INDUSTRIAL ENGINEERING

(PROGRAM)

Submitted by
Polytechnic University of Puerto Rico

(NAME OF INSTITUTION)

JUNE 12, 1995

(DATE)

to the
Engineering Accreditation Commission

Participating Bodies
American Academy of Environmental Engineers
American Congress on Surveying and Mapping
American Institute of Aeronautics and Astronautics
American Institute of Chemical Engineers
American Nuclear Society
Engineers
American Society of Agricultural Engineers
American Society of Civil Engineers
American Society of Engineering Education
American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
The American Society of Mechanical Engineers
The Institute of Electrical and Electronics Engineers, Inc.
Institute of Industrial Engineers, Inc.
and
The Minerals, Metals, and Materials Society
National Council of Examiners of Engineering and Surveying
National Institute of Ceramic Engineers

National Society of Professional Engineers
Society of Automotive Engineers
Society of Manufacturing Engineers
Society of Mining, Metallurgy, and Exploration, Inc.
Society of Naval Architects and Marine Engineers

Society of Petroleum Engineers

Associate Body
Instrument Society of America

Affiliate Bodies
American Consulting Engineers Council
American Institute of Mining, Metallurgical, and Petroleum Engineers
American Society of Nondestructive Testing, Surveying
American Society of Safety Engineers
Society of Plastics Engineers

EC 27A
Revised December 1994
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A. Industrial Engineering Program of Study (by component)
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XI. OBJECTIVES AND SELF-ANALYSIS

A. Preparation for evaluation

The Polytechnic University of Puerto Rico (PUPR) started in 1985 the preparation process for accreditation by the Accreditation Board of Engineering and Technology (ABET). At that time, Dr. Arthur F. Gould, professor of Industrial Engineering, evaluated the Institution and reported his findings based on the Industrial Engineering program. Since PUPR was planning to offer other programs in engineering, the preparation process for accreditation was delayed. In 1990, PUPR continued the preparation process for the evaluation by ABET. In that year, PUPR hired as a consultant to Dr. Robert D. Kersten, Dean of Engineering at University of Central Florida. He evaluated all the engineering programs, including the IE program. Dr. Kersten's report included is several recommendations which PUPR should implement before seeking accreditation from ABET. Dr. Kersten is recommendations have been followed.

On August 1992, the IE program was thoroughly revised. ABET's curriculum criteria was kept in mind by the IE faculty while revising the program. Through all this process many changes were taking place among them we moved to a new campus, full time faculty increased, faculty salaries improved, and more resources were funneled to the engineering program including funds for labs.

On January 1994, PUPR submitted a request for evaluation of the 4 engineering programs before ABET. During the months of March through May PUPR engineering programs were once again evaluated. This time 4 consultants were hired one per program. At that time, Dr. Frank Tillman former Industrial Engineering Department Head at Oklahoma State University, did review the IE Program. Each consultant submitted reports which involved general recommendations as well as more specific and program oriented recommendations. All consultants agreed that PUPR still should improve several areas before seeking accreditation. They also thought that PUPR should wait for the completion of the engineering laboratories building, which at the time was completion. As a result PUPR decided to postpone its request for accreditation, until 1995.

Once again on January 1995, PUPR submitted a request for evaluation. This time PUPR decided to conduct a simulation of ABET's evaluation by a visiting team, resembling as close as possible the real one. For this purpose an evaluation of 4 experts in ABET were hire. This team included once again to Dr. Robert Kersten, who was appointed as the chairman of the evaluation team. Dr. Leslie Benmark evaluated the IE program. All recommendations from the consultants were submitted to the President of the University, the Dean of the Engineering Faculty and the Chairmen of the Engineering Departments. Almost all of their recommendations have either been implemented or are under way.

We should mention that since 1993, a committee chaired by Professor Gilberto A. Vélez, Dean of Engineering Faculty, has been meeting on a regular basis to coordinate the preparation of Volume I. Professor Vélez was responsible for Volume I, and Professor Cuauhtémoc Godoy, the Industrial Engineering Department Head, was responsible for completing Volume II of the Industrial Engineering Program. IE faculty has been meeting regularly to work on different matters related to the preparation for the evaluation by the ABET term, including curricular revisions, syllabi revisions and preparation of Volume II. Professor Rafael Cruz, IE Department Laboratory
Coordinator, prepared the 5 year laboratory development plan. Copies of the draft of Volume II were distributed to the IE faculty and Dean Vélez for their review and comments. The comments from the faculty and the Dean were incorporated in the final draft.

Additional information and detail regarding preparation for evaluation can be found in Volume I, Section II, paragraph titled "Preparation for the visit".

B. Program Objectives

In general the objective of the undergraduate program in Industrial Engineering is to provide a well-balanced and contemporary educational program based on the fundamentals of science and mathematics and on the principles and methods of engineering analysis and design. The students interact with a competent and enthusiastic faculty in a curriculum designed to provide both the theoretical foundations and practical applications of industrial engineering. Specific objectives include:

To provide an integrated curriculum which collectively constitutes a basis for self-development and life-long intellectual achievement.

To foster the understanding of lasting principles upon which engineering analysis and creative design are based.

To develop the capability of analyzing and designing productive work systems and associated operational controls based on the engineering sciences and the behavioral and economic factors of such systems.

To challenge the imagination and to thoroughly develop abilities to optimally utilize people, materials, capital, information, equipment, energy and other resources.

To provide a sufficiently broad and general education to permit effective communication and coordination with specialists in other professions.

To fulfill Polytechnic University of Puerto Rico's responsibility to the State and Nation by providing well-educated graduates.

To attain these objectives, a balance must be maintained between providing students with (1) the knowledge needed to enter a meaningful career in government, business or industry and (2) the background needed for continued professional growth and education.

C. Assessment of program objectives

We have started developing the basis for a formal mechanism to measure success in meeting program objectives. Such mechanism will include an analysis of graduate performance through: a) Quality of Capstone Design Projects, b) Performance in employment, c) Completion of Graduate Studies, d) Professional Registration, and e) Participation in Professional Societies. Regarding Capstone Design Projects our judgement indicates that most projects are of good quality, including some of exceptional quality. In many of those instances, students have been hired by the companies upon project completion. These are the cases of the following students:

II - 2
<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlos Andino</td>
<td>Harvey Hubell</td>
<td>Electrical components</td>
</tr>
<tr>
<td>Fernando Jaramillo</td>
<td>Ethicon</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Francisco Zayas</td>
<td>Ethicon</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Ralfy Calo</td>
<td>Syntex</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Dorcas López</td>
<td>Syntex</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Carmen Muñoz</td>
<td>Eli Lilly</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Guillermo Vázquez</td>
<td>Eli Lilly</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Edwin Pérez</td>
<td>Motorola</td>
<td>Electronics</td>
</tr>
<tr>
<td>José Marrero</td>
<td>General Electric</td>
<td>Electrical components</td>
</tr>
</tbody>
</table>

Regarding graduates performance in employment, we sent a letter requesting this in information from a sample of about 10 employers. However, this for only one company has sent us information. Such company is Pall Biomedical, which currently has 6 IE graduates employed. Three out of the six have received significant honors in recognition of their performance. Following are the names of our graduates and how have they been recognized.

<table>
<thead>
<tr>
<th>Graduate's Name</th>
<th>Current Position</th>
<th>Honor/Awards</th>
<th>Honored by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugenio Torres</td>
<td>Engineering Facilitator</td>
<td>Manager of the</td>
<td>Puerto Rico Manufacturer's</td>
</tr>
<tr>
<td>Director</td>
<td>year 1990 Association</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rafael Gavilanes</td>
<td>Production Manager</td>
<td>Employee Symbol 1993</td>
<td>Pall Biomedical</td>
</tr>
<tr>
<td>Delfin Rivera</td>
<td>Manufacturing Engineer</td>
<td>Employee Symbol 1993</td>
<td>Pall Biomedical</td>
</tr>
</tbody>
</table>

An informal employers survey conducted in 1994 by the Office of Research and Development showed that our graduates were doing fairly well in their jobs, and that they were academically well prepared to do their jobs, including a good mastery of computer use as a decision making tool.

A survey conducted by the department in 1994, showed that some graduates had started graduate studies in the continental United States or in Puerto Rico. Most of those graduates taking the Engineering Fundamentals Examination do pass the test. However, we do not have access to official statistics regarding how many take the Exam and how many pass it. The program objectives are well in accordance with the institutional goals.

D. Action to correct previous weaknesses.

Since this is the first time that this program is submitted for accreditation, no deficiencies have been noted by the Engineering Accreditation Commission (EAC) of ABET. However, several suggestions have been pointed out through the years, either by Self Study processes, other than ABET accreditation processes, and consultants hired by PUPR to evaluate the engineering programs, in light of ABET's criteria. The most important actions taken in response to the recommendation made by the different evaluators are as follow:

1. Reduce academic load to full time faculty. Current academic load is 9 credit-hours of teaching load and 3 credit-hours equivalent time dedicated to non-teaching endeavors per term.
2. Increase full-time faculty. Full time faculty has increased. Currently there are 9 full time faculty members (one of them on leave to pursue graduate studies).
3. Revise curriculum and syllabi contents to incorporate engineering design experiences throughout the 5 year curriculum.
4. Revise the socio-humanistic component to provide for breadth and depth, distributed along the 5 year program of study.
5. Admissions index to PUPR has been raised to a minimum GPA of 2.50.
6. Build a four story building to provide much needed space for the engineering laboratories, as well as for offices for the full time faculty and engineering administration.
7. Invest in state of the art equipment for the labs.
8. Develop a departmental PC network to support the IE academic offerings.
9. Provide full time faculty with an office on a PC.
10. Initiate a mentoring process, by integrating the full time faculty into this process.
11. Increase faculty salaries.
12. Parking facilities have been built.

It should be pointed out that, even though one could find room for improvement, it is clear that there has been a continuous effort from PUPR in improving the general conditions necessary to assure the quality of the academic offerings. There is a clear compromise from the administration to continue this effort in the future to improve those conditions.

E. Major developments since previous visit.

As mentioned before, this is the first time this program has been submitted for evaluation. However, one should mention that major developments in the last five years are the following:

1. Curriculum has been revised to meet ABET's criteria.
2. New lab facilities have been built. Lab equipment has been purchased, lab practices manuals have been either developed or revised.
3. A mentoring process has been put in place.
4. Academic load has been reduced to 9 credit-hours of teaching load and 3 credit-hours equivalent time dedicated to non-teaching endeavors per term.
5. A new building to house the library is under construction.

F. Plans for future development.

Regarding curriculum:

1. Strengthen IE's hands-on experience in robotics and automated manufacturing processes by adding 1 credit lab course in Manufacturing Processes.
2. Strengthen IE's knowledge and skills in the areas of Power Systems and Process Control by redefining the content of the courses ENGI 326 - Principles of Electrical Engineering, ENGI 428 - Industrial Electronics and adding 1 lab course in this area.
3. Strengthening communication skills in English. Oral as well as written communications including public speaking.

Regarding Laboratories:

1. As outlined in the IE Laboratories Development Plan - 1994-99, we will continue investing in state of the art equipment to provide laboratory experiences for our students in the major IE fields of study.

Regarding Faculty:

1. We should be looking to provide our faculty with a sound Development Program. This will guarantee that our faculty keeps up to date with the latest developments in the IE and related fields.
2. Seek to reduce teaching loads to provide time for faculty development activities.
3. Seek to increase the length of the academic period to 14 or 15 weeks per term.

G. Program Strengths

1. Curriculum is considered a major strength. Having a 5 year program with 170 credits required allows room to go beyond a program covering the basics of the IE field. This extra credits has been utilized to design a program with breadth and depth in IE fields. In terms of breadth, we include as part of the requirements, courses in industrial robotics, systems simulation, and theory of constraints. In terms of depth, the curriculum has been designed to provide additional time to discuss topics in more detail in the fields of probability and statistics, operations management and human factors and methods improvement.
2. Location of campus. PUPR campus is located in the metro area at a traveling distance (15-70) minutes from many industrial sites. Through the years the IE program has taken advantage from this fact in several ways. One must recognize that no campus laboratory will ever substitute real life experiences in a manufacturing or service site. Thus, the IE program has emphasized in having students perform term project in industry including by not limited to projects in motion and time studies, productivity improvement, facilities planning and design, and the senior design project. This enriches our students academic life by providing them with experiences in real life professional situations. Thus, in turns gives them a better basis for understanding what is being discussed in the classroom. There is also some faculty involvement in consulting and training activities for industry. Thus, obviously will enrich not only the material discussed in the classroom, but also provide insight in industry needs and trends to be considered in curricular revisions.

3. Faculty. Finally, but in no way less important, our faculty body is made up of 9 full-time professors (including the head) and an average of 4 part time professors. All but one faculty member have Master's degree as a minimum. Two faculty members have Ph.D. degrees. The mix of academic backgrounds is very good, since it covers all fields of IE and some related disciplines. The degree granting departments from where degrees were obtained are among the most respected IE programs of the nation. There is a good mix of youthfulness and maturity. All but one of the full time faculty have either PE licenses or EIT certification. A good deal of the faculty body has (or has had in the past) some degree of involvement in training and consulting activity to industry. Finally, the faculty is very involved participating in the academic affairs such as, curriculum revisions, mentoring, software evaluations, lab practices preparation, and in all academic matters in general.

H. Program Limitations

Following are some of what we consider at this time to be, some of the major limitations of the IE program.

1. Faculty compensation. A full time professor with a Master Degree in IE, and an academic rank of Assistant Professor makes $29,400 a year. This salary is by no means competitive with what local industry offers for similar academic preparation, not to mention experience. It is not difficult to find that B.S. graduates and even fifth year students, start with salaries over $30,000 a year. Thus, making it difficult to recruit new faculty members or even retain the ones we have.

2. Faculty vacation by spread periods. In theory professors take one-week vacation after the completion of each term. Actually, part of this period is used for grading final exams, term projects or turning in final grades and getting ready for next term.

3. Twelve-week term system. It is difficult to properly discuss all of the topics programmed for the courses in our twelve-week-quarter system. That is because the total amount of topics to be lectured, corresponds to the total amount of topics taught in a typical sixteen-week-semester system. Even though the number of hours dedicated to lecture are the same in both systems, student learning rate to mature and master all the knowledge received in class must be higher for PUPR students, in order to keep the accelerated lecturing pace. It must be mentioned that there is some consideration to increase the academic period to 14 weeks or more per term.

4. Funding for the labs. As it is explained in chapter XIII - Laboratory Facilities of this volume II, the actual state of the laboratories and particularly the lab equipment is in general very good. However, it has been with some difficulty that this has been achieved. An area for improvement is certainly planning what funds will be available for lab development and making them available for the departments to spend them.
I. Support Services

As an overall, the library provides good service and support to the IE program. In general most of the materials recommended by our personnel are purchased, including: textbooks, technical magazines, handbooks, manuals and other materials for reference. Audiovisual materials are purchased as well. The online library catalog is helpful in identifying the materials needed by the users. We believe that a more strict policy on returning of materials should be enforced. Finally, a larger and more convenient group study area should be provided. One would expect that this situation will be remedied with the new library facilities under construction.

A genuine effort to provide services with equipment and materials on the leading edge is characteristic of the library. However, a few of the basic services provided might need some improvement.

Computer Facilities and Services.

We can group computer services in three categories: a) Services offered to faculty; b) Services offered to students taking general engineering courses; c) Services offered to students taking courses related to the operations management laboratory.

Regarding services offered to faculty, each member of the IE program has access to a personal computer. At this moment three of them are connected to the Operations Management Laboratory network and thru the laboratory they can access the University Computer Center. The connection to the operations management lab provides the faculty with access to all the software presented in pages 7-8 of the Industrial Engineering Laboratories 1994-99 Development Plan. All but one full-time faculty members have PC's in their offices.

Regarding services offered to students taking general Engineering Courses, these students are attended through the Engineering Technology Center (ETC). The ETC facilities and resources are described in detail in Volume I, chapter VI, section A "Computer Facilities".

Regarding services offered to students taking courses related to the Operations Management Laboratory, we must say that the Industrial Engineering Department understands the importance of the computer as an engineering tool. Thus, we have identified those courses in our curriculum that make medium and intensive use of computer software. Students taking those courses are granted access to the department's Operations Management Laboratory. A complete description of this facility is presented on pages 7-8 of the Industrial Engineering Laboratories 1994-99 Development Plan.


CHAPTER XII - COURSE REQUIREMENTS.

A. Program modes and trends

The Industrial Engineering Department offers a 5 year program of study, leading to the Bachelor of Science in Industrial Engineering degree. Courses are offered mainly Monday through Thursday from 8 am to 10 pm. Fridays and Saturdays are available to offer some laboratory courses. A typical schedule of the courses offered by the IE Department has the following characteristics:

- Day and evening sections of the general engineering courses (ENGI 235, ENGI 449).
- All but 7 (IE 314, IE 354, IE 511, IE 512, IE 516, IE 544, IE 548) out of 26 required IE courses are offered every term. These courses are offered every other term.
- About 80% of all courses offered by the IE department, are scheduled from 4 pm to 10 pm Monday-Wednesday and Tuesday-Thursday.

There are no off-campus, nor telecommunications, nor evening programs. There is, on the other hand, a co-op program. However, it is not a graduation requirement to register for any co-op course. Co-op courses might be used by the student to meet technical elective requirements, in addition to gaining job experience. The Co-op Program Coordinator works with the Department Director to identify candidates. Students are required to turn in weekly reports of activities. They are also required to prepare a final report of projects completed. An oral presentation of the final report and an oral examination are part of the evaluation process.

Enrollment in August-November 94 quarter in the IE program was 631 students. The number of graduates in 1994 was 46. Enrollment has been steady for last 5 years, with a slight drop in the period 1994/95. Following are the number of students enrolled in the IE program in the most recent years:

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ENROLLMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990/91</td>
<td>714</td>
</tr>
<tr>
<td>1991/92</td>
<td>759</td>
</tr>
<tr>
<td>1992/93</td>
<td>718</td>
</tr>
<tr>
<td>1993/94</td>
<td>719</td>
</tr>
<tr>
<td>1994/95</td>
<td>631</td>
</tr>
</tbody>
</table>

We do not expect drastic changes in the next 5 years.

B. Degree titles

The Industrial Engineering Department at the Polytechnic University of Puerto Rico currently awards the degree of Bachelor of Science in Industrial Engineering (BSIE). No degrees at a graduate level are awarded.

C. Definition of credit unit

The academic calendar at the PUPR consists of four quarter terms with each quarter term 12 weeks long, which includes one week for final examinations. For a three credit-hour course, there are two lecture periods per week of two hours each. That represents a total of 44 hours for three credit-hours, or 14.67 hours per credit-hour. This time is a little affected by the registration activities carried on the first week of the quarter, state and federal holidays. In consequence, for a three credit-hours course 42 hours are actually devoted to teaching, or 14 hours per credit-hour. For laboratory courses, one credit-hour represents a period of four hours of instruction per week. That corresponds to a net 44 hours per credit-hour.
Implications under ABET criteria
1. According to ABET criteria, one-half year of study can be considered to be 16 credit-hours or 24 quarter-hours of study for programs with 128 credit-hours or 192 quarter-hours or more. One academic year normally represents at least 28 weeks of classes exclusive of final examinations. One semester or quarter credit hour represents one class hour or three laboratory hours per week. Therefore, a three credit-hour course would require 42 contact hours of classroom activity in a lecture course. In the quarter system, a three-quarter-hour course would on the other hand, imply 30 hours of contact time.

2. Under PUPR's situation, a three-credit-hour (or quarter-hour, if so desired) course would meet a total of 42 hours in a given quarter, corresponding exactly with the 42 credit-hours defined by ABET, as one semester hour. Nevertheless, one half year of study under the PUPR system has been conservatively defined as 18 credit hours.

3. As we can see the 170 credit hours required for the industrial engineering program, would surpass ABET's minimum criteria by at least 32.8% with regard to total number of credits.

D. Curriculum course content

Design experience is developed and integrated throughout the 5 years program of study. The model we follow to implement such strategy has 4 phases. Through each phase, the students are exposed to new concepts and experiences that will allow them to gain knowledge and develop the necessary skills to gradually prepare them to successfully complete engineering projects requiring an integrated approach.

Following is a brief description of how the design experience is developed and integrated through the 4 phases we have defined. For each phase we provide the level of refinement and degree of integration, the type of knowledge and skills to be developed, the purpose, as well as the methodology to achieve the general objectives.

Level I: Conceptual Phase

DESCRIPTION: Construction of a general body of knowledge in math, science and the humanities. Development of skills in oral and written communication and the use of the computer as an engineering tool. These knowledge and skills will serve as a base upon which the three remaining levels of the engineering design experience will be built upon. These knowledge and skills, as basic as they are, are fundamental to the engineering design process. They will be used by the engineer through the rest of his/her academic, as well as, his/her professional career.

PURPOSE: 1. For the student to learn the Math and Basic Science Concepts as necessary for further application to solve general engineering as well as IE problems.
2. Expose the student to the socio-humanistic body of knowledge to develop a general understanding of society, world economics and ethics.
3. Lays the fundamentals of the engineering design process. Attempts to develop general skills such as critical thinking and creativity.
4. Development of general technical skills such as computer aided drafting and general computer skills.

METHODOLOGY: Mostly lectures and group discussions. Team projects and oral presentations are introduced in ENGI 146 and IE 200. Also plant tours are part of the academic activities in IE 200. Laboratory experiences are conducted in the physics and chemistry courses. Students are required to take computer drafting, computer programming and computer courses requiring the use of general purpose packages such as spreadsheets, databases and word processing, early in their career (1st and 2nd years).
Level II: Developmental Phase

DESCRIPTION: Development of a general understanding of engineering science concepts. Development of a general understanding of IE science concepts.

PURPOSE: 1. To develop students skills to perform systems analysis requiring basic mechanical, electrical and structural concepts.
2. Prepares the student with the tools necessary for the analysis and evaluation of manufacturing and service sub-systems, from the following perspectives: financial, economical and cost control perspectives; from a probabilistic and a statistical point of view.

METHODOLOGY: Mostly lectures and group discussions. Lab experiences are conducted in the area of statistics.

Level III: Basic Integration Phase

DESCRIPTION: Integration of all previous coursework into an IE design experience. The design experience is limited in scope to either process control, or process design or improvement. No attempt is made to further integrate and/or expand scope to more than one area (process control, process design and improvement) at this stage.

PURPOSE: To prepare students to handle IE tasks. To design projects of limited scope which will require the student to: identify needs; clarify objectives, establish functions, set performance requirements, generate alternatives, evaluate them, improve details and implement design (when appropriate). Students will be exposed to focused design projects in the following areas:

2. Work measurement to apply criteria for evaluation. Production costs estimating by developing bill of materials, process yields and learning curves projections. Analysis, synthesis, construction and evaluation is promoted by operation and process flow charting.
4. Linear programming to integrate into one mathematical model, capacity and economic considerations, Queuing to analyze and evaluate the consequences of bottleneck operations, inventory and production control.

METHODOLOGY: Lectures, group discussions, case studies, discussion of open ended problems. Laboratory experiences. Industry based design projects, requiring the students to prepare progress reports. Oral presentations are required on a regular basis. Project evaluation will be based both in oral and written reports. Moderate to intensive use of computer software for analysis and solution of systems. Exams include open ended problems.

Level IV: Advanced Integration Phase

DESCRIPTION: Major design experiences exposing the student to industrial projects requiring study, analysis, evaluation and development of alternate solutions including process control and process design or improvement. These design experiences build upon all previous coursework.

PURPOSE: Develop students ability to handle industrial projects requiring him/her to apply each and every phase of the engineering design process, except perhaps for project implementation. Industrial design projects in which the student has to assist management in the identification of the root causes of problems and as part of the team involve themselves in identifying the causes, effects, symptoms, alternatives to implement solutions. Assist in
clarifying objectives, establishing function, setting performance requirements, generating alternatives, evaluating alternatives and improving details. Industrial projects will be oriented as follows: 1. Industry based facilities planning and design project; 2. Case studies to be solved using computer simulators; 3. A Senior design industry based project to be selected and developed by a team of students.

**METHODOLOGY:** Lectures, group discussions, case studies, discussion of open ended problems. Laboratory experiences. Industry based design projects, requiring the students to prepare progress reports. Oral presentations are required on a regular basis. Project evaluation will be based both in oral and written reports. Moderate to intensive use of computer software for analysis and solution of systems. Exams include open ended problems.

Following we present a summary of those courses claiming engineering design content. For each course we present: course code and title, the number of engineering design credits, as well as the recommended year and term to be taken by the student. This should help in showing how engineering design is developed and integrated throughout the curriculum.

<table>
<thead>
<tr>
<th>Year Quarter</th>
<th>Course</th>
<th>Design Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-C</td>
<td>ENGI 139 - Computer Aided Design</td>
<td>0.5</td>
</tr>
<tr>
<td>1-D</td>
<td>ENGI 146 - Freshman Engineering Design</td>
<td>1.0</td>
</tr>
<tr>
<td>2-D</td>
<td>ENGI 324 - Mechanics of Materials I</td>
<td>0.5</td>
</tr>
<tr>
<td>3-B</td>
<td>ENGI 325 - Engineering Mechanics - Dynamics</td>
<td>0.5</td>
</tr>
<tr>
<td>3-B</td>
<td>IE 313 - Statistics Laboratory</td>
<td>0.5</td>
</tr>
<tr>
<td>3-C</td>
<td>ENGI 327 - Fluid Mechanics</td>
<td>0.5</td>
</tr>
<tr>
<td>3-D</td>
<td>ENGI 422 - Manufacturing Processes</td>
<td>0.5</td>
</tr>
<tr>
<td>3-D</td>
<td>IE 314 - Statistics for Engineers</td>
<td>0.5</td>
</tr>
<tr>
<td>3-D</td>
<td>IE 344 - Systems Design I</td>
<td>0.5</td>
</tr>
<tr>
<td>3-D</td>
<td>IE 348 - Systems Design I Laboratory</td>
<td>1.0</td>
</tr>
<tr>
<td>4-A</td>
<td>IE 416 - Statistical Quality Control</td>
<td>1.0</td>
</tr>
<tr>
<td>4-B</td>
<td>IE 354 - Human Factors &amp; Ergonomics</td>
<td>0.5</td>
</tr>
<tr>
<td>4-B</td>
<td>IE 428 - Operations Research I</td>
<td>0.5</td>
</tr>
<tr>
<td>4-B</td>
<td>IE 444 - Systems Design II</td>
<td>0.5</td>
</tr>
<tr>
<td>4-B</td>
<td>IE 448 - Systems Design II Laboratory</td>
<td>1.0</td>
</tr>
<tr>
<td>4-C</td>
<td>IE 429 - Operations Research II</td>
<td>1.0</td>
</tr>
<tr>
<td>4-C</td>
<td>IE 524 - Production Planning &amp; Control</td>
<td>1.0</td>
</tr>
<tr>
<td>4-D</td>
<td>IE 511 - Industrial Robotics Applications</td>
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</tr>
<tr>
<td>4-D</td>
<td>IE 523 - Inventory Control Systems</td>
<td>1.0</td>
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<tr>
<td>5-A</td>
<td>IE 516 - Industrial Systems Simulation</td>
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<tr>
<td>5-A</td>
<td>IE 530 - Facilities Planning &amp; Design</td>
<td>1.5</td>
</tr>
<tr>
<td>5-A</td>
<td>IE 544 - Systems Design III</td>
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<tr>
<td>5-A</td>
<td>IE 548 - Systems Design III Laboratory</td>
<td>0.5</td>
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<tr>
<td>5-B</td>
<td>IE 539 - Facilities Planning &amp; Design Project</td>
<td>1.0</td>
</tr>
<tr>
<td>5-C</td>
<td>IE 590 - Capstone Design Course</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**TOTAL = 23.5**

The rationale for the distribution of engineering topics among the engineering science and engineering design categories has been to follow the rationale laid out in the "Criteria for Accrediting Programs in Engineering in the United States" and the "Advice to Industrial Engineering Program Evaluators". The resulting emphases are pertinent to meeting the program objectives since they are compatible.

Courses have been listed in the order in which they are given in the curriculum (year by year and term by term) and classified in the appropriate ABET category. They appear in Table XII - Course requirements of curriculum, under section E - Basic level curriculum of this chapter.

II - 10
Regarding the definition of "one-half year" of study utilized by our program, we should refer the evaluator to section C - Definition of credit unit, where the one half year of study has been defined. There we justify that for PUPR's engineering programs "one half year of study" is equivalent to 18 credit hours.

Based on the above definition of one half year of study, we conclude that the curricular content of the IE program meets ABET criteria. Following is a brief explanation of how ABET criteria is met:

i. One year of an appropriate combination of math and basic sciences.
The program claims a total of 36.5 credits in this area. The math courses include differential and integral calculus, as well as differential equations. The topics of probability and statistics are well covered in numerous courses. In the basic science area, students are required to take a sequence of three calculus based physics courses, as well as one general chemistry course. Each one of these courses has as a co-requisite a laboratory course. Finally, the basic science component is rounded with a course in the ergonomics and human factors areas.

ii. One half year of humanities and social sciences.
The IE program claims a total of 21 credits in this area. Section P of chapter XII in this volume, explains in detail how the 21 credits are distributed. Such section also explains how the "breadth and depth" requirement is met.

iii. One and one half year of engineering topics.
The IE program claims a total of 75.5 credits (equivalent to 2.1 years of study) in this area. Thus, meeting ABET requirements. Courses with engineering science content include general engineering, as well as courses within the industrial engineering field. General engineering courses with engineering design content include but are not limited to, courses in mechanics, materials science, and electrical and electronics fields. Those within the IE field include, probability and statistics courses, systems design, operations research and quality control courses, among others. As explained before in this section, students are exposed to engineering design experiences throughout the 5 year program. Students are exposed to a minimum of three major capstone design experiences. These design experiences are described in detail in section Q of chapter XII, in this volume.
ENGI 139
Computer Aided Design


Coordinator: R. Cruz, Associate Professor, Industrial Engineering

Goals: This course is designed to give IE freshmen students basics skills to prepare graphical presentation and engineering drawings using engineering graphics software and the computer as a tool.

