Accreditation Board for Engineering and Technology, Inc.
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VOLUME II

SELF-STUDY QUESTIONNAIRE

FOR REVIEW of

ENGINEERING PROGRAMS

1995-96 EDITION

USING ENGINEERING TOPICS CRITERIA

CIVIL ENGINEERING
(PROGRAM)

Submitted by

POLYTECHNIC UNIVERSITY OF PUERTO RICO
(NAME OF INSTITUTION)

JULY, 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
American Society of Agricultural Engineers
American Society of Civil Engineers
American Society for Engineering Education
American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
The American Society of Mechanical Engineers
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The Minerals, Metals, and Materials Society
National Council of Examiners for Engineering and Surveying
National Institute of Ceramic Engineers

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American Society for Nondestructive Testing, Inc.
American Society of Safety Engineers
Society of Plastics Engineers

EC 27A
Revised December 1994

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XI. OBJECTIVE AND SELF-ANALYSIS

A. Preparation for evaluation

As stated in Section II of Volume I, the preparation for the Accreditation Board for Engineering and Technology, Inc. (ABET) accreditation process at Polytechnic University of Puerto Rico started in 1985.

In order to familiarize with the ABET processes, the Director of the Civil Engineering Department, together with the Dean of the Faculty of Engineering and the other Department Heads attended the ABET Annual meetings in Chicago, San Antonio, and New Orleans. The faculty began the process of applying for membership to the American Society of Civil Engineers (ASCE) and to the National Society of Professional Engineers (NSPE), and to attend their respective annual meetings.

The physical facilities of the institution were improved, and a four story building to house all the engineering laboratories was constructed. At this building, the Civil Engineering Department has six (6) laboratories (Mechanics of Materials Lab, Constructions Materials Lab, Geotechnical Engineering Mechanics Lab, Environmental Engineering Lab, Structures Lab, Simulation Lab), the office of the Civil Engineering Department Head, and his secretary, as well as 10 offices for the full-time faculty members. Regarding the laboratory facilities, new equipment has been acquired for all of them. The laboratory manuals were revised and a Laboratory Development Plan has been prepared and approved.

In order to meet ABET criteria regarding faculty size and background, new full-time professors with at least Master's degree were incorporated to the CE Department.

All the full-time professors were involved in the development of Volume II of the document required by ABET. The first stage was to revise the curriculum, and all the course contents and descriptions, in order to incorporate the engineering design component as required by the ABET Criteria, and to emphasize the intensive use of computers and the laboratory experiences. As a result of this effort, the following goals were reached:

1. A new curriculum was established, which assures the logical and most appropriate sequence of courses, and course contents.

2. The engineering design is introduced early with an elementary freshman design course in the first year of study, is emphasized during the subsequent years, and culminated with a capstone design course in the last year of study.

3. The use of computers is introduced early through the use of CAD software in the engineering graphics course, offered in the first year of study, emphasized with a CE applied software course and a programming and algorithms course in the second year of study, and accentuated during all the years of study. To support this activity, new software packages were acquired, and others are under evaluation to be requested.

4. New laboratories were incorporated as part of the curriculum: the Mechanics of Materials Laboratory, and the Environmental Engineering Laboratory. As stated previously, all the laboratory facilities were drastically improved.
The second stage was to implement these changes. This phase has been carried out during the last two years. The third stage was to group the faculty in committees, to develop each chapter of Volume II of the present document. A coordinator of ABET activities was designated, to organize the team work.

B. Program objectives

Civil engineers are responsible for providing the world’s infrastructure facilities, which are basic to the existence of modern society. These facilities can be large and complex, thus requiring the civil engineers to be broadly trained and able to deal with the latest technologies. The goal of the civil engineering program at the Polytechnic University of Puerto Rico is to develop in the students a professional knowledge of the technology needed to enter into this highly competitive fields, and to prepare the graduates to pursue a productive civil engineering career that is characterized by continued professional growth. The program develops the ability to apply pertinent knowledge to the practice design in the major discipline areas of civil engineering: Structural Engineering, Geotechnical Engineering, Hydraulic and Environmental Engineering, Transportation Engineering, and Construction Engineering. This design experience is built upon the fundamental concepts of mathematics, basic sciences, and the humanistic and social sciences. This will provide civil engineers a healthy self image, a well rounded knowledge of their role in the society, the ability to communicate and to develop their creativity to design with originality.

C. Assessment of program objectives

When the Civil Engineering curriculum was developed, the faculty kept in mind the continuous changes in the demands and the role that professionals in civil engineering will play in order to comply with increasing society demands.

There are eight components in the CE curriculum that all CE students must go through. Movement from one component to the next requires a shift in paradigms. The CE program promotes this shift. The eight components are as follows:

1. Basic Sciences and Mathematics.
2. Humanistic and Social Sciences, and Languages.
4. Computer programming and applied software for civil engineering.
5. Civil Engineering discipline areas.
6. Laboratory experience.
7. Capstone design courses.
8. Civil Engineering Elective Courses.

The civil engineering curriculum will satisfactorily meet a variety of educational goals. A list of attributes faculty will strive to engender in the CE students is presented below:

1. Consciousness: The program generates in the students a healthy self-image and a consciousness of what is a professional, assuring that the CE graduates have a good knowledge of the civil engineering role in society, and what society needs. Besides, they understand what makes a technology-based society run and what engineers can and should do to keep it running well.

2. Assertiveness: The ability to define what should be worked on. In order to reach this goal students need experience with complex problems. They need coaching by faculty who knows, from experience, how to devise a meaningful approach from an ill-defined situation.
3. **Comprehension**: To gain competence in engineering sciences. Faculty members have examined the scientific topics important to society and determine, for each topic, the level of competence students should attain. Students should achieve the following abilities:

   a. To work on a specific problem by an specific problem-solving procedure, where more than one answer is acceptable, to assure the in-depth study of the definite technique and its support theory.
   
   b. To discover a conventional problem by himself without external intervention.
   
   c. To define a problem in an ill-defined situation and apply the required combination of solution methods.
   
   d. To identify a previously unrecognized problem and develop methods to solve it.
   
   e. To understand what other people is talking about, which is attained by reading popular magazines.

4. **Creativity**: An opportunity to design with originality. The concepts involved in engineering design are introduced with the freshman design course in the first year of study. During the subsequent years the students go deeply into the subject, and culminate with a capstone design course in the last year of study. The civil engineering design courses provide the opportunity to discern human needs and necessities; to apply knowledge from several fields of civil engineering; to consider the customer's interest in regard to cost, safety, efficiency, reliability, maintenance, and quality; and to understand the implications to the designers and constructors.

5. **Development of students skills**: The students have to learn course content developing reasoning and communication skills.

D. **Action to correct previous weaknesses**

Since this is the initial Polytechnic University of Puerto Rico application for ABET's accreditation, actions taken by the institution to address deficiencies or weaknesses noted by the E.A.C. cannot be reported.

However, the faculty could identify major areas of deficiency since the plans to achieve ABET's accreditation started, and proposed several actions to overcome this situation. These areas are described below:

1. One of the major problems detected was the reduced number of full time faculty in the Civil Engineering Department. To correct this situation, new full time professors with BSCE and MSCE were hired. The core of the faculty is formed by ten (10) full-time professors and six (6) part-time professors.

2. All civil engineering faculty have at least master degree in civil engineering or related discipline, covering the areas of structures, environmental and water resources, highway and transportation, geotechnical engineering, construction management, and design.

3. Regarding the incorporation of the design component in the Engineering curriculum, it can be stated that the Civil Engineering program has over 23 credits-hours in design, beginning with a freshman design course, and culminating with a capstone course.

4. One major weakness was the limitation of laboratory area and equipment. As stated in item A of present section, the Civil Engineering Department has six (6) laboratory rooms in the new laboratory building, totaling an area of approximately 5800 square feet to teach laboratory courses and perform experiments. Significant amount of new equipment was acquired to that purpose.
E. Major developments since previous visit

Besides those points raised in item D above, other major developments and/or progress made during the last five (5) years include:

1. Curriculum Updating: The curriculum of the Civil Engineering Program was thoroughly revised following the ABET guidelines to introduce the design component; assure breadth and depth in the socio-humanistic courses; satisfy the required number of credit-hours of courses in science and mathematics, engineering science, and engineering design; define the laboratory experience more precisely and make it more meaningful; restructure the computer courses and intensify the application of computer throughout the five years starting with the engineering graphics course; and include a course on ethics in the Engineering Practice.

2. Implementation of a mentoring system. The full-time faculty is involved in a mentoring system, to orient the students with their academic progress, graduate studies opportunities, professional opportunities, etc. Before November 1994, the student orientation and registration processes were totally separate from the engineering faculty.

3. The Conceptual development of a simulation laboratory. The need of a computer assisted analysis and design center was addressed, and the physical space within the new laboratory facilities was reserved. The hardware and software requirements for such a laboratory are under evaluation. After this stage is completed, a proposal will be submitted to the PUPR administration.

F. Plans for future development

The areas considered of major concern to be continuously improving and updating in the CE Department are the faculty, the program curriculum, and the laboratory facilities, as stated below:

F.1 Faculty

One of the major objectives of the civil engineering department is to continue increasing the number of full-time faculty with master and doctorate degree; to encourage them to get the professional registration; to reduce their teaching load in order to increase the responsibilities in other tasks like research and counseling; to retain more full-time faculty by providing them with good fringe benefits; to dispense ample faculty development opportunities; grant adequate office space and equipment; to improve the recruitment and promotion system; and end up with a better and more competitive salary scale.

F.2 Program and Curriculum

The civil engineering department will make all necessary effort to maintain its curriculum up to date, employing state of the art technology in every way possible. Regarding this point, one important goal is to improve the research activities among the faculty and students, and eventually to create master degree programs in civil engineering specific areas.

F.3 Laboratory Facilities

Although the laboratory area is considered to fit well the CE program necessities, and the laboratory equipment appropriate, it is essential to maintain this equipment and acquire new one to complement and improve the current facilities.
G. Program strengths

Among the program strengths, the following are considered the most important ones:

1. The Civil Engineering Department has completely revised its curriculum according to the new trend in engineering education. The design component was revised, requiring the teaching of engineering and design from the freshman year; a course on ethics in engineering practice has been added; and the communication skills have been emphasized as well, a course in probability & statistics.

2. The new Civil Engineering curriculum has been designed to help the students develop "Right Skills". Such skills are taught using the following methods:
   a. Case studies: case studies from actual projects are presented to the classroom audience for discussion of current design practice, and evaluation of other possible alternatives. Other design philosophies may also be addressed. An effective interaction between the various practicing engineers and the faculty members would go a long way in keeping the cases both current and interesting.
   b. Adjunct professors: the use of practicing engineers as part-time adjunct professor to teach design courses has been found to be very valuable.
   c. Field visits: project visits of the students to nearby construction sites or factory plants. Industry cooperation is generally necessary for the oncoming of such visits.
   d. Co-op studies: the students are encouraged to participate in the co-op programs where they can observe and learn from both the members of the faculty and practicing engineers.
   e. Open ended homework problems: a heavy sprinkling of open ended problems without unique answers could properly prepare the students to realize that design involves concepts tested by analysis and are subjected to many constrains.
   f. Team projects: Assignment of team projects help foster the team spirit that is so essential to any design project. Also, the discussions within the team help cross-fertilize the conceptual thinking of the team member. Each team is required to make an oral presentation of their design project to the entire class, giving the students the possibility to improve their communication skills.

3. The laboratory facilities are up to date. The area devoted to laboratory experiences in the new laboratory building, the new equipment acquired for each laboratory course, and the laboratory development plan put the CE Department as one of the best equipped in Puerto Rico.

4. The Civil Engineering faculty counts with a very active group of full time professors, with some special characteristic that assure the good health of the Department:
   a. All the full-time professor have, at least, master degree, and a good background in the engineering field and in research, consulting, and teaching activities.
   b. They are all deeply involved with the activities carried out by the CE Department, and concerned with the quality of education it offers to the students.
   c. They are always willing to help in the development of extra-curricular activities and projects that benefit the CE department and the PUPR, with a good team work attitude.
   d. Some of them are involved in activities to impulse the research in the PUPR, such as the development of a master plan to generate a research center in the PUPR, the development of a proposal to adequate the Mathematics courses content to the engineering necessities, and the participation of undergraduate students in a research and design project to develop a data acquisition system for a tension testing experiment.

5. The part-time faculty members are well-known CE practitioner engineers, who are assigned to the CE design courses, assuring that the students receive a very good input of common practice in PR.
H. Program limitations

The faculty identified the following aspects as the mayor limitations of the CE program:

1. **The need to evaluate the current quarter system.** The current system forces the students to maintain an accelerated process of study, with the following disadvantages: a) several concepts need more time to mature, and to be implemented in projects; b) the course projects can not be very comprehensive, in order to be accommodated during the quarter; c) due to the fact that there are four quarters of the same duration during the academic year, the student does not have a holidays period, so their performance is affected due to the lack of periods to rest. The faculty is also touched by this rhythm of work: a) they do not have holiday periods, but the week between quarters and the Christmas recess, with no opportunity to take summer specialization courses, or to devote full time to research or consulting activities; b) during the quarter, the intensive course schedule, together with the project, assignments, and exams evaluation does not leave much time free to dedicate to other activities. Regarding these facts, a semester system is strongly suggested.

2. **The need to evaluate the teaching load.** The load of a full-time professor ranges from 12 to 14 credit hours per week, per quarter. For instance, a normal load could be 4 courses of 3 credits each one (total 12 credits), or 2 courses of 3 credits each one plus 3 laboratories of 2.5 teaching credits each (total 13.5 credits). This high load, in a quarter systems, force the professor to concentrate only in teaching activities.

3. **The need to promote research among the faculty.** On the basis that an engineering university must not only communicate the knowledge but generate it, and that the engineering students should be in contact with the latest technologies in their fields of study, it is considered a high priority to start the promotion of research activities at the PUPR.

4. **The need to develop the research skills and knowledge of the faculty.** The opportunity of continuous education and development of the faculty is one of the topics that demand the creation of the appropriate structures to support this type of activities.

5. **The need to develop new teaching techniques.** The faculty should attend seminars in teaching techniques, where the use of modern teaching technology, such as the use of multimedia and interactive software, is addressed.

6. **The need to increase the full-time faculty.** The CE Department counts with 11 full-time professors, this number is not enough, considering the fact that the PUPR does not have a General Engineering Department, but has the general engineering courses distributed among the four engineering departments. The CE Department is responsible of 4 general engineering courses, that are offered all the quarters to the students of all the engineering fields. This fact causes that the majority of the full-time professors has one or two additional courses per quarter, and that the section sizes are greater than the maximum recommended by the CE department.

7. **The need to increase the number of faculty with advanced degrees.** In order to impulse the research activities is essential to hire professors with advanced degree, specially doctorates, and to support the faculty desire to continue doctorate studies.

8. **The need to address the faculty permanence and to improve the faculty fringe benefits and salaries.** In order to retain the faculty, a tenure system, the fringe benefits such as pension plan and sabbaticals, and the normalized 9 month salary should be equivalent to the other university institutions.

9. **The need of a CE Department Budget.** The Departments of the PUPR do not have a budget assigned to be administrated by the Department head. This situation makes the acquisition of equipment, software, and accessories very slow, and sometimes even frustrating.
10. *The need to have continued growth of the laboratory facilities.* All the laboratories were improved; this initial effort should be maintained in continuous updating and growing process, which may be affected by the fact mentioned in point 9 above.

11. *The need to extend the service hours of the PUPR.* The PUPR is opened from 7:00 am to 10:00 pm on Monday to Thursday, from 7:00 am to 3:00 pm on Fridays, from 8:00 am to 12:00 pm on Saturdays, and is closed on Sundays. This hour calendar does not allow the students and the faculty the access to use resources like the computer-center, the offices, and the library as they would like to.

1. **Support services**

1.1 **Computer facilities:**

The Polytechnic University does not have special computer laboratories for each engineering program, but has centralized facilities shared by all the students of all the programs. Despite this fact, the Civil Engineering Department is planning to develop a Simulation Laboratory, which will have special computer facilities. This laboratory will be oriented to develop special projects by advanced students, and is expected to evolve into a research center. At present, the faculty is involved in the conceptual design of the project; after this stage, the hardware and software requirements will be addressed.

The computer facilities at the Polytechnic University are extensively described in Section VI of volume I. A list of the software packages available in the Computer Center, and related to the different Civil Engineering areas is listed below:

1. Computer Aided Drawing and Design
   a. AutoCad
   b. DesignView
   c. CARD

2. Highway Design
   a. Cogo PC Plus
   b. Curver
   c. Horiz
   d. CivilCad

3. Hydrology and Water Supply
   a. CivilCad
   b. Hec 1
   c. Hec 2
   d. MNDOT
   e. Aquanet
   f. W/W Cost
   h. SMADA

4. Mathematic Processors
   a. MathCad for Windows
   b. MathLab for Windows

5. Programming Languages
   a. Fortran
   b. C
   c. QuicBasic
   d. Visual Basic for Windows

6. Project Management
   a. Microsoft Project

7. Structures
   a. ACES/FRAME
b. ANSYS

c. C-Beams
d. 3D Frames
e. Viga-B
f. Zaplel

The faculty is involved in the evaluation of new software packages for the different areas. Once the new software is selected, a proposal will be submitted to the administration.

I.2 Library:

The Polytechnic University has a centralized library. This library is specialized in the different engineering fields, and in business administration. The collection is distributed among Circulation and Reserve Department, Reference Department, Periodical Department and Audiovisual Department and Archival Department. It is arranged according to the resource format: books, periodical, audiovisual resources, CD-ROM. The resources are classified according to the Library of Congress Scheme. For more detailed explanation of the general facilities, see Section VI and Table VIII of Volume I. A list of the periodical publications available in the Civil Engineering field and related areas, and the year when the collection initiates at the Periodical Department is presented below:

3. Aberdeen's Concrete Construction, 1956 to present.
8. ASTM Standardization News, 1990 to present.
15. Concrete Abstracts, 1990 to present.
16. Concrete International: design and construction, 1979 to present.
17. Connect, 1980 to present.
22. Construction Products, formerly Highway & Heavy Construction Products, 1990 to present.
24. Disaster Prevention and Management, 1995 to present.
27. EERC News, (BPO) 1987 to present.
33. EPA Journal, (GPO) 1988 to present.
34. ES&T: Environmental Science & Technology, 1980 to present.
35. Fleet Equipment, (BPO) 1988 to present.
36. Highway and Heavy Construction Products, now Construction Products, 1990 to present.
37. Ideas, (BPO) 1990 to present.
38. Ingeniería Civil: Madrid, 1995 to present.
41. Journal of Construction Engineering and Management, 1960 to present.
42. Journal of Environmental Engineering, 1973 to present.
43. Journal of Geotechnical Engineering, 1974 to present.
44. Journal of Hydraulic Engineering, 1956 to present.
45. Journal of Irrigation and Drainage Engineering, 1956 to present.
47. Journal of Materials in Civil Engineering, 1989 to present.
51. Journal of Soil Contamination, 1984 to present.
57. Journal of Water Resources Planning and Management, 1976 to present.
58. Journal of Waterway Port Coastal and Ocean Engineering, 1956 to present.
60. Mass Transit, 1983 to present.
64. PCI Journal, 1966 to present.
66. Pollution Engineering, 1969 to present.
67. Research Journal of Water Pollution Control Federation, formerly Water Pollution Control Federation Journal, 1975 to present.
68. Research Resources Reporter, 1990 to present.
70. Steel Profile, 1987 to present.
71. Steel Today and Tomorrow, 1987 to present.
72. The Construction Specifier: advancement of construction technology, 1980 to present.
73. The Structural Engineer, 1979 to present.
74. Water Engineering and Management, 1988 to present.
76. Water Pollution Control Journal, 1993 to present.
77. Waterworld News, (BPO) 1986 to present.

