment should test the understanding of the students about ethical standards and behavior. The exams can also present one question about the topic.
2. Class discussion of case studies will be encouraged.
3. Oral presentation of lab reports will also include a component on ethics and safety.
4. For the remaining courses not mentioned above, cases related to ethics will be addressed and analyzed.
5. Questionnaires will be filled by faculty members, students, and former graduates.
6. Feedback from employers of graduates of the program will be sought also in terms of questionnaires.
7. Course portfolios will be kept on record that include the material taught to students, the homework assignments, and exams given.

6. FEEDBACK CHANNELS

An assessment on the ethical and professional responsibility of students is made by all the instructors and laboratory engineers as well as chairman of the department and other university divisions.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CERITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

This evaluation is made by the Curriculum Development Committee based on the information obtained in Section 6 above.

8. REFERENCES

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ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(g)

The Chemical Engineering program at Kuwait University will graduate engineers who have

"Graduate chemical engineers with an ability to communicate effectively".

1. PERFORMANCE OBJECTIVES

Objective A: The student will be able to conduct technical discussion.

Objective B: The student will be able to deliver formal oral presentations.

Objective C: The student will be able to express his/her work in written technical documents.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A:

1. Follows up the discussion effectively.
2. Does not interrupt other speakers.

3. Expresses the opinion briefly and to the point.
4. Does not undermine others opinion.
5. Speaks when allowed.
6. Speaks clearly and loudly.
7. Incorporates technical terms effectively.
8. Avoids multilingual expressions.
9. Supports the discussion with graphs, charts, hand sketches, etc.

Objective B:

Preparing the presentation

1. Organizes the appropriate content concisely and logically.
2. Writes the content as brief and meaningful points (sentences).
3. Starts with objectives and outline and closes with expressive conclusion.
4. Utilizes multimedia tools effectively.
5. Uses appropriate colors and fonts.
6. Uses graphical objects and plots in conveying information and representing data.

Delivering the presentation:

i. Speaks loudly and clearly.
ii. Adhere to the specified time.
iii. Motivates and interacts with the audience.

Objective C:

1. Presents ideas clearly with emphases on the main theme of the document.
2. Outlines the sections logically.
3. Uses graphical representation effectively.
4. Checks the grammar and spelling mistakes.

5. Refers to and acknowledges others work.

3 PRACTICES USED TO CHIEVE OBJECTIVES

1. English Courses

   - Effective utilization of ENG 123 & ENG 221
   - Close cooperation with the English Language Unit (ELU) and
     involving English instructors with the assessment process.

2. Oral Communication Skills

   - Oral presentations in at least three courses.
   - Oral presentation of the design project (ChE 491) and oral exams for the ChE laboratory courses (242, 344, 352, 443).
   - Discussion and brain storming sessions in at least three courses.
   - Providing students with formal classroom training on the preparation and presentation of effective oral presentations.
   - Making multimedia facilities easily accessible by the students.
   - Motivating the students to use the multimedia tools.

3. Written Communication Skills

   - Writing technical reports in the ChE laboratory courses (242, 344, 352, 443).
   - Preparing reports for assigned projects in a number of courses throughout the curriculum.
   - Providing students with formal classroom training on presenting information through charts, graphs, tables and

other visual media.

- Giving the students access to the internet and motivating them to create their own home pages.

4. ASSESSMENT METHODS

I. Data Collection:

The following sources are considered for data collection:

1. Individual instructors of the courses.
2. Laboratory reports.
3. Design course (ChE 491) reports and presentations.
4. Engineering training course (ChE 395).
5. Videotapes of oral presentations.
6. Alumni Office.

II. Data Analysis:

Appropriate methods should be developed to use the collected data in assessing the performance criteria outline above for each objective. Possible assessment methods include:

- Feedback from individual instructors, assistants and training engineers.
- Following standard checklists in evaluating written reports and oral presentations.
- Questionnaires to get the students feedback on the facilities and methods used to improve their communication skills.

ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(h)

Chemical engineering program at Kuwait University will graduate engineers who have

> *"the broad education necessary to understand the impact of solutions in a global societal context".*

PERFORMANCE OBJECTIVES:

Objective A: Knowledge of social sciences

Objective B: Understand the impact of engineering on global environment and economy

PERFORMANCE CRITERIA :

The students will:

1) have a background in social science and humanities and will be exposed to global economic, environmental, and political issues.
2) be able to understand the impact of engineering solutions in a global and social context.
3) Recognize the impact of engineering decisions on the local and global environment and economy.

Practices/ Strategies :

1. Students complete a set of social science and humanities courses that include economics, history, sociology, psychology, and political science.
2. Chemical engineering courses will include information on how engineering solutions affected the quality of life and the environment.
3. Students will solve practical problems in which they consider the effect of their decisions on the economy and on the environment.
4. Faculty will discuss case studies on the impact of past engineering decisions on the economy and the environment.
5. Students will be encouraged to actively discuss the impact of engineering solutions on the economy and the environment during the various chemical engineering courses.
6. Chemical engineering students complete courses in engineering economy, history and Islamic Civilization, 12 credits of social sciences, and 12 credits of chemical engineering electives.
7. The capstone design course includes elements of engineering solutions on Kuwait and the global society.
8. The petroleum refinery and desalination courses include elements of environmental protection, conservation of resources and process economics and their impact on the society.

4. ASSESSMENT METHODS AND CONDUCT

1. Examinations, quizzes and reports for various courses in different departments.
2. Students grades in courses such as economics, history and social sciences.

3. Assessment sheets and checklists to be filled by students, faculty, employers, and former graduates.

5. CONDUCT ASSESSMENT

Examine the course materials by evaluating the following:

1. Course contents and text book.
2. Problems, quizzes, examinations and reports.

Assess the student performance by evaluating the following:

1. Student transcript.
2. Details of course grades, which includes homework, examinations, and other class assignments.

6. DETERMINATION OF FEED BACK CHANNELS

1. Evaluation of course contents and textbook by the departmental curriculum committee.
2. Evaluation of the students performance by the departmental student affairs committee.
3. Examination of the student evaluation forms.
4. Self assessment of instructor.
5. Self assessment of students.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

The departmental curriculum committee together with course instructors are responsible for revaluation of the course contents and textbook to achieve program objectives.

8. REFERENCES

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2. Tom Walsh, "The Health and Safety Challenge", IChEME Symposium Series No. 133, 1986, pp 481-485.
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ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(i)

Chemical engineering program at Kuwait University will graduate engineers who have

"an ability to engage in life-long learning".

1. PERFORMANCE OBJECTIVES

Objective A: Be proficient in the use of a variety of educational media (textbooks, scientific and technical journals, the library system, the World Wide Web, and educational software).

Objective B: Have an understanding of support that will be available to them after graduation; this includes continuing education and short courses, needed to remain current, and professional societies inside and outside of Kuwait.

Objective C: Be engaged in independent learning and have the ability to learn on their own.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE:

Objective A: Be proficient in the use of a variety of educational media (textbooks, scientific and technical journals, the library system, the World Wide Web, and educational software).

1. Students will have the ability to comprehend technical and other material on their own.
2. Students will possess reading skills.
3. Students will be able to survey, question, read , recite, and review (SQR3) technical and other material.
4. Students will be able to conduct a literature survey on a given topic.
5. Students will be able to use the library system, the World Wide Web, and various educational softwares (interactive modules; simulators; encyclopedias, handbooks, and Journals on CDs).

Objective B: Have an understanding of support that will be available to them after graduation; this includes continuing education and short courses, needed to remain current, and professional societies inside and outside of Kuwait.

1. Students will be familiar of the services of Kuwait University in terms of continuing education courses for on-the-job, enterprise-relevant, technology-specific training.
2. Students will express an openness and desire for new and intellectual experiences.
3. Students will keep in contact with the department and understand that the faculty are willing to be continuing technical mentors and no-fee consultants for them.

Objective C: Be engaged in independent learning and have the ability to learn on their own.

1. Students will be able to independently acquire new knowledge.
2. Students will be aware of the demands of tasks facing them, the alternative strategies that they have for coping with these tasks, and how well the strategy they select is working (metacognition).
3. Students will posses problem solving and creativity skills.