Prerequisites by topic:
1. Three dimensional problems by descriptive geometry.
2. Principles and applications of the design process.

Topics:
1. Introduction to PC and Use of Dos.
2. The computer (Hardware and Software) and engineering graphics softwares.
3. Basic aspects of CAD using Autocad or equivalent software as a tool.
5. Drawing two dimensional views.
6. Dimensioning and tolerancing.
7. Isometric Drawing.
8. Three dimension drawings.
9. Introduction to layout with the computer and the interaction with other softwares.
10. Production design assembly drawings.
11. Exploded pictorial assembly drawings.
12. Solid Modeling.

Computer Usage:
- Homework assignments for each topic, requiring use of engineering graphics software on an IBM compatible computer.
- Each student must present a project integrating the steps in the design process and engineering graphics aided with the computer.
- Each student must present graphically the possible solutions to solve a case study.

ABET category content as estimated by faculty member who prepared this course:
Engineering Design: 0.5 credits or 16.7% Other: 2.5 credits or 83.3%

Prepared by: Rafael Cruz Date: March 30, 1995
ENGI 235
Probability and Statistics for Engineers

Catalog Data:


Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering.

Goals: This course is designed to give undergraduate engineering students an understanding of probabilistic and statistical tools focusing on their application to applied sciences engineering design.

Prerequisites by Topic:
1. Integral and differential calculus
2. General knowledge about engineering design objectives

Topics:
1. Descriptive statistics (1 class)
   a. Central tendency
   b. Variability
   c. Proportion
2. Probability (2 classes)
   a. Fundamental concepts
   b. Conditional probability
   c. Multiplication law
   d. Bayes' Theorem
3. Discrete probability distributions (2 classes)
   a. Binomial distribution
   b. Poisson distribution
   c. Hypergeometric distribution
4. Continuous probability distributions (2 classes)
   a. Normal distribution
   b. Exponential distribution
5. Point estimation (1 class)
   a. The estimation process
   b. Determining the required sample size
6. Test of Hypotheses (4 classes)
   a. Basic concepts
   b. Testing the mean
c. Type I error
d. Type II error
e. Comparing two means
7. Simple linear regression (3 classes)
   a. Least squares
   b. Assumptions and properties of LR
   c. Correlation analysis
8. Analysis of variance (3 classes)
   a. The single factor model
   b. Single factor analysis
9. Reliability analysis (2 classes)
   a. Basic concepts
   b. Predicting system reliability
   c. Life testing and reliability assessment
10. Tests (3 classes)

Computer Usage:
Use of an statistical package to validate manual solution of class assignments.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 3 credits or 100%
Engineering Design: 0 credits or 0%

Prepared by: Wilfred Fonseca Date: May 24, 1995
ENGI 315
PROBABILITY FOR ENGINEERS

Catalog Data:
Prerequisites: Math 215, IE275

Textbook:

References:

Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering

Goals:
This course is designed to give student basic knowledge of probability and probability distributions, for random process interpretation and analysis.

Prerequisites by topic:
1. Calculus

Topics:
1. Treatment of data (1 class)
   A) Frequency distributions
   B) Graphs of frequency distributions
   C) Descriptive measurement
   D) Quartiles and other percentiles

2. Probability (4 classes)
   A) Sample spaces and events
   B) Counting
   C) Probability
   D) The axioms of probability
   E) Some elementary theorems
   F) Conditional probability
   G) Bayes’ Theorem

3. Probability distributions (7 classes)
   A) Random variables
   B) Mathematical Expectation
   C) The Binomial Distribution
   D) The Hypergeometric Distribution
   E) The Geometric Distribution
   F) Negative Binomial Distribution
   G) The Poisson Distribution
   H) Geometric Distribution

4. Probability Densities (8 classes)
   A) Continuous random variables
   B) Mathematical Expectation
   C) The Normal Distribution
   D) The Uniform Distribution
   E) The Log-Normal Distribution
   F) The Exponential Distribution
   G) The Beta Distribution
   H) The Weibull Distribution
   I) Joint Probability Densities

5. Tests (3 classes)
Computer Usage: None
ABET Category content as estimated by faculty member who prepared this course description:
Mathematics and Basic Science: 1.5 credits or 50%
Engineering Science: 1.5 credits or 50%

Prepared by: Wilfred Fonseca  Date: May 24, 1995
Catalog Data: ENGI 336 - Engineering materials. Credits 3. Structure and Properties of Solid Phases, Structure, Properties and their control in Multiphase Solids. Course is aimed at understanding the structural elements of materials and its relationship to the materials properties, and how this knowledge can be used to modify accordingly the properties of such material. Prerequisites: SCIE 111, SCIE 249, SCIE 250.


Coordinator: Francisco Barba Nicieza, Lecturer II, Industrial Engineering

Goals: This course is designed to give engineering students the understanding of the internal structures of materials. To provide the concept that the properties and behavior of a material are closely related to the internal structures of that material.

Topics:
1. Atomic structure and interatomic bounding (3 classes)
2. Structure of crystallin solids (3 classes)
3. Imperfections in solids (1 classes)
4. Diffusion (2 classes)
5. Mechanical properties of metals (3 classes)
6. Dislocations, strengthening and failure (2 class)
7. Phase diagrams (2 classes)
8. Thermal processing of metal alloys (1 classes)
9. Ceramics (1 class)
10. Polymers (1 classes)
11. Materials in industry (2 classes)
12. Tests (2 classes)

ABET category content as estimated by faculty member who prepared this course description:

Engineering Science: 3 credits
Engineering Design: 0 credits

Prepared by: Francisco Barba Date: June 7, 1995
ENGI 422
Industrial Manufacturing Processes

Catalog Data:

Textbook:

Reference:

Coordinator:
Juan Torres Gorbea, B.S.I.E., Assistant Professor of IE

Goals:
This course is designed to provide a balanced coverage of the relevant fundamentals and real world practices, so that the students develop a good understanding of the important interrelationships among the many technical and economics factors involved in the manufacturing environment.

Prerequisites by topic:
2.- The Structure and Strengthening by Heat Treatment of Metal Alloys.
3.- Physical Properties of Materials.

Topics:
1.- Forming and Shaping Processes and Equipment (5 classes)
   - Rolling, Forging, Extrusion and Drawing, Sheet-Metal Forming, Power Metallurgy,
   - Forming and Shaping Plastics and Composites Materials, Forming and Shaping,
   - Ceramics and Glass
2.- Material Removal Processes and Machines (5 classes)
   - Fundamentals of Cutting
   - Machining Centers and Machining Economics
   - Abrasive Processes and Finishing Operations
   - Nontraditional Machining Processes
3.- Joining Processes and Equipment (2 classes)
   - Oxyfuel Gas, Arc and Resistant Welding and Cutting Processes
   - The Metallurgy of Welding, Welding Design and Process Selection
4.- Common Aspects of Manufacturing (2 classes)
   - Engineering Metrology, Testing, Inspection and Quality Assurance
5.- Manufacturing in a Competitive Environment (1 class)
   - Automation of Manufacturing Processes
   - Computer Integrated Manufacturing
6.- Competitive Aspects and Economics of Manufacturing (1 class)
7.- Principles of Pharmaceutical Processes (1 class)
8.- Pharmaceutical Dosage Forms (1 class)
9.- Product Processing, Packaging, Evaluation and Regulations (1 class)
10.- Tests (3 classes)
Project: Term paper of a particular manufacturing process (10-12 pages)
ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 2.5 credits or 83%
Engineering Design: .5 credits 17%

Prepared by Johnny Torres

Date: March 27, 1995
ENGI 449
Engineering Economics

Catalog


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering

Goals: This course is designed to give fourth year industrial engineering students the ability to evaluate investment alternatives for manufacturing and service industries. It first introduces the student to the mechanic of time-value of money and then goes through the different evaluation models currently in use, form cash flow estimation to economic evaluation.

Prerequisites by Topic:
1. Calculus
2. Probability Concepts

Topics:
1. Introduction to Engineering Economics. (1 class)
2. Time Value of Money. (2 classes)
3. Discounted Cash Flow Calculations. (3 classes)
4. Present Worth Comparison. (2 classes)
5. Equivalent Annual Worth Comparisons. (1 class)
6. Rate of Return Comparisons. (3 classes)
7. Analysis of Public Projects (1 class)
8. Replacement Analysis. (1 class)
9. Depreciation and Income Tax considerations. (2 classes)
10. Sensitivity Analysis. (1 class)
11. Break-even Analysis. (1 class)
12. Decision Trees. (2 classes)
13. Tests. (3 classes)

ABET category content as estimated by faculty member who prepared this course description: Others:
3 credits or 100% Prepared by: Rafael Cruz Date: May 24, 1995
IE 200
INTRODUCTION TO INDUSTRIAL ENGINEERING

Catalog Data: IE 200: Introduction to Industrial Engineering. Credit 1. This course gives a broad and fundamental view of the field of industrial engineering in both its traditional and contemporary aspects. Topics include quality control, human factors, engineering economy, motion and time study, operations research, production and inventory control, facilities planning and design, etc. Applications in both industrial and service environments are discussed. Pre-requisite: ENGI 146

Textbook: No textbook has been assigned to this course.

Salvendy, Gavriel, Handbook of Industrial Engineering, 2nd ed. John Wiley

Coordinator: Cuauhtémoc Godoy, Associate Professor of Industrial Engineering.

Goals: This course presents freshmen students an overview of industrial engineering both as a profession as well as an academic program at PUPR. It includes: ie definition, roles and typical activities of ie's inside an organization. Typical applications of ie techniques in both manufacturing and service organizations. It introduces the student to the IE department at PUPR including: curriculum, faculty, laboratories, student organizations and graduation requirements.

Prerequisites by topic:

1. Engineering design concepts.
2. Computer literacy.

Topics:

1. Quality & World Class Manufacturing Concepts. (1 class)
2. IE definition. IE in the manufacturing & service sectors. IE functions. (1 class)
3. Quality, Variability & SPC. (2 classes)
5. Productivity & Methods Engineering. (2 classes)
6. Human Factors and Ergonomics. (1 class)
7. Linear Programming. (2 classes)
8. Production Planning and Control. Facilities Planning & Layout. (1 class)
9. IE Curriculum at PUPR, staff and labs. Student chapters and professional societies. (1 class)

Computer Usage:
Homework assignments and projects should be prepared using word processing. Project presentation should be prepared using presentation software.

ABET category content as estimated by faculty member who prepared this course.

Engineering Science: 0.5 credits or 50 %.
Engineering Design: 0 credits or 0 %.
Other: 0.5 credit or 50 %

Prepared by: Cuauhtémoc Godoy
Date: March 27, 1995
IE 275
Computer Tools for IE's

Catalog
Data: IE 275 - Computer tools for IE's. Credits 2. Introduction to the use of computer software commonly used by industrial engineers in their day to day work. Including spreadsheets, statistical, and database software. Prerequisites: IE 200.

Statgraphics, Prentice Hall.

Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering

Goals: This course is designed to give IE freshmen students basics skills of data management through the use of database, spreadsheets and programs for statistical analysis in the computer.

Prerequisites by topic:
1. General knowledge on how to use a PC.
2. General knowledge of DOS.

Topics:

PART 1: SPREADSHEETS
1. The computer and spreadsheets. (1 class)
2. Spreadsheets basics. (1 class)
3. Fundamental commands in spreadsheets. (1 class)
4. Using functions. (1 class)
5. Managing files. (1 class)
6. Building spreadsheets models. (1 class)
7. Creating reports and graphics. (1 class)
8. Spreadsheets, word processors and database interaction. (1 class)

PART 2: COMPUTER IN STATISTICS
1. The computer and statistics programs (Statgraphics or equivalent). (1 class)
2. Statistics programs basics. (2 classes)
3. Data management. (1 class)
4. System environment. (1 class)
5. Report writer and graphics. (1 class)

PART 3: Database
1. Fundamental concepts of data bases (2 classes)
2. The computer and database programs. (1 class)
3. Database basics. (1 class)
4. Fundamental commands in database programs. (1 class)
5. Data management. (1 class)
6. Database environment. (1 class)

Computer Usage:
1. Homework assignments for each topic, requiring use of software on and IBM PC or compatible
2. Each student must write and run applications models for spreadsheets, database and statistics.
3. Each student must present a project integrating the topics covered in the course.
4. Each student must present solutions to solve a case study problem using the computer.
ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 0 credits or 0%    Engineering Design: 0 credits or 0%    Other: 2 credits or 100%

Prepared by: Wilfred Fonseca               Date: May 24, 1995
IE 312
Statistics for Engineers I


Coordinator: Professor María de L. Rodríguez, Assistant Professor, Industrial Engineering

Goals: This course is designed to give sophomore Industrial Engineering students a deep understanding of statistical tools focusing on their application to engineering design.

Prerequisites by Topic:
1. Normal, Binomial, Hypergeometric, Geometric and Poisson probability distributions.

Topics:
1. Random sampling. (3 classes)
2. Estimation. (4 classes)
3. Test of Hypotheses. (6 classes)
4. Goodness of Fit Test. Test for Independence. Test for Homogeneity. (2 classes)
5. Non-Parametric Statistics. (3 classes)
6. Tests (3 classes)

Computer Usage:
Use of an electronic spreadsheet or available computer software in most of the assignments. This course has a laboratory where extensive use of the computer is required.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 3 credits or 100% Engineering Design: 0 credits or 0%

Prepared by: María de L. Rodríguez Date: March 27, 1995
IE 313
Statistics Laboratory

Catalog Data: IE 313 - Statistics Laboratory. Credit 1. Laboratory practices and exercises using statistical computer software aimed at demonstrating theoretical concepts in probability and statistics, such as the approximation of one probability distribution to another, central limit theorem, hypothesis testing and type I and II errors, etc. Prerequisites: Co-requisite IE 312

Textbook: Laboratory Manual


Coordinator: María de Lourdes Rodríguez, Asistente Professor, Industrial Engineering

Goals: This course is designed to develop students statistical analysis skills using the computer as a tool and bring the mechanisms to apply in experiments the concepts acquired in probability and statistics courses.

Prerequisites by topic:
1. Fundamental concepts of probability.
2. Statistical inference.

Topics:
1. Laboratory Introduction. (1 lab session)
2. Statistical data analysis. (2 lab sessions)
3. Practical Demonstration of the Central Limit Theorem. (2 lab sessions)
4. Practice to approximate hypergeometric by binomial distribution. (2 lab sessions)
5. Hypothesis Testing-Anthropometric Data. (2 lab sessions)
6. Type I & II Errors using the OC curve for sampling plans. (2 lab sessions)
7. Goodness of Fit test a) using statgraphics b) using SPCDT. (2 lab sessions)
8. Independence Tests. (2 lab sessions)
9. Projects presentations. (8 lab sessions)

Computer Usage:
Homework assignments for each topic requiring use of a statistics software on an IBM or compatible computer.

Final Project:
As final project, each student will establish a hypothesis about a particular population, design a sampling plan, obtained information from the sample, test his/her hypothesis and arrive at a conclusion about it. A final report is required.

ABET category content as estimated by faculty member who prepared this course.
Engineering Science: 0.5 credit or 50% Engineering Design: 0.5 credit or 50%

Prepared by: María de L. Rodríguez Date: March 27, 1995
IE 314
Statistics for Engineers II


Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering

Goals: To provide 3rd year Industrial Engineering students the knowledge to develop curve fitting models and design simple statistical experiments.

Prerequisites by Topic:
1. Matrix Algebra.
3. Hypothesis Testing.
4. Confidence Intervals.
5. Calculus

Topics:
1. Curve Fitting (8 classes)
   The method of Least Squares
   Inferences based on the Least-Squares Estimators
   Curvilinear Regression
   Multiple Regression
   Checking the adequacy of the model
   Correlation
   Multiple Linear Regression
   Stepwise & Backwise Elimination
2. Analysis of Variance (6 classes)
   Completely Randomized Design
   Randomized-Block Designs
   Multiple Comparisons
   Latin Square Design
   Greco-Latin Square Design
   Analysis of Covariance
   An introduction to Factorials Design
3. Applications to Reliability and Life Testing (4 classes)
   Reliability
   Failure-Time Distributions
   The Exponential Model in Reliability
   The Exponential Model in Life Testing
4. Tests (3 classes)

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Computer Usage:
Selected homework making use of stored programs on IBM PC format for Statistical Analyses. (20 weeks)
Project:
Student-generated project on formulation of a particular statistical experimental design.

ABET category content estimated by faculty member who prepared this course description:
Engineering Science: 2.5 credits or 83%  Engineering Design: 0.5 credits or 17%

Prepared by:  Wilfred Fonseca  Date:  March 27, 1995
IE 315
FINANCIAL ACCOUNTING FOR ENGINEERS

Catalog Data
IE 315 - Financial Accounting for Engineers. Credits 3. Corporate
Financial Reporting, Accounting Systems, Manufacturing Accounting Systems and Statement
Format, Revenue Recognition, Financial Statement Analysis, Accounting for and Control of Assets,
Liabilities and Owner's Equity. Pre-requisites: IE 275, SOHU252


Coordinator: Rosa M. Silva de la Maza, Assistant Professor of Industrial Engineering.

Goals: This course is designed to give 3rd year students in industrial engineering the understanding of
corporate annual reports as primary source of accounting information, preparing students to
understand and work with accounting information which require students to analyze and interpret
corporate annual report disclosures.

Prerequisites by Topics:
1. Microeconomic.
2. Computer Spreadsheets.

Topics:
1. Overview of corporate financial reporting (2 classes)
2. Accounting Systems (2 classes)
3. Manufacturing accounting systems and statement format (3 classes)
4. Revenue recognition (2 Classes)
5. Financial statement analysis (3 classes)
6. Current Assets (2 classes)
7. Noncurrent Assets (2 classes)
8. Liabilities (2 classes)
9. Owner's Equity (2 classes)
10. Tests (3 classes)

Computer Usage:
Homework assignments, requirements, requiring use of stored programa on IBM computer.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 0 credits Engineering Design: 0 credits Others: 3 credits or 100%

Prepared by: Rosa Silva Date: March 27, 1995
IE 333
Cost Analysis and Control

Catalog Data:

Textbook:

Reference:

Coordinator:
Juan A. Torres Gorbea, Assistant Professor, Industrial Engineering.

Goals:
This course is designed to give 3rd. year students in industrial engineering the understanding of cost accounting concepts. To develop the ability to prepare cost analyses and overhead costs as well as an introduction to budgeting for manufacturing plans.

Prerequisites by topic:
2. Data processing cycle.
3. Accounting for and control of assets.

Topics:
1. Cost Accounting Systems and Product Costing. (7 classes)
2. Differential Costs for decision making. (6 classes)
3. Cost Data for Performance Evaluation and Control. (7 classes)
4. Tests. (3 classes)

Computer usage:
1. Homework on job costing; allocating costs to departments.
2. Homework on Just in Time and Backflush Costing.
3. Homework on cost allocation to products and activity-based costing.
4. Homework on cost estimation; economic order quantity; make or buy decisions, differential costs.
5. Homework on budget preparation, performance evaluation.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 0 credits.
Engineering Design: 0 credits.
Other: 3 credits

Prepared by: Juan Torres Gorbea  Date: March 27, 1995
IE 344
SYSTEMS DESIGN I

Catalog Data:  IE 344 - Systems Design I. Credits 3. Ergonomic design principles, workplace design, health and safety, analysis include investigation of environmental and physical human characteristics. Aim is to improve efficiency, safety and operator well-being. Prerequisites: ENGI 315, IE 333


Coordinator:  Rosa Silva de la Maza, Assistant Professor of Industrial Engineering.

Goals:  This course is designed to give 3rd year IE students basic skills in systems work analysis, work methods design and work station design with an ergonomic approach.

Prerequisites by topics:
1.- Cost analysis
2.- Concepts of central tendency and dispersion.

Topics:
1.- Engineering Design (1 class)
2.- Operation Analysis (4 classes)
3.- Organization and Physical Design of the Workstation (4 classes)
4.- Equipment (4 classes)
5.- Work Environments (5 classes)
6.- Safety (2 classes)
7.- Tests (3 classes)

Computer Usage:
Homework assignments in topics 2,3 requiring use of software on an IBM or compatible computer.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science:  2.5 credits or 80%.
Engineering Design:  0.5 credits or 20%.

Prepared by:  Rosa Silva  Date: March 27, 1995
IE 348
SYSTEM DESIGN I LABORATORY

Catalog Data: IE 348 - System Design I Laboratory. Credit 1. Practical workplace and systems design. Main emphasis is on human characteristics which affect the design of systems, work-stations and jobs. Productivity improvement through job design. Field project to analyze noise control and illumination requirements. Co-requisite: IE 344.

Textbook: Laboratory Manual


Coordinator: Rosa Silva, Assistant Professor, Industrial Engineering

Goals: This course is designed to develop students basics skills and bring the mechanism to apply the concepts acquired in the system design course for system and work station design.

Prerequisites by topic:
1. Engineering design.
2. Operation analysis.
3. Anthropometry.
4. Organization and physical design of the workstation.
5. Work Environments.

Topics:
1. Operation Analysis. (2 classes)
2. Work Method improvement. (2 classes)
3. Work Station Design. (2 classes)
4. Line Balancing. (1 class)
5. Illumination. (2 classes)
6. Audiology. (2 classes)
7. Noise control. (2 classes)

Computer Usage:
1. Reports for each topic, requiring use of computer are required.

Field Project:
1. Industrial Noise Control.

ABET category content as estimated by faculty member who prepared this course:

Engineering Science: 0 credit or 0% Engineering Design: 1 credit or 100%

Prepared by: Rosa Silva Date: March 27, 1995
IE 354
HUMAN FACTORS

Catalog Data:
IE 354 - Human Factors. Credits 3. Human Factors and the study of people at work, which includes their characteristics, limitations, structure and functions of the human body, and human behavior. Study of the work environment. Prerequisites: IE 344, IE 348

Textbook:

References:
Eastman Kodak Company Ergonomic Design for People at Work, Vols. I and II.

Coordinator:
Rosa Silva de la Maza, Assistant Professor, Industrial Engineering.

Goals:
Understand the classical Human Factors approach to improving human performance and to the solution of health and safety problems, based on the study of human characteristics; recognition of human capacities, abilities, and limitations; and the application of this knowledge to the analysis and design of tools, and equipment.

Prerequisites:
Course in Work Systems Design.

Topics:
1.- Introduction - Goals of Ergonomics (1 class)
2.- The Anatomical and Mechanical Structure of the human Body
   A) Anthropometry (2 classes)
   B) Human Biomechanics (3 classes)
   C) Energy Requirements at Work (2 classes)
   D) Circulatory and Respiratory Systems (2 classes)
   E) The Vision Sense (1 class)
   F) The Hearing sense (1 class)
3.- Evaluation of Job Demands (4 classes)
4.- Manual Material Handling (3 classes)
5.- Tests (3 classes)

Computer Usage:
Homework assignments requiring use of software on an IBM or compatible computer.

ABET category content as estimated by faculty member who prepared this course description:
Basic Science: 2 credits Eng. Science 0.5 credits. Engineering Design: 0.5 credits.

Prepared by Rosa Silva Date: March 27, 1995
IE 416
Statistical Quality Control


Coordinator: María de L. Rodríguez, Assistant Professor, Industrial Engineering.

Goals: To give 4th year IE students the ability to design Statistical Quality Control procedures (Control charts and Acceptance Sampling Plans) as an element of an overall manufacturing process or service system.

Prerequisites by topic:
1. Normal, Binomial, Hypergeometric, Geometric and Poisson probability distributions behavior.
2. Hypothesis Testing.
5. Random testing.

Topics:
1. Process Data Behavior Characterization. (2 class)
2. Process Capability Analysis. (1 class)
3. Tolerance Limits Establishment. (1 class)
4. Synthesis, criteria establishment, construction and sensitivity analysis Quality Control Chart types: (8 classes)
   Xbar/R Control Chart  P-Chart, NP-Chart
   Xbar/S Control Chart  C-Chart
   Control Chart for Individuals
5. Development of Single, Double, Multiple and Sequential Acceptance Sampling Plans: (4 classes)
7. Tests (3 classes)

Computer Usage:
Selected homework making use of stored programs on IBM PC format for Statistical Process Control Design and Statistical Analyses. (4 weeks)
Project:
Student-generated project on the full design of an Xbar/S Quality Control Chart using available design software.

ABET category content estimated by faculty member who prepared this course description:
Engineering Science: 2 credits or 67%  Engineering Design: 1 credit or 33%

Prepared by: María de L. Rodríguez  Date: March 27, 1995
IE 428
Operations Research I

Catalog

Data: IE 428 - Operations Research I. Credits 3. Deterministic models in operations research. The course covers the use of linear programming techniques for modeling and solving problems. Solutions to the problems are analyzed using sensitivity analysis. Mathematical algorithms used in the course are Simplex, transportation, assignment, minimum spanning tree, shortest route, and maximum flow. Pre-requisites: IE 333.


Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering

Goals: The general goal of the course is to teach students to model and solve non-trivial, real-life situations as a mathematical problem, stating the goal of the model and its constraints.

The specific goal is for students to learn linear programming for modeling and solving mathematical models, and perform sensitivity analysis on solutions.

Prerequisites by Topic:
1. Algebra and matrix algebra.
2. Cost structure of business.

Topics:
1. Review of matrix algebra (1 class)
2. Construction and graphical solution of linear models in two variables. (1 class)
3. Formulation of real-life situations as a mathematical model. (2 classes)
4. Standard form of the Simplex Method. Initial solution. (1 class)
5. Simplex algorithm, finding the optimal solution. (1 class)
6. Penalization method (Big-M), artificial basic solution. (1 class)
7. Two-phase method to solve LP models. Definition of duality. (2 classes)
8. Revised Simplex Method (2 classes)
9. Relationship of the primal and dual problems. Interpretation of dual variables. (1 class)
10. Dual-simplex method to solve linear programming models. (1 class)
11. Sensitivity analysis of the optimal solution. (2 classes)
12. Definition and solution to the transportation problem. (2 classes)
13. Specific cases of transportation models, assignment, transhipment. (2 classes)

14. Modeling and solution to networking problems, i.e., minimum spanning tree, shortest route, and maximum flow. (2 classes)
15. Tests (2 classes).

Computer Usage:
Students will be exposed to an operations management software to model and solve the problems presented in class. It is expected to cover two (2) homeworks using the software.
ABET category content as estimated by faculty member who prepared this course description:
Math and basic science: 1.0 credit or 33.33%  Engineering Science: 1.5 credits or 50.00%
Engineering Design: 0.5 credit or 16.67%

Prepared by: Wilfred Fonseca  Date: March 27, 1995
IE 429

Operations Research II

Catalog Data: IE 429 - Operations Research II. Credit 3. Stochastic models in operations research. The course covers the use of operations research techniques for modeling and solving optimization problems associated with stochastic processes. Prerequisites: IE428


Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering

Goals: To give 4th year IE students techniques in the formulation and modeling for optimization of System Simulation, Queuing Theory and Integer Programming.

Prerequisites by topic:
2. Formulation and Solution of Linear Programming Models.
3. Flow Charting.

Topics:
1. Integer Programming (4 classes)
   Solving Knapsack Problems by the Branch and Bound Method.
2. Markov Chains, Birth and Death Processes (4 classes)
3. Queuing Theory (6 classes)
   Modeling Arrival and Service Processes
   Birth and Death Process
   The M/M/1/GD/∞/∞ Queuing System
   The M/M/1/GD/c/∞ Queuing System
   The M/M/s/GD/∞/∞ Queuing System
   The M/G/∞/GD/∞/∞ Queuing System
   The M/G/1/GD/∞/∞ and GI/G/1/GD/∞/∞ Models
   The M/M/1/GD/∞/∞ Queuing System
   Finite Source Models
   Exponential Queues in Series
4. System Simulation (6 classes)
   System Simulation Flow Charting
   Discrete Event Simulation
   Random Numbers and Monte Carlo Simulation
   Simulation with Continuous Random Variables
   Statistical Analysis in Simulation
5. Tests (3 classes)

Computer Usage: Each student must write, run and test 3 single variable simulation sub-routines which should fit a 4GL simulation language.
ABET category content estimated by faculty members who prepared this course description:
Engineering Science: 1 credits or 33%  Engineering Design: 1 credit or 33%
Math & Basic Science: 1 credit or 33%

Prepared by: Wilfred Fonseca  Date: March 27, 1995
IE 444
Systems Design II

Catalog Data:


Coordinator: Rosa Silva, Assistant Professor, Industrial Engineering

Goals: To give 3rd year Industrial Engineering students the ability to design work methods, and develop documentation, labor-material standard data, time study motion analysis, operation list, and use of predetermined time systems as a methods tool and to determine time/unit.

Prerequisites by topic:
1.- Operations analysis.
2.- Assembly line balancing.
3.- Economic analysis.
4.- Sampling.
5.- Curve fitting.

Topics:
1.- Work Measurement (2 classes)
2.- Rating (2 classes)
3.- Allowance (2 classes)
4.- Learnings Progress curves (2 classes)
5.- Occurrence Sampling (2 classes)
6.- Predetermined time systems (3 classes)
7.- Standard data systems (3 classes)
8.- Productivity concepts (2 classes)
9.- Implementation of design (2 classes)
10.-Tests (3 classes)

Computer usage:
Use of stored programs on IBM PC format for time study and motion analysis homework.