Every quarter the library asks the faculty about their suggestions in regard to the acquisition of new books, magazines, and audiovisual material.
A. Program mode and trends

The Civil Engineering program is offered in a day mode. The students enrolled in the CE program and the number graduated in the most recent years is presented below:

<table>
<thead>
<tr>
<th>Academic year</th>
<th>Student enrolled</th>
<th>Students graduated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>1222</td>
<td>53</td>
</tr>
<tr>
<td>1992</td>
<td>1143</td>
<td>36</td>
</tr>
<tr>
<td>1991</td>
<td>941</td>
<td>26</td>
</tr>
<tr>
<td>1990</td>
<td>681</td>
<td>26</td>
</tr>
<tr>
<td>1989</td>
<td>532</td>
<td>19</td>
</tr>
<tr>
<td>1988</td>
<td>407</td>
<td>15</td>
</tr>
</tbody>
</table>

As can be concluded from the above information, the student enrolment in the CE program has been continuously growing during the most recent years, and perhaps is near to reach an stable number, considering the last gradient reduction and the actual facilities of the PUPR.

B. Degree titles

The Department of Civil Engineering offers undergraduate instruction leading to the degree of Bachelor of Science in Civil Engineering (B.S.C.E.).

C. Definition of credit unit

In Volume I, Section VIII, the PUPR calendar system is described. In order to explain this topic, the definition of one half year, and it implications under ABET criteria are addressed as presented below:

Definition of "one half year"

The quarter term as defined by PUPR consist of 12 weeks, with 3 credit hour lecture courses scheduled in two 2 hour periods per week, which totals 48 hours for the term. Nevertheless, this total must be reduced somewhat to account for registration activities conducted during the quarter's first week of classes and final examinations held in the quarter's last week. The reduction in total hours for a 3 credit-hour course, on account of the above, is six hours leaving a total of 42 hours actually devoted to teaching or 14 hours per credit-hour.

Implication under ABET criteria

1. According to ABET criteria, on-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.

3. Applying a simple interpolation, on-half year of study under the Polytechnic University defines the one half year as equivalent to 18 credit-hours.

4. As we can see the 175 credit hours required for the civil engineering program, would surpass ABET’s minimum criteria by at least 36.7% with regard to total number of credits.

D. Curriculum course content

The engineering design experience is developed and integrated throughout all the civil engineering curriculum, beginning early with an elementary freshman design course in the first year of study, emphasized during the subsequent years, and culminated in a major comprehensive capstone design course experience.

The program objectives are fulfilled, as described in the objective assessment of sections XI.B and XI.C, through a curriculum that carefully integrates all of its components: the basic sciences, mathematics, the humanistic and social sciences, and the engineering topics. The courses assignments and projects provide the students with the opportunity to develop decision making skills that lead to feasible solution that may include several constraints such as environmental, economical, safety and technical limitation. The development, completion, and presentation of team projects, improve the student's creativity, assertiveness, interpretation, comprehension and communication skills, resulting in a personal and professional self-esteem enhancement.

Using the definition of credit unit at the Polytechnic University of Puerto Rico, section XII.C, that stated that one-half year of study in the PUPR equals 18 quarter hours, the Civil Engineering program offers the following course content in order to meet ABET requirements (refer to table XII to analyze the credit distribution for math and basic sciences, engineering science and design, and humanities and social sciences):

D.1 One year of an appropriate combination of mathematic and basic sciences
   (1 year = 36 credit-hours minimum)

D.1.1 Mathematics component

The civil engineering program offers studies in mathematics beyond trigonometry. These studies include courses in differential and integral calculus and differential equations; also, additional courses of probability and statistics and numerical analysis. The codes of these courses are the following: MATH 111, MATH 122, MATH 133, MATH 144, MATH 226, MATH 237, ENGI 235, CE 247
D.1.2 Basic sciences component

The civil engineering program offers studies in basic sciences to acquire fundamental knowledge about nature and its phenomena, including analytical formulations and quantitative evaluations. These studies include courses in general chemistry, and general physics, also, an additional course of earth sciences. The codes of these courses are the following: SPAN 111, ENGL 111, SCIE 112, SCIE 213, SCIE 214, SCIE 235, SCIE 236, SCIE 249, SCIE 250, ENGI 246

A total of 46 credit-hours are required in the combination of mathematics and basic sciences components.

D.2 One half-year of humanities and social sciences
(1/2 year = 18 credit hours minimum)

The civil engineering program offers studies in the humanistic and social sciences courses as an integral part of the engineering program. Also, additional course of professional engineering ethics is offered. The codes of these courses are the following: ENGL 251, SPAN 251, SOHU 251, SOHU 252, PHIL 441, SOCIO HUMANIST ELECTIVE I, SOCIO-HUMANISTIC ELECTIVE II.

A total of 27 credit-hours are required in the Humanistic and Social Sciences component.

D.3 One and one-half years of engineering topics
(1 and 1/2 year = 54 credit-hours minimum)

D.3.1 Engineering sciences and design

The civil engineering program offers courses of engineering topics as the integral part of curriculum including subject in the engineering science and engineering design. A total of 64 credit-hours is required in engineering sciences and 23 credit hours in engineering design.

General Engineering Sciences and Design Components. The codes of these courses are the following: ENGI 146, ENGI 322, ENGI 327, ENGI 333, ENGI 335, ENGI 340

Civil Engineering Sciences and Design Component. The codes of these courses are the following: CE 318, CE 321, CE 322, CE 330, CE 331, CE 410, CE 412, CE 413, CE 415, CE 416, CE 424, CE 425, CE 437, CE 438, CE 439, CE 440, CE 441, CE 446, CE 447, CE 514, CE 540, CE 550.

Since no design credits are claimed for the elective courses, the student has freedom of choice when selecting them. However, the CE mentors encourage the students to select elective courses in one discipline area.

D.3.2 One half-year of civil engineering discipline areas
(1/2 year = 18 credit-hours)

The civil engineering program required a total of 61 credit hours in civil engineering courses covering the following five discipline areas of civil engineering: Structural Engineering, Geotechnical Engineering, Environmental Engineering, Transportation Engineering and Construction Engineering.

II-12
D.3.3  At least one engineering course outside the CE major disciplinary area

The civil engineering program requires two courses outside the major civil engineering discipline areas. One is the EE 3800 "Principles of Electrical Engineering", and the other is ENGI 449 "Engineering Economics."

D.3.4  Team projects

Team projects are carried out throughout all the civil engineering program in order to improve the flow of ideas between team members, to approach different situations that require technical ingenuity based on theoretical concepts acquired in the classroom. This continuous process begins with the Freshman Engineering Design course, and culminates with the Capstone Design courses. Oral and written reports are required as an important part of the team project described above.

In the following pages, course descriptions, (requires and electives) offered in civil engineering program are provided:
Polytechnic University of Puerto Rico
Department of Civil Engineering

ENGI 142-Descriptive Geometry
4th Quarter 93-94

1995 Catalog Data: ENGI 142 Descriptive Geometry. Credits 2.
Proposition on points, lines and planes; primary and successive auxiliary views; revolution;
intersections and developments, and vector graphics. Prerequisites: ENGI 131, MATH 122


Reference: James Earle, "Drafting Technology", Addison Wesley, 8th Edition

Coordinator: Dharma Delgado, Assistant Professor of C.E.

Goals: The primary purpose is to encourage the development of a graphic approach in the student's
through problems solving techniques the learning of fundamental concepts & graphical methods
of solving space or solid analytic geometry problems.

Prerequisites by topic:
1. Domain in orthographic projections.
2. Basic knowledge in geometry principles.

Topics:
1. Fundamental Views - Points, lines & planes (3 classes)
2. Crossed Lines - Distances between lines (1 class)
3. Perpendicularity - Between line & Planes (1 class)
4. Development of Auxiliary Views of an Object in Space (3 classes)
5. Basic Principles of Revolution (2 classes)
6. Basic Principles of Development (2 classes)
7. Vectorial geometry (3 classes)
8. Tests (3 classes)
9. Projects (4 classes)

Computer Usage: None

Laboratory Projects:
1. Practice exercises (8 weeks)

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

Engineering Science : 1 credit or 50%
Engineering Design : 1 credit or 50%

Prepared by: Dharma Delgado Date: March, 1994
ENGI246 Earth Sciences

Fundamentals of geology pertaining to engineering problems. Pre-requisite: SCIE 111


Coordinator: José Benedetty

Goals: This course is designed to give civil engineering students a solid basic knowledge in earth science that can be used in the solutions of problems connected with the natural environment of an engineering structure, particularly the surrounding ground.

Pre-requisites by Topic:
1. Propositional on points, lines and plane and vector graphics.
2. Fundamentals principles of chemistry such as atomic and molecular structures of gases, liquids and solids.

Topics:
1. Planets formation, tectonism, orogeny and Earth interior. (2.5 classes)
2. Plate tectonics. Continental drift and its relation with volcanism and earthquakes. (2.5 classes)
3. Earthquake causes and effects. (2 classes)
4. Origin, occurrence and characteristics of Volcanic, sedimentary and metamorphic rocks. (2.5 classes)
5. Structural geology and its relation with rock stability. (2.5 classes)
6. Rate, type and causes of rock weathering. (2 classes)
7. Hydro-geological cycle and its relation with underground and infiltrate water. (2 classes)
8. Test. (3 classes)

Computer Usage:
1. Non required

Laboratory projects:
Field and class recognition of minerals and rocks.

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

Prepared by: José Benedetty
Date: November, 1994


Coordinator: Gustavo E. Pacheco, Assistant professor of C. E.

Goals: To introduce the students to the calculus of displacements on deformable bodies, and its applications to the analysis of statically indeterminate structures, throughout the study of the behavior of bar elements subjected to different load conditions (axial, torsional, or flexural loads). Learn the concepts related to stability of equilibrium, and buckling of columns.

Prerequisites by topic:
1. Trigonometry.
2. Linear algebra (systems of linear equations).
5. Distributed forces. Stress resultants diagrams. Effect of different boundary conditions.
6. Stresses and strains in axially loaded members, in members subjected to torsional loads, and in members subjected to flexural loads.
7. Constitutive relationships.

Topics:
1. Displacements of axially loaded members. Statically indeterminate structures. Temperature effects. (3 Classes)
2. Nonuniform torsion of circular bars. Statically indeterminate torsional members. (2 Classes)
3. Deflection of beams. (5 Classes)
4. Statically indeterminate beams. (5 Classes)
5. Strain energy in axially loaded bars, in bars under pure shear and torsion, and in bars subjected to bending. Principle of virtual work. (3 Classes)
6. Buckling of columns. (1 Class)
7. Tests (3 Classes)

Computer usage:
1. One homework assignment, in topic 3, requiring the use of a symbolic math package stored in PC compatible computers, is required.
2. One homework assignment, in topic 4, requires the use of a structural analysis program stored in PC compatible computers.

Laboratory projects:
Related laboratory tests are carried out as part of the ENGI 340 course

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

Prepared by: Gustavo E. Pacheco Date: November, 1993
ENGL 340 - Mechanics of Materials Laboratory
3rd Quarter 93-94

Theory and laboratory experimentation of elementary concepts of stress, strain and deflection due
to axial, bending and torsional loads. Corequisites: ENGL 335.

Text Book: Mechanics of Materials Laboratory Manual, Polytechnic University of Puerto Rico internal
publication

J. D. Wilson, Physics Laboratory Experiments, D. C. Heath and Company, 1990

Coordinator: Gustavo E. Pacheco, Assistant professor of C. E.

Goals: That the students have a better understanding of the mechanic of deformable bodies through the
direct evaluation of the behavior of bar elements subjected to different load conditions (axial,
torsional, or flexural loads).

Prerequisites by topic:
1. Trigonometry.
2. Differential calculus.
3. Stresses and strains in axially loaded members, in members subjected to torsional loads, and in members
   subjected to flexural loads.
4. Constitutive relationships.
5. Displacements in members subjected to axial loads, torsional loads, and flexural loads.
6. Statically indeterminate members.

Topics:
1. Introduction, course description and methodology, visit to laboratory facilities (1 Class)
2. Elasticity: Young’s Modulus (1 Class)
3. Tension Test (2 Classes)
4. Elasticity: Modulus of Rigidity (1 Class)
5. Torsion Test (1 Class)
6. Internal Forces in Trusses (1 Class)
7. Deflection of Trusses (1 Class)
8. Shear Force and Bending Moment Diagrams (1 Class)
9. Deflection of Beams (1 Class)
10. Area Moment Method (1 Class)
11. Column Buckling (1 Class)

Computer usage:
1. The students must generate the laboratory reports through the use of commercial computer packages (word-
processors, spread-sheets, symbolic processors, graphics presentations, etc.)

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

Prepared by: Gustavo E. Pacheco Date: March, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 246 - Applied Software for Civil Engineering
4th Quarter 93-94

Working knowledge on several software packages: word processors, spread sheets, graphical
presentations, symbolic mathematics, civil engineering programs (structural analysis, hydrology,
highway design, foundations, etc.) . Prerequisites: ENGI 220, ENGI 322.

Text Book: None.


Coordinator: Gustavo E. Pacheco, Assistant professor of C. E.

Goals: This course is designed to develop the students skills and ability to effectively use computer
software in solving general engineering and civil engineering problems. Modeling and computer
simulation and emphasized.

Prerequisites by topic:
1. Algebra, Trigonometry, Analytic geometry, and Differential calculus.
2. Computer programming and algorithms.
3. DOS and UNIX operative systems.

Topics:
1. Review of operative systems concepts, DOS, Graphical User Interfaces, Windows. (2 Classes)
2. Word Processors. (2 classes)
3. Spreadsheets. (2 classes)
4. Computer Aided Drawing and Design (4 classes)
5. Continuous Simulation (2 classes)
6. Symbolic Mathematic and Numerical Solutions (3 classes)
7. The Internet. (2 classes)
8. One (or two) special purpose program(s) (4 classes)
   Structural Analysis of framed structures, Project Management, HighWay Geometric Design.
9. Tests (1 Class)

Computer usage:
The development of the computer assignments of this course require the intensive use of computers.

Laboratory projects:
The students must conform groups of 3 or 4 persons. Each group is required to carry out one computer project
for each software package covered in the class. The computer projects are as follows:
a) WordPerfect application project, b) Excel application project, c) Design-View application project, d)
VisSim application project, e) MathCad application project, f) Internet application project, g) ACES/Frame
application project, Microsoft Project application project, Cogo PC application project

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

Prepared by: Gustavo E. Pacheco
Date: July, 1994
In this course the most commonly used numerical methods in civil engineering practice are introduce. The topics include: computer and software, roots of equations, systems of linear equations, curve fitting techniques, numerical differentiation and integration, ordinary differential equations, and partial differential equations. Computer applications are emphasized. Pre-requisite: CE 246, ENGI 333; co-requisite: ENGI 235.


Coordinator: Omaira M. Collazos, Assistant Professor of CE

Goals: Introduce the student to the basic concepts in numerical analysis as applied in civil engineering problems.

Pre-requisites by Topic:
1. Computer programming.
2. Matrix analysis.

Topics:
1. Roots of equations. (3 classes)
2. Systems of linear algebraic equations. (2 classes)
3. Curve fitting. (3 classes)
4. Numerical differentiation and integration. (4 classes)
5. Ordinary differential equations. (4 classes)
6. Partial differential equations. (4 classes)
7. Test. (3 classes)

Computer Usage:
1. Each student is required to write and run five computer programs covering the first five topics. The computer programs may be written in Basic, Fortran 77, Pascal, or C programming languages.

Laboratory projects:
None

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

Prepared by: Omaira M. Collazos Date: October, 1994
CE 318-Water Resources Engineering
1st Quarter 93-94

Unit Hydrograph and Synthetic Unit Hydrograph Generation. Groundwater Flow. Prerequisites:
ENGI 328, CE 247.

Textbook:
Viessman, W., Lewis, G. and Knapp, J., "Introduction to Hydrology," Harper and Row Publishers,

Reference:

Coordinator: Juan Carlos Puig, Assistant Professor of C.E

Goals: To introduce the civil engineering students to the hydrologic science, giving them the basic
knowledge in hydrology. To provide an understanding of the hydrologic processes and the
elements of the hydrologic cycle. The student will be able to apply analytical methods to perform
a hydrologic study, and the analysis and evaluation of hydrologic existing conditions.

Prerequisites by Topic:
1. Statics and Dynamics of Fluids
2. Continuity, Energy, and Bernoulli Equations
3. Flow Measurements
4. Probability and Statistics

Topics:
1. Hydrology Concept and Hydrologic Cycle (1 Class)
2. Hydrologic Balance (1 Class)
3. Precipitation (2 Classes)
4. Hydrologic abstractions (3 Classes)
5. Discharge Measurement Methods and Instrumentation (1 Class)
6. Hydrograph Theory (1 Class)
7. Direct Runoff Determination (2 Classes)
8. Unit Hydrograph Concept (2 Classes)
9. Synthetic Unit Hydrograph Generation (3 Classes)
10. Hydrologic and Hydraulic Routing Methods (1 Class)
11. Hydrologic Design (1 Class)
12. Groundwater Hydrology (2 Classes)
13. Tests (3 Classes)

Computer Usage:
None

Laboratory projects:
Related laboratory tests are carried out as part of the CE 514 course

ABET category content as 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: Auristela Mueses    Date: December 13, 1993
Administration Specifications. Geometric Design. Prerequisites: CE247, SURV 191. Corequisites:
ENGL 142.


Oglesby, Clarkson H. and Hicks, Russell G., Highway Engineering, John Wiley & Sons, 1982.

Coordinator: J.M. González Juarbe, Assistant Professor of C.E.

Goals: This course is designed to give juniors in civil engineering an ability to use highway engineering
principles to prepare contract documents and to communicate professionally.

Prerequisites by topic:
1. Highway engineering graphics.
2. Plane trigonometry.
3. Horizontal geometry.
4. Vertical geometry.
5. Ability to use computer geometric design software.

Topics:
1. Highway administration and specifications (3 classes)
2. Horizontal curves (2 classes)
3. Compound curves (2 classes)
4. Spiral curve and superelevation (3 classes)
5. Vertical curves (3 classes)
6. Sight Distance (2 classes)
7. Tests (2 classes)

Computer Usage:
1. Three homework assignments, one each in topics 2,3, and 5 requiring use of stored programs in PC computer.
2. Each student must work out highway geometry problems manually and verify results with computer.