3. PRACTICES TO BE USED TO ACHIEVE OBJECTIVES:

1. Assign homeworks and projects that require the use of various resources including traditional textbooks, scientific and technical journals, the World Wide Web, communication with other professionals, cassettes, videos, and data-base software.
2. Inform students of the different sources for life long learning that will be available to them upon graduation. These include professional and technical societies (AIChE, Kuwait Society of Engineers), and continuing education courses (Office of Consultation and Career Development OCCD, and Center for Community Service and Continuing Education (CCSCE).
3. Invite speakers from industry to meet with the students or give a lecture in class to discuss current changes that are affecting their companies and industries.
4. Alumni office will follow up on graduates.
5. Offer an independent study course or give at least one homework/project that requires independent learning and the use of the tools described in # 1 above.

6. Encourage students to communicate with experts either in industry or academia by assigning them problems and projects that require consultations with such people.
7. Organize regular seminars on the departmental level and also on the college level and encourage students to attend them.
8. Reward faculty who develop continuing education courses.
9. Credit faculty who become continuing technical mentors and no-fee consultants for former students and thereby back-up the implied warranty of the BS degree.
10. Teach Problem solving and creativity skills including the appropriate definition of problems, systematic ways for brainstorming, solution evaluation and implementation. These skills can be taught in all CHE courses and also in core engineering courses. In the design course more attention can be given to these skills.

4. ASSESSMENT METHODS:

1. Open ended assignments, projects, and creativity exercises.
2. Assessment sheets and checklists to be filled by students and faculty.
3. Employer and former students feedback.
4. Reading and independent assignments.

5. CONDUCT ASSESSMENT

Examine the course materials by evaluating the following:

1. Course contents and text book.
2. Homeworks, examinations and reports.

Assess the student performance by evaluating the following:

1. Student performance before and after graduation.

2. Alumni advancements in their jobs (promotions, etc.).

6. DETERMINATION OF FEED BACK CHANNELS

1. Evaluation of course contents and textbook by the departmental curriculum committee.
2. Evaluation of the students performance by the departmental student affairs committee.
3. Examination of the student evaluation forms.
4. Self assessment of instructor.
5. Self assessment of students.
6. Employer questionnaire.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

The departmental curriculum committee together with course instructors are responsible for revaluation of the course contents and learning material to achieve program objectives.

8. REFERENCES:

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ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(j)

Chemical engineering program at Kuwait University will graduate engineers who have

"To develop a knowledge of contemporary issues"

PERFORMANCE OBJECTIVES

Objective A: Students to be aware of emerging technologies

Objective B: Students to be aware of impact of technology in a local and global context.

PERFORMANCE CRITERIA:

The students will be:

1. aware of emerging technologies and current professional issues.
2. knowledge of environmental disasters, causes and their global effects.
3. recognize the impact of technology on local, national and international issues.

PRACTICES/STRATEGIES:

1. The social science and humanity courses with projects and homeworks, will expose the students to a socio-humanistic understanding of contemporary issues.
2. Students will get used to read reputable newspapers and non-engineering magazines in order to broaden their knowledge. Some of the homeworks and projects will require such reading.
3. Students are encouraged to actively participate in campus activities and community service that foster a social consciousness.
4. Faculty and invited speakers will present examples and case studies that demonstrate the relation between technology and contemporary problems.
5. Broadcasting media, internet facilities keeps the student well informed and produces awareness about the country, continent, earth and universe as a whole.

ASSESSMENT METHODS:

1- Interpretation of locally environmental problems into senior projects, like deforestation, CO_2 emissions, nuclear power generation, chemical, biological warfare etc.

2- Oral examination in the laboratory project can also cover wide issues what is happening around in the world, new technological advancements, impact of industrialization on the environment.

3- Feedback from the employer after graduation (Job interviews)

REFERENCES

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ABET EC 2000

Criterion 3

Program Outcomes and Assessment

(k)

Chemical engineering program at Kuwait University will graduate engineers who have

> *"an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice"*

1. PERFORMANCE OBJECTIVES

Objective A: Developing skills to use standard computer programs, packages, and the Internet download routines for report writing, data analysis, system design, problem solution, and collection of information and data.