ABET category content estimated by faculty members who prepared this course description:
Engineering Science: 2.5 credits or 83% Engineering Design: 0.5 credits or 17%

Prepared by Rosa Silva Date: March 27, 1995
IE 448
SYSTEMS DESIGN II LABORATORY

Catalog Data: IE 448 - Systems Design II Laboratory. Credit 1. Laboratory practices to perform time studies including stop watch technique and standard data methods. Perform a work sampling study and develop a learning curve for an operation. Field project to analyze and improve operation and workstation design applying motion and time studies and work measurement techniques. Co-requisite: IE 444.

Textbook: Laboratory Manual


Coordinator: Rosa M. Silva, Assistant Professor, Industrial Engineering.

Goals: This course is designed to develop students basics skills and bring the mechanisms to apply the concepts acquired in the system design course for work measurement and design.

Prerequisites by topic:
1. Engineering design.
2. Operation analysis.
3. Anthropometry.
4. Organization and physical design of the workstation.
5. Work Environments.

Topics:
1. Productivity Analysis through Works Measurement and Method Analysis. (3 classes)
2. Work measurement. (2 classes)
3. Rating of an Operation. (2 classes)
4. Work sampling. (3 classes)
5. MTM. (2 classes)
6. Learning Curve. (2 classes)

Computer Usage:
Homework assignments for each topic, requiring use of computer for preparation of reports and graphics. Each student must present a project integrating the steps in the design process and systems design aided with the computer.

Laboratory project:
A field project is required, this project includes a study of existing work stations and report the following: time standard per unit, direct labor costs, workstation Layout and the develop of an improvement method and workstations Layout.
ABET category content as estimated by faculty member who prepared this course.

Engineering Science: 0 credit or 0%
Engineering Design: 1 credit or 100%

Prepared by: Rosa Silva

Date: March 27, 1995
IE 507
Design of Experiments


Coordinator: Wilfred Fonseca, Assistant Professor, Industrial Engineering.

Goals: To give 5th year IE students the ability to design statistical experiments.

Prerequisites by topic:

Topics:
1. Incomplete Block Designs (4 classes)
   Balanced Incomplete Block Designs
   Partially Balanced Incomplete Block Designs
2. Introduction of Factorial Designs (5 classes)
   Two-Factor Factorial Designs
   Random and Mixed Models
   General Factorial Design
3. $2^k$ and $3^k$ Factorial Design (5 classes)
   Confounding in the $2^k$ Factorial Design
   Confounding in the $3^k$ Factorial Design
   Partial Confounding
   Other Confounding Systems
4. Fractional Factorial Designs (6 classes)
   Fractional Replication of the $2^k$ Factorial Design
   Fractional Replication of the $3^k$ Factorial Design
5. Tests (3 classes)

Computer Usage:
1. Selected homework making use of stored programs on IBM PC format for Design of Experiments and Statistical Analyses.

Project:
Student-generated project on the full design of a Statistical Experiment using available DOE software.
ABET category content estimated by faculty member who prepared this course description:
Engineering Science: 2 credits or 67%  Engineering Design: 1 credit  or 33%

Prepared by: Wilfred Fonseca  
Date: March 27, 1995
IE 509
Planning of Quality Systems


Coordinator: María de L. Rodríguez, Assistant Professor, Industrial Engineering

Goals: To provide 5th year Industrial Engineering students general knowledge in the Planning of Quality Systems for an overall manufacturing process or service organization.

Prerequisites by topic:
1. Cost Accounting
2. Engineering Statistics

Topics:
1. Quality Policies and Objectives (2 classes).
2. Quality Costs Distribution (1 class).
4. New-Product Development Quality (2 classes).
6. Vendor Relations Strategy (2 classes).
7. Marketing of Quality (2 classes).
8. Field Performance Evaluation (1 class).
10. Motivation for Quality (2 classes).
11. Tests (3 classes).

ABET category content estimated by faculty member who prepared this course description:

Socio-humanistic: 0 credits or 0%
Engineering Design: 0 credit or 0%
Other: 3 credits or 100%

Prepared by: María de L. Rodríguez Date: March 27, 1995
IE 511
Industrial Robotics Applications


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering.

Goals: This course is designed to give fifth year Industrial Engineering students the fundamental about industrial robots and their interface with other manufacturing equipment.

Prerequisites by Topic:

1. Physics I - Mechanics
2. Physics II - Electricity
3. Fluid Mechanics

Topics:

1. Fundamentals (2 classes)
2. Control Systems and Components (5 classes)
3. Robot and Effectors/Sensors (4 classes)
4. Robot Programming (2 classes)
5. Economic Analysis (2 classes)
6. Robot Applications/Cell Design (4 classes)
7. Future Trends (1 class)
8. Tests (3 classes)

Computer Usage:
Use of mathematical software and/or engineering graphics software with mathematical capabilities to carry out force analysis and lengthy calculations related with course assignments.

ABET category content as estimated by faculty member who prepared this course description:

Engineering Science: 2.0 credits or 67%
Engineering Design: 1.0 credits or 33%

Prepared by: Rafael Cruz
Date: March 27, 1995
IE 516
Industrial Systems Simulation

Catalog Data: IE - 516 Industrial Systems Simulation. Credits 3. Use of animated simulation to evaluate the performance of different hypothetical manufacturing and service operations. The objective is to identify operational problems, develop and test alternative courses of action. Prerequisites: IE 429.


Reference:

Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering

Goals: This course is designed to give senior Industrial Engineering students the ability to develop animated simulation models to analyze new or existing operations to evaluate their performance, identify operational problems, develop and test practical solution design.

Prerequisites by Topic:
1. Probability/Statistics
2. Queuing theory
3. Systems design

Topics:
1. Software representation of physical system (6 classes)
2. Simulation of logical operations (7 classes)
3. Case analyses (7 classes)
4. Tests (3 classes)

Computer Usage:
This course requires intensive use of microcomputers. Each week, students are required to create a simulation model for a specific situation, identify and test alternatives for improvement, and write a report with their results, conclusions and recommendations.

Final Project:
No final project is required in this course

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 1.5 credits or 50%
Engineering Design: 1.5 credits or 50%

Prepared by: Rafael Cruz Date: March 27, 1995
IE 523
INVENTORY CONTROL SYSTEMS

Catalog Data: IE 523 - Inventory Control Systems. Credits 3. This course teaches quantitative techniques for designing inventory control systems in industry. The student will be exposed to mathematical models depicting the behavior of known inventory systems, i.e., economic order quantity, models for time-dependent and probabilistic demand. An introduction to MRP is also covered. Pre-requisites: IE 428.


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering

Goals: The general goal of the course is for students to understand a series of known inventory models, represented in mathematical form, for inventory control purposes in industrial organizations. The specific goal is for the students to learn the terminology involved in inventory control environments. The student should also be able to design and conceptually structure an inventory control system.

Prerequisites by Topic:
2. Understanding and plotting of time-series data.
3. Cost accounting terminology and concepts.

Topics:
1. Inventory control systems - problem definition, management functions. (1 class)
2. Economic cycle of the company and its relevance with inventory levels. (1 class)
3. Strategic inventory planning for individual products. (2 classes)
4. ABC classification aggregate planning. Cost consideration. (2 classes)
5. Inventory models for constant demand, i.e., EOQ. (2 classes)
6. Inventory control models for probabilistic demand, (s,Q), (s,S), (R,S), (R,s,S). (2 classes)
7. Selection of methods for establishing safety levels. (3 classes)
8. EOQ for time-dependent demands (3 classes)
9. Materials resource planning. (4 classes)
10. Tests. (3 classes)

Computer Usage: Although not required, some exercises and problems assigned for homework are easier to solve when using the computer.
ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 2 credits or 67%  Engineering Design: 1 credit or 33%

Prepared by: Rafael Cruz  Date: March 27, 1995
IE 524
Production Planning and Control


Coordinator: Johanna Cedeño, Assistant Professor, Industrial Engineering

Goals: This course is designed to give fifth year Industrial Engineering students the ability to analyze and design operations plans for manufacturing and service industries. It takes them through each stage of the evaluation and design process, from demand forecasting to capacity analysis. It is also the purpose of this course by Topic introduce the students to new management philosophies.

Prerequisites by topic:
1. Statistics
2. Knowledge of a statistical data analysis software
3. Linear programming
4. General knowledge about the behavior of industrial and service operations.

Topics:
1. Manufacturing Systems (2 classes)
2. Forecasting, (5 classes)
3. Production Planning.(4 classes)
4. Capacity Planning. (4 classes)
5. Scheduling (3 classes)
6. New Management Philosophies. (2 classes)
7. Tests (3 classes)

**Computer Usage:**
All assignments require computer solutions to problems related to every topic covered in the course.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 2 credits or 67%
Engineering Design: 1 credit or 33%

Prepared by: Johanna Cedeño
Date: March 27, 1995
IE 526
Computer Integrated Manufacturing


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering.

Goals: This course is designed to give fifth year Industrial Engineering students the knowledge required to design and evaluate computer integrated production systems. The objective is the integration of self-contained, stand alone equipment into a manageable system.

Prerequisites by Topic:
1. Computer literacy. (2 classes)
2. Process Engineering. (3 classes)
3. Fixed Automation. (1 class)
4. Numerical Control. (4 classes)
5. Process Planning. (3 classes)
6. System Integration. (3 classes)
7. Laboratory Projects (4 classes)
8. Tests (3 classes)

Computer Usage:
Use of a software that will simulate actual operation of a CNC machine. Students are also required to carry out two laboratory projects.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 2.0 credits or 67%
Engineering Design: 1.0 credits or 33%

Prepared by: Rafael Cruz           Date: March 27, 1995
IE 530
Facilities Planning and Design

Catalog Data: IE 530 - Facilities Planning and Design. Credits 3. Principles and practice of planning, location and layout of facilities and the handling of materials as applied to process industries, intermittent and continuous manufacturing. Prerequisites: IE523, IE524.


Coordinator: Juan A. Torres Gorbea, Assistant Professor, Industrial Engineering.

Goals: This course is designed to give the fifth year students in Industrial Engineering the ability to design manufacturing or service facilities through the integration of previous education in IE.

Prerequisites by topic:
1. Forecasting.
2. Economic Order Quantity, Period Order Quantity.
3. Capacity Planning.
5. Precedence Diagram.
6. Ability to use the following software: computer aided design, spreadsheets, databases, decision analysis.

Topic:
1. Strategy, long range forecasting, plant expansion and investment. (3 classes)
2. The engineering design process in the plant location and layout problem. (3 classes)
3. Developing alternatives: Material handling, layout, computer aided layout. (4 classes)
4. Developing alternatives: Manufacturing, receiving and shipping, storage and warehousing. (4 classes)
5. Developing alternatives: Quantitatively. (3 classes)
6. Tests. (3 classes)

Computer Usage:
1. Homework on Just in Time and its effect on plant layouts.
2. Homework on the use of CRAFT in the development of layouts in chapter 8.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 1.5 credits or 50% Engineering Design: 1.5 credits or 50%

Prepared by: Juan A. Torres Date: March 27, 1995
IE 531
MANUFACTURING RESOURCES PLANNING (MRP II)

Catalog Data: IE 531 - Manufacturing Resources Planning (MRP II). Credits 3. From a given business plan, students explode it into a production and materials purchasing schedule. The students also learn how to construct the bill of material and performance measurements for shop floor control. Topics covered in detail are: master schedule, materials planning, and database management, when using a computerized MRP module. Pre-requisites: IE523.

Textbook: None


Coordinator: Johanna Cedeño, Assistant Professor, Industrial Engineering.

Goals: The general goal of the course is to teach students the complete process of planning physical resources and material purchases in an industrial organization. The specific goal is for students to understand in depth how to explode a business plan into a feasible, detailed production and purchasing schedule. Another part of the goal is to teach how to develop and use the various components of this process, i.e., bill of material, master schedule, routings, and shop floor control.

Prerequisites by Topic:
1. Understanding of production control systems.
2. Exposure to forecasting techniques.
3. Operational analysis and work flow design.

Topics:
1. Why do we plan? Function of planning in the overall business strategy. Relation of a business, sales, production, and materials plans. (1 class)
2. The Manufacturing Resource Planning (MRP II) road map - how to get there. (1 class)
3. The construction of the master production schedule. (3 classes)
4. From a master schedule to a material schedule. (2 classes)
5. Capacity planning: capacity vs load, balanced capacity vs balanced flow. (2 classes)
6. The Bill of Material (BOM) and it's use in the MRP cycle. (2 classes)
7. Managing for inventory accuracy... How to use cycle counting. (1 class)
8. Routing records for MRP II: process and products. (2 classes)
9. Execution of the purchasing plan, considerations to take. (1 class)
10. Shop floor control: how to manage priorities. (2 classes)
11. Performance measurements for managing the plan (2 classes)
12. Tests (2 classes).
Computer Usage:
1. It will be required to practice the techniques learned in class using a MRP program.

Laboratory projects:
1. Working in teams, students will be required to do four homeworks using the MRP computer package.
2. A complete company scenario with a feasible plan must be completed at the end of the class.

ABET category content as estimated by faculty member who prepared this course description:
   Engineering Science: 2.5 credits or 83.33%   Engineering Design: 0.5 credit or 16.67%

Prepared by: Johanna Cedeño                   Date: March 27, 1995
IE 534
JUST-IN-TIME

Catalog Data: IE534 - Just-In-Time. Credits 3. This course teaches the techniques behind a Just in Time manufacturing/management philosophy. The main focus of the course is in waste identification and elimination through the development of a continuous improvement process. Topics covered include structured flow, small lot size, employee involvement and total quality. There is also a brief discussion on how to move from MRP to JIT. Prerequisites: IE 523, IE 524.

Textbook: None


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering.

Goals: The general goal of the course is to introduce students to the concepts behind a Just in Time environment in a manufacturing system.

The specific goal is to teach students the techniques of waste elimination in all activities in order to continually improve manufacturing performance.

Prerequisites by Topic:
1. Production planning and inventory control systems.
2. Cost accounting.

Topics:
1. Just in Time (JIT) and the manufacturing excellence path. (2 classes)
2. Operational aspects of JIT - structured flow, small lots. (3 classes)
3. Supporting environment for JIT - setup reduction, preventive maintenance. (3 classes)
4. People management for effective implementation of JIT - employee involvement. (2 classes)
5. The total quality focus and its relevance to a JIT environment. (3 classes)
6. The supplier partnership as a way to extend the pull system. (2 classes)
7. Performance measurements for day-to-day operations and long term planning. (2 classes)
8. The transition from traditional MRP to a JIT system. (3 classes)
Computer Usage:
1. Items 2 and 3 above use a computer simulated environment to analyze the impact of these changes in overall manufacturing performance.

ABET category content as estimated by faculty member who prepared this course description:

Engineering Science: 2.5 credits or 83.33%
Engineering Design: 0.5 credit or 16.67%

Prepared by: Rafael Cruz  Date: March 27, 1995
IE 539
Facilities Planning and Design Project

Catalog Data:  IE 539: Facilities Planning and Design Project. Credit 1. Students are required to prepare a project for designing or redesigning the facilities at an industrial site. Periodic reports both oral and written required as specified by the instructor. Prerequisites: IE 516, IE 530.


Coordinator:  Juan A. Torres Gorbea, Assistant Professor, Industrial Engineering

Goals:  This course is designed to give 5th year IE students the ability to design manufacturing or service facilities through the integration of previous education in IE.

Prerequisites by topic:
1. Strategic facilities planning.
3. Development of alternatives for material handling.
4. Development of alternatives for space requirements.
5. Production activity control.
6. Ability to use the following software: computer aided design, spreadsheets, database, decision analysis.

Topics:
1. Report on the strategic objectives to be satisfied by the plant layout.
2. Report describing the product, process, schedules, and facilities.
3. Report identifying the alternatives proposed to draft the layout.
4. Report evaluating the alternatives.
5. Report explaining the selection of the preferred alternative.
6. Oral presentation of the project.

Computer usage:
Preparation of the reports with the aid of one or more of the following software: word processing, flow charting, decision analysis, spreadsheet, database.

Preparation of the analysis of schedules with the aid of software for production and inventory control, materials requirement planning, spreadsheet, queing, simulation.

Preparation of the detailed layout design using computer aided drafting, flow charting software.
Laboratory projects:
The project will be developed in its entirety in an ongoing manufacturing or service industry.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Design: 1 credits or 100%.

Prepared by: Juan Torres
Date: March 27, 1995
IE 544
Systems Design III


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering.

Goals: This course is designed to give fifth year Industrial Engineering students the knowledge required to design and control manufacturing systems able to compete in global markets. Emphasis is given to understand the need for new performance measurements as well as management philosophies and techniques.

Prerequisites by Topic:
1. Production systems design
2. Inventory Planning and Control
3. Management Accounting

Topics:
1. Manufacturing Environment (1 class)
2. Current Manufacturing Operations. (3 classes)
3. Identifying and Managing Constraints. (4 classes)
4. Synchronizing the Operation. (6 classes)
5. Manufacturing Operations. (6 classes)
6. Tests (3 classes)

Computer Usage:
Use of an animated simulation software to simulate hypothetical cases. A written report is required for each case studied.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 2.0 credits or 67%
Engineering Design: 1.0 credits or 33%

Prepared by: Rafael Cruz Date: March 27, 1995
Catalog Data: IE 546 - Industrial Engineering Practice. Credits 3. Professionally supervised experience in a real-life environment involving projects for which the student assumes a degree of professional responsibility. Activities must be approved in advance by the student's advisor. May consist of full-time or part-time engineering experience, in an industrial or service setting, either individually or as a responsible group member. Periodic reports both oral and written required as specified by the advisor. Pre-requisites: Approval of Department Head.

Textbook: None

Reference: All Industrial Engineering textbooks

Coordinator: Cuauhtémoc Godoy, Associate Professor, Industrial Engineering

Goals: Provide students the experience to practice Industrial Engineering in an industrial manufacturing or service setting. This experience will allow them to familiarize with a working environment, its demands and day to day requirements. They should be able to work in teams, and handle IE related projects with due dates established.

Prerequisites by topic: No specific topics are required, however students must be in their fifth year

Topics:
1. Student orientation about IE practice requirements
2. Students are expected to complete 500 hours of IE practice in an industrial manufacturing or service setting. They should submit a letter from the company indicating the type of projects assigned to the student and the students involvement in those projects.
3. Students are required to submit weekly progress reports
4. Students must submit a final report, as well as an oral presentation.
5. An oral examination is also required.

Computer Usage:
1. Students are expected to use all software packages related to the projects assigned by the company.
2. All progress reports must be prepared using a word processor
3. The oral presentation must be presented making use of a presentation software

ABET category content estimated by faculty member who prepared this course description:
Other: 3 credits or 100%

Prepared by: Cuauhtémoc Godoy Date: March 27, 1994
Catalog: IE 548 - Systems Design III. Credit 1. Through the use of specially designed manufacturing simulators students will be able to apply the material learned regarding manufacturing control, analysis of dependent events in manufacturing systems, identifying and managing constraints, synchronized manufacturing, ongoing improvement, and analysis of manufacturing operations. Co-requisite: IE 544.


Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering.

Goals: This course is designed to give fifth year Industrial Engineering students the experience required in the analysis of improvement alternatives. Emphasis is given to understand the need for new performance measurements as well as management philosophies and techniques. Through the use of computer simulators and case studies, students will carry out productivity improvement analysis to determine their real impact to the company's bottom line.

Prerequisites by Topic:
7. Production systems design
8. Inventory Planning and Control
9. Management Accounting

Topics:
1. Introduction to the simulators. (1 Class)
2. Case 1: Simulation 10 - Base Case, Case 2: Simulation 11 - Efficiencies, Case 3: Simulation 12 - Batch Sizing (1 Class)
3. Case 4: Simulation 13 - Engineering Improvements, Case 5: Simulation 14 - Trimming Capacity to Reduce Operating Expense (2 Classes)
6. Case 14: Simulation 110 - Reworking at a Bottleneck, Case 15: Simulation 111 - Creating a CCR Reworking at a Non-Bottleneck, Case 16: Simulation 112 - Reworking BN Parts on a Non-BN, Case 17: Simulation 113 - Coping with malfunctions on BN, Case 18: Simulation 114 - Coping with malfunctions on a Non-BN (2 Classes)
8. Tests (2 classes)

Computer Usage:
Use of an animated simulation software to simulate hypothetical cases. A written report is required for each case studied.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 2.5 credits or 83.33%
Engineering Design: 0.5 credits or 16.67%

Prepared by: Rafael Cruz Date: March 27, 1995
IE 590
Capstone Design Course

Catalog Data: IE 590 - Capstone Design Course. Credits 4. Student teams work on professional-level engineering projects selected from a wide range of participating organization. Projects are equivalent to those normally experienced by beginning professionals, and require integration of Industrial Engineering concepts. Oral and written reports and examinations. Pre-requisite: Approval of department head. Pre-requisite: IE 530. Co-requisite: IE 516.

References: Depending on the specifics of the project, students must develop their own list of references.

Coordinator: Rafael Cruz, Associate Professor, Industrial Engineering

Goals: This course is designed to give fifth year Industrial Engineering students hands on experience in the integration of their industrial engineering knowledge. It requires data collection, analysis and results evaluation of a particular problem in a manufacturing/service industry continue to design alternative solutions and evaluate such solutions. Emphasis is given to the integration of techniques and the design process.

Prerequisites by Topic:
1. Production systems design
2. Inventory Planning and Control
3. Facilities Planning
4. Quality Control/Design of Experiments
5. Systems Simulation
6. Operations Research

Topics:
1. Project proposal, project presentation and content. (1 class)
2. Progress report. (6 classes)
3. Project presentation. (1 class)

The project will be carry out in groups of up to four students. Meetings to evaluate or discuss specific situations will be based on group needs, by appointment with the faculty advisor assigned to the group carrying out the project.

Student groups will choose their senior design project from a list of real life situations obtained from a wide variety of manufacturing/service industries. The list will contain project previously evaluated by a faculty committee to assure that they meet the department's criteria related to IE techniques integration and design requirements.

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 0 credits or 0%  Engineering Design: 4.0 credits or 100%

Prepared by: Rafael Cruz  Date: March 27, 1995
## TABLE XII
### COURSE REQUIREMENTS OF CURRICULUM
#### BASIC-LEVEL PROGRAM

<table>
<thead>
<tr>
<th>Year; Semester or Quarter</th>
<th>Course</th>
<th>Math &amp; Basic Science</th>
<th>Engineering Topics</th>
<th>Humanistics &amp; Social Sciences</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Engrg. Science</td>
<td>Engrg. * Design</td>
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</tr>
<tr>
<td>1-A</td>
<td>MATH 111 - Precalculus I</td>
<td>( )</td>
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<tr>
<td></td>
<td>ENGL 111 - English Reading &amp; Writing</td>
<td>( )</td>
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<tr>
<td></td>
<td>SPAN 111 - Spanish Reading &amp; Writing</td>
<td>( )</td>
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<tr>
<td>1-B</td>
<td>MATH 122 - Precalculus II</td>
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<td>SCIE 111 - General Chemistry</td>
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<td>SCIE 112 - Chemistry Laboratory</td>
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<td>( )</td>
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<tr>
<td></td>
<td>ENGL 251 - Analysis of World Literature</td>
<td>( )</td>
<td>( )</td>
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<tr>
<td>1-C</td>
<td>MATH 133 - Calculus I</td>
<td>3</td>
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<tr>
<td></td>
<td>SOHU 251 - Socio Humanistic Studies I</td>
<td>( )</td>
<td>( )</td>
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<td>3</td>
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<tr>
<td></td>
<td>ENGI 139 - Computer Aided Design</td>
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<tr>
<td>1-D</td>
<td>MATH 144 - Calculus II</td>
<td>3</td>
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<tr>
<td></td>
<td>SCIE 213 - Physics I-Mechanics</td>
<td>3</td>
<td>( )</td>
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<tr>
<td></td>
<td>SCIE 214 - Physics I Laboratory</td>
<td>1</td>
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<tr>
<td></td>
<td>ENGI 146 - Freshman Engineering Design</td>
<td>(1)</td>
<td>( )</td>
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</tbody>
</table>

*See instructions on reverse. Check only those courses that contain significant design. Provide (in parentheses) engineering design credit hours for courses and for the totals only when required by program criteria.

(continued on next page)
### TABLE XII
**COURSE REQUIREMENTS OF CURRICULUM BASIC-LEVEL PROGRAM**

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<thead>
<tr>
<th>Year; Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Math &amp; Basic Science</th>
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<th>Humanities &amp; Social Sciences</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-A</td>
<td>MATH 215 - Calculus III</td>
<td>3</td>
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<tr>
<td></td>
<td>SCIE 235 - Physics II Heath, Light &amp; Sound</td>
<td>3</td>
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<td></td>
<td>SCIE 236 - Physics II Laboratory</td>
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<td>ENGI 220 - Computer Programming &amp; Algorithms</td>
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<td>2-B</td>
<td>MATH 226 - Calculus IV</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>SCIE 249 - Physics III Electricity &amp; Magnetism</td>
<td>3</td>
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<tr>
<td></td>
<td>SCIE 250 - Physics III Laboratory</td>
<td>1</td>
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<tr>
<td>2-C</td>
<td>MATH 237 - Differential Equations</td>
<td>3</td>
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<tr>
<td></td>
<td>ENGI 322 - Applied Mechanics-Statics</td>
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<tr>
<td></td>
<td>IE 200 - Introduction to Industrial Engineering</td>
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<td></td>
<td><strong>Elective Socio-Humanistics</strong></td>
<td>( )</td>
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<tr>
<td>2-D</td>
<td>ENGI 324 - Mechanics of Materials I</td>
<td>2.5</td>
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<tr>
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<td>SPAN 251 - Hispanic Literature</td>
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<tr>
<td></td>
<td>IE 275 - Computer Tools for IE's</td>
<td>( )</td>
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</tbody>
</table>

*(continued on next page)*

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<th>Other</th>
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<tbody>
<tr>
<td>3-A</td>
<td>IE 315 - Financial Accounting</td>
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<td>( )</td>
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<td></td>
<td>ENGI 315 - Probability for Engineers</td>
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<td></td>
<td>PHIL 441 - Professional Ethics in Engineering</td>
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<td>IE 312 - Statistics for Engineers</td>
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<td></td>
<td>IE 313 - Statistics Laboratory</td>
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<td>ENGI 325 - Engineering Mechanics - Dynamics</td>
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<td>EE 3800 - Principles of Electrical Engineering</td>
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<td>ENGI 327 - Fluid Mechanics</td>
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<td>ENGI 422 - Manufacturing Processes</td>
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<td>IE 314 - Statistics for Engineers</td>
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<td>IE 348 - Systems Design I Laboratory</td>
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</tbody>
</table>

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<td></td>
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<td>Engrg. * Design</td>
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<td>IE 4800 - Industrial Electronics</td>
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<td></td>
<td>ENCI 449 - Engineering Economics</td>
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<td></td>
<td>IE 416 - Statistical Quality Control</td>
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<td>4-B</td>
<td>IE 354 - Human Factors &amp; Ergonomics</td>
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<td>IE 428 - Operations Research I</td>
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<td>IE 444 - Systems Design II</td>
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<td>IE 448 - Systems Design II Laboratory</td>
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<td>IE 429 - Operations Research II</td>
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<td>IE 524 - Production Planning &amp; Control</td>
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<tr>
<td>4-D</td>
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<td>( )</td>
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<tr>
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<td>IE 511 - Industrial Robotics Applications</td>
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<td>IE 512 - Industrial Robotics Laboratory</td>
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<td></td>
<td>IE 523 - Inventory Control Systems</td>
<td>2</td>
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</table>

*(continued on next page)*

*See instructions on reverse.* Check only those courses that contain significant design. Provide (in parentheses) engineering design credit hours for courses and for the totals only when required by program criteria.
<table>
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<tr>
<th>Year; Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Math &amp; Basic Science</td>
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<td>5-A</td>
<td>IE 516 - Industrial Systems Simulation</td>
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<td>IE 530 - Facilities Planning &amp; Design</td>
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<tr>
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<td>IE 544 - Systems Design III</td>
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<td>IE 539 - Facilities Planning &amp; Design Project</td>
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<td>5-C</td>
<td>IE 590 - Capstone Design Course</td>
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<td>IE 590E - Capstone Design Course Extension</td>
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<tr>
<td>Totals: ABET Basic-Level Requirements</td>
<td>36.5</td>
<td>52</td>
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**OVERALL TOTAL FOR DEGREE**

**PERCENT OF TOTAL**

<table>
<thead>
<tr>
<th>Must satisfy one set of conditions</th>
<th>Minimum semester credit hours</th>
<th>TOTAL=48</th>
<th>16</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum quarter credit hours</td>
<td>48</td>
<td>TOTAL=106</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Minimum percentage</td>
<td>25</td>
<td>TOTAL=37.5</td>
<td>12.5</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Note that instructional material and student work verifying course compliance with ABET criteria for the categories indicated above will be required during the campus visit.

*Check only those courses that contain significant design. Provide (in parentheses) engineering design credit hours for courses and for the totals only when required by program criteria.*
F. Alternative Modes

This program is not offered in alternative modes.

G. Advanced-level curriculum

No accreditation of an advanced-level program is being sought.

H. Advising System

The PUPR's advising system mainly consists of professional counseling, academic advisement and faculty mentoring. The system has mainly been designed to assist every student prior to, and during registration, in the selection and sequence of required and elective courses. This assistanship is available throughout the whole five-year program. However, mentors handle other student needs, such as, orientation regarding graduate studies, job search or checking for students meeting the graduation requirements, among other things.