Laboratory projects:
1. Each student is assigned a homework problem to explain the highway funding procedure (2 classes)
2. Each student is assigned a homework problem to explain how vehicle speed impacts highway design (2 classes)
3. Problems assigned on the various types of highway geometry principles (2.5 classes)

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

Prepared by: Juan M. González Juarbe Date: April 7, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 322 Highway Design II
4th Quarter 93-94

1995 Catalog Data: CE 322 - Highway Design II. Credit 3.
Interchanges, Drainage, Contract Supervision. Prerequisites: CE 321.


Coordinator: J.M. González Juarbe, Assistant Professor of C.E.

Goals: This course is designed to give juniors in civil engineering an ability to use highway engineering principles to prepare contract documents and to communicate professionally.

Prerequisites by Topic:
1. Highway engineering graphics.
2. Plane trigonometry.
3. Horizontal geometry.
4. Vertical geometry.
5. Computer usage of highway engineering software.

Topics:
1. Intersections, Interchanges, Mass Transit (3 classes)
2. Drainage and Drainage Structures (3 classes)
3. Traffic Engineering Safety (2 classes)
4. Surveys, Plans, Contracts, Supervision (2 classes)
5. Earthwork Operations and Equipment (3 classes)
6. Highway Maintenance and Rehabilitation (2 classes)
7. Tests (4 classes)

Computer Usage:
1. Three homework assignments, one each in topics 2 and 5 requiring use of stored programs in PC computer.
2. Each student must work out highway engineering exercises manually and verify results with computer.

Laboratory projects:
1. Each student is assigned a homework problem to develop skills in highway drainage design (2 classes)
2. Each student is assigned a homework problem to develop skills in analysis of earthwork and construction equipment operations (2 classes)
3. Problems assigned on the various types of highway engineering special topics (2.5 classes)

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

Prepared by: Juan M. González Juarbe Date: May 10, 1994
Polytechnic University of Puerto Rico
Civil Engineering Department

CE 330 Construction Materials
3rd Quarter 93-94

1995 Catalog Data: CE 330: Materials of construction. Credit 3. Students will be introduce in the use of prevalent construction materials which will be tested in the laboratory. Prerequisites: ENGI 324, CE 247. Corequisites: CE 331.


Coordinator: Felix Sanchez, Associate Professor of C.E.

Goals: This course is designed to provide Civil Engineering students with required knowledge of materials and products used in the construction industry. Allowing for a wide variety of alternatives with which to meet the challenges and requirements of the industry.

Prerequisites by topics:
1. General knowledge of types of construction and materials mostly used in the community.
2. Basic knowledge of mechanical of materials and the uses the way they react under working conditions.

Topics:
1. Wood (2 classes)
2. Cement, aggregates, and concrete (2 classes)
3. Concrete admixtures (1 class)
4. Concrete masonry building units (1 class)
5. Precast concrete (2 classes)
6. Brick and tile (1 class)
7. Stone (1 class)
8. Ferrous and nonferrous metals (1 class)
9. Gypsum and lime (1 class)
10. Glass (1 class)
11. Bituminous materials (1 class)
12. Plastics (1 class)
13. Insulating materials (1 class)
14. Acoustical materials (1 class)
15. Adhesives, sealers, and sealants (1 class)
16. Protective and decorative coatings (1 class)
17. Test (3 classes)

Computer usage: None

Laboratory projects:
To be executed under course CE 331.

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

Prepared by: Omaira Collazos - Félix Sánchez  Date: March 27, 1994.
CE 331 Laboratory of Construction Materials
3rd Quarter 93-94


Coordinator: Felix Sanchez, Associate Professor of C.E.

Prerequisite by Topics:
1. The laboratory course, being supportive of the theoretical course, calls for a direct correlation between the two of them.

Topics:
1. Wood Properties: Compression, tension and flexure (1 class)
2. Granulometry of Course and fine aggregates (1 class)
3. Specific gravity of aggregates and cement (1 class)
4. Compression test of and impurities in, sand (1 class)
5. Initial and final salting of cement (1 class)
6. Mix Design & Mixing; concrete sampling (1 class)
7. Compression test on concrete (1 class)
8. Tension and flexure tests on concrete (1 class)
9. Tension test on reinforcing steel (1 class)
10. Tension and flexure tests on aluminum (1 class)

Computer Usage:
1. Obtain printed output of compression and flexure tests on materials
2. Preparation of statistical data
3. Both the text and graphics of the laboratory reports are generated through existing computer programs.

ABET category content:
Engineering Science : 1 credit or 100 %

Prepared by: Félix Sánchez
CE-410 Construction Management
3rd Quarter 93-94

1995 Catalog Data: CE-410 Management Engineering, Credit 3.
The study of the construction industry from a professional point of view. Management & Control of Construction Projects including Estimates, Bidding Contracts, Critical Path, Safety & Labor Relating. Prerequisites: CE 330, CE 247.


Coordinator: Félix Sánchez, Associated Professor, C.E.

Goals: To introduce the student to his functions as a Civil Engineering in the management of construction projects along the development steps from concept of design to construction and use.

Topics:
1. Management in the Engineering Construction Industry (1 class)
2. Development Organization of Projects (1 class)
3. Applications & Requirements for Management Organizations (1 class)
4. Introduction to an Example Project (1 class)
5. Preconstruction site investigation, planning and design (1 class)
6. Bidding & Award (1 class)
7. Construction (1 class)
8. Application of Controls (1 class)
9. Selecting a professional construction manager (1 class)
10. Concepts of project planning of control (1 class)
11. Estimating project costs (2 classes)
12. Planning of control of operations of resources (2 classes)
13. Costs Engineering (1 class)
14. Procurement (1 class)
15. Value engineering of quality assurance (1 class)
16. Safety of health in construction (1 class)
17. Risk management (1 class)
18. Industrial relations (1 class)
19. Claims liability of dispute resolution (1 class)

Abet category content as estimated by faculty member who prepared this course description:
Engineering Science: 2 credits or 66.67 %
Engineering Design: 1 credits or 33.33 %

Prepared by: Félix E. Sánchez               Date: May 4, 1994
Behavioral description statistically determinate structures under various types of static and moving loads; in order to predict strength and elastic deformations of the above mentioned structures. The actual advances in microcomputer development make compulsory to introduce students to the use of PC and related software which can serve as solution checks to problems. Prerequisites: ENGI 335, ENGI 340


Coordinator: Francisco Arencibia, Assistant Professor, CE

Goals: To provide a clear and simple revision to classical structural methods for analysis of determinate beams, frames and trusses; and to integrate the application of personal computer software to deal with open-ended structural analysis problem and design.

Prerequisites by topic:
1. Elementary Statics
2. Mechanics of Materials

Topics:
1. Types of structures and loads (1 class)
2. Reactions and static equilibrium equations (2 classes)
3. Analysis of space determinate trusses and computer solutions (3 classes)
4. Analysis of statically determinate beams. Relationship among load, shear and moments (1 class)
5. Analysis of statically determinate rigid frames (4 classes)
6. Influence lines for statically determinate rigid frames (4 classes)
7. Deflections: Geometric methods (1 class)
8. Deflections: Energy methods (1 class)
9. Tests (3 classes)

Computer Usage:
1. Three homework assignments, one each in topics pair (3,4) (5,6) (7,8) requiring use of program software

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

Prepared by: Francisco Arencibia    Date: June, 1993
Polytechnic University of Puerto Rico  
Department of Civil Engineering

CE 413- Water Supply Engineering  
2nd Quarter 93-94

Demand and use of potable water. Water availability, collection, treatment, and transportation.  
Prerequisites: CE-318

College Publisher, Fifth Edition, 1993

Inc., 1985  

Coordinator: Juan Carlos Puig, Assistant Professor of C.E.

Goals: To introduce the civil engineering students to the concepts of water resources, potable water  
treatment and water distribution system. Scientific concepts and design criteria will be studied  
regarding water availability and use, conventional potable water treatment, potable water quality  
criteria, water distribution systems, and water pumps.

Pre-requisites by Topics:
1. Basic sciences and mathematics
2. Statics and dynamics of fluids
3. Surface-water and ground-water hydrology

Topics:
1. Water resources, use sectors and trends (1 class)
2. Water quality parameters (physical-chemical-biological) and water quality standards (2 classes)  
Potable water treatment processes:
3. Water flow measurement, rapid mixing, and flocculation (2 classes)
4. Sedimentation (1 class)
5. Gravity granular-media filtration (1 class)
6. Chemistry basis (1 class)
7. Chemical coagulation and flocculation (2.5 classes)
8. Water disinfection (2.5 classes)
9. Non conventional potable water treatment process (ozone, reverse osmosis air-stripping towers, distillation) (1 class)  
Potable water distribution systems:
10. Review of fluid mechanics (1 class)
11. Hydraulic analysis of pipe systems (3 classes)
12. Water pumps and selection (2 classes)
13. Tests (2 classes)

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

Prepared by: Juan Carlos Puig, Assistant Professor of C.E.          Date: December, 1993
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 415- Steel Structures Design
2nd Quarter 93-94

Design of steel structural beams and columns with and without lateral supports. Combined axial compression and bending. Building connections, design. Prerequisite: CE-412


Coordinator: Balhan A. Alsaadi, Associate Professor of C.E.

Goals: This course is designed to give seniors in civil engineering an ability to analysis and design of structural steel members, using ASD method.

Pre-requisites by Topics:
1. Analysis of statically determined beams and frames
2. Analysis of statically indeterminate beams.
3. Analysis of stresses due to combined loads.
4. The theory of columns.

Topics:
1. Specifications and building codes, loads and methods of design. (2 classes)
2. Analysis and design of tension members. (2 classes)
3. Analysis and design of axially loaded compression members. (2 classes)
4. Design of beams continued. (2 classes)
5. Bending and axial stress. (2 classes)
6. Bolted and welded connections. (1 class)
7. Building connections. (1 class)

Computer Usage:
1. Four homework assignments, one each in topics 2, 3, 4, and 5 requiring use of stored programs in PC computer.

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Credits or %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Science</td>
<td>0 credits or 0%</td>
</tr>
<tr>
<td>Engineering Design</td>
<td>3 credits or 100%</td>
</tr>
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</table>

Prepared by: Dr. Balhan A. Alsaadi, Associate Professor of C.E. Date: February, 1995
Introduction to environmental engineering and planning. Improvement of the environment as a factor in health and social well being. Precautions in the disposal of solid, liquid, and gaseous wastes. Control of pollution of the environment. Prerequisites: CE-413.


Coordinator: Juan Carlos Puig, Assistant Professor of C.E.

Goals: Introduce the civil engineering students to the application of engineering principles to comprehensive environmental problems (air, public and radiological health, solid wastes, and water). Expose the students to the various aspects of environmental planning and regulation. Emphasize on the science and design criteria of air pollution and solid waste occurrence, measurement, and control systems.

Pre-requisite by Topic:
1. Basic sciences and mathematics
2. Statics and dynamics of fluids
3. Water Supply
4. Potable water treatment design

Topics:
1. Overview of environmental pollution problems and the environmental engineer role (1 class)
2. Review of the principal environmental protection laws; and environmental engineering planning (1 class)
3. Historical overview, classification, sources, and effects of the principal air pollutants (1 class)
4. Basic meteorology (1 class)
5. Dispersion on the atmosphere of pollutants (1 class)
6. Air Pollution measurement methods (1 class)
7. Air Pollution control process for particulate contaminants (2 classes)
8. Air Pollution control process for gaseous contaminants (2 classes)
9. Characteristics of solid wastes (types, sources, and properties) (2 classes)
10. Measurement of solid waste generation (1 class)
11. Collection, transportation, and processing of solid wastes (2 classes)
12. Design of operation of landfills (disposal of solid wastes) (2 classes)
13. Unconventional methods for solid wastes disposal (hazardous wastes) (1 class)
14. Basis of resources and energy recovery (1 class)
15. Fundamentals of environmental impact analysis (1 class)
16. Tests (2 classes)

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

Prepared by: Juan Carlos Puig, Assistant Professor          Date: December, 1993
1995 Catalog Data: CE 420 - Concrete Structures Design. Credit 3.
Design of Reinforced concrete structures, using ultimate strength method. Design of beams for flexure and shear, continuous beams and one way slab systems column design. Prerequisites: CE 415.


References: Building code requirements and commentary for Reinforced Concrete. (A.C.I. 318) Revised 1992

Coordinator: Balhan A. Alsaadi; Associate Professor of CE

Goals: This course is designed to enable the student of civil engineering at the senior level to develop safety, economically and efficiency design of reinforced concrete beams, columns and one way slab systems according to the A.C.I. code.

Prerequisites by topics:
1. Analysis of statically determined structures and continuous beams.
2. Mechanical properties of plain concrete and reinforcement bars.
3. Ability to use and develop the simple computer design program.

Topics:
1. Mechanical properties of plain concrete and steel reinforcement (1 class).
2. Design methods and requirements (1 class).
3. Design of rectangular beam section in bending (5 classes).
4. Design of rectangular beam sections for shear (2 classes).
5. Design of continuous beams (2 classes).
6. Design of one way slab systems (2 classes).
7. Design of T beam sections for bending and shear (2 classes).
8. Development of Reinforcement (2 classes).
10. Tests (2 classes)
11. Project presentation (1 class).

Computer Usage: Four homework assignments, one each in topics 3, 4, 6 and 7, requiring use of beams design program prepared by the professor.

Design project: The team project is required covering topics 3, 4, 5, 6, 7, 8, and 9. The project should satisfy economically, and safety criteria.

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

Prepared by: Balhan Altayeb Alsaadi          Date: March 30, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 424 Theory of Structure II
1st Quarter 93-94

Behavioral description of statically indeterminate structures under various types of static and
moving loads; in order to predict strength and elastic deformations of the above mentioned
structures. The actual advances in microcomputer development make compulsory to introduce
students to the use of PC and related software which can serve as solution checks to problems.
Prerequisites: CE 412.


Coordinator: Francisco Arencibia, Assistant Professor, CE

Goals: To provide a clear and simple revision to classical structural methods for analysis of
indeterminate beams, frames and trusses; and to integrate the application of personal computer
software to deal with open-ended structural analysis problems and design.

Prerequisite by topic:
1. Elementary Statics
2. Mechanics of Materials
3. Theory of Structure I

Topics:

Part A (Flexibility Methods)
1. Statistically Indeterminate Structures: Methods of consistent deformation for beams, frames and trusses. (3 classes)
2. Influence line for indeterminate structures (quantitative and qualitative) Computer use for influences lines. (2 classes)

Part B (Displacement Methods and Approximate Solutions)
3. Slope Deflection: slope deflection equation - sideways, symmetry and antisymmetry (2 classes)
4. Moment Distribution: component factors, stiffness modifications, simple end, symmetry and antisymmetry. Sideways (3 classes)
5. Matrix Analysis of Structures: the stiffness method - beams and trusses. (7 classes)
7. Tests (2 classes)

Computer Usage:
1. Five homework assignments requiring use of program software, one each in the following topics: (1), (2), (5) and (6)

ABET Category content as estimated by faculty member who prepared this course description:
Engineering Science: 3 credits of 100%

Prepared by: Francisco Arencibia Date: June, 1993


References: Building code requirements and commentary for reinforced concrete. (A.C.I 318/89) Revised 1992
CRSI Handbook, Concrete Reinforced Steel Institute, Schaumberg II1, 1992
PCI Design Handbook - Precast and Prestressed Concrete. Precast/Prestressed Concrete Institute, Chicago, 1985
Uniform Building Code, International Conference of Building Officials

Coordinator: Balhan A. Alsaaadi, Associate Professor of C.E.

Goals: This course is designed to give seniors in civil engineering an essential background to a complete and proper understanding and using of building codes for design of reinforced concrete and composite structural systems.

Prerequisites by Topics:
1. Statically indeterminate structures analysis
2. Steel structures design
3. Concrete structures design
4. Ability to use steel design and reinforced design code
5. Ability to use computer software for structural analysis and design

Topics:
1. Design of reinforced concrete short and slender columns (4 classes)
2. Design of two-way floor systems (3 classes)
3. Design of reinforced concrete walls (3 classes)
4. Design of square spread footing (3 classes)
5. Introduction to prestressed concrete (3 classes)
6. Design of composite structures (3 classes)
7. Tests (2 classes)
8. Project presentation (1 class)

Computer Usage:
Each student must use of stored programs to develop the structural design project.

Design Project:
Each team project is requiring to developing a structural design project, which solving an civil engineering problem, including economical, environmental an social effects.

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

Prepared by: Balhan A. Alsaaadi Date: April 1, 1994
1995 Catalog Data: CE-437: Geotechnical Engineering I. Credit 3.
Description and identification of soils; index properties, mineralogical composition, weight-volume relationships and hydraulic properties. Stresses and strain in Soils. Prerequisite: ENGI 335


Coordinator: José Alfredo Martinez, Assistant Professor of C.E.

Goals: This course is designed to provide the juniors in civil engineering with the basic concepts of soil mechanics stressing its importance in civil engineering projects.

Prerequisite by Topic:
2. Mineralogy of fine grained soils.
3. Darcy’s Law for laminar flow.
4. Evaluation of fluid-induced pressures.
5. Laplace equation for steady flow.
7. Stress-strain relationships.
8. Ability to program micro computers.

Topics:
1. Soil nature and origin, phase relationships, physical properties (3 classes)
2. Soil consistency and classification systems (2 classes)
3. Moisture-dry density relationships, compaction control (2 classes)
4. Clay minerals, laminar structures, swelling potential (1 class)
5. Groundwater, permeability coefficient, effective stress concept (3 classes)
6. Flow nets for groundwater and seepage through earth dams (2 classes)
7. Consolidation theory, preconsolidation pressure, settlement evaluation (3 classes)
8. Time and consolidation rate relationships (3 classes)
9. Tests (3 classes)

Computer Usage:
1. Two homework assignments, one each in topics 7 and 8 to be run on student-generated programs in either C, FORTRAN or BASIC language.

Laboratory Projects:
1. Basic soil properties are determined through laboratory test carried out as part of the CE 438 course

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

Prepared by: José Alfredo Martinez Date: December, 1993
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE-438 Geotechnical Engineering Laboratory I
2nd Quarter 93-94


Coordinator: José Alfredo Martinez, Assistant Professor of C.E.

Goals: That the civil engineering Juniors have a better understanding of soils as an engineering material through the direct evaluation of their basic properties.

Prerequisites by Topic:
1. Soil phase relationships.
2. Atterberg limits.
3. Grain size distribution.
4. Soil classification systems.
5. Moisture - density relationships.
6. Compaction Control

Topics:
1. Introduction, visit to laboratory facilities, description of equipment (1 class)
2. Field collection of samples (1 class)
3. Water Content (1 class)
4. Atterberg limits (1 class)
5. Mechanical grain size analysis (1 class)
6. Classification of soils (2 classes)
7. Compaction control (2 classes)
8. Unconfined Compression (1 class)
9. Final Project (1 class)

Computer Usage:
1. Both the text and graphics of the laboratory reports are generated through existing computer programs.

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

Engineering Science : 1 credit or 100%

Prepared by: José Alfredo Martinez Date: December 1993
1995 Catalog Data: CE 439: Geotechnical Engineering II. Credit 3.
A continuation of CE 437. The theory of consolidation, settlement and contact pressure, stress analysis, stability of slopes, soil compaction and stabilization. Prerequisite: CE 438, CE 437.