Objective B: Learning the fundamentals and use of analytical methods and devices for identification of elements, groups, and compounds.

Objective C: Learning the fundamentals, function, selection and use of measuring instrumentation and data collection systems.

Objective D: Learning the fundamentals, function, selection and use of equipment and devices forming engineering processes.

2. PERFORMANCE CRITERIA FOR EACH OBJECTIVE

Objective A: Developing skills to use standard computer programs, packages, and the Internet download routines for report writing, data analysis, system design, problem solution, and collection of information and data.

1. Use of standard programs for spreadsheet calculations, word processing, drawing graph, table and figures, scanning, and preparation of presentations.
2. Use of chemical engineering computer packages for system design and analysis, i.e., PDPLUS, PRO II, HYSIS.
3. Download non-commercial packages from the Internet for design and analysis of specific unit operations and processes, i.e., packages for systems analysis in fluid mechanics, thermodynamics, and heat transfer.

Objective B: Learning the fundamentals and use of analytical methods and devices for identification of elements, groups, and compounds.

1. Learn fundamentals of analytical methods.
2. Develop skills to use of laboratory units and chemicals to prepare samples and to perform basic analytical methods.
3. Develop skills to use advanced analytical devices.

Objective C: Learning the fundamentals, function, selection and use of measuring instrumentation and data collection systems.

1. Learn fundamentals of measurements.

2. Develop skills on specification and selection of measuring instrumentation.
3. Develop skills for use of on-line data collection devices.
4. Data handling error concept and statistical application.

Objective D: Learning the fundamentals, function, selection and use of equipment and devices forming engineering processes.

1. Learn fundamentals of unit operations and control processes.
2. Develop skills on specification and selection of equipment and control devices.

3. PRACTICES USED TO ACHIEVE OBJECTIVES

Objective A: Developing skills to use standard computer programs, packages, textbook routines, and the Internet download routines, for report writing, data analysis, system design, problem solution, and collection of information and data.

Use of standard computer programs is found in the major part of the chemical engineering curriculum, where the student utilize the programs for report writing, data analysis, drawing graphs, figures and tables, and solution of equations.

Use of packages is found in the following courses:

ChE 212	Chemical Engineering Principles II	(PDPLUS)
ChE 308	Numerical Methods	(PASCAL)
ChE 324	Kinetics and Reactor Design (A)	(MATHEMATICA)
ChE 457	Optimization	(FORTRAN)
ChE 472	Petroleum Refining Engineering	(HYSIS)
ChE 491	Plant Design	(HYSIS)

Use of textbook and Internet download routines is found in the following courses

ChE 241 Fluid Mechanics
ChE 242 Fluid Mechanics Laboratory
ChE 321 Chemical Engineering Thermodynamics
ChE 324 Kinetics and Reactor Design (A)
ChE 343 Heat Transfer
ChE 344 Heat Transfer Laboratory
ChE 345 Mass Transfer
ChE 351 Process Dynamics and Control
ChE 352 Process Control Laboratory
ChE 427 Kinetics and Reactor Design (B)
ChE 440 Mass Transfer Operations
ChE 442 Unit Operations Laboratory
ChE 461 Water Desalination
ChE 472 Petroleum Refining Engineering

Objective B: Learning the fundamentals and use of analytical methods and devices for identification of elements, groups, and compounds.

Fundamentals of analytical methods are taught in the analytical chemistry course (CHEM 234). However, many of the underlying principles for analytical procedures are taught in basic science, physical chemistry, general engineering, and chemical engineering courses.

Applications and use of analytical methods are found in the physics, chemistry, engineering, and chemical engineering courses. Devices may include a simple pH or conductivity electrodes, a complex titration procedure, or an advanced computer controlled chromatography system, rheometer, refractometer, spectroscopy.

Objective C: Learning the fundamentals, function, selection and use of measuring instrumentation and data collection systems.

Fundamentals of measuring methods are taught in several of the basic science, general engineering, and chemical engineering courses.