In their first year, students are required to take the orientation seminar ATUL 100 - Adjustment to the University Life, which is offered by the professional counselors of the Institution. Individual academic advisement is provided by the staff of the Office of Student Development and Retention (ODRE).

In their second year IE students take the IE 200 - Introduction to Industrial Engineering course. In this course time is allotted to discuss the curriculum structure, course requirements, graduation requirements and to explain the departmental mentoring system.

The second and third year students receive the academic advisement from the Assistant to the IE Department Head for Student Affairs. The assistant insures the compliance of the current curriculum paying attention to the individual needs of each student. The same service is offered to the fourth and fifth year students by the full time faculty. By this time, students are assigned to an IE faculty mentor, who will advise the student on academic matters all the way through graduation. At this level, a comprehensive analysis of the student record is required to verify the completion of the IE program requirements. This task is performed by the faculty mentor assigned to each student.

Regarding course equivalencies and/or substitutions, whenever a curricular revision takes place, students are provided with guides for course equivalencies and/or substitutions. These guides are prepared through faculty meetings. Students are advised on these curricular revisions through the bulletin board, IE 200 course, interviews with their mentors and/or through mail. There is a general university policy regarding curricular revisions. Through these revisions, programs of study are kept up to date. The university policy guarantees that curricular revision will not force students to end up taking more credits that the number of credits they initially were required by any curricular revision. However, it does require that students do meet all the revised course requirements in a prospective way, that is from the date the revised curriculum is in effect up to graduation.

Course substitutions are not common, unless a curricular revision takes place. A course substitution might be necessary when a student has already approved courses that were required in the curriculum prior to the revision, but are no longer part of the revised curriculum. The mentor will then initiate the process for a course substitution. Such process will need the approval of the department head or his/her Assistant in Student Affairs.
I. Verification of student programs of study.

On their first year students are advised by the professors offering the ATUL-100 "Introduction to University Life" course. In addition, there are 2 Rehabilitation Counselors and one Professional Counselor providing students with academic advisement and counseling. Their names are Elsa Zayas, Liliana Martínez and Emma Contreras, respectively. Currently, Professor Rosa Silva is the Assistant to the Department Head in Student Affairs. The faculty mentors are all full time professors, except Dr. Rafael Faría and Prof. Rafael Cruz. Both however, are deeply involved in advising and evaluating students in the Capstone Design Course, thus providing still very valuable academic coaching in this regard to students.

On the other hand, personnel from the Registrar's Office as well as personnel from the IE department verify that at the time of graduation, all requirements for the degree and all ABET criteria are satisfied. An Academic Evaluator from the Registrar's Office thoroughly reviews every academic file of the graduation candidates. Currently, Mrs. Elizabeth Cuadra occupies this position. She prepares a transcript of courses, computes the general and specialization graduation point average and prepares a general report of the student academic performance. From the IE department either Prof. Rosa Silva or the Department Head, make sure that every candidate meets the graduation criteria. The documents utilized in this process appear on appendixes A and C.

J. Transfer credit

Policy with regard to transfer credit is the same for all engineering programs. Such policy is described in chapter VIII, section A under, "Transfer applicants". Tables of equivalencies have been prepared for most courses in the areas of Mathematics, Basic Science and Socio-Humanistic studies, for most common programs from which students transfer to PUPR. These tables are prepared and revised by the department heads of the corresponding areas. However, there is an officer in charge of handling the academic records of transfer applicants. However, it is the responsibility of the department head or his/her assistant in academic affairs to decide whether an IE course can be made equivalent to courses in transfer. For general engineering courses, it is necessary to consult with those departments administering the general engineering course being considered.

K. Oral and written Communication

The native language of the Puerto Rican population is Spanish. Nevertheless, a large part of the population have good communication skills in the English language. This is due to among other things its strong ties with the U.S.A., be them political as well as economical. Furthermore, Puerto Rico's manufacturing industry is mostly American based, where the official business language is English. On the other hand, engineering education in Puerto Rico's very strongly influenced by the United States system. Most, if not all of the engineering textbooks, handbooks, technical magazines, videos, and all other educational materials are in English.

Finally, practice of engineering in Puerto Rico is regulated by the local government, which requires by law that all engineers get their professional registration. Such professional registration is conditioned to approving both the fundamental as well as the professional engineering exams (prepared by the NCCE and locally administrated by the Puerto Rico's Examiner's Board of Engineers, Architects and Land Surveyors). The exam is in English.

From the above discussion, it is clear that our students are expected to develop competence in oral and written communication on the English language upon graduation.

Oral and written communication skills are taken care of throughout the English courses offered as part of the curriculum of the Socio-Humanistic Component. In both courses (Engl 111 and Engl 251) students are required to
give oral presentations on topics, either assigned by the professor or chosen by themselves. These topics must be closely related to the material discussed in class.

Written assignments such as paragraphs, short essays, and analysis of short stories, poems, and/or dramas, in which the students show their capability in using the language are a must.

Grammar mistakes are pinpointed and corrected, but the main emphasis is on reading comprehension and interpretation. Students are required to take a grammar course, English 110, before taking Engl 111, which is a reading course. Although competence in oral and written communication skills is not tested as such, each professor decides, in an individual basis, what criteria to use when grading the students oral and written performance.

Opportunities are provided in some required engineering courses for the development and competence in oral and written communication in English such as ENGI 146, IE 524, IE 548, IE 539. Mathematics departmental examinations are given in English. Many of the exams in the IE department are in English. Although students are allowed to answer in Spanish.

ENGI 146, IE 516*, IE 524*, IE 548 and IE 539 are some of the engineering courses that provide opportunities for the development of competence in oral and written communication through oral and written reports. IE laboratory courses require laboratory reports to be written in English. These include IE 348, IE 448 and IE 548. Finally IE 590 - Senior Design Project requires a minimum of three oral presentations and written reports including one for proposal defense, one progress report and one for the final presentation.

*The overall grades for reports in most IE courses is the lower of two assigned grades: one based on the quality of technical content, the other based on the form and structure of the work including, grammar, punctuation neatness and format.

L. Computer Experience.

Preparing IE professionals with high competencies in the use of special, as well as, general purpose computer packages is part of IE program goals. Students are instructed to view the computer as a decision making tool which will aid them throughout the design processes. In order to meet our objective, the curriculum demands the following competencies developed in the courses described below.

Knowledge on general purpose packages: such as Computer Aided Drafting, use of spreadsheets, databases, presentation and word processing programs. Students get to learn such programs as Auto Cad, Excell, Database, Freelance and Word Perfect, among others. These programs are covered in the ENGI 139 - Computer Aided Design and IE 275 - Computer Tools for IE's courses in the first two years of their careers. Students are expected to prepare homework assignments, as well as term projects, in a neat and professional way, making use of these general purpose packages.

Programming Skills: Students are taught how to prepare flowcharts and to develop general programming skills in C-Language.

Special purpose packages. Most of the IE courses will require students to make from a moderate to an intensive use of special purpose packages. Following is a list of the courses which demand an intensive use of the computer and the related special purpose packages.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Computer Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE 516</td>
<td>Industrial Systems Simulation</td>
<td>Witness</td>
</tr>
<tr>
<td>IE 544/548</td>
<td>Systems Design III Course &amp; Lab</td>
<td>Manufacturing Simulators (TOC)</td>
</tr>
<tr>
<td>IE 590</td>
<td>Capstone Design Course</td>
<td>As required by the design project</td>
</tr>
</tbody>
</table>

The following courses demand a moderate to high use of special purpose packages. They are used either for term projects, laboratory projects or just homework assignments including the solution of case studies.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Computer Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE 312</td>
<td>Statistics for Engineers</td>
<td>Statgraphics</td>
</tr>
<tr>
<td>IE 313</td>
<td>Statistics Laboratory</td>
<td>Statgraphics</td>
</tr>
<tr>
<td>IE 314</td>
<td>Statistics for Engineers II</td>
<td>Statgraphics</td>
</tr>
<tr>
<td>IE 344/348</td>
<td>Systems Design I/Laboratory</td>
<td>Mannequin/Backsoft</td>
</tr>
<tr>
<td>IE 416</td>
<td>Statistica Quality Control</td>
<td>SPC Design Tool</td>
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<tr>
<td>IE 428</td>
<td>Operations Research I</td>
<td>Storm</td>
</tr>
<tr>
<td>IE 444/448</td>
<td>Systems Design II/Laboratory</td>
<td>4M-U</td>
</tr>
<tr>
<td>IE 524</td>
<td>Production Planning &amp; Control</td>
<td>Statgraphics</td>
</tr>
<tr>
<td>IE 530/539</td>
<td>Facilities Planning &amp; Design</td>
<td>Auto Cad, Storm, Factory Cad</td>
</tr>
<tr>
<td></td>
<td>/Facilities Planning &amp; Design Project</td>
<td></td>
</tr>
</tbody>
</table>

**M. Laboratory experience**

Our program puts great emphasis in matching theory with practice. The courses in the IE curriculum requiring laboratory practices can be classified in categories according to the level of laboratory practice required:

- **Category 1:** Courses involving classroom discussion having an specific one credit hour course dedicated to laboratory practices.
- **Category 2:** One credit hour courses dedicated exclusively to laboratory practices (associated with category 2.)
- **Category 3:** Courses requiring 50% classroom discussion and 50% laboratory practice.

**Categories 1 and 2**

For those courses for which hands on experience can be provided through laboratory practices, we assign a one credit hour laboratory. These laboratories are made up of practices designed to provide a more thorough understanding of the course theory. Our curriculum has 6 courses in category 1 and 5 courses in category 2. In the following table courses in category one appear on the left side of the table, while courses in category 2 appear on the right side of the table.
<table>
<thead>
<tr>
<th>Three Credit Hours Theory Course</th>
<th>One Credit Hour Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Engi 315</td>
<td>Probability for Engineers</td>
</tr>
<tr>
<td>IE-312</td>
<td>Statistics for Engineers I</td>
</tr>
<tr>
<td>IE-344</td>
<td>Systems Design I</td>
</tr>
<tr>
<td>IE-444</td>
<td>Systems Design II</td>
</tr>
<tr>
<td>IE 511</td>
<td>Industrial Robotics</td>
</tr>
</tbody>
</table>

When course theory does not provide for laboratory practices or the facilities required for such practices are well beyond the scope of the curriculum, we provide for case studies and homework problems. In many of these courses, students make intensive use of our Operations Management Laboratory to use the different computer packages available in this facility (for a detailed description of the Operations management Laboratory see appendix B - Industrial Engineering Laboratories 1994-99 Development Plan, pages 7, 14, and 19).

Following you will find a brief description of how our laboratory practices support the theory discussed in the classroom.

**Relationship between ENGI 315 - Probability for Engineers and IE 313 - Statistic Laboratory.**

ENGI 315 is a 3 credit-hours course designed to give third year industrial engineering students basic knowledge of probability and probability distributions for random process interpretation and analysis.

The areas of study required to achieve the objectives of the course can be grouped in the following major topics: 1. Treatment of data. 2. Probability Distributions. 3. Probability densities.

The laboratory practices associated with these topics correspond to:

1. The use of a statistical software to analyze data and descriptive statistics, such as, measures of central tendency, measures of dispersion, and measures of location.
2. Show the relationship between Poisson and Exponential distributions, the demonstration of the effect of sample size in the approximation of Hypergeometric Distribution, and the empirical determination of some probabilities values.

**Relationship between IE 312 - Statistics for Engineers I and IE 313 - Statistics Laboratory.**

Statistics for Engineers is a three credit-hours course designed to give third year industrial engineering students a deep understanding of statistical tools, focussing on their application. The areas of study required to achieve the objectives of the course can be grouped in five major topics, they are: 1. Random Sampling, 2. Estimation, 3. Test of Hypotheses, 4. Non-Parametric Statistics, and 5. Test for Independence and Homogeneity. Following, you will find a brief description of each topic and the corresponding laboratory experience.
1. Random Sampling: The major concern of modern statistics is drawing conclusions about populations. This places the focus on the sample, a known and measurable entity representing a population with unknown characteristics. Statistics embodies theory and procedures for using sampling information to draw inferences about uncertain populations. The laboratory practice associated with these topics corresponds to the planning, data collection and evaluation of a random variable to draw conclusion about the population's parameters.

2. Estimation: one of the basic forms of statistical inference is estimation, and an important part of the statistical art is deciding what particular statistic to employ. The quality of a statistical estimate has two dimensions, precision and reliability. Although the desired level of one of these is always attained at the expense of the other, we can achieve high levels of both by increasing the sample size. Should there be constraints on sample size, perhaps owing to budgetary limitations or a shortage of time, some optimal balance between precision and reliability must be reached. The laboratory practices associated with this topic consider the fundamental relationship among: sample size, precision and reliability, demonstrating the effects of the sample size in approximations and in the estimation of the error.

3. Test of hypotheses: like estimation, hypothesis testing is one of the basic forms of statistical inference. This broad area of statistics usually culminates in a immediate decision, making it the more dynamic form of statistical inference. The laboratory practices associated with this topic include, a hypothesis test for means and variances, a goodness of fit test for an exponential distribution and the demonstration of the relationship between sample size and the occurrence of type I and type II errors.

4. Test of independence: in many circumstances, the elements of a sample are classified according to two different criteria. We then want to know if the methods of classification are statistically independent. We now want to test the hypothesis that the methods of classification are independent. The laboratory practice associated with this topic includes and empirical application of the test for independence, also known as contingency table test.

**Relationship between IE 344 Systems Design I and IE 348 Systems Design I Lab.**

Systems Design I is a 3 credit-hours course designed to give third year IE students basic skills in systems work analysis, work methods and work stations design with an ergonomics approach.

The areas of study required to achieve the objectives of the course, can be grouped in the following major topics: 1. Process and Operations Analysis; 2. Work methods improvement; 3. Work Station Design; 4. Work Environment; 5. Safety.

1. Process and Operations Analysis.

This topic discusses how to approach any problem in a logical, organized fashion, utilizing the principles of the scientific method and the relationship between analysis and problem solving. The laboratory practices associated with this topic, correspond to the analysis of a manufacturing process in which each student must use any process chart that will illustrate and document why the solution is optimal. Students must document the solution with cost per unit calculations.

2. Work methods improvement.

We proceed to discuss the process whereby a task is analyzed and possible changes are identified that will either, increase the productivity of the worker, make the work easier to perform, or both. This analysis is usually performed by, identifying the current method of the laboratory practice and devising an improved way to perform portions of the task that are really necessary. This implies that the task may be redesigned to eliminate unnecessary
and inefficient movements and/or operations. The final portion of the laboratory practice requires the student to convince that the improved method is really better.

3. Work station design.

Our primary concern here is the systematic study of workstations with the purpose of: (1) Developing the preferred workstation and method - usually the one with the lowest cost, (2) Standardizing this system and method, through the analysis of a present work station design. Based on the consideration of the relationship between the operator and his or her physical capabilities.


Two major components comprise this part of the laboratory. The first is, providing adequate illumination, ensure that the worker will be able to complete the tasks under conditions of comfort, efficiency and safety.

The second is control of noise levels. This is done through a noise control project performed in a real industrial environment. The student seeks to eliminate noise through an analysis of the task and a design process. If it is impossible to eliminate it, at least to protect the operators from it, by redesigning the processes or the environment, or even by providing with the protection equipment and or materials. The first part of the project is controlling the noise, so that, no damage to the human hearing system occurs. The second is the psychological effect of noise and the interference it has with effective worker performance.

Relationship Between IE 444 Systems Design II and IE 448 Systems Design II Lab.

Systems Design II is a three credit hours course designed to give fourth year Industrial Engineering students the ability to design work methods, and develop documentation, labor - material standard data, time study analysis, and use of predetermined time systems as a methods tool and to determine time/unit.

The areas of study required to achieve the objectives of the course can be grouped in the following major topics:
1. Work measurement.
2. Rating.
3. Learning Curves.
4. Occurrence Sampling.
5. Predetermined time systems.

Following you will find a brief description of each topic and the corresponding laboratory experience.

1. Work measurement: the objectives of the laboratory practices associated with this topic are: a) to present the techniques of work measurement as a useful tool to measure productivity improvement, b) to introduce the students to the time study equipment, c) to introduce the students to the time study information gathering form, and to help the students understand the importance of preceding a time study by a methods analysis.

2. Rating: Begin the development of the skill of rating an operation. There are several systems to do rating of an operation. These practices will concentrate in the one most widely used: the "performance rating" method. This method is also known as "Pace Rating", "Speed Rating" and "Tempo Rating".

3. Occurrence Sampling: the objective of this practice is to develop the student's skill in designing and conducting an occurrence sampling study. Through this practice, the students make sufficient random
observations of an operation's activities to determine the relative amount of time the operator spends on the various activities associated with the job.

4. **Learning curve**: the objective here is to develop the skill in constructing a learning curve for an operation, and to make predictions based on it.

5. **Predetermined time systems**: Proper application of the most widely publicized system, Methods Time Measurement (MTM) in productivity measurement and work improvement. The following procedure is utilized. The job is analyzed in terms of work to be performed. When the motions required to complete the work have been identified, the standard can be set. The practice associated with this topic includes an Analysis of a Universal Pipe Union Assembly operation with the 4 MU software.

6. **A project to be conducted in an industrial setting is required.** This project includes the following:

   Study existing work stations in a real industrial environment and report the following.

   2. Current Direct Labor cost.
   3. Time standard per unit (stopwatch).
   4. Time standard per unit (MTM-4M).
   5. Development of an improvement in the current method.
   6. Time standard for the new method (MTM-4M).
   7. Productivity gain.

**Relationship Between IE 544 Systems Design III and IE 548 Systems Design III Lab**

Systems Design III is a three credit hours senior level course designed to give fifth year Industrial Engineering students the knowledge required to design and control manufacturing systems capable to compete in global markets. Emphasis is given to understand the need for new performance measurements as well as management philosophies and techniques.

The areas of study required to achieve the objectives of the course can be grouped in six major topics. They are:

1. Manufacturing Environment (1 class)
2. Current Manufacturing Operations. (4 classes)
3. Identifying and Managing Constraints. (7 classes)
4. Synchronizing the Operation. (2 classes)
5. Manufacturing Operations. (4 classes)
6. Distribution operations (2 classes)

Following you will find a brief description of each topic and the corresponding laboratory experience.

1. **Manufacturing environment**
   This topic discusses the status of our industry, global conception, and world class manufacturing concepts. The objective is to give an overview of where we are and what is being currently done. No laboratory practice is associated with this topic.

2. **Current Manufacturing operations**
   Here we discuss the current manufacturing environment, especially performance measurements. The objective is to present how current performance measurements are a representation of what current cost accounting expects from manufacturing: a) Low unit cost, b) high resource utilization, and c) High efficiencies.

The laboratory practices associated with this topic correspond to the analysis of different manufacturing situations presented as simulation cases. They are:
Case 1 - Simulation 10 Base case
Case 2 - Simulation 11 Efficiencies
Case 3 - Simulation 12 Batch sizing
Case 4 - Simulation 13 Engineering improvement
Case 5 - Simulation 14 Trimming capacity to reduce operating expense

3. Identifying and Managing Constraints
The objective here is to discuss what is the GOAL of a manufacturing organization with the aim of arriving at the following goal: The aim is to make money—in the present and in the future. We introduce the bottom line measurement to be used as indicators of, whether or not we are moving toward the goal or away from it. Next we must link operational decisions to company's bottom line results. We define what a constraint is and the impact it has in defining product mix, investment justification, marketing strategies, performance measurements, maintenance priorities, quality control policies, rework criterias, and new products analysis.

As with the previous topic, we present the laboratory practices as cases, presenting different manufacturing situations requiring the use of simulators. These cases are:

Case 6 - Simulation 101 Base case
Case 7 - Simulation 102 Process improvement
Case 8 - Simulation 103 Process improvement
Case 9 - Simulation 104 Process improvement
Case 10 - Simulation 106 Coping with scrap
Case 11 - Simulation 107 Selecting areas to eliminate scrap
Case 12 - Simulation 108 Selecting areas to eliminate scrap
Case 13 - Simulation 109 Selecting areas to eliminate scrap
Case 14 - Simulation 110 Reworking Bottleneck(BN) parts on a BN
Case 15 - Simulation 111 Creating a Capacity Constrained Resource(CCR) by
rereking BN parts on a non-BN
Case 16 - Simulation 112 Reworking BN parts on a non-BN
Case 17 - Simulation 113 Malfunctions on a BN
Case 18 - Simulation 114 Malfunctions on a non-BN
Case 19 - Simulation 116 Engineering for a new product

4. Synchronizing the Operation
We proceed to discuss how to run a smooth operation, we present Abraham Y. Goldrat's Drum-Buffer-Rope technique. We talk about how to develop a schedule, how to design constraint, shipping, and assembly buffers, and finally, how to subordinate all plant operations to the constraint.

Laboratory practices for this topic will use again cases and simulators. For this topic, we use the same simulations used for cases 13 to 19.

Category 3
In category three our program has two courses: 1) ENGI 139 Computer Aided Design, and 2) IE 275 Computer Tools for Industrial Engineers. These two courses meet twice a week during the quarter. One of the meetings is in the classroom and the other in the Operations Management Laboratory.

N. Engineering Design Experience

In section "D - Curriculum course content" of this chapter, we have described how the design experience is developed and integrated throughout the 5-year program. There, we explain the methodology utilized to expose our students to engineering design experiences. Through table XII in section E of this volume II, we have listed course requirements for the IE program (year by year and term by term). The summary at the end of Table XII indicates that the IE program at PUPR exceeds the minimum requirements in each of the categories established by ABET's criteria.
Constraints of engineering design experiences are discussed in this volume II as follows: ethical, social, safety and economic considerations are discussed in section A, chapter XIV, of this volume; Reliability is discussed on section Q, chapter XII, of this volume. We must emphasize that most, if not all of these constraints which are part of the engineering design experiences, are faced by the students through the major capstone design courses, namely: IE 530/539 - Facilities Planning Design Course/Project, IE 544/548 - Systems Design III Course/Laboratory and IE 590 - Capstone Design Course.

These capstone design experiences are covered in more detail in section Q, chapter XII, of this volume.

O. **Course/section size**
This item consists of Table XIII - Course/section size summary, which is presented in the following pages.
<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>TITLE</th>
<th>NO. OF SECTIONS(^3) Offered in Current Year</th>
<th>AVG. SECTION ENROLLMENT</th>
<th>LECTURE</th>
<th>LAB.</th>
<th>RECIT.</th>
<th>OTHER (SPECIFY)(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 235</td>
<td>Probability and Statistics for Engineers</td>
<td>16</td>
<td>28</td>
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<tr>
<td>ENGI 315</td>
<td>Probability for Engineers</td>
<td>6</td>
<td>26</td>
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<tr>
<td>ENGI 336</td>
<td>Engineering Materials</td>
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<tr>
<td>ENGI 422</td>
<td>Manufacturing Processes</td>
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<td>27</td>
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<td></td>
<td></td>
<td>25% Oral Presentation</td>
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<tr>
<td>ENGI 449</td>
<td>Engineering Economics</td>
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<tr>
<td>IE 200</td>
<td>Into. to Industrial Eng.</td>
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<td>19</td>
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<tr>
<td>ENGI 139/IE 239</td>
<td>Computer Aided Designed</td>
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<td>50%</td>
<td></td>
<td></td>
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<tr>
<td>IE 275</td>
<td>Computer Lab for IE's</td>
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<tr>
<td>IE 312</td>
<td>Statistics for Engineers I</td>
<td>4</td>
<td>19</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>IE 313</td>
<td>Statistics Lab</td>
<td>4</td>
<td>17</td>
<td>100%</td>
<td></td>
<td></td>
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<tr>
<td>IE 314</td>
<td>Statistics for Engineers II</td>
<td>3</td>
<td>31</td>
<td>100%</td>
<td></td>
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<tr>
<td>IE 315</td>
<td>Financial Accounting</td>
<td>4</td>
<td>17</td>
<td>100%</td>
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<tr>
<td>IE 333</td>
<td>Cost Analysis and Control</td>
<td>4</td>
<td>22</td>
<td>100%</td>
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<tr>
<td>IE 344</td>
<td>Systems Design I</td>
<td>4</td>
<td>16</td>
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<td>IE 348</td>
<td>Systems Design I Lab</td>
<td>4</td>
<td>15</td>
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<tr>
<td>IE 416</td>
<td>Statistical Quality Control</td>
<td>4</td>
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<tr>
<td>IE 428</td>
<td>Operations Research I</td>
<td>4</td>
<td>18</td>
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<tr>
<td>IE 429</td>
<td>Operations Research II</td>
<td>4</td>
<td>24</td>
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<tr>
<td>IE 444</td>
<td>Systems Design II</td>
<td>4</td>
<td>17</td>
<td>100%</td>
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<tr>
<td>COURSE NO.</td>
<td>TITLE</td>
<td>NO. OF SECTION(S) OFFERED IN CURRENT YEAR</td>
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<td>LECTURE</td>
<td>LAB.</td>
<td>RECIT.</td>
<td>OTHER (SPECIFY)</td>
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<td>IE 448</td>
<td>Systems Design II Lab</td>
<td>7</td>
<td>12</td>
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<tr>
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<td>Management Information Systems</td>
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<td>50%</td>
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<td>IE 507</td>
<td>Design of Experiments</td>
<td>1</td>
<td>15</td>
<td>0.7</td>
<td>0.3</td>
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<td>40% (Audiovisual Programs), 20% (Program Solving)</td>
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<td>IE 509</td>
<td>Quality Planning Systems</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
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<tr>
<td>IE 511</td>
<td>Industrial Robotics</td>
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<td>25</td>
<td>70%</td>
<td>30%</td>
<td></td>
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<tr>
<td>IE 512</td>
<td>Industrial Robotics Laboratory</td>
<td>1</td>
<td>17</td>
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<td></td>
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<td>Project Management Techniques</td>
<td>1</td>
<td>17</td>
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<td>20% (Project Tint Meeting), 20% (Software Practices)</td>
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<tr>
<td>IE 516</td>
<td>Industrial Systems Simulation</td>
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<td>IE 523</td>
<td>Inventory Control Systems</td>
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<td>20</td>
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<td>Production Planning and Control</td>
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<td>Computer Integrated Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.7</td>
<td>0.3</td>
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<td>IE 530</td>
<td>Facilities Planning and Design</td>
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<td>14</td>
<td>70%</td>
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<td>30% Videos</td>
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<td>IE 531</td>
<td>Manufacturing Resources Planning</td>
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<td>19</td>
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<td>IE 534</td>
<td>Just in Time</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>(Industrial Project) 100%</td>
</tr>
<tr>
<td>IE 539</td>
<td>Facilities Planning and Design Project</td>
<td>4</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COURSE NO.</td>
<td>TITLE</td>
<td>NO. OF SECTIONS&lt;sup&gt;(3)&lt;/sup&gt; OFFERED IN CURRENT YEAR</td>
<td>AVG. SECTION ENROLLMENT</td>
<td>TYPE OF CLASS&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>------------------------</td>
<td>-------------------------------------------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE 544</td>
<td>Systems Design III</td>
<td>1</td>
<td>18</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE 546</td>
<td>IE Practice</td>
<td>4</td>
<td>13</td>
<td>100% (Ind. Project)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE 546E</td>
<td>IE Practice Extension</td>
<td>4</td>
<td>10</td>
<td>100% (Ind. Project)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE 548</td>
<td>Systems Design III Lab</td>
<td>1</td>
<td>13</td>
<td>75%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE 590</td>
<td>Senior Design Project</td>
<td>6</td>
<td>12</td>
<td>100% (Industrial Project)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE 590E</td>
<td>Senior Design Project Extension</td>
<td>4</td>
<td>13</td>
<td>100% (Industrial Project)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEMI 503</td>
<td>IE Project</td>
<td>4</td>
<td>25</td>
<td>100% (Industrial Project)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEMI 503E</td>
<td>IE Project Extension</td>
<td>4</td>
<td>16</td>
<td>100% (Industrial Project)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Enter the appropriate percent for each type of class for each course (e.g., 75% lecture, 25% recit.)
2. Use this column to indicate evening, extension, graduate, or other types of courses.
   Source: MIS Director
3. Current Year: (August-Nov 94), (Nov 94-March 95), (March-June 95)
P. Satisfaction of "breadth and depth" requirement in the humanities and social sciences

The socio-humanistic curricular component is conceived as an integral part of the engineering program. It is designed to provide both the breadth and depth expected in a modern well balanced engineering curriculum.

In order to achieve this, PUPE has structured its Humanities and Social Sciences offerings in two levels: a basic level of four three-credit-hours courses, two in Spanish and English literature (Spanish 251 and English 251) and two introductory socio-humanistic courses (SOHU 251 and SOHU 252), which provide the breadth requirement and serve as the foundation for the second level courses, which consist of nine (9) additional credit-hours taken from eight available areas of study. Each one of these eight (8) areas of socio-humanistic studies (economy, politics, psychology, philosophy, history, literature, Puerto Rican studies, and engineering related topics) consists of a group of at least 5 different, but related courses to satisfy the depth requirement.