Coordinator: José Alfredo Martínez, Assistant Professor of C.E.

Goals: To provide the juniors in civil engineering with the most common applications of geotechnical engineering to civil engineering problems.

Prerequisite by Topic:
1. Ability to program microcomputers.
2. Consolidation theory.
3. Stress-Strain relationships.
4. Mohr's circle.
5. Statics of isolated bodies.
6. Effective stresses, pore pressure.

Topics:
1. Sub-soil exploration and sampling (1 Class)
2. Stress distribution and settlement evaluation (2 Classes)
3. Design parameters for soils (3 Classes).
4. Earth retaining structures (4 Classes).
5. Bearing capacity and selection of foundation type (3 Classes).
6. Slope stability (3 Classes)
7. Introduction to deep foundations (3 Classes).
8. Tests (3 Classes).

Computer Usage:
1. Three homework assignments, one each in topics 2, 4, and 6 to be run on student-generated programs in either C, FORTRAN or BASIC language, student calculations are checked against existing faculty generated software.

2. The program of topic 6 is used to optimize the analysis, of slope stability for an actual highway project.

Laboratory Projects:
1. Parameters used for geotechnical design are obtained through laboratory test carried out as part of the CE 440 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: José Alfredo Martínez
Date: December, 1993
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 440 Geotechnical Engineering Laboratory II
2nd Quarter 93-94

Determination of consolidation and shearing strength of soils; permeability tests and soil
exploration. Corequisite: CE-439


Coordinator: José Alfredo Martinez, Assistant Professor of C.E.

Goals: That the civil engineering juniors who already have a knowledge of geotechnical engineering
applications obtain the required design parameters through laboratory experiments.

Prerequisites by Topic:
1. Sub-soil exploration and sampling
2. Fine grain distribution
3. Soil hydraulics
4. Consolidation theory
5. Stress-strain relationships
6. Design parameters for soils

Topics:
1. Introduction, visit to laboratory facilities, description of equipment (1 Class)
2. Sub-soil exploration and sampling (1 Class)
3. Hydrometer analysis (1 Class)
4. Coefficient of permeability (2 Classes)
5. Consolidation - Oedometer (2 Classes)
6. Unconfined compression (1 Class)
7. Triaxial Tests (2 Classes)
8. Final Project (1 Class)

Computer Usage:
1. Both the text and graphics of the laboratory reports are generated through existing computer
   programs.
2. Student-generated software is used to evaluate the stability of a slope with the design parameters obtained
   throughout the course.

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

Prepared by: José Alfredo Martinez                        Date: December, 1993
CE 441  Foundation Engineering
2nd Quarter 93-94

1995 Catalog Data:  CE-441-Foundation Engineering. Credits 3
Two-two lecture periods per week. Evaluation of sub-soil condition as they affect the
behavior, proportions and choice of type of foundation; relation between foundation and other
structural problems; design project. Pre-requisites: CE 425, CE 439, CE 440


Coordinator:  Bernardo Deschapelles, Professor, Ph.D.

Goals:  The objective of this course is to introduce the student into the field of substructure analysis
and design. Using appropriate computer programs, a wide variety of situations involving soil-
structure interaction are studied. In these cases, the student applies previous knowledge
acquired in courses of concrete and steel design to prepare structural details adequate for
actual construction.

Prerequisites by Topic:
4.  Reinforced Concrete Design.
5.  Structural Steel Design.
6.  Introduction to Prestressed Concrete.
7.  Stiffness Method of Analysis.

Topics:
1.  Review of engineering properties of soils. Spread footings. Eccentric loading. Moment transfer to
of rotational fixity at foundation level. Methods to reduce eccentricity. (4 classes)
2.  Combined and strap footings. Case of two columns and rigid foundation. Case of three or more columns.
Coefficient of subgrade reaction. Beams on elastic foundation. Soil-Structure interaction and the Finite
Element method. Beam analogy for the solution of cylindrical tanks. Mat foundations. Simplified
designs. (5 classes)
beams. Tie backs. Prestressing strands. (2 classes)
Moment reduction. Wales. Tie rods. Methods of anchorage. (4 classes)
Construction. (1 class)
construction. (1 class)
Computer Usage:
1. Each student is required to use stored computer programs on PC-compatible to perform a substantially complete design of a structure with soil interaction. The design project may consist of a combined footing supporting several columns, an anchored sheet piling for waterfront facilities, a bridge abutment supported by vertical and batter piles or a clarifier tank studied by the analogy of beam on elastic foundation. Obviously, the computer program should have the capability of processing structural elements on elastic foundation.

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: Bernardo Deschapelles  Date: October, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 446 Wastewater Engineering
2nd Quarter 93-94

1995 Catalog Data: CE 446 Wastewater Engineering. Credit 3.
Disinfection and sludge treatment. Prerequisites: CE -413

Coordinator: Juan Carlos Puig, Assistant Professor at Civil Engineering Department

Goals: To provide a knowledge of all the environmental problems related with the handling and disposal of wastewater. The student will learn the methods for the design of sanitary sewer systems and sewage treatment plants and the current effluent quality limitations imposed by the regulatory agencies.

Prerequisites by Topic:
1. Fluid Mechanics
2. Basic Concepts of Hydraulic Engineering
3. Environmental Engineering (Water Pollution)

Topics:
1. Physical, Chemical and Biological Characteristics of Wastewater (3 Classes)
2. Wastewater Sources and Flow rates (1 Class)
3. Forecasting Population (1 Class)
4. Design of sanitary sewer pipes (1 Class).
5. Regulatory Agencies (1 Class)
6.a. Pre-treatment (2 Classes)
6.b. Primary Treatment (2 Classes)
6.c. Secondary Treatment ( 10 hrs)
   1. Activated Sludge
   2. Trickling Filters
   3. Other Processes
6.d. Secondary settling tanks (1 Class)
6.e. Introduction to Advanced Treatment (1 Class)
6.f. Disinfection (1 Class)
6.g. Sludge treatment and disposal (2 Classes)
6.h. Exams (2 Classes)

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

Prepared by: José Borrageros Date: December 12, 1993
1994 Catalog Data: CE 447 Transportation Engineering. Credit 3.
Transportation Systems. Operations and Control of Transportation Vehicles. Principles of
Transportation Planning. Prerequisites: CE 322

Textbook: Paul H. Wright and Norman J. Ashford, Transportation Engineering Planning and Design, John
Wiley & Sons.


Coordinator:

Goals: This course is designed to give seniors in civil engineering a basic knowledge on transportation
matters, such as: The transportation system in the United States, the governmental activity,
Operation and control of transportation vehicles and transportation planning.

Topics:
1. The transportation System in the United States and Puerto Rico: Classification by Mode (2 classes)
2. Governmental Activity in Transportation (2 classes)
3. Operational and Vehicular Characteristics (3 classes)
4. Uniform Devices for Traffic Control (3 classes)
5. Urban Planning Types and Models (3 classes)
6. Transportation Studies (3 classes)
7. Oral Reports (3 classes)
8. Tests (2 classes)

Computer Usage:
1. Reports are generated through existing computer programs.

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: Eugenio Dávila Date: March, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 450 - Pavement Design
2nd Quarter 94-95

Methods of evaluating the load-carrying capacity of soil subgrade, sub-base courses; critical
analysis of the methods of design of flexible and rigid pavements; methods of increasing the load-
carrying capacity of highway and airport pavements. Prerequisites: CE441.


References:
American Association of State Highway and Transportation Officials: Guide for Design of
Portland Cement Association: Thickness Design for Concrete Highway and Street Pavements,
1984.

Coordinator: Bernardo Deschapeltes; Associate Professor of CE

Goals:
The objective of this course is to provide the rationale underlying the principles of pavement
design. It includes the empirical data on soil behavior as well as the analytical models used for
computer studies of slabs supported on elastic foundation and subjected to wheel loads. The
student is introduced to the Finite Element Method that forms the basis of the corresponding
software.

Prerequisites by topics:
1. Soil Mechanics. 1,3,7
2. Foundation Engineering. 4,5
3. Reinforced Concrete Design. 5,6,8
4. Mechanics of Materials. 4,5
5. Matrix Analysis of Structures. 5

Topics:
   (1 class)
2. Road traffic and axle configurations. Distribution of traffic hence of axle configurations. Aircraft wheel
   arrangements. Equivalent single wheel. Standard axles. Damaging effect of traffic. (2 classes)
   Strength of soil. Elastic properties of soil. Modulus of subgrade reaction. Soil groups as per AASHTO, FAA
   and US Army Corp of Engineers. California Bearing Ratio. (2 classes)
   and compatibility. Load on infinite slab. Westergaard's studies. Edge and corner loads. Slab warping caused
   by differential temperature and shrinkage. (3 classes).
5. Introduction to the Finite Element Method. Plate bending element with 12 degrees of freedom. Soil
   for plates on elastic foundation including attached beam elements. Application to the study of bridge approach
   slab. Reinforcement design. (5 classes).
   and expansion points. Dowel bars. Longitudinal joints. Tie bars. Thickness design. Design charts. Distributed
   steel. Continuously-reinforced pavements. Concrete overlays. (3 classes).
7. Flexible pavements. Typical cross section. Serviceability concept. AASHTO design chart. Equivalent 18k
   method. (3 classes).

Computer Usage:
Each student is required to use a stored computer program on PC compatible to carry out a design of a rigid pavement subjected to moving loads simulating the wheels of vehicles. Each student is assigned a different axle configuration and must take into account the action of edge and corner loads, the effect of warping in the slab and the possibility of soil partial voids under the pavement. The corresponding software shall include plate bending elements (with at least 12 DOP), beam elements (with compatible degrees of freedom) and stiffness contribution of the elastic support provided by the soil.

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

Prepared by: Bernardo Deschapelles                        Date: November, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE-455 Cost Estimates
3rd Quarter 93-94

The study of estimates for construction projects. From conceptual of Preliminary Estimates to
final estimates for bidding. Prerequisites: CE 410


Coordinator: Félix E. Sánchez, Associate Professor, CE

Goals: To introduce the civil engineering students in the preparation of estimate of construction
projects.

Topics:
1. Introduction (1 class)
2. Construction Equipment Cost (1 class)
3. Transportation of Materials (1 class)
4. Earth Work and Excavations (1 class)
5. Highways of Pavements (1 class)
6. Piles of Bracing (1 class)
7. Concrete Structures (1 class)
8. Floor Finishes (1 class)
9. Floor Systems (1 class)
10. Masonry (1 class)
11. Carpentry (1 class)
12. Interior finish, Millwork & Millboaod (2 classes)
13. Lathing & Plastering (1 class)
14. Painting (1 class)
15. Plumbing (1 class)
16. Electric Wiring (1 class)
17. Steel Structures (1 class)
18. Water-Distribution Systems (1 class)
19. Sewerage Systems (1 class)
20. Test (2 Classes)

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

Prepared by: Félix E. Sánchez Date: May 4, 1994
CE 500 Matrix Computer Analysis of Structures
3rd Quarter 93-94


Coordinator: Bahram Alsaadi, Associate Professor of C.E.

Goals: To introduce the matrix analysis methods for bar-element structures, with particular emphasis on the stiffness method and its computer implementation.

Prerequisites by topic:
1. Linear algebra.
2. Differential calculus.
5. Mechanics of deformable bodies: internal forces; stresses and strains; constitutive relationships.
6. Structural analysis of trusses and frames.

Topics:
1. Review of matrix algebra (2 Classes)
2. Degree of freedom; Coordinate systems; Structural idealization (1 Class)
3. Axial force member; Flexibility and stiffness corresponding examples (1 Class)
4. Axial force members; Local stiffness matrix; Assembling process; Examples (3 Classes)
5. Axial force members; Global stiffness matrix; Assembling process; Examples (3 Classes)
6. Development of algorithms; DOF numeration; ID matrix; Computer programs assembling process (2 Classes)
7. Stiffness analysis of frames; Local stiffness matrix; Global stiffness matrix; Coordinate transformations; In-span loads (7 Classes)
8. Tests (3 Classes)

Computer usage:
1. The structural systems analysis assignments expose students to the use of computer programs.
2. The students are required to design and develop a computer program to analyze two-dimensional trusses.

Laboratory projects:
None

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

Prepared by: Gustavo E. Pacheco Date: March, 1993


Coordinator: Balhan Alsaaadi, Associate Professor of C.E.

Goals: This course is designed to give seniors in Civil Engineering an ability to understand the behavior of structures under time-dependent loads, vibration analysis, and design for earthquake and impact loadings.

Prerequisites by topic:
1. Analysis of statically determined and indeterminate of beams, frames and trusses.
2. Analysis of stresses due to combined loads.
3. Methods of interpolation and numerical differentiation and integration.

Topics:
1. Overview of structural dynamics. (2 classes)
2. Analysis of free vibrations. (2 classes)
3. Response to harmonic, periodic, dynamics loading. (2 classes)
4. Response to general dynamic loading. (3 classes)
5. Formulation of the MDOP equations of motion. (3 classes)
6. Damped and undamped vibrations. (3 classes)
7. Introduction to design of structures for earthquake and impact loadings. (5 classes)
8. Tests (2 classes)

Computer usage:
1. Two homework assignments, one each in topics 3, 4, requiring use of stored analysis program.

Laboratory projects:
None

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

Engineering Science: 3 credits or 100%

Prepared by: Balhan A. Alsaaadi

Date: February, 1995


Coordinator: Balham Alsaaed, Associate Professor of C.E.

Goals: To introduce the design of engineering systems as a systematic and well-organized activity, that dispose of the methods of optimization as valid tools to improve the final result.

Prerequisites by topic:
1. Linear algebra.
2. Differential calculus.
5. Mechanics of deformable bodies: internal forces; stresses and strains; constitutive relationships; failure definition.

Topics:
1. Introduction to the economic considerations in the design process (1 class)
2. Design process; Notation; Formulation; Examples (3 classes)
3. Graphical solutions (1 class)
4. Unconstrained problems; Necessary and sufficient conditions; Examples (4 classes)
5. Constrained problems; Lagrange theorem; Kuhn-Tucker conditions; Examples (4 classes)
6. Global optimality; Examples (1 class)
7. Sensitivity theorem; Examples (1 class)
8. Solution of systems of equations review (1 class)
9. Simplex Method; Examples (3 classes)
10. Tests (3 classes)

Computer usage:
The structural systems design projects expose students to the advanced use of optimization methods and computer programs.

Laboratory projects:
None

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: Gustavo E. Pacheco Date: March, 1993
Polytechnic University of Puerto Rico  
Department of Civil Engineering

CE 503 Prestressed Concrete Structures  
3rd Quarter 93-94

General design principles, pretensioning vs. posttensioning. Design criteria.  
Prerequisite: CE 425


Coordinator: Balhan Alsaadi, Associate Professor of C.E.

Goals:  This course is designed to give seniors in civil engineering the ability to design the prestressed  
concrete elements and their application through the modern structures.

Prerequisites by topic:
1. Structural Analysis  
2. Design of Reinforced Concrete Structures  
3. Design of Steel Structures  
4. Design of Composite Structures

Topics:
1. Principles and methods of prestressing. (2 classes)  
2. Prestressing materials: Steel and Concrete. (2 classes)  
3. Design Methods. (2 classes)  
4. Design for Shear and Torsion. (4 classes)  
5. Deflection Computation and Control. (4 classes)  
7. Continuous Beams and Indeterminate Structures. (3 classes)  
8. Prestressed Concrete Slabs. (3 classes)

Computer usage:  
Team design project is required using stored computer software.

Laboratory projects:  
None

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: Balhan A. Alsaadi, Associate Professor.  
Date: February, 1995


Coordinator: Bernardo Deschapelles, Associate Professor of C.E

Goals: The main objective of this course is to introduce the student to the engineering principles of structural seismic resistance. Principles of seismology are included to establish rational basis for ground motion predictions. The methodology of response spectra is discussed in considerable detail to provide the student with the necessary background for code understanding and interpretation. Another objectives are to present the connection between the mathematical solution of eigenproblems and the seismic response of a structure, to study building behavior in accordance with its framing and materials, to discuss ACI 318 seismic regulations and to examine the lessons learned from past earthquakes.

Prerequisites by topic:
2. Differential Equations.
3. Dynamics.
5. Soil Mechanics.
6. Foundation Engineering.
7. Reinforced Concrete Design.
8. Structural Steel Design.

Topics:


Computer usage:
All students are required to use stored computer programs on PC compatible computers to solve different problems related to seismic analysis and design. Each student shall study the effect of ground motion on a shear wall building including period of vibration, center of rigidity and distribution of the lateral load between resistant walls, taking into account the accidental torsion. In the field of material behavior, each student shall examine in detail the curvature ductility available in different reinforced concrete columns and shear walls with boundary elements, in accordance with the acting axial load and taking into consideration the non linear behavior of concrete.

Laboratory projects:
None

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: Bernardo Deschapelles Date: October, 1994
General review of different types of bridges. Consideration of the most common types. Moving load analysis. Prestressed, post-tensioned, reinforced concrete, and steel member design. Prerequisite: CE 425


Coordinator: Bernardo Deschapelles, Associate Professor of C.E

Goals: The main objectives of this course are to introduce the student to the design criteria established in the latest AASHTO Specifications and to provide a wide field of applications in which he/she may use previous knowledge acquired in courses of structural analysis and design of concrete and steel. Due to the seismic risk in Puerto Rico, special emphasis is given to the rationale supporting the bridge seismic design criteria. Moreover, because of the substructure impact on the total cost of the bridge, different solutions are discussed in detail.

Prerequisites by topic:
2. Reinforced Concrete Design.
3. Introduction to Prestressed Concrete.
4. Structural Steel Design.
5. Dynamics.

Topics:
8. Discussion of bridge failures in past earthquakes. Retrofit schemes. (1 class)
Computer usage:
All students are required to use stored computer programs on PC compatible computers to solve the following situations: a) Frame analysis, including shear deformations. The program shall be able to process beams on elastic foundation for the analysis of pile bents and study of abutments supported by piles driven into soil with different strata. b) Design of concrete columns subjected to axial and flexure to cover the bridge pier design. Students shall have to use these programs in the design of one span and one pier of a bridge. Each student is assigned specific geometric conditions and materials of construction.

Laboratory projects:
None

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: Bernardo Deschapellos Date: October, 1994
Advanced analysis and design of metal structures, flexible, semi rigid and rigid connections, comprehensive design using both CRED and ASD methods. Prerequisite: CE 425

Text Books:

Reference:

Coordinator: Balhan A. Alsaaedi, Associate Professor of C.E.

Goals: This course is designed to give seniors in civil engineering an ability to analysis and design of steel structures using both LRFD and ASD philosophic of design.

Prerequisites by topic:
1. Analysis of Frame structures.
2. Analysis of Stresses due to combined loads.

Topics:
1. Design and behavior of tension members. (3 classes).
2. Bolted connections. (3 classes)
3. Welded connections. (3 classes)
4. Design of the flexural behavior of stable beam system. (3 classes)
5. Design of indeterminate systems with both LRFD and ASD specifications. (2 classes)
6. Connector Design and detailing consideration. (4 classes)
7. Test (2 classes)

Computer usage:
Each student is required to use stored computer program to perform a substantially complete design of steel frame structures including P-D effect

Laboratory projects:
None

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: Balhan A. Alsaaedi Date: February, 1995
CE 507  Computer Analysis and Design of Structural Systems
2nd Quarter 93-94

Use computer software do analysis and design of structural systems. Prerequisite: CE 425, CE 247

Text Book: Computer Reference Manuals: Microsoft project, ACCESS Frame, Cheams, Vigab, Risa2D.