Use of instrumentation, specification, and selection is found in the physics, chemistry, and chemical engineering laboratories. Instrumentation includes measurement of temperature, pressure, flow rate, and stream composition. Measuring devices may include simple dial gauges, manometers, or probes connected to digital read out units, stand-alone data loggers, or computer based data collection system. Stream composition is measured by batch sample analysis or on-line devices.

Objective D: Learning the fundamentals, function, selection and use of equipment and devices forming engineering processes.

Fundamentals of unit operations and chemical engineering processes are taught throughout the chemical engineering courses.

Applications are found in the four chemical engineering laboratories, plant and process design, desalination, petroleum refining and a number of elective courses (senior project, field training, air pollution, and wastewater treatment).

3. ASSESSMENT CRITERIA

1. Learning fundamentals of analytical methods, measurements and instrumentation, and unit operations.
2. Develop abilities to use standard computer programs for report writing, spreadsheet calculations, graphing, and preparation.
3. Develop skills for selection, specification, and operation of instrumentation, analytical devices, and unit operations.

5. CONDUCT ASSESSMENT

Evaluate student performance in various courses and laboratories, which includes chemistry, physics, and chemical engineering. Evaluation includes examination of reports prepared on the computer, solution of problems using packages and other routines, and oral presentation of assignments, laboratory experiments, and term projects.

6. DETERMINATION OF FEED BACK CHANNELS

1. Evaluation of assignments, reports, and oral presentations by instructor and independent examiner.
2. The department curriculum committee also evaluates samples of student work.
3. Self-assessment by students.
4. Self-assessment by instructor the instructor.
5. Assessment by the examiner.

7. EVALUATION OF WHETHER OR NOT THE PERFORMANCE CRITERIA WERE MET AND THE OBJECTIVES WERE ACHIEVED

The departmental curriculum committee together with instructors reevaluate practices, assignments, and course contents to propose necessary modifications necessary to achieve program objectives.

RECOMMENDATIONS

This document reports the results of the first phase on the outcomes assessment plan development. In the next phases the remaining 5 criteria for ABET EC 2000, must also be considered at the same time. According to the schedule and events in the second phase the faculty should work on development of objectives and assessment for each course in the program. Proposed assessment methods should be implemented and based on the feedback necessary changes on the program should be recommended as a continuing process.

One important point at this stage is that our current program concentrates on petroleum, water sciences and environment. The department desires to add polymer and biochemical engineering to the program. This requires offering 3 or 4 courses in each of these new areas. Any student who desires to be specialized in one of the program concentrations needs to take at least 3 courses in related area. In addition the student must take his/her senior level project in related subject area. As an example if one student wishes to be specialized in polymer engineering he/she is required to take 3 courses related to petroleum technology among elective courses in addition to a project in this area.

Another recommendation is related to the issue of ethics which is required by the ABET EC 2000. Although ethics is addressed in various courses throughout the program, we have also recommend that a one or two-credit course such as “Introduction to Chemical Engineering”, where general aspects of chemical engineering with emphasis on ethical issues will be discussed.

The next phase of this work for the second semester of 1998-1999 academic year should be on development of objectives and strategies for all courses as well as development of polymer and biochemical engineering programs.

REFERENCES

1- ABET Engineering Criteria 2000. Third Edition, 1997. http://www.abet.org/EAC/eac 2000.html

2- Gloria M. Rogers and Jean K. Sando, "Stepping Ahead : An Assessment Plan Development Guide", Rose-Hulman Institute of Technology, Foundation Coalition, 1996.

3- Program Self-Study for Chemical Engineering, Georgia Institute of Technology, August, 1997.

4- ABET Criteria 2000 : Worcester Polytechnic Institute http://www.wpi.edu/academics/ABET/

5- MSU Chemical Engineering ABET Accreditation Program Assessment Tools, Michigan State University, http://www.egr.msu.edu/che/html/nf/abet/assessment/index.html

6- Outcomes Assessment Plan Development Report, Mechanical and Industrial Engineering Department, Kuwait University, June 1998.

APPENDIX A

Schedule of Events

APPENDIX B

Faculty Seminar at ChE Department

APPENDIX C

Minutes of Chemical Eng. OAC Meetings