Q. Satisfaction of ABET criteria for this specific program

The IE program relies heavily in the application of probability and statistics concepts to the solution of engineering problems. In order to provide the tools the curriculum requires 4 courses in probability and statistics, namely:

<table>
<thead>
<tr>
<th>Course Code and Title</th>
<th>Credit-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 315 - Probability for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>IE 312 - Statistics for Engineers I</td>
<td>3</td>
</tr>
<tr>
<td>IE 313 - Statistics for Engineers Lab</td>
<td>1</td>
</tr>
<tr>
<td>IE 314 - Statistics for Engineers II</td>
<td>3</td>
</tr>
<tr>
<td>IE 344 - System Design I</td>
<td>3</td>
</tr>
<tr>
<td>IE 348 - System Design Lab.</td>
<td>1</td>
</tr>
<tr>
<td>IE 416 - Statistics Quality Control</td>
<td>3</td>
</tr>
<tr>
<td>IE 429 - Operation Research II</td>
<td>3</td>
</tr>
<tr>
<td>IE 516 - Introduction to System Simulation</td>
<td>3</td>
</tr>
<tr>
<td>IE 523 - Inventory Control System</td>
<td>3</td>
</tr>
<tr>
<td>IE 524 - Production Planning &amp; Control</td>
<td>3</td>
</tr>
<tr>
<td>IE 530 - Facilities Planning and Design</td>
<td>3</td>
</tr>
<tr>
<td>IE 544 - System Design III</td>
<td>3</td>
</tr>
<tr>
<td>IE 548 - System Design III Lab</td>
<td>1</td>
</tr>
<tr>
<td>IE 590 - Capstone Design Course</td>
<td>4</td>
</tr>
</tbody>
</table>

ABET criteria has defined three curriculum requirements that apply to this program. The first one is related to a capstone design experience. Our program satisfies this requirement with 3 major capstone design experiences. Students complete these design experiences through the following courses: IE 590 - Capstone Design Course, IE 530 and IE 539, Facilities Planning and Design Course and Facilities Planning and Design Project, and IE 544 and 548 System Design III Course and System Design III Laboratory.

In IE 590, students are required to complete a full scale industry based project, covering most phases of the engineering design process. Perhaps they are limited in the step of project implementation but otherwise, the experience covers most phases. Through the Facilities Planning and Design Course and Project (IE 530/IE539), students have the opportunity to go through another design experience, since they are required to complete such project in an industry or service site. Once again most phases of the engineering design process are covered. In theses courses students are required to present project proposals, progress reports, as well as final reports. They should work in teams, make oral presentations and turn in written reports in English. They are expected to present professional reports both in technical content, as well as in appearance.
Finally, through IE 544 and IE 548, students integrate most previous knowledge to solve industrial based cases, using the computer as a decision making tool. For each case study, students are required to hand in a written report.

The second curricular requirement is related to computer use, in terms of "appropriate use of computers to be integrated throughout the curriculum". With regard to this, it has been thoroughly presented in section L of chapter XII, how computer experience is incorporated in the engineering curriculum. Also students get proficiency in C-language through the ENGI 220 - Computer Programming and Algorithms. Furthermore, they take a full Systems Simulation course. Currently they use Witness as the simulation package.

The third requirement expresses the need for calculus-based probability and statistics instruction. This requirement is thoroughly met through one probability course (ENGI 315), two statistics courses (IE 312 and IE 314) and one statistics lab course (IE 313). The probability and statistics concepts are applied to analyze and solve engineering problems through most if not all the IE courses and labs, in various degrees. In many courses probability and statistics concepts are fundamental to the material covered in the course. This is the case, for no less than 3 courses including IE 416 - Statistical Quality Control, IE 429 - Operations Research II and IE 516 - Industrial Systems Simulation.

Satisfaction of humanities and social sciences "breadth and depth" requirements has been discussed in section P of this chapter.
CHAPTER XIII. LABORATORY FACILITIES

A. Summary of laboratories utilized for instruction related to Industrial Engineering.
Table XIV summarizes the laboratories used for instruction related to the Industrial Engineering program, and describe their adequacy for instruction, condition, number of student stations, and square feet of space.

Table XIV

<table>
<thead>
<tr>
<th>Physical Facility</th>
<th>Purpose of Laboratory</th>
<th>Conditions of Laboratory</th>
<th>Adequacy of Instruction</th>
<th>No. of student stations</th>
<th>Area (Sq. Ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab. Building L-108</td>
<td>Industrial Robotics</td>
<td>Good</td>
<td>Good</td>
<td>1</td>
<td>810</td>
</tr>
<tr>
<td>Lab. building L-210</td>
<td>Computer Integrated Mfg.</td>
<td>Good</td>
<td>Good</td>
<td>2</td>
<td>1675</td>
</tr>
<tr>
<td>Lab. Building L-209</td>
<td>Human Factors and Methods Engineering</td>
<td>Excellent</td>
<td>Excellent</td>
<td>5</td>
<td>925</td>
</tr>
<tr>
<td>Lab. Building L-208</td>
<td>Quality Control</td>
<td>Currently, statistics lab practices are being offered but, QC practices are limited to the design of QC charts using available. Room already available Equipment to be purchased</td>
<td>Good/NA</td>
<td>4</td>
<td>815</td>
</tr>
<tr>
<td>Lab. Building L-206</td>
<td>Power Systems &amp; Controls</td>
<td>Room already available Equipment to be purchased</td>
<td>N/A</td>
<td>0</td>
<td>730</td>
</tr>
<tr>
<td>Lab. Building L-204</td>
<td>Operations Management</td>
<td>Excellent</td>
<td>Excellent</td>
<td>12</td>
<td>865</td>
</tr>
</tbody>
</table>

Total Area: 5820

B. Assessment of laboratory equipment and instrumentation.
The IE department has always maintained a constant effort to develop its laboratories. Our laboratories afford the students first hand experience showing the applicability and usefulness of the theory discussed in the classroom. Following we provide an assessment of the equipment and the
instrumentation available in each laboratory to meet instructional needs.

1. List of equipment per laboratory
The six laboratories listed above are grouped in four categories or fields. These are:

   i. Human Factors and Methods Engineering
   ii. Operations management
   iii. Industrial Robotics and Computer Integrated Manufacturing
   iv. Statistics and Quality Control

Next, we present a complete list of the current distribution of equipment for each field.

1. Human Factors and Methods Engineering
   This laboratory was designed to provide the students with the opportunity to carry out practical experiments concerning motion and time studies, noise and illumination, workstation design, methods' improvement, performance rating, and many other areas of human performance at work. The laboratory has the following equipment available.

   **Human Factors and Methods Engineering**
   **Laboratory Equipment**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Adjustable workstation</td>
<td>5</td>
</tr>
<tr>
<td>2. Material handling car</td>
<td>1</td>
</tr>
<tr>
<td>3. Ergonomic screw driver</td>
<td>1'</td>
</tr>
<tr>
<td>4. Sound proof cabin</td>
<td>2</td>
</tr>
<tr>
<td>5. Portable audiometer</td>
<td>2</td>
</tr>
<tr>
<td>6. Sound level meter</td>
<td>10</td>
</tr>
<tr>
<td>7. Light meter</td>
<td>14</td>
</tr>
<tr>
<td>8. Titmus vision tester</td>
<td>1</td>
</tr>
<tr>
<td>9. JBL speakers</td>
<td>5</td>
</tr>
<tr>
<td>10. Laser disk player</td>
<td>1</td>
</tr>
<tr>
<td>11. Cassette player</td>
<td>1</td>
</tr>
<tr>
<td>12. Sound amplifier</td>
<td>1</td>
</tr>
<tr>
<td>13. Sound mixer</td>
<td>1</td>
</tr>
<tr>
<td>14. Meylan time study trainer</td>
<td>4</td>
</tr>
</tbody>
</table>
Most equipment is in very good condition. Thus, instructional needs are being fairly well covered in this lab.

ii. Operations Management
The operations management laboratory, which currently consists of a Novell network with 14 personal computers for student use. This network offers the student the opportunity to access specialized software to tackle industrial engineering problems. At this point, three members of the faculty have their personal computers connected to the operations management laboratory network. Office location has made impossible to connect the remaining faculty’s PCS to the network.

The Operations Management Laboratory has the equipment and software required to develop the system analysis, solutions development, and decision making skills in our students. The following tables present the hardware and software available in this field category.

<table>
<thead>
<tr>
<th>Operations Management Lab - Equipment Available</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>1. Digital Equipment Corp. personal computers 486/33 MHz</td>
</tr>
<tr>
<td>2. Digital Equipment Corp. personal computers 486/66 MHz</td>
</tr>
<tr>
<td>3. Digital Equipment Corp. personal computers Pentium 90 MHz</td>
</tr>
<tr>
<td>4. Compaq server</td>
</tr>
<tr>
<td>5. Hewlett-Packard Laserjet IV printer</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>1. Statgraphic DOS version (statistics)</td>
</tr>
<tr>
<td>2. Storm (operations research, production planning)</td>
</tr>
<tr>
<td>3. Witness (simulation)</td>
</tr>
<tr>
<td>4. Slamsystem (simulation)</td>
</tr>
<tr>
<td>5. Fourth Shift (MRP II)</td>
</tr>
<tr>
<td>6. AutoCAD (computer aided drafting)</td>
</tr>
<tr>
<td>7. Factory CAD (facilities planning)</td>
</tr>
<tr>
<td>8. Factory Flow (facilities planning)</td>
</tr>
<tr>
<td>9. Mannequin (ergonomics)</td>
</tr>
<tr>
<td>10. Excel (spreadsheet)</td>
</tr>
<tr>
<td>11. Statgraphic Plus for Windows</td>
</tr>
<tr>
<td>12. Statistica</td>
</tr>
<tr>
<td>13. Microsoft Project (project management)</td>
</tr>
<tr>
<td>14. Database (data base)</td>
</tr>
<tr>
<td>15. Theory of Constraint Simulators</td>
</tr>
<tr>
<td>16. Disaster (scheduling)</td>
</tr>
<tr>
<td>17. Backsoft (ergonomics)</td>
</tr>
<tr>
<td>18. Freelance (presentation graphics)</td>
</tr>
<tr>
<td>19. Metadesign (flowcharting)</td>
</tr>
<tr>
<td>20. SPC Design Tool (statistical process control)</td>
</tr>
<tr>
<td>21. 4M-U (time standards)</td>
</tr>
<tr>
<td>22. Lotus 1-2-3 (spreadsheet)</td>
</tr>
<tr>
<td>23. Lindo</td>
</tr>
<tr>
<td>24. Timeline (project management)</td>
</tr>
</tbody>
</table>
Assessment of laboratory equipment and instructional materials in this lab is very good in terms of adequacy for instructional needs.

**iii. Industrial Robotics and Computer Integrated Manufacturing**

In this laboratory students are able to carry out practices regarding robot programming, equipment interfacing, and bar code operation. The next table presents the equipment available.

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Robotics and CIM:</td>
<td></td>
</tr>
<tr>
<td>1. EMCO VMC-100 CNC Milling Machine</td>
<td>1</td>
</tr>
<tr>
<td>2. EMCO Compact-5 CNC Lathe</td>
<td>1</td>
</tr>
<tr>
<td>3. Pegasus Robots</td>
<td>2</td>
</tr>
<tr>
<td>4. Unimate 2070 (industrial robot)</td>
<td>1</td>
</tr>
<tr>
<td>5. Industrial conveyor</td>
<td>1</td>
</tr>
<tr>
<td>6. Industrial carrousel</td>
<td>1</td>
</tr>
<tr>
<td>7. Automated Guided vehicle</td>
<td>1</td>
</tr>
<tr>
<td>8. Microbot Teachmover (teaching robot)</td>
<td>4</td>
</tr>
<tr>
<td>9. Toshiba SR 654-H</td>
<td>1</td>
</tr>
<tr>
<td>10. CNC lathe (tabletop)</td>
<td>1</td>
</tr>
<tr>
<td>11. CNC milling machine (tabletop)</td>
<td>1</td>
</tr>
<tr>
<td>12. Computer control carrousel (tabletop)</td>
<td>2</td>
</tr>
<tr>
<td>13. Gravity feeder (tabletop)</td>
<td>1</td>
</tr>
<tr>
<td>14. Conveyor (tabletop)</td>
<td>1</td>
</tr>
<tr>
<td>15. Hero I (robot)</td>
<td>1</td>
</tr>
<tr>
<td>16. Personal computer</td>
<td>2</td>
</tr>
<tr>
<td>17. Speech recognition system</td>
<td>1</td>
</tr>
</tbody>
</table>
Bar code:

| 1. Starnode data collection system (computer card) | 1 |
| 2. Light pen readers | 2 |
| 3. Laser band reader | 1.00 |
| 4. High speed conveyor reader | 1 |
| 5. Zebra thermal printer | 1 |

Equipment in this is in general in good conditions, even though some equipment will be necessary to replaced soon. Due to the high cost of the equipment the number of stations is limited. However, in general the laboratory equipment satisfies the instructional needs.

iv. Statistics and Quality Control

In this laboratory students get see the application of statistical and quality control principles. This objective is achieved through lab practices carefully designed and/or selected by the IE faculty.

<table>
<thead>
<tr>
<th>Statistical and Quality Control Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment Available</strong></td>
</tr>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>1. Sampling Bowl</td>
</tr>
<tr>
<td>2. Sampling Box</td>
</tr>
<tr>
<td>3. Lightning Calculator</td>
</tr>
<tr>
<td>4. Cracker Factory (Quality Control game)</td>
</tr>
<tr>
<td>5. Catapult (Design of Experiments game)</td>
</tr>
</tbody>
</table>

Currently this laboratory is mostly oriented to practices in the area of statistics. Faculty is interested in developing some practices in the area of quality control but, that is currently in process to be developed. Laboratory equipment is in good condition. Some additional equipment will be necessary when practices in the quality control area are developed. Currently, instructional need are being met.

C. Equipment and instrumentation installed in the last six years.

Almost all the equipment listed in section XIII.B was acquired during or after 1989. The only equipment acquired prior to that date correspond to two educational CIM cells the IE Department bought from UMI-Microbot and a Hero I educational robot bought from Zenith. The rest of the equipment bought prior to that date has not been listed, since either it is non-functional or has been disposed of.
D. Critical needs for each lab and plans to satisfy them.

At this point, the IE Department Laboratories have enough space to grow according to the strategic plan develop for the next five years. There is a need to recruit an additional faculty member in the area of Computer Integrated Manufacturing and Robotics. The Department also needs a full time technician in the same field. Regarding laboratory equipment, the needs have been identify and were included in the development plan presented in next section (XIII.E).

E. Plans for development of the instructional laboratories.
The IE department recently modified its Curriculum to provide the students the knowledge and skills demanded by our modern industry. This revised curriculum gives special attention to the human environment at work, the use of a computer as a powerful analytical tool, the integration of manufacturing systems, and the ever increasing quality awareness required to compete in global markets. In order to include these elements in our curriculum, each one of our course syllabus were thoroughly evaluated. Several elective courses are now required courses and new courses were developed. These curriculum changes are expected to be in place with minor changes for the following 5 to 6 years.

Our laboratories must provide the students with the means to put in practice the knowledge and techniques acquired in the classroom. Therefore, we must revise our lab facilities and practices to meet the requirements of the new curriculum.

1. Plan for improvement of laboratory facilities

We believe that the future trend in Industrial Engineering will demand more and more the analysis of the work environment and of human behavior at work and in work teams. We also believe that given the current economic developments in Puerto Rico (especially in relation to the 936 industries), local industries will, in the future, require more automation and consequently the engineers to design and run automated systems. Therefore, we are developing our curriculum and laboratories accordingly.

Our plan for the next five years includes improvements on each of our laboratory facilities. In addition, we will create three new laboratories: (1) Quality control, (2) Manufacturing processes, and (3) Process controls and power systems.

Computer Integrated manufacturing

We will expand the CIM laboratory in order to satisfactorily serve 12 students per group and include new manufacturing technology. This expansion requires:

- 2 Basic CIM Workcells $ 86,000
Quality control laboratory
Our faculty has identified the need for developing a Statistical Process Control Lab. This will be one in five stages:

I. Prepare development plan
   - Physical facilities
   - Practices

ii. Install equipment
   - 6 workstations $48,000

iii. Train faculty and technicians (dept. expense) $5,000

iv. Faculty develops and/or carry out lab practices

v. Offer laboratory practices to students

We designed the laboratory to serve groups of 12 students working in teams. Each team will consist of two students, therefore we need to set up six workstations. We have already discussed equipment availability with educational equipment manufacturers.

Power Systems and Controls Laboratory
This is a new laboratory to be created during the next four years. It includes modules in two major areas: (1) Power systems, and (2) Process Control. This modules are already available from an educational manufacturer and are specially designed to teach the specifics of each area. They include:

(1) Power Systems:
   - Pneumatic power/sensors, $37,000
   - Hydraulic Power 24,000

(2) Process Control:
   - Programmable Logic Controllers $16,000

Total $77,000

Manufacturing Processes Laboratory
This new laboratory will provide the hands on experience required in manufacturing processes such as rolling, forging, and foundry as well as process industry. This experience is necessary for a complete understanding of the material discussed in ENGI 422 Manufacturing Processes. The proposed modules will provide desktop facilities to carry out laboratory experiments in the processes already described. They require a total investment of $75,000.

Human Factors and Methods Engineering
The expansion of our human factors and methods engineering is, essentially, the development of an ergonomic work environment laboratory. In this lab, students will be able to control noise, illuminance, and workstation characteristics. Also, they will be able to videotape workers behavior under different working conditions and analyze their impact
on worker performance. In order to achieve this expansion we will require:

- 1 Acoustic cabin $3,000
- 6 Illumination workstations 9,000
- 2 Sound lab stations 10,000

Total $22,000

Operations Management Laboratory
The operations management laboratory has achieved the original plan of a total of 15 computers in a Novell Network. We also consider the need to offer the students remote access to our laboratory and the facility to integrate graphics, figures and/or schematics into their work through the use of scanners.

Tables A, B, and C present a complete description of the equipment and investments the IE department for the next five years. In table A we present the Computer Integrated Manufacturing, Quality Control, and Power Systems and Process Control Laboratory Plans. All funds required for the implementation of this development plan will come for the IE Department annual budget. Donations or grants were not considered as funding sources.
### Table A

**Computer Integrated Manufacturing, Quality Control, Process Control/Power Systems**

**Five Years Development Plan**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qty</td>
<td>$k</td>
<td>Qty</td>
<td>$k</td>
<td>Qty</td>
</tr>
<tr>
<td><strong>CIM Laboratory:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic CIM Workcell</td>
<td>1</td>
<td>43</td>
<td>1</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Advanced CIM Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality Control Laboratory:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QC Workstations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power Syst/Process Control:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Servo Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumatic Power/Sensors</td>
<td>3</td>
<td>10</td>
<td>1</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Hydraulic Power</td>
<td>3</td>
<td>16</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Electric Motor Drives</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Electrical Relays</td>
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<tr>
<td>Programmable Controllers</td>
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<td>16</td>
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<tr>
<td>Computer Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Mfg. Process Lab.:</strong></td>
<td></td>
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<tr>
<td>Mfg. Processes Module</td>
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<tr>
<td>Process Control Module</td>
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<tr>
<td>Fault Troubleshooting</td>
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<td>Sub-total</td>
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<tr>
<td><strong>Year Total</strong></td>
<td>85</td>
<td>28</td>
<td>64</td>
<td>25</td>
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<td>------------------------------</td>
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<tr>
<td>Human Factors:</td>
<td></td>
<td></td>
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<tr>
<td>Illumination Station</td>
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<td>Acoustic cabin</td>
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<td>3</td>
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<td>Sound Lab. Station</td>
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<td></td>
<td>1</td>
<td>5</td>
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<td>Equipment replacement</td>
<td>1</td>
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<td>Sub-total</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td>6</td>
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<tr>
<td>Methods Engineering:</td>
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<tr>
<td>New technology</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Equipment replacement</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>Sub-total</td>
<td>2</td>
<td>2</td>
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<td>2</td>
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<tr>
<td>Operations Management:</td>
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<td></td>
</tr>
<tr>
<td>New PC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement of PC</td>
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<td></td>
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</tr>
<tr>
<td>Printer</td>
<td></td>
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</tr>
<tr>
<td>Plotter</td>
<td>2</td>
<td>4</td>
<td></td>
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<td></td>
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<tr>
<td>Scanner</td>
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<td></td>
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<tr>
<td>Remote access</td>
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<td></td>
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</tr>
<tr>
<td>New technology</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sub-total</td>
<td>5</td>
<td>17</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Year Total</td>
<td>14</td>
<td>23</td>
<td>7</td>
<td>9</td>
<td>9</td>
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Table C
Total Laboratory Equipment Investment
($000)

<table>
<thead>
<tr>
<th>Year</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>99</td>
</tr>
<tr>
<td>1995-96</td>
<td>76</td>
</tr>
<tr>
<td>1996-97</td>
<td>79</td>
</tr>
<tr>
<td>1997-98</td>
<td>50</td>
</tr>
<tr>
<td>1998-99</td>
<td>52</td>
</tr>
</tbody>
</table>

2. Financial Sources for the Development Plan
All students pay a $25.00 fee to gain access to the Educational Technology Center and use of the computers facilities for report writing. Additionally, the student pays a mandatory fee of $75.00 for every laboratory course he/she takes each term. The revenue collected is set aside in a special account used exclusively for purchasing computer and laboratory equipment (C & L account). The only allowed expenditures that can be charged to this account are: CTB equipment, institutional networking equipment (PUPR Net), and the laboratory equipment.

Both the computers and the laboratory equipment ordered by our academic program will be registered, identified and assigned to our inventory of the program. The costs will be charged to our C & L account.

The institution distributes the C & L funds proportionally among the different academic programs taking into consideration the number of students served. In the event the fund does not grow at a rate high enough to be able to cover the needs of our program, the institution will assign additional financial resources to guarantee the minimum amount given in the following table. We would like to indicate that the number of students registered in the Industrial Engineering Department for the last four years has been stable with an average of approximately 700 students per year.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget Assigned</td>
<td>$76,000</td>
<td>$79,000</td>
<td>$50,000</td>
<td>$52,000</td>
</tr>
</tbody>
</table>

Our laboratory development plan was developed considering only the institutional funds assigned by the administration to our department.
F. **Provisions for maintaining and servicing laboratory equipment.**

Equipment maintenance is coordinated by the laboratory coordinator and the laboratory technician. Basic maintenance is normally performed by the laboratory personnel: Mr. Arnaldo Colón, laboratory technician, or Prof. Rafael Cruz, laboratory coordinator according to the following predefined maintenance program.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Qty</th>
<th>Description</th>
<th>PM Instructions</th>
</tr>
</thead>
</table>
| Personal Computer (PC)               | 12  | 5 Digital (466-D2) & 7 Digital (433 dxLp) | Monitors:  
- Vacuum cleaning  
- Buttons Set-up (color, screen increasing)  
- PC Power Cord and System Power Switch check  
- Notify if not working properly in order to repair or scrap.  
Keyboards:  
- Vacuum cleaning  
- Bottoms check for proper operation.  
- Notify if not working properly in order to repair or scrap.  
CPU:  
- Communication boards check  
- Inside vacuum cleaning  
- In relation to Software, check for any loose end needing spot welding (condensers, Resistances, etc.)  
- Remove any student file  
- Upgrade programs if needed  
- If RAM memory increase, make a previous back-up.  
- Run Diskfix, Compress and Antivirus. |
| Hewlett Packard Printer              | 1   | Laser Jet IV                        |  
- Cleaning  
- If needed, change of toner  
- Power Cord and System Power Switch Check. |
| Server                               | 1   | Compaq                              |  
- Deep Vacuum Cleaning  
- Union Cord and on-off switch check |
| UPS 900                              | 1   | Smart UPS                           |  
- Power Cord Check  
- Vacuum Cleaning |
| Multiport                            | 1   | HUB                                 |  
- Cables to PC connection check  
- Cleaning  
- Power Cord check |
| Server Monitor and Keyboard          | 1   |                                     |  
- As per PC Monitor and Keyboard instructions |

Operation Management Laboratory (L-204)
### Human Factors Laboratory (L-209)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>PM Instructions</th>
</tr>
</thead>
</table>
| Chronometers (Stop watches)    | - Battery check. Change if needed.  
- Stop and Start Switch check  
- Vacuum cleaning  
- Trial test. If not working properly, notify for reparation or scrap. |
| Sound Level Meters             | - Battery check  
- Calibration  
- Cleaning |
| Foot Candles                   | - Calibration  
- Cleaning  
- Trial test. If not working properly, notify for reparation or scrap. |
| Time Sroprietys                | - Power Cord check  
- Trial test. If not working properly, notify for reparation or scrap. |
| Noise properly                 | - Calibration  
- Power Cord check  
- Vacuum cleaning |
| Audimeters (MA-39)             | - Vacuum cleaning  
- Check for replacement need. Notify for reparation or scrap if apply. |
| Micro-eye Vision System        | - Cleaning  
- Power Cord check  
- Noise Dosimeter Calibration  
- Cleaning  
- Mechanical Set-up  
- Check for replacement need. Notify for reparation or scrap if apply. |
### CIM Laboratory (L-210)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>PM Instructions</th>
</tr>
</thead>
</table>
| Microbot Teach Mover | - Mechanical Set-up  
|                      |   - Power Cord check  
|                      |   - Cleaning  
|                      |   - Check teach-control  
|                      |   - Check arm move for normal operation  
|                      |   - Notify for reparation or replacement if needed.  |
| Milling Machine      | - Mechanical Set-up  
|                      |   - Cleaning  
|                      |   - Notify for reparation if needed.  |
| Robot Hero           | - Cleaning  
|                      |   - Mechanical Set-up  
|                      |   - Notify for reparation or replacement if neededCont. CIM laboratory.  |
| Lathe                | - Mechanical Set-up  
|                      |   - Cleaning  
|                      |   - Notify for reparation if needed  |
| Power Supplies       | - Power Cord check  
|                      |   - Cleaning  
|                      |   - Notify for reparation or replacement if needed  |
| Motor Mover          | - Mechanical Set-up  
|                      |   - Cleaning  
|                      |   - Notify for reparation if needed  
|                      |   - Connection check  |
| GV-30                | - Cleaning  
|                      |   - Connections check  
|                      |   - Power cord check  
|                      |   - Notify for reparation if needed  |
| Scanstar             | - Vacuum cleaning  
|                      |   - Connections check  
|                      |   - Power cord check  
|                      |   - Notify for reparation if needed  |

### Robotics Laboratory (L-108) *

<table>
<thead>
<tr>
<th>Equipment</th>
<th>PM Instructions</th>
</tr>
</thead>
</table>
| Robot (Unimate 2070) | - Mechanical Set-up  
|                     |   - Cleaning  
|                     |   - Lubrication  
|                     |   - Notify for reparation if needed  |
| Robot (Toshiba)    | - Cleaning  
|                     |   - Mechanical Set-up  |

* An adequate equipment maintenance plan must be conducted. Lubrication, cogwheels, gears, oil and nuts replacement must be performed in a periodic manner.
In case of a major breakdown or complex problem, the first option is to send the equipment to the manufacturer. If the previous option is not possible, we bring a technician to the PUPR. The Industrial Engineering Department does not carry maintenance contracts for any of its laboratory equipment.
CHAPTER XIV - STUDENT DEVELOPMENT IN ENGINEERING PROFESSIONAL PRACTICE

A. Assurance of the development of an understanding of the ethical, social, safety, and economic considerations in engineering practice.

The development of an understanding of the ethical, social, safety and economic considerations in engineering practice is developed through the 5 year program. The approach is one which includes not only curricular, but also extra curricular activities.

Through the curriculum, the student will find several courses which will focus on one particular topic. Regarding ethical aspects, IE students must take the Professional Ethics in Engineering Course (PHIL 441). Through this course, the ethical conduct of the engineers is explained, as well as the Code of Ethics and the functions of the Ethics Committee in the College of Engineers and Land Surveyors of Puerto Rico. These courses are regularly offered by professionals with academic degrees in engineering as well as in law.

A set of courses focusing on economics, as well as cost accounting considerations are: Engineering Economics (ENGI 449), Cost Analysis and Control (IE 333) and the Financial Accounting (IE 315) courses. Safety considerations are taken care through the Systems Design I (IE 344) course, as well as through the laboratory courses. Through the Human Factors course (IE 354), an in depth study of people at work is conducted. This includes people's characteristics, limitations, structure and functions of the human body, and human behavior. All these courses are requirements for all IE students.

On the other hand, there are numerous courses that do present the student the importance of the ethical, social safety and economic considerations in the engineering practice, through a more integrated approach. Among these courses we can list the following:

- ENGI 146 - Freshman Engineering Design
- IE 200 - Introduction to Industrial Engineering
- SOHU 251 - Socio-Humanistic Studies I
- SOHU 252 - Socio-Humanistic Studies II

IE students are required to develop industry based projects in at least the four courses listed below:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE 348</td>
<td>Systems Design I &amp; Laboratory</td>
</tr>
<tr>
<td>IE 448</td>
<td>Systems Design II Laboratory</td>
</tr>
<tr>
<td>IE 539</td>
<td>Facilities Planning &amp; Design Project</td>
</tr>
<tr>
<td>IE 590</td>
<td>Capstone Design Course</td>
</tr>
</tbody>
</table>

Even though it is not a required course, many students select IE 546 - Industrial Engineering Practice as an elective course. As has been pointed elsewhere, having the students participate in industry based project has been very positive for both students and industry.

As pointed above, extracurricular activities are also a mean to attain the objective discussed in this item. Extracurricular activities include the following:

1. Student chapter activities including plant tours, campus conferences, attending local professional conferences.
2. Interacting with practitioners through activities with professional chapters including:
- Orientation and get together activities with the Institute of Industrial Engineers of the College of Engineers and Land Surveyors.
- Logistics Support to the IIE professional chapter #188 on their annual regional conference.
- Recognition of the Distinguished Student of the Year by the professional chapter. This recognition consists of a diploma, handed in at the closing dinner of the annual convention.