References: U.S. Department of Transportation, Federal Highway Administration, Standard plans for Highway
Bridges, 1990.
American Association of State Highway and Transportation officials, Standard Specification for
Building code requirements and commentary for reinforced concrete (A.C.I.) 318189, Revised
Institute of Steel Construction, Inc.

Coordinator: Balhan A. Alsaadi, Associate Professor of C.E.

Goals: This senior level course in civil engineering is designed to develop computer skills and abilities
necessary for advanced analysis and design of reinforced, prestressed and steel structures.

Prerequisites by topic:
2. Design prestressed concrete elements.
3. Design of composite structures.
4. Design of Steel structures.
5. Analysis of statically indeterminate structures.

Topics:
1. Frame Analysis using computer programs. (6 classes)
2. Analysis of bridge structures using engineering software. (7 classes)
3. Design of structural elements using engineering software. (7 classes)
4. Test (2 classes)

Computer usage:
Each team project design is requiring to developing a structural design project using computer structural
engineering software on PC

Laboratory projects:
None

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: Balhan A. Alsaadi        Date: February, 1995
1995 Catalog Data: CE 508-Design of Wood Structures. Credit 3
Design of wood structures, beams design, columns design subject to axial forces and combined bending and axial forces. Design of diaphragms and shear walls, connection design.
Prerequisites: CE 425


Coordinator: Balhaan A. Alsaadi, Associate Professor of C.E.

Goals: This course is designed to enable the students of Civil Engineering to develop safety design of wood structures using wood buildings design criteria.

Prerequisites by topic:
1. Analysis of statically determined and indeterminate structures.
2. Steel Structures Design
3. Concrete Structures Design

Topics:
1. Wood Building and Design criteria.
2. Design loads.
5. Axial forces and combined bending and axial forces.
6. Horizontal diaphragms.
7. Design of shear walls.
8. Wood connections. (4 classes)

Computer usage:
The students are required to develop programs in topics 4 and 5.

Design Project:
The team project is required covering topics: 4, 5, 6, 7 and 8.

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

Prepared by: Balhaan A. Alsaadi, Ph.D.CE Date: February, 1995
CE 509 Structural Engineering Laboratory
3rd Quarter 93-94

1994 Catalog Data: CE 509: Structural Engineering Laboratory. 1 credit. Experimental determination and correlation with theoretical predictions of "Behavior" of basic structures under static and dynamic loading conditions. Test include tension, compression, displacement, stability and strain gauge measurement. Prerequisite: CE 425

Textbook: Manual of Experiments prepared by the instructor in charge of conducting the course.

Reference:

Coordinator: Prof. Francisco Arencibia, Assistant Professor of C.E.

Goals: Use simple examples to clarify physical behavior of structures and compare experimental with theoretical results in order to gain insight of structures behavior.

Prerequisites by Topic:
1. Elementary static
2. Mechanics of materials & lab
3. Theory of structures I & II
4. Steel structures design
5. Concrete Structure design
6. Advanced structural design
7. Application of computer in structural analysis

Topics:
1. Principle of superposition. Bending strain-curvature relation. Linear elastic beam theory. (2 classes)
2. Unsymmetric bending of straight beams. Flexural Formulas (Alternative formula) of stresses & location of neutral axis. Beam deflection in unsymmetric bending. (2 classes) (HST 2/9)
3. Shear center calculations: bending without "twisting". Open sections with one axis of symmetry. (2 classes) (HST 2/8)
4. Combine axial and flexural stresses in structural elements. Simple compression (Kernel points). (2 classes) (HST 2/7)
6. Moment distribution: a) checking the way beams and frames deform under loads in actual construction. Single degree of freedom per node. b) frames translations without rotation "first cycle", "second cycle": rotation with no translations. (2 classes) (HST 3/D)
7. Plastic collapse and limit analysis. Collapse loads in beams. Computer analysis in order to trace the development of hinges in proper sequence, computing displacements, so verifying the sequential plastic hinges of each mechanism generated in the process of loading the frame. (2 classes) (HST 4/3)
8. Elastic buckling and stability. Critical load in columns. (2 classes) (HST 2/d)
9. Two dimensional bending calculations of associated bending and twisting moments and displacements in simple cases of plate bending: a) bending to a cylindrical surface. b) pure twist. (2 classes) (HST 4/10)
Computer Usage:
Each laboratory requires calculation so the student laboratory report should include student-generated programs in C, Fortran or Basic Language for calculation implementation.

**ABET category content as estimate by faculty member who prepared this course description:**
Engineering Sciences: 1 credit or 100%

Prepared by: Francisco Arencibia
Date: November, 1994
1994 Catalog Data: CE 510 Open Channel Engineering. 3 credits.
Study of hydrography and determination of design for rain. Flow in open channels, rivers, creeks, irrigation channels, dam weirs and similar man-made structures; analysis by open-channel hydraulics. Prerequisites: CE 318.


Coordinator: Prof. Juan C. Puig, Assistant Professor of C.E.

Goals: This course is designed to give the civil engineering students a solid knowledge in open channel hydraulics. The student will be able to apply analytical methods to perform hydraulics analysis and open channel design.

Prerequisites by Topic:
1. Fluid Mechanics
2. Topography
3. Hydrology

Topics:
1. Open Channel Flow and Its Classification (1 Class)
2. Open Channels and Their Properties (1 Class)
3. Energy and Momentum Principles (1 Class)
4. Critical Flow (Computations & Applications) (1 Class)
5. Development of Uniform Flow and Its Formulas (1 Class)
6. Computation of Uniform Flow (1 Class)
7. Design of Channels for Uniforms Flow (2 Classes)
8. Theory and Analysis of Gradually Varied Flow (1 Class)
9. Methods of Computation of Gradually Varied Flow (1 Class)
10. Practical Problems of Gradually Varied Flow (2 Classes)
11. Introduction to Rapidly Varied Flow (1/2 Class)
12. Flow Over Spillways (Rapidly Varied Flow) (1 Class)
13. Hydraulic Jump and Its Use as Energy Dissipator (Rapidly Varied Flow) (1 Class)
14. Flow in Channels of Nonlinear Alignment (Rapidly Varied Flow) (1 Class)
15. Flow Through Nonprismatic Channel Sections (Rapidly Varied Flow) (1 1/2 Class)
16. Gradually Varied Unsteady Flow (1 Class)
17. Rapidly Varied Unsteady Flow (1 Class)
18. Flood Routing (1 Class)
19. Tests (3 Classes)

ABET category content as estimate by faculty member who prepared this course description:
Engineering Science : 2 credits or 66%
Engineering Design : 1 credit or 33%

Prepared by: Francisco Pérez Blair Date: March 28, 1994
CE 511 Environmental Improvement
3rd Quarter 93-94

Planning the improvement of the environment. Additional topics related to the environment,
and problems of environmentalists. Pre-requisites: CE 416

Sons, Inc., 1992

Butterworths, 1988

Coordinator: Juan C. Puig, Assistant Professor of C.E.

Goals: To introduce the civil engineering students to the application of engineering sciences to the
planning and design of special topics in environmental improvement and pollution control
projects, including public health, environmental impact analysis, noise control, radiation
protection, food protection, administration of environmental programs, and environmental
ethics.

Prerequisites by Topic:
1. Basic Sciences and Mathematics

Topics:
1. Non infection diseases associated with the environment, its control, and investigation. (3 classes)
2. Planning for environmental control and impact analysis. (3 classes)
3. Sources, control, and reglamentation of noise pollution. (3 classes)
4. Food protection, storage and transportation. (3 classes)
5. Radiation sources and biological effects. (2 classes)
6. Radiation protection and monitoring. (2 classes)
7. Administration of environmental control programs and enforcement. (3 classes)
8. Environmental ethics (1 class)
9. Tests. (3 classes)

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

Prepared by: Juan Carlos Puig Date: November, 1994
Polytechnic University of Puerto Rico  
Department of Civil Engineering  

CE 512 Advanced Topics in Water Resources Engineering  
3rd Quarter 93-94

1995 Catalog Data:  
CE 512 Advanced Topics in Water Resources Engineering. Credit 3.  
Prerequisite: CE 413

Textbooks:  

Coordinator:  
Juan C. Puig, Assistant Professor of C.E.

Goal:  
To introduce the civil engineering student to the application of engineering sciences to the planning and design of water resources projects including use, development and control.

Prerequisites by Topic:  
1. Water Supply Engineering  
2. Hydrology  
3. Environmental Engineering

Topics:  
1. Water Demand: Uses and Quantities (1.5 classes)  
2. Water Characteristics and Quality (2.5 classes)  
3. Quantitative Hydrology: Estimating Volume of Runoff (4 classes)  
4. Probability Concepts in Water Resources Planning (3.5 classes)  
5. Groundwater Hydraulics and Wells (2 classes)  
6. Reservoirs (2.5 classes)  
7. Water Treatment: Design of a Treatment Plant (5 classes)  
8. Tests (2 classes)

ABET category content as estimated by faculty member who prepared this course description:  
Engineering Science: 1 credit or 33.3%  
Engineering Design: 2 credits or 66.7%

Prepared by: José Borrageros  
Date: May 1, 1994
CE 514 Environmental Engineering Laboratory
1st Quarter 94-95

Theory and practice of the solution of environmental and sanitary engineering design
problems by experimentation. Experiments on monitoring and control as part of the
environmental engineering design process. Prerequisite: CE 416, CE 446

Textbook: Faculty developed guidelines


Coordinator: Auristela Mueses

Goals: This laboratory course is designed to provide civil engineering students a better understanding
of the physical aspects of environmental and water resources engineering through the direct
contact with experimentation, data evaluation and analysis.

Prerequisites by Topic:
1. Hydrologic cycle elements; precipitation, infiltration, evaporation, runoff.
2. Existing methods and instrumentation in hydrological measurements.
3. Logical concepts.
4. Physical characteristics of water and wastewater.
5. Chemical characteristics of water and wastewater.

Topics:
1. Introduction, description of lab course outline. Visit to laboratory facilities description of equipment. (1
class)
2. Precipitation and discharge measurements. (2 classes)
3. Infiltration and evaporation measurements. (2 classes)
4. Determination and measure of meteorological factors. (2 classes)
5. Anaerobic fermentation test. (2 classes)
6. Water and wastewater physical characteristics determination. (2 classes)
7. Water and wastewater chemical characteristics determination. (4 classes)
8. Centrifugation test and jar test. (2 classes)

Computer Usage:
1. Both the text and graphics of the laboratory report are recommended to be generated through available
computer software.

ABET category content as estimate by faculty member who prepared this course description:
Engineering Science : 1 credit or 100%
Engineering Design : 0 credit or 0%

Prepared by: Auristela Mueses Date: November, 1994
CE 515 Computer-Aided Design in Hydraulic and Environmental Engineering  
3rd Quarter 93-94


Coordinator: Juan Carlos Puig, Assistant Professor of C.E.

Goals: To introduce the civil engineering students to the hydrologic and hydraulic design using computer programs. To provide a design tool for the analysis and evaluation of existing and proposed hydrologic and hydraulic conditions. The student will be able to use computer programs to perform hydrologic and hydraulic studies.

Pre-requisites by Topic:
1. Definition of Basin Hydrologic Characteristics
2. Definition of Rainfall-Runoff process
3. Definition of Hydrograph and Unit Hydrograph Concepts
4. Definition of Hydrologic an Hydraulic Routing
5. Definition of Saint Venant Equations
6. Definition of Open Channel Hydraulics

Topics:
1. Hydrology and Hydraulic Analysis. Introduction (1 class)
2. Hydrology: Basic Concepts (1 class)
3. Hydrologic Parameters Definition for Computer Application (2 classes)
4. Introduction to Hydrologic Program. Variables and Program Definition (1 class)
5. Hydrologic Design: Hydrologic Applications (2 classes)
6. Hydraulic: Basic Concepts (1 class)
7. Hydraulic Parameters Definition for Computer Application (1 class)
8. Introduction to Hydraulic Program. Variables and Program Definition (1 class)
9. Hydraulic Design: Hydraulic Applications (3 classes)
10. Hydrologic and Hydraulic Integration (2 classes)
11. Computer Projects (2 classes)

Computer Usage:
1. Special Assignments require use of Hydrologic and Hydraulic Programs HEC-1 and HEC-2.
2. Each student must present a computer project for a selected basin.

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

Prepared by: Auristela Mueses Date: January 18, 1994
Fundamental of Ground-Water Hydrology
3rd Quarter 93-94

Fundamentals of ground-water hydrology and well hydraulics. Determination of hydraulic properties of aquifers. Description of ground-water/surface-water relationship. Study of ground-water contamination and flow modeling. Pre-requisites: CE 318


Coordinator: Juan Carlos Puig, Assistant Professor of C.E.

Goals: To introduce the civil engineering student to the field of ground-water hydrology. The students will be exposed to ground-water resources assessment, design of tests to determine hydraulic properties and to recognize ground-water contamination sources and potential remedial actions.

Pre-requisites by Topic:
1. Basic sciences, mathematics and computer programming.
2. Fluid mechanics.
3. Hydrologic cycle parameters.

Topics:
1. Ground-water and aquifers. (1 class)
2. Pressure-head, porosity, water content and soil-water characteristics. (1 class)
3. Storage coefficient, specific yield. (1 class)
4. Darcy's law, hydraulic conductivity, transmissivity. (1 class)
5. Well flow systems, steady flow, transient flow. (2 classes)
6. Determination of aquifer parameters (Hydraulic Conductivity, Transmissivity, Specific Yield, and Storage Coefficient). (4 classes)
7. Ground-water resources assessment (exploratory methods, potentiometric surface, safe yield). (3 classes)
8. Ground-water surface-water relationships (seepage) (1 class).
9. Ground-water budget analysis. (1 class)
10. Ground-water quality characterization. (1 class)
11. Ground-water contamination sources and transportation. (2 classes)
12. Seawater intrusion. (1 class)
13. Ground-water flow system analysis (analytical methods, computer simulation). (3 classes)
14. Tests (2 class)

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

Prepared by: Juan Carlos Puig Date: September, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 522 Transportation Facility Design and Planning
2nd Quarter 93-94

1995 Catalog Data: CE 522: Transportation Facility Design and Planning. Credit 3
Description and implementation of the transportation design and planning process. Implement
manual methods with microcomputer use. Pre-requisite: CE 447.

Textbook: Wolfgang S. Homburger, Louis E. Keefer, and William R. McGrath, editors; "Transportation and


Coordinator: Juan M. González, Assistant Professor, CE

Goals: This senior level course in Civil Engineering is designed to develop skills and abilities necessary
for planning, design, and operation of surface transportation facilities.

Prerequisites by topic:
2. Intersections, interchanges, bus truck terminals.
4. Transportation engineering and safety
5. Highway administration. Highway contracts and specifications
6. Highway construction management, maintenance and rehabilitation.

Topics:
1. Urban transit and travel characteristics. (3 class)
2. Transportation and urban planning. (2 classes)
3. Traffic flow theory. (2 classes)
4. Highway capacity and levels of service. (2 classes)
5. Transportation safety. (2 classes)
6. Lighting of traffic facilities. (2 classes)
7. Traffic regulations. (2 classes)
8. Environmental and Energy consideration. (2 classes)
9. Intercity passenger and Freight Systems. (2 classes)
10. Tests. (3 classes)

Computer Usage:
1. Use spread sheet program for solving mathematical models on urban forecast activities, trip and distribution
generation, and transportation networks.

Engineering Analysis Laboratory:
1. Each student is assigned a homework exercise to develop skills in transportation and urban planning.
2. Each student is assigned a homework exercise to develop skills in highway capacity and level of service.
3. Each student is to be assigned various types of transportation planning special topics.

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 M. González Juarbe Date: November, 1994
CE 523  Computer-Aided Design in Transportation and Highways Engineering
2nd Quarter 1994-95

1995 Catalog Data:  CE 523: Computer-Aided Design in Transportation and Highways Engineering. Credit 3. Use computer software to design and plan transportation facilities. Prerequisite: CE 322, CE 246

Textbooks:  Computer Reference Manuals: Microsoft Project, Microsoft Excel; Civil Soft-Engineering Software, Microsoft Word.


Coordinator:  J.M. González Juarbe, Assistant Professor of CE

Goals:  This senior level course in Civil Engineering is designed to develop computer skills and abilities necessary for planning, design, and operation of surface transportation facilities.

Pre-requisites by Topic:
2. Critical Path Scheduling.
3. Engineering Economics.

Topics:
1. Solve Horizontal curves using engineering software. (3 classes)
2. Solve Vertical Curves using engineering software. (3 classes)
3. Solve Spiral Curves using engineering software. (2 classes)
4. Solve Super elevation using engineering software. (2 classes)
5. Solve Sight Distances using engineering software. (2 classes)
6. Prepare Highway Construction schedule using Microsoft project. (2 classes)
7. Perform economic analysis of various project alternatives using Microsoft Excel. (2 classes).
8. Prepare typical construction contract specification form master specifications on computer. (4 classes)
9. Tests. (3 classes)

Computer Usage:
Use spreadsheet, project scheduling, master specification programs, and other software to solve transportation design and construction management exercises.

Laboratory Projects:
1. Each student is assigned a homework exercise to develop skills in using computer software to solve transportation design exercises. (2 weeks)
2. Each student is assigned a homework exercises to develop skills in using computer software to program and schedule transportation construction projects. (2 weeks)
3. Each student is assigned a homework exercises to develop skills in using computer software to plan transportation projects. (2 weeks)

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

Prepared by:  Juan M. González Juarbe  Date:  November, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 528 Deep Foundations
1st Quarter 1994-95

Characteristics and capabilities of deep foundations. Sheet pile walls on sandy and clayey soils.
Estimation of pile length. Load transfer mechanisms. Estimation of pile capacity. Settlement
Negative skin friction. Drilled-pier and caisson foundations. Prerequisites: CE 440


Coordinator: José Alfredo Martínez, Assistant Professor of CE

Goals: That senior CE students be able to choose and evaluate efficient and practical deep foundations
as an alternative when dealing with troublesome geotechnical conditions.

Pre-requisites by Topic:
1. Settlement evaluation.
2. Design parameters for soils.
4. Earth retaining structures.
5. Load transfer mechanisms.
6. Pile driving dynamics.

Topics:
1. Characteristics of deep foundations. (1 class)
2. Sheet piles. (3 classes)
3. Pile capacity. (4 classes)
4. Pile settlement. (1 class)
5. Pullout resistance. (1 class)
6. Dynamic formulas. (2 classes)
7. Group capacity. (1 class)
8. Negative skin friction. (1 class)
9. Drilled-piers and caissons. (4 classes)
10. Test and project evaluations. (3 classes)

Computer Usage:
Two homework assignment, one each in topics 2 and 7 to be run on student-generated programs in either C,
Fortran or QBASIC language.