B. Opportunities available on campus for student participation in technical and/or professional societies.

The students have the opportunity to become members of the Institute of Industrial Engineering (IIE) student chapter #926. The IIE Student Chapter provides support through member interaction, as well as field trips, special speakers, and social programs that emphasize the value of networking and leadership. The student chapter has recently started publishing a brief newspaper.

Membership in IIE also gives industrial engineering students the opportunity to practice leadership skills. The student chapter offers many leadership opportunities, giving students an even greater opportunity to shine in a potential employer's eyes. Student members can also join their local senior chapter. Student members participate in the annual Industrial Engineering Convention, in which a variety of conferences not only sharpens the systems integration skills, it also puts the student in contact with potential employers. Professor Rosa M. Silva de la Maza is assigned as counselor of the IIE student chapter.

Supports to the IIE student chapter includes, transportation for plan tour activities, accident insurance, audiovisual equipment, networking to find part or full time employment, economic assistance from Dean of Students budget, and registration as a student organization on Dean of Students office. Student chapter in campus activities such as conferences, awareness and fund raising activities do receive logistics support from the department.

C. Student interaction with practitioners.

The IE program aggressively pursues, to expose the IE student to the real life working environment for which he/she is getting ready. The reasons we understand this is necessary are:

1. Because student need to know whether they have made the right decision on choosing to embrace industrial engineering as a profession.

2. Because such exposure will allow them to get a better understanding of those academic concepts being discussed in the classroom. Thus, one can find a diversity of activities throughout the 5 year program in which the student will come to contact with practitioners. Following is a list of some of these opportunities:

   i. Faculty. In general, part time faculty is drawn from industry, government and private practice. They do possess an an invaluable practical experience that is brough to the classroom. Full time faculty is encouraged to do consulting as long as this activity does not interfere with teaching.

   ii. Industry based projects. By design the IE curriculum requires the students to complete a minimum of 4 extensive and intensive industry based design projects. These experiences have demonstrated through the years to be very positive for students, industry as well a for the university. Students do get a valuable resource to get some job done. It also has the opportunity to evaluate prospective candidates for future employment. University gets recognition and exposure through the students.

   iii. Student Chapter Activities. A major purpose of an student chapter is to interact with practitioners in
industry, government and private practice. This is accomplished by the IE student chapter through plant
tours, in campus conferences, as well as attendance to professional conferences.

iv. Part-time or full time employed students. Even though we have not made a formal survey, we estimate
that approximately 25% of our student body in their 4th and 5th year have either part-time or full time
employment in industry. These students have special needs (such as course schedule) and require special
attention. They are commended for deciding to complete undergraduate studies in engineering, while
working. However, they are cautioned that this is not an easy task. Thus they are advised on keeping
contact with their mentor to carefully plan their studies, in such a way that, they not only complete their
degree and hold their job, but also they have gone through a truly learning experience that will allow them
to practice the engineering career.

D. Encouragement and arrangements made to have the students take the Fundamentals of Engineering Examination.

Taking the Fundamentals of Engineering Examination is not a graduation requirement of the IE program.
However, the local state law specifies that a graduate of an engineering program should approve as a minimum the
Fundamental of Engineering Examination. This will allow him/her to receive certification as an Engineer in
Training, and thus be able to practice the engineering profession under the supervision of a Professionally
Registered Engineer. This fact, as well as other advantages of becoming a Professional Engineer, are pointed out by
faculty through most of the courses mentioned on section D, chapter XIV, in volume II. This is particularly true for
the Professional Ethics in Engineering (PHIL 441) and Introduction to Industrial Engineering (IE 200) courses.

In addition there are other activities in which the university and/or the IE faculty participate, regarding the
Fundamentals of Engineering Examination. Every year for the last 4 or 5 years, the Institute of Industrial Engineers
has coordinated a Refresher Course for the professional examination. The university has helped on the logistics and
facilities aspects, mailing brochures announcing the course, providing classroom and audiovisual equipment.

Faculty members have traditionally participated as proctors during the Professional Engineering Examination.
Every year the Board of Directors of the Institute of Industrial Engineers invite the IE students to a get together
activity at their facilities. Through these activities the members of the board of directors explain students among
other things, the importance of approving the Fundamentals, as well as the Professional Examination, and then
registering as professional engineers.
CHAPTER XV - INFORMATION REGARDING FACULTY MEMBERS

A. Faculty analysis
Table XV - Faculty Analysis is presented in the following page.

B. Faculty activity summary.
Table XVI - Faculty activity summary follows immediately after table XV.

C. Satisfaction of ABET engineering criteria regarding faculty, by the IE program.
ABET's criteria for IE programs regarding faculty qualifications and size specifies that "A majority of the full-time-equivalent faculty members devoted to undergraduate teaching, counseling, and curriculum matters, and in no case fewer than three, must have at least one degree in industrial engineering."

There are 9 full time professors in the IE program, including the department head, the Lab Coordinator, the Assistant to the Department Head in Student Affairs, and one faculty member on leave to get his PhD in Mechanical Engineering. There are on the average 4 part time professors. All of them having at least one degree in Industrial Engineering.

Among the 9 full time professors one has a PhD in Industrial Engineering. Five of them have M.S. or M.E. degrees in IE. One faculty member has a master's degree in Systems Engineering and one more in Business Administration. The remaining faculty member is a candidate to get a Master's degree in Engineering Management.

D. Faculty's curriculum vitae.
Faculty's curriculum vitae are presented immediately after table XVI.
<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Rank</th>
<th>FT or PT</th>
<th>Highest Degree</th>
<th>Institution from which Highest Degree Earned and Year</th>
<th>Years of Experience</th>
<th>Professional Registration (Indicate State)</th>
<th>Level of Activity (high, med, low, none)</th>
<th>Professional Society (Indicate Society)</th>
<th>Research</th>
<th>Consulting/Summer Work in Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amjad, Patricia</td>
<td>28</td>
<td>Lect. II</td>
<td>PT</td>
<td>MSMR MSI &amp;OM</td>
<td>Univ. Wisconsin 1993, Univ. of Michigan 1991</td>
<td>1.5</td>
<td>EIT(PR)</td>
<td>CIAPR(Low)</td>
<td>None</td>
<td>None</td>
<td>High</td>
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<tr>
<td>Barba, Francisco</td>
<td>36</td>
<td>Lect. II</td>
<td>PT</td>
<td>BSChE MSChE</td>
<td>UPRR-Mayaguez 1985</td>
<td>4/7</td>
<td>EIT(PR) (Low)</td>
<td>CIAPR</td>
<td>None</td>
<td>None</td>
<td>High</td>
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<tr>
<td>Cedeño, Angela J.</td>
<td>28</td>
<td>Assit. Prof.</td>
<td>FT</td>
<td>MESE</td>
<td>UPRR-Mayaguez 1991</td>
<td>5</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<td>Cruz, Rafael</td>
<td>39</td>
<td>Assoc. Prof.</td>
<td>FT</td>
<td>MEIE</td>
<td>LeHigh Univ. 1983</td>
<td>3</td>
<td>EIT(PR) (Low)</td>
<td>CIAPR</td>
<td>None</td>
<td>None</td>
<td>Med</td>
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<tr>
<td>Faria, Rafael</td>
<td>53</td>
<td>Prof.</td>
<td>FT</td>
<td>PhDIE</td>
<td>Penn State 1973</td>
<td>30</td>
<td>PE(PR)</td>
<td>Med(CIAPR, UPADI)</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Fonseca, Wilfred</td>
<td>30</td>
<td>Asst. Prof.</td>
<td>FT</td>
<td>MSIE</td>
<td>Georgia Tech 1991</td>
<td>1</td>
<td>EIT(PR)</td>
<td>ASQC(Low), IIE (none)</td>
<td>None</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Name</td>
<td>Age</td>
<td>Rank</td>
<td>FT or PT</td>
<td>Highest Degree</td>
<td>Institution from which Highest Degree Earned and Year</td>
<td>Years of Experience</td>
<td>Professional Registration (Indicate State)</td>
<td>Level of Activity (high, med, low, none) in.</td>
<td>Consulting/Summer Work in Industry</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Godoy, Cuauhtémoc</td>
<td>36</td>
<td>Assoc. Prof.</td>
<td>FT</td>
<td>MSIE</td>
<td>Purdue Univ 1984</td>
<td>11</td>
<td>PE(PR)</td>
<td>Medium (CIAPR, IIE, ASQC, NSPE)</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>González, Carlos</td>
<td>29</td>
<td>Lect. II</td>
<td>PT</td>
<td>PhD</td>
<td>NCSU 1995</td>
<td>8</td>
<td>EIT (PR)</td>
<td>IIE (Low)</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>González, Fernando</td>
<td></td>
<td>Lect. II</td>
<td>PT</td>
<td>MSOH &amp; S</td>
<td>W.Virginia Univ. 1993</td>
<td>1</td>
<td>None</td>
<td>ASSE (Low)</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>López, Eduardo</td>
<td>36</td>
<td>Lect. II</td>
<td>PT</td>
<td>MSIE</td>
<td>Univ. of Michigan 1983</td>
<td>14</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
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</tr>
<tr>
<td>Pons, Carlos</td>
<td>44</td>
<td>Lect. II</td>
<td>PT</td>
<td>MEM</td>
<td>UPPR 1994</td>
<td>20</td>
<td>PE(PR)</td>
<td>APPR (Med.), CIAPR (Low), AIIE (Low)</td>
<td>None</td>
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<tr>
<td>Rodríguez, María de L.</td>
<td>29</td>
<td>Assit. Prof.</td>
<td>FT</td>
<td>MSIE</td>
<td>Texas A&amp;M Univ 1989</td>
<td>4/1</td>
<td>PE(PR)</td>
<td>CIAPR (Low)</td>
<td>None</td>
<td></td>
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<tr>
<td>Silva, Rosa</td>
<td>29</td>
<td>Assit. Prof.</td>
<td>FT</td>
<td>MBA</td>
<td>U.P.R. 1995</td>
<td>8</td>
<td>EIT (PR)</td>
<td>AIIE (med.)</td>
<td>Med.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suárez, Ricardo*</td>
<td>30</td>
<td>Assit. Prof.</td>
<td>FT</td>
<td>MSME</td>
<td>Univ. of Detroit, 1993</td>
<td>2</td>
<td>EIT (PR)</td>
<td>Low (ASME, III, CIAPR)</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Age</td>
<td>Rank</td>
<td>FT or PT</td>
<td>Highest Degree</td>
<td>Institution from which Highest Degree Earned and Year</td>
<td>Years of Experience</td>
<td>Professional Registration (Indicate State)</td>
<td>Level of Activity (high, med, low, none) in:</td>
<td></td>
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<tr>
<td>Torres, Juan A.</td>
<td>58</td>
<td>Asst. Prof.</td>
<td>FT</td>
<td>BSIE</td>
<td>UPR/RUM 1961</td>
<td>10</td>
<td>PE(PR)</td>
<td>Med. (IIE), Low (CIAPR)</td>
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</tr>
</tbody>
</table>

*On leave to complete a PhD program in ME.

Instructions:
Complete table for each member of the faculty of the program. Use additional sheets if necessary. Updated information is to be provided at the time of the visit. The level of activity should reflect an average over the current year (year prior to visit) plus the two previous years. Rev 5/95
### TABLE XVI
**FACULTY ACTIVITY SUMMARY, PROGRAM INDUSTRIAL ENGINEERING**

<table>
<thead>
<tr>
<th>Faculty Member (Name)</th>
<th>FT or PT</th>
<th>Classes Taught (Course No./Credit Hrs.) Current Term</th>
<th>Total Activity Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Teaching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Term</td>
</tr>
<tr>
<td>Amjad, Patricia</td>
<td>PT</td>
<td>IE 314/3, IE 428/3</td>
<td>100</td>
</tr>
<tr>
<td>Barba, Francisco</td>
<td>PT</td>
<td>ENGI 336/3 (2 sessions)</td>
<td>100</td>
</tr>
<tr>
<td>Cedeño, Johanna</td>
<td>FT</td>
<td>ENGI 235/3, ENGI 449/3 (2 sessions), IE 524/3, IE 531/3</td>
<td>100</td>
</tr>
<tr>
<td>Cruz, Rafael</td>
<td>FT</td>
<td>IE 511/3, IE 512/1, IE 523/3, IE 590/4</td>
<td>50</td>
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<tr>
<td>Faria, Rafael</td>
<td>FT</td>
<td>IE 429/3, IE 590E/0</td>
<td>100</td>
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<tr>
<td>Fonseca, Wilfred</td>
<td>FT</td>
<td>ENGI 235/3, ENGI 315/3, IE 275/2 (2 sessions)</td>
<td>75</td>
</tr>
<tr>
<td>Godoy, Cusuhátemoc</td>
<td>FT</td>
<td>IE 200/1, IE 546/3, SEMI 503/2, IE 546E/0, SEMI 503E/0</td>
<td>35</td>
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<tr>
<td>González, Carlos</td>
<td>PT</td>
<td>IE 523/3, IE 530/3, IE 590/4, IE 590E/0</td>
<td>100</td>
</tr>
<tr>
<td>López, Eduardo</td>
<td>PT</td>
<td>ENGI 139/3 (2 sessions)</td>
<td>100</td>
</tr>
<tr>
<td>Pons, Carlos</td>
<td>PT</td>
<td>ENGI 235/3 (3 sessions), IE 448/1</td>
<td>100</td>
</tr>
<tr>
<td>Rodríguez, Lourdes</td>
<td>FT</td>
<td>ENGI 235/3, ENGI 315/3, ENGI 449/3, IE 312/3, IE 313/1, IE 416/3</td>
<td>100</td>
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<tr>
<td>Silva, Rosa</td>
<td>FT</td>
<td>IE 315/3, IE 344/3, IE 448/1, IE 444/3, IE 448/1</td>
<td>50</td>
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<tr>
<td>Suárez, Ricardo</td>
<td>FT</td>
<td>None (On leave to complete PhD studies)</td>
<td>On leave</td>
</tr>
<tr>
<td>Torres, Juan</td>
<td>FT</td>
<td>ENGI 449/3 (3 sessions), IE 333/3, IE 539/1</td>
<td>75</td>
</tr>
</tbody>
</table>

**Instructions**

1. Provide classes taught for current term, total activity distribution for current term (item in which Volume II is being developed) and the fall term immediately preceding the visit.

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2. Activity distribution should be in percent effort. Members' activities should total 100%.
3. Indicate sabbatical leave, etc., under "Other."
4. Updated information is to be provided at the time of the visit.
1. Name: Patricia Amjad  
   Date of Birth: June 22, 1967

2. Academic Rank: Lecturer II  
   Date Appointed: March 1995

3. Degrees:  
   M.S. Marketing Research  
   University of Wisconsin, Madison Wisconsin, May 1993  
   M.S. Engineering, Industrial and Operations Engineering  
   University of Michigan, Ann Arbor, Michigan, June 1991  
   B.S. Industrial Engineering  
   University of Puerto Rico, Mayaguez Campus, May 1989

4. Years of Service: 3 months

5. Other Teaching Related Experience: None

6. Relevant Experience in Industry:

   Puerto Rico Tourism Co., San Juan, Puerto Rico  
   3/95 - present  
   Director of Statistics and Economic Studies  
   - Responsible for collecting and analyzing all tourism-related data including registrations, rooms rented, rooms available, and length of stay.  
   - Responsible for all local and international market research studies.  
   - Prepare special presentations for other government entities.  
   - Assist in the preparation of press releases and speeches.  
   - Responsible for managing Office's budget.

   The Procter and Gamble Commercial Co., San Juan, Puerto Rico  
   11/93 - 11/94  
   Assistant Brand Manager  
   - In charge of Pampers Direct Marketing Program. Responsibilities included overall program design, material development, analysis of research results, and recommendations.  
   - Analysis, evaluation, and recommendation of new products and initiatives.  
   - Design of TV and print advertising.  
   - Design and implementation of promotional activities, such as in-store demonstrations and joint promotions with other brands, analysis of results and recommendations.  
   - Responsible for managing brand's budget.

   8/93 - 11/93  
   Brand Assistant  
   - Implemented Always School Program pilot project, including development of materials and script, training and overall coordination. In addition, designed individual questionnaires for students and teachers to assess the success of the program and identify areas of opportunity. Coded and analyzed the results and presented recommendations to management.
8/92 - 12/92
University of Wisconsin, Madison, Wisconsin
Project Assistant - Marketing Research
- Assisted in literature research and research design, as well as data collection, coding and analysis.

5/92 - 8/92
Frito-Lay, Inc., Beloit, Wisconsin
Project Engineer (Summer Intern)
- Conducted an environmental audit for the plant.
- Compiled all the chemicals used in the plant, identifying their hazardous components and recommending the appropriate disposal method.
- Prepared/ submitted the stormwater discharge permit application for the plant.
- Verified the plant's compliance with applicable environmental regulations.

7/91 - 8/91
Baxter Healthcare Corp., Aibonito, Puerto Rico
Quality Engineer (Summer Intern)
- Developed and implemented a SPC at the Injection Molding Area.

6/90 - 8/90
Baxter Healthcare Corp., Round Lake, Illinois
Reliability and Quality Engineer
- Conducted and overall review and update to the product control specifications.
- Performed the protocol and validation for the elimination of the cleaning process for a component which resulted in $120k in savings per year for the Baxter-Aibonito plant.

7. State(s) in which registered: EIT - Puerto Rico

8. Principal publications of last five years: None

9. Scientific and Professional Societies:

10. Honors and awards:

11. Courses Taught:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses Codes</th>
<th>Hours/Week</th>
<th>No. of Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept.-Nov. 1994</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Nov.94-March 95</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>March-June 95</td>
<td>IE 314, IE 428</td>
<td>4 (lecture)</td>
<td>1</td>
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</tbody>
</table>

12. Assigned Duties: None

13. Specific Programs: None
1. Name: Francisco Barba Nicieza
   Date of Birth: September 9, 1958

2. Academic Rank: Lecturer II
   Date appointed: May 1994

3. Degrees:
   M.S. Environmental Health - in progress
   University of Puerto Rico
   M.S. Chemical Engineering - 1985
   University of Puerto Rico
   B.S. Chemical Engineering - 1982
   University of Puerto Rico

4. Years Service: 1 year

5. Experience:
   1990 - Present
   Bristol Myers Squibb Co.
   Environmental Engineer

   1988-90
   Eli Lilly Industries

6. Consulting, patents, etc.: None

7. State(s) in which registered: EIT (PR)

8. Principal publications of last five years: None


    Engineer of the Year 1992, Bristol Myers Squibb Co.
    Bronze Medal Award 1987, US EPA Region II

11. Courses Taught:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses Codes</th>
<th>Hours/Week</th>
<th>No. of Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept.-Nov. 1994</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Nov.94-March 95</td>
<td>ENGI 336</td>
<td>4 (lecture)</td>
<td>2</td>
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<tr>
<td>March-June 95</td>
<td>ENGI 336</td>
<td>4 (lecture)</td>
<td>2</td>
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</table>

12. Assigned Duties: None

13. Specific Programs: None
1. Name: Angela Johanna Cedeno de la Rosa  
   Birth date: March 14, 1967

2. Academic Rank: Assistant Professor  
   Date Appointed: November 1994

3. Degrees:  
   Master of Engineering in Industrial Engineering  
   University of Puerto Rico at Mayaguez, 1990

   Bachelor of Science in Industrial Engineering  
   Instituto Tecnológico de Santo Domingo, Dom. Rep., 1987

4. Years in service on Polytechnic Industrial Engineering Faculty:  
   0.5 years

5. Other related experience:  
   1990 - 1994 Eli Lilly Industries  
   1. - Process Team Leader  
   2. - Quality Control Representative  
   3. - Production Supervisor

   1988 - 1988 Compañía Dominicana de Teléfonos, filial of GTE company  
   1. - Trainee at Materials Control Department

   1985 - 1986 Instituto Tecnológico de Santo Domingo (INTEC)  
   Mathematic Laboratory Instructor

6. Consulting, Patents, Etc.: None

7. State(s) in which registered: None

8. Publications, Research and Projects  
   University of Puerto Rico at Mayaguez  
   Mayaguez, Puerto Rico.
   - Research Topic: Simulation of the vehicular traffic at the access ramps of the Luis Muñoz Marín  
     International Airport for evaluating the traffic behavior under different scenarios and conclude about  
     the best ramps design. 1989 - 1990. (not published)
   - Research Topic: Simulation of a hospital emergency area to determine the bottle-neck cases and  
     optimize the resources distribution. 1989. (not published)
   - Research Topic: Design of an experiment for determining the impacting variables to control for the  
     balance of a flexible production line. 1989. (not published)
   - Research Topic: Marketing analysis using economic engineering tools to establish an entertainment  
     place at the university campus. 1988. (not published)

9. Scientific and professional societies of which a member: None

10. Honors and Awards:  
    - "Magna Cum Laude" (Honor Diploma), awarded by Instituto Tecnológico de Santo Domingo, Dom. Rep.,  
      1987.
    - 1987 "Class Valedictorium", honor for obtaining the best GPA among the Industrial Engineering students,

11. Courses taught:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses</th>
<th>Hours/Week</th>
<th>No. of Sections</th>
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<tbody>
<tr>
<td>Sept.-Nov. 1994</td>
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<td></td>
<td>IE 515</td>
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<td>IE 524</td>
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<td>Nov. 94-March 95</td>
<td>ENGI 235</td>
<td>4 (lecture)</td>
<td>1</td>
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<td>ENGI 449</td>
<td>4 (lecture)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>IE 524</td>
<td>4 (lecture)</td>
<td>1</td>
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<tr>
<td>March-June 95</td>
<td>ENGI 235</td>
<td>4 (lecture)</td>
<td>1</td>
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<td>ENGI 449</td>
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<td>IE 524</td>
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<tr>
<td></td>
<td>IE 531</td>
<td>4 (lecture)</td>
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</table>


13. Faculty Development Activities:
   Two day workshop on How to Design Variable Control Charts, San Juan, P.R., 1995

14. Special duties of Co-op faculty: None
CURRICULUM VITAE

1. Name: Rafael N. Cruz  
   Date of birth: January 23, 1956

2. Academic Rank: Associate Professor

3. Degrees:  
   Master of Engineering, Industrial Engineering,  
   Lehigh University, June 1983  
   Bachelor of Science in Industrial Engineering  
   Pontificia Universidad Católica Madre y Maestra, June 1980

4. Number of years of service: 8 years  
   Original Appointment: Assistant Professor (1986)  
   Associate Professor (1993)

5. Other Related Experience:
   Teaching Responsibilities: Dictate courses in Materials Management, Production Planning and Control, Simulation of Industrial Systems, and Manufacturing Automation, to 4th and 5th year industrial engineering students.

   Laboratory Coordinator
   - Achievements: The successful implementation of:
     1. An Operations Management laboratory with Theory of Constraints software (TOC Simulators and Disaster Scheduling program), Statistical Software (Statgraphics), Human Factors software (Mannequin), Computer Aided Design software (AutoCAD), Statistical Quality Control software (SPC Design Tool), Spreadsheet software (Excel), Presentation software (Freelance), JIT simulation games, and Industrial Simulation packages (Simsystem and Witness). I personally installed a Novell network with 8 Personal computers and a Compaq dedicated server.

     2. Bar Code System. This bar code system has three terminals. Two using light pens and one with a laser wand reader. An additional high speed reader is also available. All terminal can be connected to a personal computer using a communication card. The information is transmitted in ASCII format and programs can be written to read this information into any application.

     3. Computer Integrated Manufacturing laboratory. This laboratory has two workcells. One with a desktop CNC lathe and one with a desktop CNC milling machine. Both machines have pneumatic chucks and each machine is served by a small Microbot robot. They have part feeders and carousels with sensors and are connected by a small conveyors. The two cells are computer controlled and communication between them is achieve through electrical signal send through optical relays.

     4. Industrial Robotics laboratory. Set up and start up of a Unimate 2070 industrial robot which was donated to the University by Westinghouse.

     5. Five year development plan. This include equipment identification as well as preparing the plans to develop three new laboratories: a) Quality control laboratory, b) Power systems and Process control laboratory, and c) Manufacturing processes laboratory.

Industrial Experience
   - Planning Manager, American Can Co., August 1983 - March 1986

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Responsibilities: Planning department and MIS Department
Planning Department Responsibilities: Materials Logistic. Supervision of Purchasing, Production Planning, Warehouse, and Traffic operations. Capital appropriation analysis and Project Auditing. I was also responsible for negotiating raw material prices. Purchases amounted to over $20 millions per year. Management Information Systems Department Responsibilities: Supervise the operation of the MIS operation.

Other Instructional Activities

6. Consulting:
- Baxter Healthcare: Manpower requirement analysis and software development for a 600 employees plant. This analysis led to a reduction from 192 temporary workers to less than 25 in a period of two months. Savings of $167k/month.
- Smith Kline & Beecham: Evaluation of warehouse space requirements. The company manufactures over 10 product brands and had over 7,000 pallet spaces. The construction of a $6MM warehouse was requested to meet company needs. Our analysis recommended more efficient use of current available space to satisfy company needs without building additional warehouse space.
- Smith Kline Beecham: Study incoming inspection requirements and sampling procedures. The outcome of this project was the development of a plan to update incoming inspection operations and procedures.
- Smith Kline & Beecham: Simulation of a proposed $60 millions strategic expansion plan to transfer new products to Puerto Rico. This plan included several stages and the project objective was to simulate each of the three proposed expansion stages to determine if they would meet market demand.
- Pfizer: Analysis of a tablet manufacturing process to evaluate variability in potency blend. This included a process capability analysis. Also, a regression analysis to determine relationship between theoretical values and process variables.
- Smith Kline & Beecham: Analysis of maintenance department personnel requirements to meet production line, preventive maintenance, and physical facilities requirements.
- Baxter Healthcare: Evaluation of manufacturing scheduling procedures for the sterilization department. The objective was to eliminate production backlogs and to develop a software that will automatically prepare three alternative schedules to meet manufacturing due dates.
- Signal Caribe: Troubleshooting of a robotics welding cell. Including re-programming and technical evaluation of operating conditions.

7. State Registration

Registered Engineering in Training in the Commonwealth of Puerto Rico, 12862 EIT

8. Publications of the Last Five Years


9. Scientific and Professional Societies

- American Institute of Industrial Engineers
- Society of Manufacturing Engineers
- American Production & Inventory Control Society
- American Society for Quality Control
- Member of "Colegio de Ingenieros y Agrimensores de Puerto Rico"

10. Honors and Awards

- Certified Academic Jonah by the Avraham Y. Goldratt Institute, June 1991
- Fulbright scholarship to carry out masters studies, 1981-1983
- Professor of the Year, elected by my peers, 1988

11. Courses Taught During the Most Recent Academic Year

12. Other Assigned Duties

- Industrial Engineering Department Laboratories Coordinator
- Associate Director of Industrial Engineering
- Senior Project Advisor

13. Program to Improve Teaching and Professional Competence During the Last Five Years

* The World Class Manufacturing Company, Dr. R. J. Schonberger, 16hrs, Condado Plaza Hotel, June 1992.
* Jonah Course, Avraham Y. Goldratt Institute, 40hrs, Offered at the University of Georgia, Athens, Georgia, June 1991.
* Programming and Operating the Microbot Automated Factory, UMI/Microbot, 40hrs, Sunnyvale, California, October 1988.


14. Special duties of co-op faculty: None
CURRICULUM VITAE

1. Name: Rafael Faría

2. Academic Rank: Professor
   Date Appointed May 1991

3. Degrees:
   Ph.D. in Industrial Engineering
   The Pennsylvania State University, 1973
   M.S. in Industrial Engineering
   The Pennsylvania State University, 1967
   B.S. in Industrial Engineering

4. Faculty Service: 4 years

5. Professional Experience:
   1989-92 Metcalf & Eddy de Puerto Rico, Inc. - Training Manager/Project Manager
   - Managed a project to develop, a Strategic Plan for Operations and Staffing for the Puerto Rico
     Aqueduct and Sewer Authority to be presented to the U.S. District Court for Puerto Rico.
   - Assistant Project Manager for a major multi-million dollar Program Management contract in
     support of a $1.5 billion resort in Isabela, Puerto Rico.
   - Significant participation in the preparation of proposals for major projects in Venezuela, Mexico,
     the U.S. Virgin Islands and Jamaica. Liaison with state and federal government agencies in
     matters pertaining to permitting activities. Participation in business development and marketing
     efforts.
   1985-89 City of San Juan, Puerto Rico
   - Chancellor of the Technological College of the City of San Juan
   - Chief Executive and Academic Officer responsible for coordinating and supervising all programs
     and activities, providing the necessary leadership to give direction and motivation to the various
     institutional components at this two-year post-secondary institution. The college offered associate
     degree programs in electronics technology, telecommunications, computer programming,
     accounting, nursing, and secretarial sciences. Managed a staff of 150 full-time and 50 part-time
     employees, and an annual consolidated budget of $2 million.
   1980-85 Department of Transportation and Public Works, Commonwealth of Puerto Rico
   - Secretary of Transportation and Public Works
   - Chief Executive Officer of the department and Chairman of the Board of three public
     corporations: Puerto Rico Highway Authority, Puerto Rico Ports Authority, and Metropolitan Bus
     Authority.
   - Had the responsibility of managing this complex multi-agency and multi-program department
     with over 8,500 employees and a consolidated annual budget of $450 million.
   1964-80 University of Puerto Rico - Tenured Engineering Faculty Member and Academic
   - Administrator
   - Started as Instructor and grew to become Full Professor of Industrial Engineering. Teaching
     responsibilities included the following subjects: Industrial Organization and Management,
     Personnel Administration and Industrial Relations, Plant Layout, Engineering Economics,
     Production Scheduling and Control, Quality Control, Reliability Theory, Simulation Using Digital
     Computers, and Engineering Statistics.
As academic administrator, served in several positions: Chairman of the Department of Industrial Engineering (managed an annual budget of $200,000 and coordinated/supervised 10 faculty members and three laboratory technicians); Associate Dean of the School of Engineering (annual budget of $2 million; coordinated/supervised three assistant deans, seven academic department heads, a librarian, and the coordinator of the school's computer center); Dean of Administration (annual budget of $24 million; coordinated/supervised two assistant deans, director of personnel, director of planning and director of building and grounds); Acting Chancellor of the Mayaguez Campus (annual consolidated budget of $50 million; coordinated/supervised seven academic and administrative deans, and three assistants); and Dean and Director of the Aguadilla Regional College (annual budget of $2 million; coordinated/supervised three assistant deans and 120 academic and administrative personnel).