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

Prepared by: José Alfredo Martínez  Date: October, 1994
Polytechnic University of Puerto Rico  
Department of Civil Engineering  

CE 529 Design with Geosynthetics

Soil improvement techniques using geosynthetics for separation, reinforcement, filtration, drainage  
and as moisture barriers. Uses of geotextiles, geogrids, geonets, geomembranes and  


Coordinator: José Alfredo Martínez, Assistant Professor of CE

Goals: That the student be able to select and design with geosynthetics as soil improvement tools.

Pre-requisites by Topic:
1. Stress-strain relationships of materials.
2. Permeability coefficient.
3. Degradation processes.
4. Earth pressure stress distribution.
5. Slope stability.

Topics:
1. Overview of geosynthetics. (2 classes)
2. Designing with geotextiles. (4 classes)
3. Designing with geogrids. (3 classes)
4. Designing with geonets. (2 classes)
5. Design with geomembranes. (4 classes)
6. Designing with geocomposites. (4 classes)
7. Test and project evaluations. (3 classes)

Computer Usage:
- One homework assignment, in topics 2 and 3 to be run on student-generated program in either C, Fortran or  
Q basic language.

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

Prepared by: José Alfredo Martínez    Date: October, 1994
1995 Catalog Data: CE-530: Geotechnical Engineering III. Credits 3.
Sampling identification and description of soils; index and hydraulic properties; interaction
between mineral particles and water; permeability and seepage; stress, strain, and
consolidation characteristics of soils; shear-strength determination. Stress distribution and
soil improvement. Prerequisite: CE-440

Textbook: Robert D. Holtz & W.D. Kovacs, An Introduction to Geotechnical Engineering, Prentice Hall,
1991


Coordinator: José Alfredo Martínez, Assistant Professor of C.E.

Goals: Further study of the effect of water in the behavior of soils and consolidation-induced
settlements. Determination of design parameters for geotechnical applications and stress
distribution within a soil mass.

Prerequisites by Topic:
1. Soil hydraulics
2. Soils classification systems
3. Groundwater dynamics
4. Consistency limits of soils
5. Consolidation time rate
6. Tests to determine design parameters of soils, Mohr's circle
7. Boussinesq equations of stress distribution

Topics:
1. Soil sampling and identification (2 classes)
2. Capillarity, shrinkage and swelling of soils (2 classes)
3. Permeability of Soils (1 class)
4. Seepage, flow nets (2 classes)
5. Stress distribution, consolidation-induced settlements (4 classes)
6. Failure theories (2 classes)
7. Tests for shear strength of soils (2 classes)
8. Stress paths (4 classes)
9. Tests (3 classes)

Computer Usage:
1. Two homework assignments, one each in topics 4 and 5 to be run an student-generated programs in C,
   Fortran or QBASIC languages

Laboratory Projects:
1. Determination of consistency limits of fine soils to be carried out at the geotechnical engineering
   laboratory. The result of such tests to be used throughout the duration of the course for application
   problems.

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

Prepared by: José Alfredo Martínez Date: Abril, 1994
Advanced study of the fundamentals of soils mechanics. Transmission of stresses within
particles. Soils in which the pore water is either stationary or flowing under steady condition.
Soils in which pore pressures are influenced by applied loads, and hence the water is flowing
under transient conditions. Prerequisite: CE 440

Textbook: Robert D. Holtz & W.D. Kovacs, An Introduction to Geotechnical Engineering, Prentice Hall,
1981


Coordinator: José Alfredo Martínez, Assistant Professor of CE

Goals: To study the behavior of soils as an engineering material in conditions of partial to full
saturation stressing the difference to that of drained soil.

Prerequisites by Topic:
1. Critical hydraulic gradient, liquefaction
2. Effective stresses
3. Stress-strain relationships for coarse and fine soils
4. Earth pressure coefficients
5. Stress paths

Topics:
1. Behavior of saturated sands (2 classes)
2. Factors that affect the shear strength of sands (1 class)
3. Liquefaction and cyclic mobility of saturated sands (2 classes)
4. Stress deformation and strength characteristics of saturated cohesive soils (4 classes)
5. Special problems of the shear strength of cohesive soils (1 class)
6. Pore pressure parameters (2 classes)
7. The coefficient of earth pressure at rest for clays (2 classes)
8. Stress paths during undrained loading (3 classes)
9. Application of stress paths to engineering practice (2 classes)
10. Tests (3 classes)

Computer Usage:
1. One homework assignment in topic 9 to be run on student-generated program in either C, FORTRAN or
QBASIC language to illustrate the application of the concepts discussed in class to problems in
geotechnical engineering

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

Prepared by: José Alfredo Martínez Date: April, 1994
CE 532 Soil Dynamics
3rd Quarter 93-94

1995 Catalog Data: CE 532: Soil Dynamics. 3 Credits.


Coordinators: José Alfredo Martinez, Assistant Professor of C.E.

Goals: To study the effect of cyclic loading on the behavior of foundations, retaining walls and saturated sands.

Prerequisites by Topic:
1. Dynamics of oscillatory motion
2. Damping ratio
3. Bearing capacity of shallow foundations
4. Earth pressure evaluation
5. Pore pressure evaluation
6. Liquefaction of saturated sands

Topics:
1. Fundamentals of vibration (3 classes)
2. Stress waves in bounded elastic medium (2 classes)
3. Foundation vibration, lumped parameter system (2 classes)
4. Dynamic bearing capacity of shallow foundations (3 classes)
5. Earthquake and ground vibration (4 classes)
6. Dynamic forces on retaining walls (3 classes)
7. Liquefaction of saturated sands (3 classes)
8. Tests (3 classes)

Computer Usage:
Three homework assignments, one each in topics 1, 4 and 6, to be run on existing and student generated software.

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

Prepared by: José Alfredo Martinez Date: April, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 533 Advanced Foundations
3rd Quarter 93-94

The applications of the principles of soil mechanics to the design of foundations. Subsurface investigation. Design of foundation, retaining walls, pile foundations, flexible retaining structures, anchor tie-backs, bridge piers, abutments, dewatering systems and underpinning. Case studies. Prerequisite: CE 441


Coordinator: José Alfredo Martínez, Assistant Professor of C.E.

Goals: That the CE student applies the principles of soil mechanics to the design of foundations for complex situations. Extensive design work is carried out by the student throughout the course stressing the use of microcomputers for such task.

Prerequisite by Topic:
1. Determination of design parameters for soils
2. Bearing capacity of soils
3. Evaluation of earth pressure
4. Reinforced concrete design
5. Allowable stress timber and steel design
6. Evaluation of pile bearing capacity
7. Soil hydraulics

Topics:
1. Subsurface profiles (1 class)
2. Factors to consider in foundation design (1 class)
3. Spread footing design (4 classes)
4. Design of concrete retaining walls (3 classes)
5. Design of pile foundations (3 classes)
6. Design of flexible retaining structures and tie-backs (3 classes)
7. Dewatering systems (2 classes)
8. Underpinning (2 classes)
9. Tests (3 classes)

Computer Usage:
1. Extensive use of microcomputers is encouraged throughout the course to increase the student efficiency when computing for both analysis and design of foundations.

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

Prepared by: José Alfredo Martínez Date: April 1, 1994
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 534 Computer-Aided Design in Geotechnical Engineering
3rd Quarter 93-94

This course introduces the advanced concepts in computer automation in foundation analysis and design. Special applications to geotechnical engineering will be emphasized. Prerequisite: CE 440, CE 246


Reference: Ralph B. Peck, Walter Hanson & Thomas Thomburn, Foundation Engineering, John Wiley & Sons, 1974

Coordinator: José Alfredo Martínez, Assistant Professor of C.E.

Goals: That the student be able to perform analysis of complex foundation structures and systems by means of existing software and advanced numerical analysis techniques.

Prerequisite by Topic:
1. Analysis of spread footings
2. Finite differences method fundamentals
3. Finite element method fundamentals
4. Mat foundation analysis
5. Earth pressure evaluation
6. Sheet pile analysis

Topics:
Application of existing computer programs to:
1. Rectangular combined footing analysis (3 classes)
2. Finite element solution of beams on elastic foundation (4 classes)
3. Finite element solution for mat foundation analysis (4 classes)
4. Lateral pressure evaluation (4 classes)
5. Finite element analysis of sheet pile walls (4 classes)
6. Project evaluations (3 classes)

Computer Usage:
Existing software depicted in the textbook is used to carry out projects in all the topics of the course

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

Prepared by: José Alfredo Martínez Date: April, 1994
Polytechnic University of Puerto Rico  
Department of Civil Engineering

CE 535 Monitoring of Construction Projects  
3rd Quarter 93-94

In this course the students will monitor the development of a construction project using CPM diagram and computers. Prerequisites: CE 410.


Coordinator: Yamil Castillo, Assistant Professor of C.E.

Goals: Provide the student with a detailed and practical knowledge of the construction process, and the different available techniques to monitoring a construction project. Expose the student to the use of computer systems to automate the construction management process.

Prerequisites by topic:
2. Construction materials.

Topics:
1. Introduction (1 Class)
3. Presentation and discussion of class projects (1 Class)
4. Analysis of direct costs (labor, material, subcontractors, equipment, alternatives) (4 Classes)
5. Analysis of indirect costs (job overhead, general and administrative overhead, profit) (2 Classes)
6. Scheduling techniques. Linear techniques (2 Classes)
7. Networks. Critical Path Method (5 Classes)
8. Networks. Program evaluation review technique (1 Class)
9. Networks. Compression analysis (2 Classes)
10. Networks. Resource leveling analysis (1 Class)
11. Examinations (2 Classes)

Computer usage:
1. The students will be required to use the following computer applications for the course:
   a) Electronic spreadsheet (Excel, Lotus, Quattro, etc.)
   b) Wordprocessing Software (WordPerfect, Word, Amiapro, etc.)
   c) CPM Software (MS Project, Primavera, Harvard Total Project Management, etc.)

Laboratory projects:
None

ABET category content as estimated by faculty member who prepared this course description:
Engineering Science: 1.0 credits or 33.3%
Engineering Design: 2.0 credits or 66.7%

Prepared by: Yamil Castillo  Date: March, 1993
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 536 Soil Improvement
3rd Quarter 93-94

Current ground modification techniques to improve soil stability, reduce deformation, control
seepage and increase erosion resistance. Case Studies. Prerequisite: CE 440


Coordinator: José Alfredo Martínez, Assistant Professor of CE

Goals: That the CE student be able to evaluate and select soil improvement techniques when dealing
with troublesome shallow and deep geotechnical conditions.

Prerequisites by Topic:
1. Compaction theory.
2. Soil hydraulics.
3. Preloading applications.
4. Consolidation theory.
5. Stress distribution evaluation.
6. Earth lateral pressure evaluation.

Topics:
1. Introduction to engineering ground modification (1 class)
2. Mechanical modification, compaction (3 classes)
3. Hydraulic modification, dewatering of slopes and excavations (3 classes)
4. Drainage and seepage control with geosynthetics (2 classes)
5. Preloading and vertical drains (2 classes)
6. Modification by admixtures (3 classes)
7. Soil reinforcement (3 classes)
8. Grouting (2 classes)
9. Tests and Project Evaluations (3 classes)

Computer Usage:
Two homework assignments, one each in topics 2 and 5 to be run on student-generated programs in either
C, Fortran or QBasic language.

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: José Alfredo Martínez Date: April, 1994

II-73
Polytechnic University of Puerto Rico  
Department of Civil Engineering

CE 538 Inspection of Projects  
3rd Quarter 93-94

In the inspection course emphasis is made in pointing the responsibilities of a construction  
inspector in regard quality control but also in promoting a well balance environment in the project  
among the people involved, without any conflict of interest, making judicious and proper  
decisions. Pre-requisite: CE 410 & CE 246.

Coordinator:  Félix Sánchez, Associated Professor of C.E.

Goals:  To introduce the student to his functions as a Civil Engineer in the inspection of construction  
during the construction period of a project.

Topics:
1. The Role of the inspector (2 classes)  
2. The anatomy of a project (2 classes)  
3. Contract documents (2 classes)  
4. Code of Standards (2 classes)  
5. Temporary Constructions (2 classes)  
6. Safety (2 classes)  
7. Concrete (2 classes)  
8. Site improvements (3 classes)  
9. Construction Materials (3 classes)  
10. Test (2 classes)

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

Prepared by:  Félix Sánchez  
Date:  February, 1995
Polytechnic University of Puerto Rico
Department of Civil Engineering

CE 540 Civil Engineering Capstone Design I
3rd Quarter 93-94

Open ended design projects to correlate all areas of civil engineering to apply at a high level the
principles of engineering design and science, developing awareness of social and economic effects of
engineering projects. Oral presentation and written reports will cover alternates to be considered at
first initial stage of preliminary design. Prerequisites: CE Director approval.

Text Book: None.
Reference: Textbooks of the CE design and analysis courses.
Coordinator: Yamil Castillo, Assistant Professor of C.E.

Goals: To expose the future CE graduate to the concepts used in the development of a project which
objective is the solution of an specific CE problem. It also expose the students to a team work
experience. The students are involved in a decision making process, where some alternatives must be
outlined; then the most effective one is selected, considering economic, environmental, and technical
points of view; lastly, a detailed pre-project must be developed for the selected alternative.

Prerequisites by topic:
1. Engineering analysis.
2. Engineering design.
3. Engineering Economy.
4. Student must be graduating within the 3 quarters

Topics:
1. Introduction (1 Class)
2. Overview of Engineering Economy (2 Classes)
3. Problem solving process. Problem ID, Brainstorming techniques (2 Classes)
4. Team work. Team-building. Team Selection (1 Class)
5. Definition of Problem. Discussion and analysis (2 Classes)
6. Assesses/Evaluate alternatives. Flow-charting of design process (2 Classes)
7. Selection of most viable alternative (1 Class)
8. Oral presentations (1 Class)
9. Test (1 Class)
10. Peer reviews and evaluations

Computer usage:
1. The analysis and design must be supported by software packages calculations.
2. The written report must be done using Word-Processor, Spreadsheets and other applicable software.

Laboratory projects:
None

ABET category content as estimated by faculty member who prepared this course description:
Engineering Design: 2 credits or 100%

Prepared by: Yamil Castillo          Date: March, 1993
A continuation of CE 540 Civil Engineering Capstone Design I, with special attention to cover
alternatives considered, design assumptions, cost, safety, and feasibility. Oral presentation and written
reports will be used to develop the objectives. Prerequisites: CE Director approval, CE 540: Civil
Engineering Capstone Design I

Text Book: None.

Reference: Textbooks of the CE design and analysis courses.

Coordinator: Yamil Castillo, Assistant Professor of C.E.

Goals: To expose the future CE graduate to the concepts used in the development of a project which
objective is the solution of an specific CE problem. It also expose the students to a team work
experience. The students are involved in a decision making process, where some alternatives must be
outlined; then the most effective one is selected, considering economic, environmental, and technical
points of view; lastly, a detailed pre-project must be developed for the selected alternative.

Prerequisites by topic:
1. Engineering analysis.
2. Engineering design.
3. Student must be graduating within the next 2 quarters.

Topics:
1. Introduction (1 Class)
2. Preliminary/Conceptual design (3 Classes)
3. Team oral presentation (1 Class)
4. Cost estimates. Economic analysis (2 Classes)
5. Scheduling of project (2 Classes)
6. Preliminary team presentation of problem solution (1 Class)
7. Team presentation to faculty (1 Class)
8. Peer evaluations.

Computer usage:
1. The analysis and design must be supported on software packages calculations.
2. The written report must be done using Word-Processor, Spreadsheets, etc.

Laboratory projects:
None

ABET category content as estimated by faculty member who prepared this course description:
Engineering Design: 2 credits or 100%

Prepared by: Castillo Date: March, 1993
### TABLE XII
COURSE REQUIREMENTS OF CURRICULUM
BASIC-LEVEL PROGRAM
(First Year)

<table>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Category (Credit Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Math &amp; Basic Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engrg. Science</td>
</tr>
<tr>
<td>1-A</td>
<td>ENGL 111 - English Reading and Writing</td>
<td>( )</td>
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<tr>
<td></td>
<td>MATH 111 - Precalculus I</td>
<td>( )</td>
</tr>
<tr>
<td></td>
<td>SPAN 111 - Spanish Reading and Writing</td>
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<tr>
<td>1-B</td>
<td>ENGI 131 - Engineering Graphics</td>
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<tr>
<td></td>
<td>MATH 122 - Precalculus II</td>
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<tr>
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<td>SCIE 111 - General Chemistry I</td>
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<td>SCIE 112 - General Chemistry I, Laboratory</td>
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<tr>
<td>1-C</td>
<td>ENGI 142 - Descriptive Geometry</td>
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<tr>
<td></td>
<td>ENGI 146 - Freshman Engineering Design</td>
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<tr>
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<td>ENGI 246 - Earth Sciences</td>
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<tr>
<td></td>
<td>MATH 133 - Calculus I</td>
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<tr>
<td>1-D</td>
<td>ENGI 220 - Programming &amp; Algorithms</td>
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<tr>
<td></td>
<td>MATH 144 - Calculus II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>SCIE 213 - Physics I, Mechanics</td>
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<tr>
<td></td>
<td>SCIE 214 - Physics I, Laboratory</td>
<td>1</td>
</tr>
</tbody>
</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>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Category (Credit Hours)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Math &amp; Basic Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineering Topics</td>
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<tr>
<td></td>
<td></td>
<td>Humanistic &amp; Social Sciences</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
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<tr>
<td>2-A</td>
<td>ENGI 235 - Probability &amp; Statistics for Engineers</td>
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<tr>
<td></td>
<td>MATH 215 - Calculus III</td>
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<tr>
<td></td>
<td>SCIIE 235 - Physics II, Heat, Light &amp; Sound</td>
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<td>SCIIE 236 - Physics II Laboratory</td>
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<tr>
<td>2-B</td>
<td>MATH 226 - Calculus IV</td>
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<tr>
<td></td>
<td>SCIIE 249 - Physics III, Electricity &amp; Magnetism</td>
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<td>SCIIE 250 - Physics III, Laboratory</td>
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<td>SPAN 251 - Hispanic Literature</td>
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<tr>
<td>2-C</td>
<td>ENGI 322 - Applied Mechanics, Static</td>
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<tr>
<td></td>
<td>ENGL 251 - Analysis of World Literature</td>
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<tr>
<td></td>
<td>MATH 237 - Differential Equations</td>
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<tr>
<td>2-D</td>
<td>CE 246 - Applied Software for Civil Engineers</td>
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<td>ENGI 324 - Mechanics of Materials I</td>
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<td>ENGI 333 - Applied Mechanics, Dynamics</td>
<td>2.5</td>
</tr>
</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.
### TABLE XII
**COURSE REQUIREMENTS OF CURRICULUM BASIC-LEVEL PROGRAM**
(Third Year)

<table>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Category (Credit Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Math &amp; Basic Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engrg. Science</td>
</tr>
<tr>
<td>3-A</td>
<td>ENGI 327 - Fluid Mechanics</td>
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<tr>
<td></td>
<td>ENGI 328 - Fluid Mechanics, Laboratory</td>
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<tr>
<td></td>
<td>CE 247 - Applied Numerical Analysis</td>
<td>2.5</td>
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<tr>
<td></td>
<td>SOHU 251 - Socio-Humanistic Studies I</td>
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</tr>
<tr>
<td>3-B</td>
<td>ENGI 335 - Mechanics of Materials II</td>
<td>3</td>
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<tr>
<td></td>
<td>ENGI 340 - Mechanics of Materials Laboratory</td>
<td>1</td>
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<tr>
<td></td>
<td>CE 330 - Construction Materials</td>
<td>2.5</td>
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<tr>
<td></td>
<td>CE 331 - Laboratory of Construction Materials</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>SURV 191 - Surveying Instruments Laboratory</td>
<td></td>
</tr>
<tr>
<td>3-C</td>
<td>CE 318 - Water Resource Engineering</td>
<td>2.5</td>
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<tr>
<td></td>
<td>CE 321 - Highway Design I</td>
<td>1.5</td>
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<tr>
<td></td>
<td>CE 410 - Construction Management</td>
<td>2</td>
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<tr>
<td>3-D</td>
<td>CE 412 - Theory of Structures I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>CE 322 - Highway Design II</td>
<td>1.5</td>
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<tr>
<td></td>
<td>CE 437 - Geotechnical Engineering I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>CE 438 - Geotechnical Engineering Laboratory I</td>
<td>1</td>
</tr>
</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.*
### TABLE XII
COURSE REQUIREMENTS OF CURRICULUM
BASIC-LEVEL PROGRAM
(Fourth Year)

<table>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Category (Credit Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Math &amp; Basic Science</td>
<td>Engineering Topics</td>
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<tr>
<td>4-A</td>
<td>CE 424 - Theory of Structures II</td>
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<tr>
<td></td>
<td>CE 413 - Water Supply Engineering</td>
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<tr>
<td></td>
<td>CE 415 - Steel Structures Design</td>
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<tr>
<td>4-B</td>
<td>CE 420 - Concrete Structures Design</td>
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<tr>
<td></td>
<td>CE 416 - Environmental Engineering</td>
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<tr>
<td></td>
<td>SOHU 252 - Socio-Humanistic Studies II</td>
<td>( )</td>
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<tr>
<td>4-C</td>
<td>CE 439 - Geotechnical Engineering II</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>CE 440 - Geotechnical Engineering, Laboratory II</td>
<td>1</td>
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<tr>
<td></td>
<td>CE 446 - Wastewater Engineering</td>
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<tr>
<td></td>
<td>PHIL 441 - Professional Ethics in Engineering</td>
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<tr>
<td>4-D</td>
<td>CE 425 - Advanced Structural Design</td>
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<tr>
<td></td>
<td>CE 447 - Transportation Engineering</td>
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<tr>
<td></td>
<td>Socio-Humanistic Elective I (Level II)</td>
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<tr>
<td></td>
<td>CE 514 - Environmental Engineering/Laboratory</td>
<td>( )</td>
</tr>
</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.
<table>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Category (Credit Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Math &amp; Basic Science</td>
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<tr>
<td>5-A</td>
<td>CE 441 - Foundation Engineering</td>
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<tr>
<td></td>
<td>BE 3800 - Principles of Electrical Engineering</td>
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<td>Socio-Humanistic Elective II (Level I)</td>
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<tr>
<td>5-B</td>
<td>ENGI 449 - Engineering Economics</td>
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<td></td>
<td>CE . . . Civil Engineering Elective I</td>
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<tr>
<td></td>
<td>CE . . . Civil Engineering Elective II</td>
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</tr>
<tr>
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<tr>
<td>5-C</td>
<td>CE 540 - Civil Engineering Capstone Design I</td>
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</tr>
<tr>
<td>5-D</td>
<td>CE 550 - Civil Engineering Capstone Design II</td>
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<tr>
<td>TOTALS - ABET BASIC-LEVEL REQUIREMENTS</td>
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<tr>
<td>OVERALL TOTAL FOR DEGREE</td>
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<td>39.5</td>
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<tr>
<td>PERCENT OF TOTAL</td>
<td></td>
<td>22.6</td>
</tr>
<tr>
<td>Must satisfy one set of conditions</td>
<td>Minimum semester credit hours</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Minimum quarter credit hours</td>
<td>48</td>
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<tr>
<td></td>
<td>Minimum percentage</td>
<td>25</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.
<table>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Category (Credit Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Math &amp; Basic Science</td>
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<td></td>
<td>Engrg. Science</td>
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<tr>
<td>CE 450 - Pavement Design</td>
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<tr>
<td>CE 500 - Matrix Computer Analysis of Structures</td>
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<td>CE 501 - Dynamics of Structures</td>
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<td>3</td>
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<tr>
<td>CE 502 - Structural Optimization</td>
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<tr>
<td>CE 503 - Prestressed Concrete Design</td>
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</tr>
<tr>
<td>CE 504 - Earthquake Engineering</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CE 505 - Bridges Design</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CE 506 - Advanced Steel Structures Design</td>
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<td>3</td>
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<tr>
<td>CE 507 - Computer Analysis and Design of Structural Systems</td>
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<td>CE 508 - Design of Wood Structures</td>
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<tr>
<td>CE 509 - Structural Engineering Laboratory</td>
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<tr>
<td>CE 510 - Open Channel Engineering</td>
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<td>2</td>
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<td>CE 511 - Environmental Improvement</td>
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<tr>
<td>CE 512 - Advanced Topics in Water Resources Engineering</td>
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<tr>
<td>CE 515 - Computer-Aided Design in Hydraulic and Environmental Engineering</td>
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<tr>
<td>CE 516 - Fundamentals of Ground-Water Hydrology</td>
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<td>3</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.
<table>
<thead>
<tr>
<th>Year, Semester or Quarter</th>
<th>Course (Department, Number, Title)</th>
<th>Math &amp; Basic Science</th>
<th>Engineering Topics</th>
<th>Humanistic &amp; Social Sciences</th>
<th>Other</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td>( 1.5 )</td>
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</tr>
<tr>
<td>CE 528 - Deep Foundations</td>
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<tr>
<td>CE 529 - Design with Geosynthetics</td>
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<td>3</td>
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<tr>
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<td>3</td>
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</tr>
<tr>
<td>CE 531 - Advanced Soil Mechanics</td>
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<td>3</td>
<td>( )</td>
<td></td>
<td></td>
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<tr>
<td>CE 532 - Soil Dynamics</td>
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<td>3</td>
<td>( )</td>
<td></td>
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</tr>
<tr>
<td>CE 533 - Advanced Foundations</td>
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<td>3</td>
<td>( )</td>
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<tr>
<td>CE 534 - Computer-Aided Design in Geotechnical Engineering</td>
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<td>( )</td>
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<tr>
<td>CE 536 - Soil Improvement</td>
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<td>2</td>
<td>( 1 )</td>
<td></td>
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<tr>
<td>CE 455 - Cost Estimates</td>
<td></td>
<td></td>
<td>( 3 )</td>
<td></td>
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</tr>
<tr>
<td>CE 535 - Monitoring of Construction Projects</td>
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<td>( 3 )</td>
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<tr>
<td>CE 538 - Inspection of Projects</td>
<td></td>
<td></td>
<td>( 3 )</td>
<td></td>
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<tr>
<td>CE 445 - Civil Engineering Practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
</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.
F. Alternative modes

The program of Civil Engineering is not offered in alternative modes.

G. Advanced-level curriculum

Up to date, the Civil Engineering program does not offer any accreditation of an advanced level program is being sought.

H. Advising system

Polytechnic University of Puerto Rico's advising system is a multi-faceted approach ranging from professional counseling and academic advisement to faculty mentoring. The system is designed to assist student prior to and during registration in the selection and sequence of required and elective courses. The CE students are served in the following manner:

1. First Year Students:

All first-year students are required to take the University Orientation Seminar (ATUL 100) offered by the Institution's professional counselors. Follow-up is provided via the interventions by the counseling staff of the Office of Student Development and Retention for individual academic advisement.

2. Sophomore and Junior Students:

The Director of CE Department has an Assistant to the Academic Director for Student Affairs that insures full compliance with the current curriculum paying special attention to the individual needs of the students. A standard form (see attached) that relates previous curricula courses to the current one and a structured quarterly course sequence are used for such purpose.

3. Senior Students:

Five full-time CE professors assist this group of students in the matters described above. A comprehensive record analysis is carried out in order to insure full curricular compliance well in advance with regard to the completion of the CE program requirements, all five specific areas are addressed as follows:

   a. Mathematics
   b. Basic Sciences
   c. Socio-Humanistic and Languages
   d. General Engineering
   e. Civil Engineering
      e.1 Concentration Courses
      e.2 Elective Courses.

All of the above is speeded up by means of direct access to the records office via computer by all mentors. The number of CE students that express their intention to pursue graduate studies has increased thus making the advising regarding elective courses a critical aspect of the mentoring activity, the multi-disciplinary character of the mentoring staff (Two structural, two environmental, one geotechnical and one construction management engineer) is certainly a valuable asset when dealing with that need. Information regarding the preparation and submission of documents required to obtain the professional license is given to the students while stressing its importance.

Finally, there are some cases that require special attention, mainly those involving transfer students; the CE department head deals with such students on a case by case basis to insure full equivalence when and if accepting approved courses from other institutions, updated course and program descriptions from leading mainland and island institutions are used as reference for such task.
I. Verification of student programs of study

As mentioned in part XII H, a mentoring system is currently being implemented. Beginning in the third quarter of the academic year 94 - 95, the mentors will be in charge of the verification of student programs of study. The mentors are members of the civil engineering full time faculty. The following are the names and titles of these mentors: Omaira Collazos (assistant professor), Alfredo Martínez (assistant professor), Auristela Museses (assistant professor), Gustavo Pacheco (assistant professor), Juan Carlos Puig (assistant professor) and Félix Sánchez (associate professor).

Prior to the third quarter of the academic year 1994-95, the verification of student program of study was the responsibility of the Registrar’s office.

J. Transfer credit

As stated in section VIII, item 1 of Volume I, there is a general procedure applicable to all engineering programs regarding transfer credits, under the is responsibility of the admission office for its administration. However, all engineering courses (especially those containing design) must be evaluated by the civil engineering head to assure the compliance with engineering science and design content.

K. Oral and written communication

Improving oral and written communication skills of undergraduates in the civil engineering curriculum is the responsibility of engineering professors shared within the faculty of arts and sciences professors.

The major assumption of the program is that improvement of student's communication skills will not be possible unless students are required to do written and oral work and receive appropriate feedback regularly throughout the five years of their civil engineering curriculum. This goal can be best achieved if instructors design a variety of short written and oral assignments as well as longer technical reports.

The view of language underlying the program allows to regard written and oral assignments as an integrated part of the civil engineering curriculum rather than as an "added on" component. Communication assignments help to develop communication skills and also help students acquire engineering knowledge and develop reasoning skills.

Efforts are directed on improving oral and written communication throughout the civil engineering curriculum as an understanding that adequate communication skills among civil engineering graduates is the responsibility of the English and Spanish Departments and the Civil Engineering Department together. The ability to write and speak effectively cannot be taught in a few isolated courses, so these skills must be developed over time if the student is to become proficient prior to graduation.

The students from the Civil Engineering Department have some sort of written and oral assignment in each course the student takes from the beginning of the freshman engineering design until Capstone engineering design.

Written and oral example: Considering written and oral assignments as a way of learning engineering, assignments that develop engineering concepts and principles are created, trying to provide students with a "real world" context for each task. What follows are some examples of written and oral assignments that have been recently used in the Civil Engineering Department: a) In the freshman year, all engineering student are required to take four courses in English and Spanish composition. As well, they are required to make oral and written presentation of their project reports in the freshman engineering design course; b) In the sophomore and junior years specially in all laboratory courses, Mechanics of Materials Lab (ENGI 340), Construction Materials Lab (CE 330), and Geotechnical Engineering labs (CE 438, CE 440), the students are required to present written reports; c) At the junior level, the students are required to submit final written projects in all their CE courses, specially in the design courses; d) In the Capstone Design courses (CE540 and CE 550), students have to submit final written projects. A one-half hour oral presentation of the project is made to the audience using slides or any other audiovisual method.

L. Computer experience
The Civil Engineering program assures the development of competence in the engineering applications of computers throughout its curriculum as described below:

L.1 Introductory Courses:

The CE students are introduced early to the use of computers through the use of computer-aided drawing packages as a part of the ENGI131 Engineering Graphics course, offered in the second quarter of the freshman year. This course develops the student skills to generate isometric and orthogonal representations of models by means of AutoCad software package, and Card software package. The course ENGI146 freshman design, offered in the third quarter of the freshman year, contributes to the development of competence in the engineering applications of computers by assigning projects that require PERT diagrams, AutoCad drawings, and wordprocessor written reports. The extent of required computer application covers the planning and presentation of design problems. Later, the course ENGI220 programming and algorithms, offered in the fourth quarter of the freshman year, formalizes the introduction to computers, algorithms, and C programming language. The student is expected to generate his own programs for simple engineering applications.

On the other hand, the use of word processing and graphics packages, though not equally demanding, is carried out specially when submitting laboratory reports in all courses.

L.2 Civil Engineering Courses:

The intensity and frequency of computer usage is greatly increased at this level through both totally computer-oriented courses and technical CE courses.

The course CE246 Applied Software for Civil Engineering is introduced early in the curriculum, in the fourth quarter of the second year, being a prerequisite of all the CE courses. This course is designed to assure that the students acquire a working knowledge in the use of several software packages that are extremely helpful in both the carrier and the professional life. The course covers the following packages: a) WordPerfect as a word processor, with special emphasis in the use of tables, equations, and drawings, as tools necessary to generate high quality technical reports. b) Excel as a spreadsheet, developing some basic engineering problems such as displaying a system response, solving linear equations, etc. c) Design View as a CAD program, where a variational geometry can be defined in terms of parameters, allowing the parametric design of a geometric problem through the evaluation of system response equations that depend on the geometry. d) MathCad as a math processor program, used to solve both numerically and symbolically engineering problems. e) Internet, as a way to communicate with the world. f) Some special purpose packages that can be introduced with no difficulty at this level, such as ACES/FRAME, a program to analyze framed structures under static loads, and MicroSoft Project, a program to generate Gant and PERT diagrams. The students are assigned special team projects for each software, and are evaluated in a practical individual examination.

The course CE247 Applied Numerical Analysis is offered by the beginning of the third year. This course focuses the following numerical methods: a) Roots of equations. b) Systems of linear equations. c) Curve fitting. d) Numerical differentiation and integration. e) Ordinary differential equations. The students are expected to develop their own computer programs to implement the algorithms, and to use special software packages such as MathCad.

As shown in the course descriptions contained in this document, most of the technical courses include computer usage in the form of problem solution through the use of existing software packages and/or student-generated software in either C, FORTRAN, BASIC or PASCAL languages. Such applications include, among others, the following:

L.2.1 Geotechnical Engineering:

Student-generated software for consolidation analysis, compaction control, grain size distribution, stresses within a soil mass, active earth pressure evaluation and slope stability analysis for soils with cohesion and friction. The evaluation of three geotechnical engineering software sources, namely SMAP-S2 by Comtech Research; GEOPRO, GEOLOG AND GEOCAL by Data Surge and software by GEOSYSTEM Co. is currently under way, a final decision on such applications is to be made in the near future in order to:

a) Get the CE student acquainted with the State of the Art application of computer techniques to the most common geotechnical engineering problems such as settlement evaluation, multi staced excavation and embankment and structural safety of earth and earth supported structures.

b) Have the CE student check the results of student generated software against those obtained through existing packages as described above.

II-86
L2.2 Structural Engineering:

The use of structural analysis programs is introduced early in the curriculum, as described below:

a) The course ENGI324 Mechanics of Material I makes use of the ACES/FRAME structural analysis package to analyze real type structures in order to perform the member design.

b) The course ENGI335 Mechanics of Material II makes use of the ACES/FRAME structural analysis package to analyze the deflected shape of statically determinate beams and to solve statically indeterminate beams. MathCad is used to perform numerical and symbolic integrations.

In the advanced analysis courses, and the design courses the variety of programs used is spread. The most used programs and their application can be summarized as follows:

a) ACES/FRAME is an interactive, computer graphics oriented program, to analyze linear elastic framed structures under static loads. It is used to study the deflected shape of bar structures (beams, trusses, frames), and to solve statically indeterminate bar structures.

b) ZAPEL is a finite element program developed by a faculty member to perform linear elastic analysis of plane stress and plain strain problems. It is used to analyze shear walls, deep beams, and elastic foundation of continuous beams.

c) VIGA-V is a computer program developed by a faculty member to address the design of reinforced concrete beams under flexure, shear, and torsion. It is used in the R/C design courses.

d) C-BEAMS is a computer program developed by a faculty member to address the design of R/C continuous beams and one way slabs.

New software packages will be also acquired. After the evaluation of various FEM software packages, the faculty selected the WeCan for Windows, due it is windows native, and it results the most friendly, so the time necessary to learn it's use is comparatively short. At present, the proposal has been submitted to the administration. Some other software packages are under evaluation:


b) Robot V6 - Structural Analysis and Design Software for steel framed structures and plates.

c) VisualAnalysis - Static linear analysis, Dynamic modal analysis, and Response spectrum analysis of framed structures and plates.

d) WinSTRUDL - Structural Analysis and Design Software for steel framed structures and plates.

e) STAAD III - Integrated analysis, design, and drafting of both building and bridges. Design includes steel, concrete and timber, according to a variety of codes and specifications.

L2.3 Hydraulic and Environmental Engineering:

In the discipline of Environmental and Water Resource Engineering, within the Civil Engineering Department, the development of competence in the engineering applications of computers is achieved mainly by encouraging students, either to develop their own computer programs or to apply existing software to solve homework problems or to propose required special course projects. In addition, independently of the course, students are stimulated to apply general application packages to assist them with report preparation, data handling and graphics, including Excel, WordPerfect, and others.

In the Water Resources Engineering course (CE318) students are required to use Excel spreadsheet to apply hydrologic techniques, such as the construction of hydrographs, and the hydrologic program SMADA for solving practical hydrological problems. This course covers various topics for which computer models are available, such as SMADA. Other two of these computer models are HEC-1, which is used for surface hydrology design, and HEC-2, which is used for open-channel hydraulic design. The CE318 students are introduced to these two models, but are not compelled to use them. However, in an advanced elective course, Computer-Aided Design in Hydraulic Engineering (CE515), the students get on-hand experience in applying these two computer programs. Additionally, both models have been installed and are available in the academic computer center of the PUPR. The Water Supply Engineering (CE413) topic for which more software packages have been developed is the hydraulic analysis of pipe systems. Even though the students are not required to apply any specific computer model, they may opt to apply for the course project either AQUANET (Hydraulic and Water Quality Modeling and Simulation for Pressurized Pipe Networks) or W/WW Costs (computer software for estimating water and wastewater treatment cost), which are available at the PUPR computer center, search for other water supply engineering models, or develop their own computer programs.

Specific applications of computer models or packages in the course of Environmental Engineering (CE416) may be experienced by the students while working on the course project. As part of the requirements of the course
the students must prepare a written report, where a software package for applications in environmental engineering design (preferably in the area of air pollution or soil wastes) is selected or developed, and applied to an specific problem using the computer system of the PUPR.