While working at the University of Puerto Rico, served as: Member of the Scholarship Program Advisory Committee of the Economic Development Administration ("Fomento"); Lecturer in the Quality Control Development Program of "Fomento's" Industrial Laboratory; Lecturer in "Fomento's" Managerial Development Program for Industry; Lecturer, Graduate School of Business Administration, Catholic University of Puerto Rico.


7. Registration: PE (Puerto Rico)
   PE (Pennsylvania) inactive at present

8. Principal publications of last five years:
   Author or co-author of over ten publications in local, national and international professional/technical journals. Have delivered technical presentations in the Dominican Republic, Canada, Curacao and the Continental U.S.A.

9. Professional Societies:
   Puerto Rico Association of Engineers and Surveyors
   Inter-American Association of Sanitary Engineers
   Tau Beta Pi - Engineering Honorary Society
   Alpha Pi Mu - Industrial Engineering Honorary Society
   Phi Kappa Phi - General Scholastic Honorary Society
   Society of the Sigma Xi - Scientific Honorary Society

10. Honors & Awards:

11. Courses Taught:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses Codes</th>
<th>Hours/Week</th>
<th>No. of Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept.-Nov. 1994</td>
<td>IE 523, IE 590</td>
<td>4 (lecture) Time schedule by arrangement (capstone design project)</td>
<td>1</td>
</tr>
<tr>
<td>Nov. 94-March 95</td>
<td>IE 590E</td>
<td>Time schedule by arrangement (capstone design project)</td>
<td>1</td>
</tr>
</tbody>
</table>

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13. Improvement Teaching Programs:
Numerous seminars and short courses which include, among others: Human Resources Development for Increased Productivity, Negotiations, Project Control and Reporting, Business Development, Occupational Safety and Health, Supervision, Leadership, Municipal and State Revenue Bonds, Testifying with Impact, Stress Management, Motivational Techniques, Substance Abuse, Rules of Order, Evaluating Performance, and many others on technical/engineering and educational/teaching subjects.

14. Special duties of co-op faculty:  None
CURRICULUM VITAE

1. Name: Wilfredo Fonseca
   Date of Birth: June 6, 1965

2. Academic Rank: Assistant Professor
   Appointment: November 1992

3. Degrees:
   - Master of Science, Industrial Engineering
     Georgia Institute of Technology, December 1991,
   - Bachelor Science, Industrial Engineering
     University of Puerto Rico, Mayaguez Campus, 1989

4. Number of Years of Service:
   2.75 years

5. Other Related Experience:
   Industrial Experience
   - Computer Manager, AVON-Lomalinda San Sebastian
     (October 1989-September 1990) Responsibilities
     1. Developed and implemented a Master Production Schedule Program and application
        manual.
     2. Updated Manufacturing Schedule Programs and Warehouse Barcoding System.
     3. Collaborated on implementation of a Local Area Network to link manufacturing and
        planning departments.
     4. Responsible for buying new software and hardware.

6. Consulting: None

7. State(s) in which registered:
   None.

8. Principal publications of last five years:
   None.

9. Scientific and Professional Societies:
   - American Society of Quality Control (ASQC)
   - Institute of Industrial Engineering (IIE)

10. Honors and awards:
    None

11. Courses Taught:
<table>
<thead>
<tr>
<th>Term</th>
<th>Courses Codes</th>
<th>Hours/Week</th>
<th>No. of Sections</th>
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<tr>
<td>Sept.-Nov. 1994</td>
<td>ENGI 235</td>
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</table>

12. **Other Assigned Duties:**

Student advisor

13. **Specific programs in which faculty member has participated to improve teaching and professional competence during last five years:**

Two-day workshop on "Programming and Operation of the EmcoVMC 100 milling machine and the Emco PC-5 CNC lathe", Columbus, Ohio, February 1995

Design of Experiments workshop, San Juan, P.R., 1994

14. **Special duties of co-op faculty (coordinators): None**
CURRICULUM VITAE

1. Name: Cuauhtémoc Godoy Vinaja; Born: September 7, 1959
2. Academic Rank: Associate Professor and IE Department Head
3. Degrees: MS Industrial Engineering, Purdue University, 1984
  BS Industrial Engineering, Institute of Technology at Cd. Madero, Mexico, 1981
4. Number of Years of Service: 9.5 years (by April 1995)
   Appointments and dates of advancement in rank:
   Associate Professor - August 1989
   Department Head - October 1987
   Lab Coordinator (Part Time) - August 1986
   Assistant Professor - Nov. 1985
5. Other related experience:
   Provides technical training on SPC and Statistical Analysis of Data to local industries, since 1987
   Part-time Instructor in Statistics and SPC courses in the Graduate Program of Industrial Pharmacy, Medical Sciences Recint, University of Puerto Rico, since 1992
6. Consulting, patents:
   Statistical analysis of tablet potency (blending process); Pfizer Pharmaceuticals, Barceloneta, P.R.; 1993
   Development of software for scheduling and sequencing of jobs (PCB's production); National Circuits Caribe; 1987
7. States in which registered: Puerto Rico, Mexico.
8. Principal publications of last 5 years: None
9. Scientific and professional societies of which a member:
   The Institute of Industrial Engineers (since 1987)
   American Society for Quality Control (since 1989)
   Colegio de Ingenieros y Agrimensores de Puerto Rico (since 1989)
   National Society of Professional Engineers (since 1991)
   American Society of Engineering Educators
10. Honors and Awards:
    Distinguished Industrial Engineer of the Year - IIE/PR Chapter 188; June 1989
    Scholarship to pursue graduate studies in Industrial Engineering at Purdue University -
    Granted by the Council of Higher Education of Mexico - June 1989
b) Distinctions
   Member-Academic Council - UPR; 1993-94, 1991-93
   Member-Board of Directors - IIE/College of Engineers and Land Surveyors; 1993-94, 1992-93
   Member-Board of Directors - IIE/Puerto Rico Chapter 188; 1992-93, 1991-92, 1990-91,
   1989-90, 1988-89
### 11. Courses Taught:

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<th>No. of Sections</th>
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<td>IE 546E</td>
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</table>

### 12. Other assigned duties performed during the academic year:
- Member Steering Committee - 1994 Institutional Self Study prepared for Middle States Association
- President - Teaching Learning Process Committee
- From January 1991 to September 1993 I was Co-director of the Faculty Development Program. As part of such program I dedicated an average of 8 hours a week. These duties carried extra compensation.

### 13. Faculty development activities:
- ABET Annual Convention (3 days) Nov. 1993 N. Orleans NO
- Copinera Convention (3 days) Oct. 1993 San Juan, PR
- Univ. Politécnica de PR (4 hrs.) June 1993 San Juan, PR
- Institute of Ind. Engineers - IIE International Conference (3 days) May 1993 Los Angeles, CA
- P. R. Manufacturers Associations - Ind. Excellence Award Ceremony (1.5 days) Feb 1993 San Juan, PR
- IE Dept. UPPR-Simulation using Witness (1 day) Feb. 1993 San Juan, PR
- ABET-Annual Convention (3 days) Oct. 1992 San Antonio, TXS
- Univ. Politécnica de PR-Teaching Methodology of Effective (1 day) Oct. 1992 San Juan PR
- IIE Puerto Rico Chapter 188-3rd Industrial Engineering Congress on PR (1.5 days) Oct. 1992 San Juan, PR
- Univ. Politécnica de PR-Critical Thinking (1 day) Sep. 1992 San Juan, PR
- AIEE Chapter 188-1st Congress of Industrial Engineering in PR (1.5 days) Sep. 1992 San Juan, PR
- Manuistics Corporation-Design of Experiments (3 days) July 1992 Princeton, NJ
- IIE- CICAIP/Univ. Politécnica-World Class Manufacturing Seminar (2 days) June 1992 Detroit, MI
- IIE- CICAIP/Univ. Politécnica de PR-Ergonomics (1 day) May 1992 San Juan, PR
- AIEE Chapter 188-2nd Congress of Industrial Engineering in PR (1.5 days) Sept. 1991 San Juan, PR
- Ins. of Industrial Engineers-International Industrial Engineering Conference (3 days) May 1991 Detroit, MI
- PRMA/Puerto Rico 2000, Inc.-2nd Industrial Excellence in Manufacturing Seminar (1.5 days) Feb. 1991
14. Special duties of co-op faculty:
I am in charge of the evaluation of each and every co-op student of the IE program.
CURRICULUM VITAE

1. Name: Carlos González Miranda  
   Date of Birth: September 25, 1965

2. Academic Rank: Lecturer II  
   Date Appointed: November 1994

3. Degrees:  
   Ph.D. in Industrial Engineering  
   North Carolina State University, 1995  
   M.I. Manufacturing Systems Engineering  
   North Carolina State University, 1990  
   B.S. in Industrial Engineering  
   University of Puerto Rico, 1987

4. Faculty Service: 0.5 Years

5. Professional Experience:  
   Mar 94 - Present Assistant Professor, Industrial Engineering Department  
   University of Puerto Rico - Mayaguez Campus, Puerto Rico  
   - Developing, teaching, and grading courses for the Industrial Engineering Department  
   Jan 94 - Feb 94 Instructor, Industrial Engineering Department  
   University of Puerto Rico - Mayaguez Campus, Puerto Rico  
   - Developing, teaching, and grading the following courses for the Industrial Engineering Department: Production & Inventory Control, Probability Theory for Engineers, and System Simulation with Digital Computers (graduate level).  
   Aug 88 - Dec 93 Research Assistant & Teaching Assistant, Industrial Engineering Department  
   North Carolina State University, Raleigh, North Carolina  
   Mr 88 - Jul 88 Manufacturing Systems Technician, Advanced Materials Department  
   General Electric Corporation, Rio Piedras, Puerto Rico  
   - Assisted in the implementation and operation of MAPICS, ULTIMICS, and CAMPRI Manufacturing Systems. Developed procedures, user manuals, and training sessions in the proper utilization of the systems.


7. Registration: EIT (Puerto Rico)

8. Principal publications of last five years:  
   Master Thesis subject Design Procedure for Microload AS/RS using Simulation."
Involved in a senior design project at Baxter-Bentley, Areasco, Puerto Rico, helped in the implementation of a new product.

9. Professional Societies:
   Member, Institute of Industrial Engineers, Mayaguez Chapter.
   Member, American Production and Inventory Control Society, Raleigh N.C. Chapter
   Member, Phi Eta Mu Fraternity, Beta Chapter.

10. Honors & Awards:
    The Material Handling Institute Nashville Wire Products & St. Onge Company Honor scholarship.
    The Material Handling Institute Automatic Guided Vehicle Systems Production Section and Penton Publishing Honor scholarship.
    National Science Foundation Minority Graduate fellowship.
    The Material Handling Institute - AT & T scholarship.
    Presidential scholarship (University of Puerto Rico).
    Puerto Rico Economic Development Administration scholarship.
    Member, Tau Beta Pi, Engineering Honor Society.
    Member, Alpha Pi Mu, Industrial Engineering Honor Society.
    Member, The Dean's List, Honor Students Annual List.

11. Courses Taught:

<table>
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<tr>
<th>Term</th>
<th>Courses Codes</th>
<th>Hours/Week</th>
<th>No. of Sections</th>
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<td>Sept.-Nov. 1994</td>
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<td>IE 590/IE 590E</td>
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12. Assigned Duties:
    Advisor/Reference for Capstone Design Projects.

13. Improvement Teaching Programs:
    None

14. Special duties of co-op faculty:
    None
CURRICULUM VITAE

1. Name: Fernando González

2. Academic Rank: Lecturer II

3. Degrees: M.S. Occupational Health and Safety Engineering
Concentrations: Industrial Hygiene and Safety Engineering
West Virginia University, Morgantown, WV (Dec. 93)

B.S. Industrial Engineering
Polytechnic University of Puerto Rico, Hato Rey, PR (1992)

4. Years Service: 6 months
  Appointed: November, 1994
  Advancement in rank: None

5. Experience:
   Safety/Industrial Hygiene Eng. Pfizer Pharmaceutical (1/94 to present) Barceloneta, Puerto Rico
   IH Technician Snap Dragon (8/93 to 6/94) Morgantown, West Virginia
   Safety Engineer NIOSH, DSR (6/93 to 6/94) Morgantown, West Virginia
   Production Supervisor Customed, Inc. (5/92 to 9/92) Fajardo, Puerto Rico

6. Consulting, patents, etc.:

7. State(s) in which registered:

8. Principal publications of last five years:

9. Scientific and Professional Societies:
   American Society of Safety Engineers
   American Industrial Hygiene Association, Vice President Student Chapter

10. Honors and awards:

11. Courses Taught:

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12. Assigned Duties:

13. Specific Programs:

abet/cv.fg
1. Name: Eduardo López Muñoz

2. Academic Rank: Lecturer II
   Date appointed: November 1994

3. Degrees:
   Master of Science in Industrial Engineering
   University of Michigan (1983)

   Bachelor of Science in Industrial Engineering
   University of Puerto Rico (1982)

4. Years Service: 1 year

5. Other Related Experience:
   1993-Present
   Inter-American University - Bayamon Campus
   Part-time professor at the Information Systems Department

   1981-1982
   University of Puerto Rico - Mayaguez Campus
   Industrial Engineering Department
   - Research work in computer aided production monitor system
   - Quality Control Lab Instructor

6. Consulting, patents, etc.:
   1994-Present
   Productivity Systems & Tompkins Associates (Partner)
   - Consultant to Baxter Healthcare, Corp. in the design and implementation of a database
     reporting system integrated to a PLC.
   - Consultant to Squibb Manufacturing in the preparation, distribution, and evaluation of a
     supplier relationship survey.

   1993-94
   Independent Consultant
   - Consultant to Prosperity, Inc. in information systems.
   - Consultant to Roosevelt Mail Station in computer systems.
   - Consultant to "Ministerio de Planificación de El Salvador" in telecommunication sector
     re-structuring.
   - Consultant to Bopy, Inc. in organizational re-structuring, project management, work
     methods, and information systems.
   - Consultant to TEAM Consultants, Inc. in information systems.
   - Consultant to Metrodata, Inc. in database design, implementation, and procedures.

   1989-93
   TEAM Consultants - San Juan, Puerto Rico
   - Consultant to "Centro de Recaudaciones de Ingresos Municipales - (CRIM)" in project
     management.
   - Consultant to Department of Transportation and Public Works in organizational re-
     structuring.
   - Consultant to Metrodata, Inc. in database design and implementation.
   - Consultant to the Puerto Rico State and Management Office in database system design,
     programming implementation, and software validation.
   - Consultant to the Puerto Rico telecommunications Regulatory Commission to develop
     quality of service criteria and objectives.
   - Consultant to the "Fondos de Inversiones de Venezuela" in the strategic planning for the
     privatization of the Venezuelan Telephone Company.
   - Consultant to Eli Lilly Industries in computer training.
   - Consultant to the Puerto Rico State Department in information systems, and software
     validation.
- Consultant to the Puerto Rico Budget and Management Office in information systems, programming and software validation.
- Consultant to the Puerto Rico Communications Authority in a feasibility study of a submarine optical fiber cable between Puerto Rico, Vieques, Culebra, and St. Thomas.
- Consultant to the San Juan Port Front Development Office in project management.
- Responsible for the project management of a feasibility study of a submarine optical fiber cable between Puerto Rico and Venezuela.

1982-1989        AT & T Bell Laboratories - Naperville, Illinois

Oct. 1988-Aug. 89 Department 55241 - Data Switching Integration Group
Jan. 1986-Oct. 88 Department 55241 - Administration Software Development Group
Jan. 1985-Dec. 85 Department 59563 - Design Quality Group

7. State(s) in which registered:

8. Principal publications of last five years:

9. Scientific and Professional Societies:

10. Honors and awards:

11. Courses Taught:

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12. Assigned Duties: None

13. Faculty development activities: None

14. Special duties of co-op faculty: None
CURRICULUM VITAE

1. Name: Carlos A. Pons Fontana

2. Academic Rank: Lecturer II

3. Degrees: Master Engineering Management
Polytechnic University of Puerto Rico (1994)
B.S. Industrial Engineering
Polytechnic University of Puerto Rico (1986)
Master Clinical Psychology
Centro Caribeño de Estudios Postgraduados, Puerto Rico (1975)
B.A. Psychology
University of Puerto Rico, 1972

4. Years Service: 9 years, advancement in rank to Assistant Professor in 1989

5. Experience: 1975 to Present Alcoholism Outpatient Clinic ASSMCA, Rio Piedras, Puerto Rico

6. Consulting, patents, etc.: None

7. State(s) in which registered: PE (Puerto Rico)
Clinical Psychologist (Puerto Rico)

8. Principal publications of last five years: None

9. Scientific and Professional Societies:
   Colegio de Ingenieros y Agrimensores de Puerto Rico
   Asociación de Psicólogos de Puerto Rico
   Institute of Industrial Engineers (IIIE)
   Editor of the Newsletter 1992-1993

10. Honors and awards:
    None

11. Courses Taught:

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12. Assigned Duties:
   Member Disciplinari Committee (PUPR)

13. Faculty development activities:

14. Special duties of co-op faculty: None
1. Name: María de Lourdes Rodríguez González

2. Academic Rank: Assistant Professor
   Appointed: September 1994

3. Degrees: Master of Science Industrial Engineering
   Texas A & M University, 1989
   Bachelor of Science Industrial Engineering
   University of Puerto Rico, 1988

4. Faculty Service: 0.75 years

5. Professional Experience:
   QC Eng. Supervisor - ORC Caribe, Cidra P.R.
   April 1992 - Nov. 1993
   Industrial Engineer - Searle & Co., Caguas P.R.
   Feb. 1990 - April 1992

6. Consultant:
   Independent Consultant - Beato & Associates
   (subcontracts: Warner Lambert, Inc; Vega Baja & Chiron Beta, Canóvanas P.R.)
   Dec. 1993 - Present

7. Registration: Professional Engineer, Puerto Rico

8. Principal publications of last five years: None

9. Professional Societies:
   "Colegio de Ingenieros y Agrimensores de P.R."
   Institute of Industrial Engineers - Director

10. Honors & Awards:
    Certified Quality Engineer - 1992
    Economic Development Scholar - 1988
    National Hispanic Scholar - 1988
    Alpha Pi Mu, IE Honor Society - 1987
11. Courses Taught:

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12. Assigned Duties:
   Laboratory Manual for Statistics for Engineers I - 8 hours/week
   Open House Committee - 3 hours/week
   Acceptance Sampling Seminar (CASE) - extra compensation
   Member of the Course Curriculum Development - Mathematical Committee (working in a NSF proposal)

13. Faculty development activities:
   Attended Puert Rico's 1994 Convention in Industrial Engineering
   Attended 2 day workshop on "How to design Variable Control Charts" at Polytechnic University of Puerto Rico.

14. Special duties of co-op faculty:
   None
CURRICULUM VITAE

1. Name: Rosa M. Silva de la Maza
   Date of Birth: September 12, 1965

2. Academic Rank: Assistant Professor
   Appointment date: August 1987 (Initially as instructor)
                    Advancement in rank: 1989

3. Degrees:
   Master in Business Administration
   University of Puerto Rico, 1995

   Bachelor Science in Industrial Engineering

4. Number of Years of service: 8 years.

5. Other Related Experience:
   Developed laboratory manual for the course IE 348 - Systems
   Design I, at the Polytechnic University of Puerto Rico.
   Developed curriculum for course IE 354 - Ergonomics, at the
   Polytechnic University of Puerto Rico.
   Taught Quality Control Course at University of Puerto Rico,
   Bayamón Campus.

6. Consulting:
   Performed Statistical Quality Control consulting in several
   companies.

7. State(s) in which registered:
   Puerto Rico - EIT Certification No. 12173
   Certifications:
   MTM Instructor, by the MTM Association, Chicago, Ill., 1991.

8. Principal publications of last 5 years:
   None

9. Scientific and Professional Societies:
   Colegio de Ingenieros y Agrimensores de Puerto Rico
   American Society of Quality Control. (ASQC)
   Institute of Industrial Engineering. (IIE)

10. Honors and awards:
11. Courses Taught:

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<th>Hours/Week</th>
<th>No. of Sections</th>
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12. Other Assigned Duties:
Assistant to the Industrial Engineering Department Head in charge of
Student Affairs (Appointed November 1994)
IIE Student Branch Counselor
President - Curriculum Committee 1990-92

13. Faculty development activities:
Two-day workshop on Design of Experiments, San Juan, PR 1994
Puerto Rico's IIE Convention, San Juan, PR 1994
Puerto Rico's IIE Convention, San Juan, PR 1993
Humantech's Ergonomic training, San Juan, PR 1992
Two week course leading towards certification as MTM Instructor, by the MTM Association,
Chicago, Ill., 1991

14. Special duties of co-op faculty: None
CURRICULUM VITAE

1. Name: Juan A. Torres Gorbea
   Date of Birth: December 31, 1936

2. Academic Rank: Assistant Professor, Full Time

3. Degrees: Bachelor of Science in Industrial Engineering
   University of Puerto Rico, June 1961

4. Number of Years of Service: 10
   Original Appointment: Instructor * Nov. 1984
   Assistant Professor 1987

5. Other Related Experience:

   Teaching Experience:
   Quality Control Seminar, Extension Courses Div. University of P.R. 1967
   Quality Control Seminar, Extension Courses Div. Colegio Universitario Tecnológico de Bayamón, 1986
   Garment Manufacturing, Two day Seminar, Universidad Madre y Maestra, Santiago de los Caballeros, Dominican Republic, 1987

   Industrial Experience
   Electrical Instruments Supervision and Production Control
   Needle trades - new garments, production line planning, predetermined time standards - MTM based (Sewing Performance & Methods Analysis), Plant layout.
   Military uniforms, production program planning using learning curves for scheduling, management recruiting and training practices to match productivity requirements to meet program budget. Plant Layouts, illumination
   Electronic products, Manufacturing Engineer Cable & wire, Dock to Prod. line (stallkess),
documentation auditing, incoming inspection work standards.
   Engineer Advisor/Patent Engineer at Economic Development Adm. (Fomento)
   Assistant to Shoe industry Consultant
   Organization of Shoe Industry Vocational School, planning of materials to be consumed during
   semester long training, identification of skills in Dictionary of Occupational Titles, purchasing assistant,
   Engineering Advisor to investors in small industry and not so small
   Products: Garment commodities and fashion; electrical equipment, office equipment metal, plastic
   bottle blow molding, Plant layout, production planning, training, electrical power distribution,
   Cooperative Development Administration, development of production program for small manufacturing
   shops, visits to prospective groups to promote projects with Administrator and SubAdministrator.
   Patent Engineer, Secretary to Patent Program Committee (State Level). Interview inventors and process
   application through Committee and Patent Lawyer in Washington.
   Representative in Vocational Education Curriculum Evaluation Committee
   Telephone Traffic Engineer
   Trucking Requirements Studies Long Distance, Intertoll and Local Area Networks.
   Specifications writing for trucking in new equipment purchases.

6. Consulting:
   Council on Higher Education, Amendments to the License of the Interamerican University, Bayamon Campus:
The addition of a concentration in Materials Management to the Business Administration Department.
   Council on Higher Education, Amendments to the License of the Interamerican University, Bayamon Campus:
The begin offering three bachelors degrees in engineering science, Electric, Industrial and Mechanical.
7. **State Registered:**
   Puerto Rico License #4848

8. **Principal Publications of the Last Five years:**

9. **Scientific and Professional Societies:**

   Registered Industrial Engineers of the Engineers Assn., President 1975-77
   Engineers Association of P.R., Treasurer, Auditor, Pres. Defense of Profession Comm., UPADI 1982 Congress Comm, Auditor
   Institute of Industrial Engineers, Ch. 188 Vice President 1974

10. **Honors and Awards:**

   Soldiers Medal of Valor, 1962
   Distinguished Industrial Engineer, 1983
   Graduation Dedication, 1991
   Teacher of the Year (I.E. Student's) 1987-1990

11. **Courses Taught During the Most Recent Academic Year:**

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12. **Other Duties Performed During The Academic Year**

   IIE Student Chapter Advisor
   Discipline Committee- Dean of Students
   Library Committee- Middle States Accreditation
   IIE Faculty Committee- ABET

13. **Specific programs in which faculty member has participated to improve teaching and professional competence during last five years.**
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<td>Seminar Miller Consulting Group</td>
<td>15 Sept. 94</td>
<td>IIE Ch. 188 San Juan, P.R.</td>
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<td>Int. IE Conference</td>
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<td>3rd. IE Research Conference</td>
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<td>18-19 May 94</td>
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<td>TQM in Higher Education</td>
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<td>17 June 93</td>
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<td>Interactive teaching in the classroom</td>
<td>Workshop Cesar O. Malave Ph.D. Texas A&amp;M</td>
<td>22 December 93</td>
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<td>Seminar R. Schonberger</td>
<td>11, 12 June 92</td>
<td>Colegio de Ingenieros San Juan</td>
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<td>3rd. Industrial Excellence</td>
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14. Special duties of co-op faculty (coordinators)
None.
APPENDIX A

INDUSTRIAL ENGINEERING
PROGRAM OF STUDY
(BY COMPONENT)
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<th>COURSE</th>
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*IF REQUIRED, THESE COURSES ARE IN ADDITION TO THE MINIMUM GRADUATION REQUIREMENTS OF THE DEGREE

REV. MAY 1995
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** Must select 6 credits from Level II Socio-Humanistic Alternative Course Components.

REVISED: V/95
| COURSE | COURSE TITLE                   | CRED | GRADES | DATE | INITIALS | EQUIV | +-
|--------|--------------------------------|------|--------|------|----------|-------|------
|        | SCIENCE COMPONENT              |      |        |     |          |       |      |
| SCIE 111 | GENERAL CHEMISTRY I             | 4    |        |     |          |       |      |
| SCIE 213 | PHYSICS I                      | 3    |        |     |          |       |      |
| SCIE 214 | PHYSICS I LAB.                 | 1    |        |     |          |       |      |
| SCIE 235 | PHYSICS II                     | 3    |        |     |          |       |      |
| SCIE 236 | PHYSICS II LAB                 | 1    |        |     |          |       |      |
| SCIE 249 | PHYSICS III                    | 3    |        |     |          |       |      |
| SCIE 250 | PHYSICS III LAB                | 1    |        |     |          |       |      |
|        | SUBTOTAL                        | 16   |        |     |          |       |      |
|        | GENERAL ENGINEERING COMPONENT  |      |        |     |          |       |      |
| ENGI 139 | COMPUTER AIDED DESIGN          | 3    |        |     |          |       |      |
| ENGI 146 | FRESHMAN ENGINEERING DESIGN    | 3    |        |     |          |       |      |
| ENGI 220 | COMPUTER PROGRAMMING & ALGORITHMS | 3 | | | | | |
| ENGI 315 | PROBABILITY FOR ENGINEERS      | 3    |        |     |          |       |      |
| ENGI 322 | STATICS                        | 3    |        |     |          |       |      |
| ENGI 324 | MECHANICS OF MATERIALS I       | 3    |        |     |          |       |      |
| ENGI 325 | DYNAMICS                       | 3    |        |     |          |       |      |
| ENGI 327 | FLUID MECHANICS                | 3    |        |     |          |       |      |
| ENGI 336 | ENGINEERING MATERIALS          | 3    |        |     |          |       |      |
| ENGI 422 | MANUFACTURING PROCESSES        | 3    |        |     |          |       |      |
| ENGI 449 | ENGINEERING ECONOMICS          | 3    |        |     |          |       |      |
| EE 3800 | PRINCIPLES OF ELECTRICAL ENGINEERING | 3 | | | | | |
| EE 4800 | INDUSTRIAL ELECTRONICS         | 3    |        |     |          |       |      |
|        | SUBTOTAL                        | 39   |        |     |          |       |      |

REVISED: V/95
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<td>IE 428</td>
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<tr>
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<td>3</td>
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</tr>
<tr>
<td>IE 523</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>IE 524</td>
<td>PRODUCTION PLANNING &amp; CONTROL</td>
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## POLYTECHNIC UNIVERSITY OF PUERTO RICO
### INDUSTRIAL ENGINEERING DEPARTMENT
#### EFFECTIVE - AUGUST 1994

<table>
<thead>
<tr>
<th>STUDENT'S NAME</th>
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<td>IE 526 COMPUTER INTEGRATED MANUFACTURING</td>
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<tr>
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<td>IE 534 JUST IN TIME</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|        | SUBTOTAL  | 6     |        |      |          |        |    |

*** Must select 6 credits from elective courses. A partial list of such courses is presented here.
SOCIO-HUMANISTIC COMPONENT COURSES

LEVEL I - 12 CREDITS (REQUIRED)

<table>
<thead>
<tr>
<th>Socio-Humanistic</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sohu 251</td>
<td>Span 251</td>
</tr>
<tr>
<td>Sohu 252</td>
<td>Engl 251</td>
</tr>
</tbody>
</table>

LEVEL II - 9 CREDITS (6 CREDITS IN ELECTIVE COURSES)

Phil 441 - Ethics in Engineering. Required for Engineering and Land Surveying.

Select the remaining six (6) credit hours from the following eight (8) alternatives.

I. Economics (Pre-requisite: Sohu 251-252)
   - Econ 351 - Microeconomics
   - Econ 352 - Macroeconomics
   - Econ 441 - Economics of Puerto Rico
   - Econ 541 - International Economics
   - Econ 599 - Special Topics in Economics

II. Politics (Pre-requisite: Sohu 251-252)
   - Posc 351 - Government and Politics of Puerto Rico
   - Posc 352 - Government and Politics of the United States
   - Posc 441 - Comparative Politics
   - Posc 541 - International Politics
   - Posc 599 - Special Topics in Political Science

III. Psychology (Pre-requisite: Sohu 251-252)
   - Psyc 351 - Industrial Psychology
   - Psyc 352 - Human Development
   - Psyc 441 - Social Psychology
   - Psyc 541 - Theories of Personality
   - Psyc 599 - Special Topics in Psychology

IV. Philosophy (Pre-requisite: Sohu 251-252)
   - Phil 351 - Logic
   - Phil 441 - Ethics in Engineering
   - Phil 451 - Hosto's Philosophy
   - Phil 541 - Comparative Philosophical Movements
   - Phil 599 - Special Topics in Philosophy

V. History (Pre-requisite: Sohu 251-252)
   - Hist 351 - History of Puerto Rico
   - Hist 352 - History of the United States
   - Hist 441 - History of the Engineering Profession
   - Hist 541 - History and Art Appreciation
   - Hist 599 - Special Topics in History

VI. Literature (Prerequisite: Span 251 and/or Engl 251)
   - Span 351 - Puerto Rican Literature
   - Span 352 - Hispanic-American Literature
   - Engl 441 - American Literature
   - Engl 541 - Comparative Literature
   - Lite 599 - Special Topics in Literature

VII. Engineering Related Socio-Humanistic Topics (Pre-requisite: Sohu 251-252)
   - Econ 351 - Microeconomics
   - Psyc 351 - Industrial Psychology
   - Hist 441 - History of the Engineering Profession
   - Phil 441 - Ethics in Engineering
   - Sohu 541 - Contemporary Social Problems in Engineering

VIII. Puerto Rican Studies (Pre-requisite: Sohu 251-252)

<table>
<thead>
<tr>
<th>Socio-Humanistic Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
</tr>
<tr>
<td>Level II</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
APPENDIX B

INDUSTRIAL ENGINEERING
STRATEGIC DEVELOPMENT PLAN
(1994-99)
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   5. Donations ......................................................... 4

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Industrial Engineering Laboratories

A. Historical data Brief

The Puerto Rican Council for Higher Education approved the Industrial Engineering Program (IE program) in 1980. The Polytechnic University of Puerto Rico started this program February of 1981 with a part-time department head and 90 students. The department started to serve a student body with special requirements and possessing special characteristics. All the students were attending an evening program. Most of them were working full time. They had started their career at other institution but were unable to finish their studies there, or were pursuing a second degree. This student body required special course schedules.

1. When established
The industrial engineering laboratories started in 1983. At this time they consisted of mostly covered the traditional time study practices. No space was available and laboratory practices were limited to work measurement and performance rating. The equipment available consisted of stopwatches and videotapes of industrial operations. Students watch those videos in an audiovisual classroom where they carried out their laboratory practices. At the time, the only other equipment available were sound level meters and light meters. These equipment were used to carry out field projects in industry regarding noise control and workstation design. For courses outside the area of methods engineering, the faculty assigned projects which the students would do in industries located nearby. At this point, the university used the industrial facilities as an extension of its laboratories and the idea worked adequately.

2. History of development
The IE department has maintained a policy to develop its laboratories to support its curriculum. Any changes in class programs are followed by changes in laboratory practices and facilities (if required).

In item one we already described the beginnings of the IE Laboratories. Changes in industry requirements and technology showed the need to develop a deeper knowledge in human factors and a basic knowledge in industrial robotics. In 1984, a faculty member received the responsibility to identify and recommend equipment for a Human Factors and Methods Engineering Laboratory. During this time, a proposal was presented to obtain federal funds to develop/improve the industrial engineering laboratory facilities. During the years 1984-1985, using funds granted by MISIP and institutional funds, the university developed two new laboratories. A Human Factors Laboratory and a Robotics Laboratory. The estimated investment in equipment and materials required to implement these laboratories was $25,000. At this time, the university assigned the Methods Engineering and Human Factors Laboratory to Room
508 with 589 squared feet. The Robotics Laboratory was assigned an additional room with approximately 380 squared feet. The 380 squared feet later became part of the Educational Technology Center. In a period of two years, about 50% of the equipment became obsolete or damage beyond repair. In 1987 the university hired for the first time a full time department head. As one of his priorities, he started a new program to revitalize the laboratories.

3. Number of students initially served, personnel and support
As we said before, the IE Laboratories started in 1983. From 1983 to 1993, the IE department grew quickly to 750 students in 1993. The laboratories grew parallel to the student population. During this time, a member of the faculty was always in charge of the operations of the IE laboratories. In theory, he/she was responsible for equipment purchases and maintenance, laboratory development planning, equipment inventory and control, and any other activity related to the laboratories. The person in charge had the voluntary help of the full time faculty members although they did not have any direct responsibility.

In 1988, the IE department created an administrative position with the name Industrial Engineering Laboratories Coordinator and hired a qualified professional to fill it out. This was a part time position requiring a 20-hours weekly schedule. The IE Laboratory Coordinator position stayed in operation for the period 1988-1991 when the last person in charge quit the institution. The position stayed vacant and the laboratories went back to the previous system. This time, the department decided that the responsibility was equivalent to six credit-hours. The department divided the laboratories in two major areas: (a) Human Factors and Methods Engineering, and (b) Industrial Robotics. The department head assigned two members of the faculty to laboratory development, one to each area. Their duties were equipment selection and recommendation, equipment maintenance, laboratory development planning, equipment inventory and control, and any other activity related to the laboratories. In November 1993 all IE laboratories were integrated under the supervision of a single faculty member. Time and compensation is the equivalent of a full time professor requiring the laboratory coordination and teaching laboratory sessions or regular courses equivalent to three credit hours. He also works as Associate Director of Industrial Engineering and must be thesis advisor to graduating students. This policy is currently in operation.
4. Moneys allotted to equipment acquisition, maintenance, and modernization

Moneys Allotted during 1981-1994

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount ($)</th>
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<tbody>
<tr>
<td>1. Equipment acquisition</td>
<td>$147,298</td>
</tr>
<tr>
<td>2. Software acquisition</td>
<td>$79,800</td>
</tr>
<tr>
<td>3. Maintenance</td>
<td>$17,000</td>
</tr>
<tr>
<td>4. Personnel</td>
<td>$68,000</td>
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</tbody>
</table>

5. Donations
Our laboratories have received grants and donations from private institutions, industries, and professional associations. The following table presents a list of these donations including their dollar value.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>DESCRIPTION</th>
<th>COMPANY</th>
<th>APPROXIMATE VALUE ($)</th>
</tr>
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<tbody>
<tr>
<td>1987</td>
<td>Unimate 2070 workcell</td>
<td>Westinghouse</td>
<td>60000</td>
</tr>
<tr>
<td>1992</td>
<td>Cash Donation</td>
<td>Inst. of Ind. Eng.</td>
<td>4000</td>
</tr>
<tr>
<td>1992</td>
<td>Grant</td>
<td>Avraham Y. Goldratt Institute</td>
<td>40000</td>
</tr>
<tr>
<td>1992</td>
<td>Grant</td>
<td>MTM Association</td>
<td>40000</td>
</tr>
<tr>
<td>1994</td>
<td>Toshiba SR-654-II</td>
<td>ABBOT Laboratories</td>
<td>20000</td>
</tr>
<tr>
<td>1995</td>
<td>Electronics Equipment: Sales and distribution</td>
<td>PLC's and electronic accessories</td>
<td>15000</td>
</tr>
</tbody>
</table>

The grant from the Avraham Y. Goldratt Institute included the attendance of two of our faculty members to three weeks of training which certified them as "Jonah", the license to use their manufacturing simulators and their scheduling software "Disaster" in our Operations Management Lab. MTM association also gave us the license to use the software 4M-U in our Operations Management Laboratory.
B. Present status of the laboratories

The IE department has always maintained a constant effort to develop its laboratories. Our laboratories afford the students first hand experience showing the applicability and usefulness of the theory discussed in the classroom.

1. Laboratory space

The Industrial Engineering Department currently has physical facilities allocated to laboratories. The laboratories areas and the space available for each one of them are presented in the following table.

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Space (square feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Human Factors/Methods Engineering (room L-209)</td>
<td>925</td>
</tr>
<tr>
<td>2. Computer Integrated Manufacturing (room L-210)</td>
<td>1,675</td>
</tr>
<tr>
<td>3. Robotics Laboratory I (room L-108)</td>
<td>810</td>
</tr>
<tr>
<td>4. Operations Management (room L-204)</td>
<td>865</td>
</tr>
<tr>
<td>5. Power systems &amp; controls (room L-206)</td>
<td>730</td>
</tr>
<tr>
<td>6. Quality Control (room L-208)</td>
<td>815</td>
</tr>
</tbody>
</table>

2. List of equipment per laboratory

The six laboratories listed above are grouped in four categories or fields. These are:

A. Human Factors and Methods Engineering
B. Operations management
C. Industrial Robotics and Computer Integrated Manufacturing
D. Statistics and Quality Control

Next, we present a complete list of the current distribution of equipment per category or field.

A. Human Factors and Methods Engineering
This laboratory was designed to provide the students with the opportunity to carry out practical experiments concerning motion and time studies, noise and illumination, workstation design, methods' improvement, performance rating, and many other areas of human performance at work. The laboratory has the following equipment available.
<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Adjustable workstation</td>
<td>5</td>
</tr>
<tr>
<td>2. Material handling car</td>
<td>1</td>
</tr>
<tr>
<td>3. Ergonomic screw driver</td>
<td>1</td>
</tr>
<tr>
<td>4. Sound proof cabin</td>
<td>2</td>
</tr>
<tr>
<td>5. Portable audiometer</td>
<td>2</td>
</tr>
<tr>
<td>6. Sound level meter</td>
<td>10</td>
</tr>
<tr>
<td>7. Light meter</td>
<td>14</td>
</tr>
<tr>
<td>8. Titmus vision tester</td>
<td>1</td>
</tr>
<tr>
<td>9. JBL speakers</td>
<td>5</td>
</tr>
<tr>
<td>10. Laser disk player</td>
<td>1</td>
</tr>
<tr>
<td>11. Cassette player</td>
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</tr>
<tr>
<td>12. Sound amplifier</td>
<td>1</td>
</tr>
<tr>
<td>13. Sound mixer</td>
<td>1</td>
</tr>
<tr>
<td>14. Meylan time study trainer</td>
<td>4</td>
</tr>
<tr>
<td>15. Stopwatches</td>
<td>24</td>
</tr>
<tr>
<td>16. Assembly board (with wooden inserts)</td>
<td>5</td>
</tr>
<tr>
<td>17. Datamyte data collection system 2000</td>
<td>1</td>
</tr>
<tr>
<td>18. Eye display</td>
<td>1</td>
</tr>
<tr>
<td>19. Ear display</td>
<td>1</td>
</tr>
<tr>
<td>20. Camcorder</td>
<td>1</td>
</tr>
<tr>
<td>21. Noise dosimeter</td>
<td>2</td>
</tr>
</tbody>
</table>
B. Operations Management
The operations management laboratory, which currently consists of a Novell
network with 14 personal computers for student use. This network offers the
student the opportunity to access specialized software to tackle industrial
engineering problems. At this point, three members of the faculty have heir
personal computers connected to the operations management laboratory
network. Office location has made impossible to connect the remaining
faculty's PCs to the network.

The Operations Management Laboratory has the equipment and software
required to develop the system analysis, solutions development, and decision
making skills in our students. The following tables present the hardware and
software available in this field category.

<table>
<thead>
<tr>
<th>Operations Management Lab - Equipment Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>1. Digital Equipment Corp. personal computers 486/33 Mhz</td>
</tr>
<tr>
<td>2. Digital Equipment Corp. personal computers 486/66 Mhz</td>
</tr>
<tr>
<td>3. Digital Equipment Corp. personal computers Pentium 90 Mhz</td>
</tr>
<tr>
<td>4. Compaq server</td>
</tr>
<tr>
<td>5. Hewlett Packard Laserjet IV printer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operations Management Lab - Software Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>1. Statgraphic DOS version (statistics)</td>
</tr>
<tr>
<td>2. Storm (operations research, production planning)</td>
</tr>
<tr>
<td>3. Witness (simulation)</td>
</tr>
<tr>
<td>4. Slamsystem (simulation)</td>
</tr>
<tr>
<td>5. Fourth Shift (MRP II)</td>
</tr>
<tr>
<td>6. AutoCAD (computer aided drafting)</td>
</tr>
<tr>
<td>7. Factory CAD (facilities planning)</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td>8. Factory Flow (facilities planning)</td>
</tr>
<tr>
<td>9. Mannequin (ergonomics)</td>
</tr>
<tr>
<td>10. Excel (spreadsheet)</td>
</tr>
<tr>
<td>11. Statgraphic Plus for Windows</td>
</tr>
<tr>
<td>12. Statistica</td>
</tr>
<tr>
<td>11. Microsoft Project (project management)</td>
</tr>
<tr>
<td>12. Database (database)</td>
</tr>
<tr>
<td>13. Theory of Constraint Simulators</td>
</tr>
<tr>
<td>14. Disaster (scheduling)</td>
</tr>
<tr>
<td>15. Backsoft (ergonomics)</td>
</tr>
<tr>
<td>16. Freelance (presentation graphics)</td>
</tr>
<tr>
<td>17. Metadesign (flowcharting)</td>
</tr>
<tr>
<td>18. SPC Design Tool (statistical process control)</td>
</tr>
<tr>
<td>19. 4M-U (time standards)</td>
</tr>
<tr>
<td>20. Lotus 1-2-3 (spreadsheet)</td>
</tr>
<tr>
<td>21. Lindo</td>
</tr>
<tr>
<td>22. Timeline (project management)</td>
</tr>
</tbody>
</table>

**C. Industrial Robotics and Computer Integrated Manufacturing**

In this laboratory students are able to carry out practices regarding robot programming, equipment interfacing, and bar code operation. The next table presents the equipment available.
### Industrial Robotics and Computer Integrated Manufacturing

#### Equipment Available

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial Robotics and CIM:</strong></td>
<td></td>
</tr>
<tr>
<td>1. EMCO VMC-100 CNC Milling Machine</td>
<td>1</td>
</tr>
<tr>
<td>2. EMCO Compact-5 CNC Lathe</td>
<td>1</td>
</tr>
<tr>
<td>3. Pegasus Robots</td>
<td>2</td>
</tr>
<tr>
<td>4. Unimate 2070 (industrial robot)</td>
<td>1</td>
</tr>
<tr>
<td>5. Industrial conveyor</td>
<td>1</td>
</tr>
<tr>
<td>6. Industrial carrousel</td>
<td>1</td>
</tr>
<tr>
<td>7. Automated Guided vehicle</td>
<td>1</td>
</tr>
<tr>
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<td>15. Hero I (robot)</td>
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<td>3. Laser band reader</td>
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<td>Description</td>
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**D. Statistics and Quality Control**

In this laboratory students get see the application of statistical and quality control principles. This objective is achieve through lab practices carefully designed and/or selected by the IE faculty.

**Statistical and Quality Control Lab**

**Equipment Available**

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<td>3. Lightning Calculator</td>
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<td>4. Cracker Factory (Quality Control game)</td>
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<td>5. Catapult (Design of Experiments game)</td>
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**3. Number of students served per section and number of sections**

Our program uses the physical laboratory facilities to serve the needs of all laboratories included in our program. These are normally one credit-hour courses that meet four hours once a week. Currently, our curriculum includes the following laboratory courses.

- IE 313 Statistics Laboratory
- IE 348 Systems Design I Laboratory
- IE 448 Systems Design II Laboratory
- IE 548 Systems Design III Laboratory
- IE 512 Industrial Robotics Laboratory

The IE program also has two and three credit-hours courses that make intensive use of the Operations Management Laboratory and the Industrial Robotics Laboratory. They are:
### Course Credits

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<td>IE 275 Computer Tools for Industrial Engineers</td>
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<td>IE 314 Statistics for Engineers II</td>
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<td>IE 428 Operations Research I</td>
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<td>IE 515 Project Management</td>
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<td>IE 516 Industrial Systems Simulation</td>
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<td>IE 534 Manufacturing Resource Planning</td>
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</table>

The number of students officially registered in our laboratory courses is about 16 per section. The department normally offers one section of IE 313, IE 348, and IE 448 per quarter. For IE 512 and IE 548, the current policy is to offer one section every other quarter. This totals an average of 64 students per quarter and 256 students per year. Such quantity does not reflect the total number of students using our operations management facilities. Students from the two and three credit-hours courses listed previously used the NOVELL network and the software available for class assignments. With an average of 20 students per course, the total number of students served by the Operations Management Laboratory is about 240 per quarter and 960 students per year. This gives a grand total of 1216 students per year.

### 4. Laboratory-curriculum relationship

The Industrial Engineering curriculum is always under evaluation to assure a continuous improvement process. This is the only way we can guarantee our students a world class education. The policy of the Industrial Engineering department is to provide students the opportunity to put in practice the knowledge acquired in the classroom. Since our program is under continuous evaluation, our laboratories are also under continuous evaluation. An analysis of the evolution of the IE program and the IE laboratories can easily show that both go hand-in-hand. We next present some examples to support our position.

Immediately after the introduction of the Industrial Robotics course, the IE Department created the Industrial Robotics Laboratory. This laboratory was later expanded to include computer integrated manufacturing. The reason for the expansion was to support the existing Industrial Robotics course and the newly created Computer Integrated Manufacturing course.
When we first introduced the simulation course, we immediately purchased the Simulink software from Pritsker and Associates, the best simulation software available at the time. This course evolved to include animated simulation, therefore we purchased Witness from AT&T Isetel.

When we decided to strengthen the areas of Human Factors, Methods Engineering, and Quality Control in the curriculum, we got programs such as Mannequin, Backsoft, and 4MU. We also purchased adjustable workstations so the students could design the workstation from the ground up. We invested in camconders, sound mixers, high quality speakers, and other related equipment, so the students could analyze human performance under changing conditions.

Our faculty identified Statistical Quality Control as one area requiring of computer tools for control chart design. One of our professor develop such tool and called it Statistical Process Control Design Tool, which is now installed in our Operations Management Network. This software is also available commercially.

We have provided some examples showing the tight relationship between our class program and our laboratories. A careful study of our curriculum and laboratory practices will show in every case that laboratory practices are designed to strengthen and support the theory presented in the classroom.

5. Equipment maintenance
Equipment maintenance is coordinated by the laboratory coordinator and the laboratory technician. Basic maintenance is normally performed by laboratory personnel. In case of a major breakdown or complex problem, the first option is to send the equipment to the manufacturer. If the previous option is not possible, we bring a technician to the PUPR. The Industrial Engineering Department does not carry maintenance contracts for any of its laboratory equipment.

6. Laboratory personnel
The department has an IE Laboratories Coordinator, a laboratory development technician, and a laboratory operations support clerk. The responsibilities for each of these positions are presented in Appendix A. They include all activities related to the development, operation and maintenance of the IE laboratories, including budgeting.
C. Laboratory Development Plan

The Strategic Development Plan for the Industrial Engineering Laboratories must follow the guidelines established in the Strategic Development Plan prepared for the IE curriculum for the same period of time which in turn follows the guidelines established in the Strategic Development Plan prepared for the Institution. These guidelines provide the overall vision and mission of the institution and the department, as well as the specific objectives to be achieved during this period.

The IE department recently modified its Curriculum to provide the students the knowledge and skills demanded by our modern industry. This revised curriculum gives special attention to the human environment work, the use of a computer as a powerful analytical tool, the integration of manufacturing systems, and the ever increasing quality awareness required to compete in global markets. In order to include these elements in our curriculum, each of one of our courses syllabus were thoroughly evaluated. Several elective courses are now required courses and new courses were developed. These curriculum changes are expected to be in place with minor changes for the following 5 to 6 years.

Our laboratories must provide the students with the means to put in practice the knowledge and techniques acquired in the classroom. Therefore, we must revised our lab facilities and practices to meet the requirements of the new curriculum.

1. Plan for improvement of laboratory facilities
We believe that the future trend in Industrial Engineering will demand more and more the analysis of the work environment and of human behavior at work and in work teams. We also believe that given the current economic developments in Puerto Rico (especially in relation to the 936 industries), local industries will, in the future, require more automation and consequently the engineers to design and run automated systems. Therefore, we are developing our curriculum and laboratories accordingly.

Our plan for the next five years includes improvements on each of our laboratory facilities. In addition, we will create three new laboratories: (1) Quality control, (2) Manufacturing processes, and (3) Process controls and power systems.

*Computer Integrated manufacturing*
We will expand the CIM laboratory in order to satisfactorily serve 12 students per group and include new manufacturing technology. This expansion requires:

- 6 Basic CIM Workcells $\,202,000
- 1 Advanced CIM System 68,000
Total $270,000
Quality control laboratory
Our faculty has identified the need for developing a Statistical Process Control Lab. This will be done in five stages:

i. Prepare development plan
   - Physical facilities
   - Practices
ii. Install equipment
   - 6 workstations $48,000
iii. Train faculty and technicians (dept. expense) $5,000
iv. Faculty develops and/or carry out lab practices
v. Offer laboratory practices to students

We designed the laboratory to serve groups of 12 students working in teams. Each team will consist of two students, therefore we need to set up six workstations. We have already discussed equipment availability with educational equipment manufacturers.

Power Systems and Power Control Laboratory
This is a new laboratory to be created during the next four years. It includes modules in two major areas: (1) Power systems, and (2) Process Control. This modules are already available from an educational manufacturer and are specially designed to teach the specifics of each area. They include:

(1) Power Systems:
   - Pneumatic power $20,000
   - Hydraulic Power 20,000
   - Electric Motor Drives 20,000

(2) Process Control:
   - Servo/Sensor Modules $32,000
   - Electrical Relays 20,000
   - Computer Control 6,000

Total $118,000
Manufacturing Processes Laboratory
This new laboratory will provide the hands on experience required in manufacturing processes such as rolling, forging, and foundry. This experience is necessary for a complete understanding of the material discussed in ENGI 422 Manufacturing Processes. The proposed modules will provide desktop facilities to carry out laboratory experiments in the processes already described. They require a total investment of $130,000.

Human Factors and Methods Engineering
The expansion of our human factors and methods engineering is, essentially, the development of an ergonomic work environment laboratory. In this lab, students will be able to control noise, illuminance, and workstation design. Also, they will be able to videotape workers behavior under different working conditions and analyze impact on worker performance. Investment required:

- 2 Acoustic controlled cabins AR-9S $7,000
- 2 portable audimeter MA-39 1,000
- 6 Illumination workstations 9,000
- 2 Sound lab stations 10,000
Total $27,000

Operations Management Laboratory
Completion of the operations management laboratory to achieve the original plan of a total of 15 computers in a Novell Network. We also consider the need to offer the students remote access to our laboratory and the facility to integrate graphics, figures and/or schematics into their work through the use of scanners. The replacement of the initial 8 PCs was programmed for 1997-98. All this requires:

- 8 PCs with network cards and cables $17,500
- 1 printer/plotter 3,800
- Remote access 10,000
- Scanner 1,000
- PC Replacement 48,000
Total $80,300

Tables 1, 2, and 3 present a complete description of the equipment and investments the IE department for the next five years. In table 1 we present the Computer Integrated Manufacturing, Quality Control, and Power Systems and Process Control Laboratory Plans. The investments required for the period 1994-99 will amount to $500,000. All other laboratories will require $112,000 for a grand total of $612,000.
### Table 1
Computer Integrated Manufacturing, Quality Control, Process Control/Power Systems
Five Years Development Plan

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2. Space Availability
Taking into consideration the needs of our laboratories facilities, the administration built a four stories laboratory building. A total of 6,360 squared feet were assigned to the IE Laboratories and faculty offices. The new facilities house all IE laboratories since August 1994. Following is a description of each of the areas assigned to our department.

**Human Factors and Methods Engineering**
The space assigned to the laboratories of Human factors and methods engineering totals approximately 950 square ft. This facility has two areas. One dedicated to methods engineering. The other is used for the human factors laboratory. Figure 1 shows the proposed layout for these laboratories.
Computer Integrated Manufacturing
In this facility we installed our current CIM equipment and plan to install the additional workcells we have included in the development plan. A total of six workcell will be available for the students to work on. Here we will also locate our advanced computer integrated manufacturing system which will provide the students the opportunity to work with a complete manufacturing facility containing material handling and storage, quality control, computer numerical control machines, industrial robots, and vision systems.

The facility has approximately 1,990 squared ft. Figure 2 shows the preliminary layout of the area.

Power Stems and Process Control Laboratory
This laboratory will be located in a room with approximately 840 squared ft. Here we will have all the power systems and control equipment. The space for this laboratory is located in Room 216 of the new laboratory building, shown in Figure 3.

Figure 2 - Computer Integrated manufacturing 1,990 sq.ft.

Figure 3 - Power Systems & Process Control 840 sq. ft.
Operations Management Laboratory
Figure 4 presents the layout for the Operations Management Laboratory. It has approximately 900 squared ft. and houses the computer network used in the Operations Management Laboratory.

Quality Control laboratory
Figure 5 shows the Quality Control Laboratory with an approximately 840 squared ft. It houses all the statistics and quality control equipment.

Industrial Robotics
Figure 6 shows the Industrial robotics facility. It houses the Unimate 2070 and Toshiba industrial robots which are part of the Computer Integrated Manufacturing Laboratory. This room has approximately 840 squared ft and is located in the first floor of the laboratory building.

Other facilities

Figure 4 - Operations Management Laboratory 900 sq. ft.

Figure 5 - Quality Control Laboratory 840 sq. ft.

Figure 6 - Industrial Robotics Laboratory 840 sq. ft.
Figure 7 shows Industrial Engineering faculty offices which are also located in the laboratory building. This offices have a total of 550 squared ft.

Figure 7-Offices - 550 sq. ft.

3. Financial Sources for the Development Plan
All students pay a $25.00 fee to gain access to the Educational Technology Center and use of the computers facilities for report writing. Additionally, the student pays a mandatory fee of $75.00 for every laboratory course he takes each term. The revenue collected is set aside in a special account used exclusively for purchasing computer and laboratory equipment (C & L account). The only allowed expenditures that can be charged to this account are: CTE equipment, institutional networking equipment (PUPR Net), and the laboratory equipment.

Both the computers and the laboratory equipment ordered by our academic program will be registered, identified and assigned to our inventory of the program. The costs will be charged to our C & L account.

The institution distributes the C & L funds proportionally among the different academic programs taking into consideration the number of students served. In the event the fund does not grow at a rate high enough to be able to cover the needs of our program, the institution will assign additional financial resources to guarantee the minimum amount given in the following table. We would like to indicate that the number of students registered in the Industrial Engineering Department for the last four years has been stable with an average of approximately 700 students per year.

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Our laboratory development plan was developed taking considering only the institutional funds assigned by the administration to our department.
APPENDIX C

CHECK SHEETS FOR
ACADEMIC RECORD ANALYSIS
HOJA DE ANALISIS DE RECORD

NOMBRE: __________________________ #ESTUDIANTE: __________________________ FECHA DE SOLICITUD: __________________________

DEPARTAMENTO: __________________________ NUM. SECURO SOCIAL: __________________________

I. INFORME DE LA OFICINA DE REGISTRADURIA

TOTAL DE CREDITOS CORRESPONDIENTES A CURSOS:

A) REQUISITOS (PROGRAMA (19_)
    READMITIDO (19_)

B) CONVALIDADOS

C) APROBADOS EN NUESTRA INSTITUCION AL DIA

D) QUE APARECEN CON INCOMPLETO AL DIA

E) EN PROGRESO DURANTE EL TRIMESTRE EN CURSO (____)

F) CONVALIDADOS, APROBADOS, CON INCOMPLETO Y EN PROGRESO

G) QUE FALTA POR TOMAR (G-A-F)

PREPARADO POR: __________________________ FECHA: __________________________

II. INFORME DEL DIRECTOR DEL DEPARTAMENTO DE:

A CONTINUACION SE LISTAN LOS CURSOS QUE EL ESTUDIANTE DEBERA TOMAR Y APROBAR PARA CUMPLIR CON LOS REQUISITOS DE SU PROGRAMA (ADemas DE AQUELLOS EN LOS CUALES HA RECIBIDO INCOMPLETO O QUE TIENE EN PROGRESO)

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<th>CODIGO</th>
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A) CURSOS REQUISITOS

_Aprobar cdtis en progreso (____)

_Discutir este analisis con tu director

 Se te considera graduando a (____)

_Repetir cursos de concentracion con calificacion "D"

B) ELECTIVAS TECNICAS

C) ELECTIVAS LIBRES

D) DIFERENCIAS DE CREDITOS DEBIDO AL CUADRE DEL EXPEDIENTE

E) TOTAL DE CREDITOS

PREPARADO POR: __________________________ FECHA: __________________________
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<th>Course Code and Title</th>
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Total # of Design Credits:     Analysis performed by:     Date:      

Comments of the evaluator:      

cgodoy 26/fv/95    design chk

Mentor:    