L.2.4 Transportation Engineering:

The use of existing software packages (Cogo PC, CivilCad) with large application to the geometric design of highways (including vertical and horizontal alignments), earth-work, and drainage is required for the team projects. In the individual assignments, the students must use general application software, such as Excel spreadsheet and MathCad, to verify their manual computation against the computer results.

L.2.5 Construction Management:

The use of existing software packages, like MicroSoft Project Management, for the preparation of cost estimates, take offs, and related management tools like critical path diagrams and progress schedules, is promoted.

L.2.6 Capstone design courses

Finally, two capstone design courses are mandatory for all the CE students. The multi-disciplinary character of this open-ended design courses lends itself to intense computer usage when evaluating alternatives through diverse approaches.

L.3 Elective Courses:

Computer usage is an essential tool to deal with more complex problems at this stage, such problems include the matrix analysis of indeterminate structures, advanced dynamic analysis of structures and optimal design. Fundamental topics such as bridge and prestressed concrete designs are dealt with by means of the use of existing software packages, the same is true for the analysis of the effect of seismic forces on soil-structure systems and the design of complex foundations. All of the above is complemented by elective courses in specific advanced computer applications for all the major specialty areas of Civil Engineering at UPPR.

As it can be seen above, the computer has become a powerful and essential tool in the academic formation of the civil engineers at UPPR. This will be taken even further through new programs that will increase computer usage; one of such programs, being currently under consideration as a pilot project, is aimed to teaching the mathematics courses in totally computerized classrooms.

M. Laboratory experience

Laboratory courses in the civil engineering department are supportive of their corresponding theoretical courses.

On August 1992 a new revised curriculum was adopted. The new curriculum includes the following: in the general engineering component, the Freshman Design laboratory course (ENGI 146), and the Mechanics of Materials laboratory course (ENGI 340). In the civil engineering component, the Construction Materials laboratory (CE 331), the Geotechnical laboratory course (CE 438), the Advanced Geotechnical laboratory course (CE 440), and the Environmental Engineering laboratory course (CE 514). In the elective component, a Structural Engineering laboratory course (CE 509) has been included.

The structure of the laboratories is in general a totally structured, follow-a-procedure type approach as the main purpose is to develop psychomotor skills and the ability to use measuring instruments.
The laboratory courses are conducted by a professor, with assistance of a laboratory technician. Each experiment consists of two-two hour class meetings. The first meeting is for the theory review and explanation of the experiment procedure; the second meeting is for the experiment development.

Experiments are accomplished by a team effort. Teams should present a written report at the end of each laboratory. Reports should include the following: theory description, equipment, experiment procedure, results, discussion of results (practice vs. theory) and conclusions.

Course evaluation is based on team written reports and quizzes related to experiments theory. Oral reports are presented as requested by the professor.

The purposes of laboratory courses are specific to the civil engineering field and the type of laboratory. However, as the general goals for laboratory courses:

**Environmental skills.** Students can learn a variety of skills involved in doing experimental engineering work.

**Real world.** Students can learn to function in a real world environment where the theory may or may not work and the equipment occasionally malfunctions.

**Build objects.** Students can build and test their designs. They can learn to use working models to solve engineering problems.

**Discovery.** Students can discover results which can improve theory and reinforce their ability to predict the results of using complex devices.

**Equipment.** Students can work with modern equipment and can also learn about the importance of safety.

**Motivation.** Students feel that even though the theoretical work is difficult, the physical doing makes it worthwhile.

**Teamwork.** Laboratories are team efforts, and students can learn to function as a member of a team.

**Communication.** Both written and oral communication skills are emphasized through preparation, progress and final reports.

**Independent learning.** Since all the knowledge needed for laboratory courses is not at their fingertips, students have to independently review old material and learn new one.

N. **Engineering design experience**

The concept of engineering design can be defined as the process of designing a system component, or process to meet desired needs. More specifically, it is a decision making process, in which the basic sciences and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective or to solve a technical problem. The design goals in the Civil Engineering Program promotes the five discipline areas of specialty: Structural Engineering, Hydraulic and Environmental Engineering, Geotechnical Engineering, Transportation Engineering, and Construction Management. Additionally to engineering design content courses in these five areas, within the civil engineering program is the civil engineering capstone design course. This capstone course consists of an open ended design problem which contemplates and integrates all areas of CE and include most of the design goals. Specific elements of design which are included as part of the design components of civil engineering courses are the following:
- Problem definition and redefinition
- Synthesis and creativity
- Trouble shooting
- Use of engineering mathematics and science principles
- Use of computer tools
- Decision making
- Conceptual design. Generic design procedures
- Economic evaluation
- Industrial or real-life experience
- Oral and written communication
- Planning and management skills
- Interpersonal skills
- Team design projects

No single course can satisfy all these goals. However, the entire Civil Engineering curriculum is designed so that these and other objectives are globally satisfied. The specifics of engineering design experience in particular courses are discussed below, grouping them in general engineering courses and in each of the five discipline areas of the civil engineering program.

N.1 General Engineering:

The basic concepts of design, and experiences to foment creative solutions are introduced early in the program, through the ENGI146 Freshman Design course, where the students have to work in groups in order to produce a physical model of a solution proposed by themselves for a particular problem, with some required constrains.

Then, in the ENGI324 Mechanics of Materials I course, the concepts of material behavior, failure, factor of safety, and member structural design are introduced. The students have to propose a structural design, and to perform the member design of its components by the allowable stress design philosophy, for a real-type structure, with particular requirements and load conditions for each group. In the courses ENGI327 Fluid Mechanics, and ENGI333 Applied Mechanics, Dynamics, administered by the Mechanical Engineering Department, the developed concepts are applied to the design of related systems, such as a gates, pipe-line systems, and dynamic systems.

N.1 Geotechnical Engineering:

Although only one of the eight required credits in the geotechnical engineering field is considered to be in design, both the laboratory and the introductory CE 437 courses prepare the students for the design activity. The above is accomplished through direct soil testing where geotechnical properties and design parameters are determined thus enabling the student to associate expected results with specific soil types.

The design experience begins in the CE-439 course with the application of a student generated computer program to the analysis of the stability of the slopes for a section of highway to be built at a given level in a contour map. The limitations of the right of way width as well as the static stability of the slopes are the main constrains to consider when selecting a feasible alternative. The data for the problem is selected in such a way that several attempts are required to insure stability; different combinations of slope height, pitch and surcharge are considered and evaluated not only for stability but to minimize the required earthwork as well.

Elective Courses. There is a strong design content in most of the elective courses including geotextile and deep foundation design, although no elective geotechnical engineering courses have been taught so far, the corresponding course descriptions depict their design content.

N.2 Structural Engineering:

Seven courses in structural analysis and design are required in the undergraduate Civil Engineering Program: ENGI 335, Mechanics of Materials II (3 credits), CE 415 Design of Steel Structures (3 credits), CE 420 Reinforced Concrete Design (3 credits), CE 424 Structural Analysis II (3 credits), and CE 441 Foundation Engineering (3 credits). The total of nineteen (19) credits required in this area, nine (9) credits are in engineering design and ten (10) credits are in engineering science.

In the course Mechanics of Materials II, the students are introduced to the calculation of displacements on deformable members, and its applications to analysis of statically indeterminate structures, throughout the study of the behavior of the bar elements subjected to different load conditions and buckling of columns. No design credits are claimed in this course, 100% engineering science.
In the Mechanics of Materials Laboratory, the students will have a better understanding of the behavior of mechanics of deformable members throughout the experimental evaluation of the structural elements subject to different load condition (axial, torsional, or flexural loads). No design credits are claimed in this course, 100% engineering science.

In the course Theory of Structure Analysis I, the students are provided with a clear and simple introduction to the classical structural analysis methods of statically determinate beams, frames and trusses with application of personal computer software to deal with open ended structural analysis and design. No design credits are claimed in this course, 100% engineering science.

In the course Steel Structural Design, the students deal with the design of steel structural beams and columns with and without lateral supports, subject to combined axial and bending loads using ASD method. Three credit-hours of design are claimed in this 100% design course.

In the course Concrete Structures Design, the students are enable to develop safe and, economical one way slab systems, using the ultimate strength Design Method. A team design project is required and should satisfy the economy and safety criteria. Two and half credits of design are claimed in this 83.33% design course.

In the course Theory of Structures Analysis II, the students are exposed to the analysis of statically indeterminate beams, frames and trusses, with application of personal computer software to deal with open-ended structural analysis and design. No design component is claimed in this course, 100% engineering science.

In the course of Advanced Structural Design, the civil engineering students at the senior level are enable to have an essential background to a complete and proper understanding and using of building codes for design of reinforced prestressed and composite structural systems. The team design project is requiring to developing a structural design, which solves an civil engineering problem and taking into consideration economical, environmental and social effects. Three credit-hours design are claimed in this or 100% of design course.

In the course of Foundation Engineering, the students are introduced into the field of substructures analysis and design using appropriate computer programs, a wide variety of situations involving soil-structure interaction, the student applies previous knowledge acquired in courses of structural analysis and design of concrete and steel structures. The claimed design portion in the course is one (1) credit-hour or 33%.

N.3 Environmental and Water resources Engineering:

There are five required courses in this area: CE 318 Water Resources Engineering (3 credits), CE 413 Water supply Engineering (3 credits), CE 416 Environmental Engineering (3 credits), CE 446 Wastewater Engineering (3 credits), and CE 414 Environmental Engineering Laboratory (1 credits). In sum, of the thirteen (13) required credits in this area, four (4) are engineering design credits and nine (9) are engineering science credits.

In the Water Resources Engineering course the students are exposed to limited scope projects in the area of hydrologic and hydraulic design through the use of generic design procedures to estimate the maximum discharges and hydrographs. The students in this course are encouraged to use computer tools and are required to prepare and submit a technical report at the end of the term. The claimed engineering design component for this course is 0.5 credits, a 17% of the total of 3 credits.

The Water Supply Engineering course contains various features relevant to engineering design, for a total of 1 design credit out of 3 credits. In this course the students are introduced to the physical and chemical design procedures for potable water treatment. The students learn to define the problem, apply mathematics and science principles and, through generic design procedures and design criteria, to determine the dimensions and other design parameters of the components of a potable water treatment plant. Additionally, students in this course go through decision making procedures for selection of water pumps. Students are required to prepare a course project which should contain design elements.

The Environmental Engineering course is interdisciplinary in nature. However, out of 3 credits, 0.5 credits or 17% of it is considered engineering design. The students in this course learn the fundamentals of air pollution control processes and calculation of design parameters through generic design procedures. The students, through team work in the preparation and oral presentation of a special course project, are required to either perform an indepth investigation, apply or develop a computer software to assist the design relevant to environmental engineering problems, or to identify and solve a simple real world environmental problem.

Lastly, in this area, the Wastewater Engineering course has a large content of engineering design (2 credits or 67%). In this course the student goes through the whole process of designing a wastewater treatment plant, including hydraulic considerations and primary and secondary treatment. The student is required to submit a final course project which consists of designing a wastewater treatment plant for a given design capacity.

The Environmental Engineering Laboratory course does not include engineering design credits.
N.4 Transportation Engineering:

Three courses are required in this area: CE 321, Highway Design I (3 credits); CE 322, Highway Design II (3 credits), CE 447, Transportation Engineering (3 credits) and SURV 191, Surveying Instruments Laboratory (1 credit).

In the course Highway Design I, the students are introduced to geometric design of highways and they are exposed to drafting contract documents for highways and to communicate professionally. The claimed engineering design credits for this course are 1.5 credits or 50% of the total of 3 credits.

In the course Highway Design II, the students are introduced to geometric design of intersections, interchanges, and mass transit of highways and they are exposed to contract supervision, earth operation and equipment and highway maintenance and rehabilitation. The claimed engineering design credits for this course are 1.5 credits or 50% of the total of 3 credits.

In the Transportation Engineering course, the students are introduced to transportation systems and principles of transportation planning, and they are exposed to the transportation systems in the U.S. and the governmental activity. The claimed engineering design credits for this course is 0.5 credit or 16.67% of the total of 3 credits.

N.5 Construction Management:

The purpose of the construction management courses is to introduce the students into the complex world of engineering construction projects, while at the same time injecting a high degree of professionalism in the construction industry. It is understood that the improvement of the standards of living of the society requires that people educated as engineers become more involved in the management of construction projects.

The required courses in this area are as follows: CE 410 Construction Management - in this course the students are acquainted with the major engineering and management techniques used in the professional construction management approach.

CE 330 Construction Materials. A construction manager must have a well defined knowledge of the materials used in the construction industry in order to consciously evaluate alterations in the determination of the materials to be used in a given project.

CE 331 Construction material laboratory. Through laboratory experiments the students become familiar with the physical characteristics of the materials under study.

CE 535 Monitoring of Construction Projects. This is an elective course for students interested in the specialization in construction management. The students must follow the procedures used in the control of the construction stage of a project.

CE 455 Cost Estimates. In the course the students are familiarized with the different types of estimates. From the conceptual stage of a project to the bidding stage. This is an elective course for those students interested in the construction management specialization.

CE 538 Inspection of Projects. This course is an elective course for those students interested in construction. Its purpose is to acquaint the students with the process of quality assurance in a construction project. It includes not only the inspection of the materials and construction techniques to comply with contract specifications but the promotion of a well developed environment in terms of the relations among the people involved in the project.

O. Course/section size

The typical section size depends on the type of course under consideration. Grouping them in three categories, General Engineering courses, Laboratory courses, and Concentration courses, the section sizes can be summarized as follows:

a) The section size of the General Engineering courses normally range from a minimum of about 15 students to a maximum of 30 students (as suggested by the CE Department). Since these courses are required by all the engineering curriculums, they are heavily demanded, and sometimes the maximum is exceeded. For instance, during the last academic year, the course ENG146 Freshman Engineering Design registered a maximum of 55 students in one section, and the course ENG322 Applied Mechanics - Statics registered a maximum of 42 students.

b) The section size of the Laboratory courses normally range from a minimum of 10 students to a maximum of 16 students (suggested by the CE Department). However, this maximum has been sometimes exceeded. During the last academic year, the course ENG1340 Mechanics of Materials Laboratory registered a maximum of 18 students.
c) The section size of the courses corresponding to the civil engineering concentration range from a minimum of 15 (assessed by the registration office) to a maximum suggested by the CE Department that range from 20 to 30 (being the lower limit for those courses containing large amount of project assignments). This minimum sometimes is lowered to 10 students when the course is an elective one. As it happen in other courses, the suggested maximum is sometimes exceeded; for instance, the CE246 Applied Software for CE has a suggested maximum of 20 students but in one occasion 35 students were registered.
### TABLE XIII
Course/Section Size Summary

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>No. of Sections Offered in Current Year</th>
<th>Avg. Section Enrollment</th>
<th>Type of Class¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 131</td>
<td>Engineering Graphics</td>
<td>37</td>
<td>23</td>
<td>100</td>
</tr>
<tr>
<td>ENGI 142</td>
<td>Descriptive Geometry</td>
<td>16</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>ENGI 146</td>
<td>Freshman Engineering Design</td>
<td>43</td>
<td>26</td>
<td>100</td>
</tr>
<tr>
<td>ENGI 246</td>
<td>Earth Sciences</td>
<td>7</td>
<td>22</td>
<td>80  20</td>
</tr>
<tr>
<td>ENGI 322</td>
<td>Applied Mechanics, Static</td>
<td>18</td>
<td>29</td>
<td>100</td>
</tr>
<tr>
<td>ENGI 324</td>
<td>Mechanics of Materials I</td>
<td>18</td>
<td>29</td>
<td>100</td>
</tr>
<tr>
<td>ENGI 335</td>
<td>Mechanics of Materials II</td>
<td>8</td>
<td>22</td>
<td>100</td>
</tr>
<tr>
<td>ENGI 340</td>
<td>Mechanics of Materials Laboratory</td>
<td>1</td>
<td>16</td>
<td>30  70</td>
</tr>
<tr>
<td>CE 246</td>
<td>Applied Software for Civil Engineers</td>
<td>1</td>
<td>34</td>
<td>100</td>
</tr>
<tr>
<td>CE 247</td>
<td>Applied Numerical Analysis</td>
<td>3</td>
<td>13</td>
<td>100</td>
</tr>
<tr>
<td>CE 318</td>
<td>Water Resource Engineering</td>
<td>5</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>CE 321</td>
<td>Highway Design I</td>
<td>7</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>CE 322</td>
<td>Highway Design II</td>
<td>5</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>CE 330</td>
<td>Construction Materials</td>
<td>6</td>
<td>20</td>
<td>80  20</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: oral and written reports from visits to actual materials factories

(continued on next page)
### TABLE XIII
Course/Section Size Summary

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>No. of Sections Offered in Current Year</th>
<th>Avg. Section Enrollment</th>
<th>Type of Class¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 331</td>
<td>Laboratory of Construction Materials</td>
<td>7</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>CE 410</td>
<td>Construction Management</td>
<td>5</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>CE 412</td>
<td>Theory of Structures I</td>
<td>7</td>
<td>29</td>
<td>100</td>
</tr>
<tr>
<td>CE 413</td>
<td>Water Supply Engineering</td>
<td>4</td>
<td>22</td>
<td>100</td>
</tr>
<tr>
<td>CE 415</td>
<td>Steel Structures Design</td>
<td>6</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>CE 416</td>
<td>Environmental Engineering</td>
<td>6</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>CE 420</td>
<td>Concrete Structures Design</td>
<td>3</td>
<td>23</td>
<td>100</td>
</tr>
<tr>
<td>CE 424</td>
<td>Theory of Structures II</td>
<td>6</td>
<td>21</td>
<td>100</td>
</tr>
<tr>
<td>CE 425</td>
<td>Advanced Structural Design</td>
<td>5</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>CE 437</td>
<td>Geotechnical Engineering I</td>
<td>6</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>CE 438</td>
<td>Geotechnical Engineering Laboratory</td>
<td>5</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>CE 439</td>
<td>Geotechnical Engineering II</td>
<td>7</td>
<td>21</td>
<td>100</td>
</tr>
<tr>
<td>CE 440</td>
<td>Geotechnical Engineering Laboratory II</td>
<td>4</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>CE 441</td>
<td>Foundation Engineering</td>
<td>3</td>
<td>23</td>
<td>100</td>
</tr>
<tr>
<td>CE 446</td>
<td>Wastewater Engineering</td>
<td>7</td>
<td>20</td>
<td>100</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: field trips.

(continued on next page)
<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>No. of Sections Offered in Current Year</th>
<th>Avg. Section Enrollment</th>
<th>Type of Class¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 447</td>
<td>Transportation Engineering</td>
<td>4</td>
<td>19</td>
<td>100</td>
</tr>
<tr>
<td>CE 514</td>
<td>Environmental Engineering Laboratory</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>CE 450</td>
<td>Pavement Design</td>
<td>1</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>CE 500</td>
<td>Matrix Computer Analysis of Structures</td>
<td>3</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>CE 501</td>
<td>Dynamics of Structures</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 502</td>
<td>Structural Optimization</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 503</td>
<td>Prestressed Concrete Design</td>
<td>1</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>CE 504</td>
<td>Earthquake Engineering</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 505</td>
<td>Bridges Design</td>
<td>1</td>
<td>22</td>
<td>100</td>
</tr>
<tr>
<td>CE 506</td>
<td>Advanced Steel Structures Design</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 507</td>
<td>Computer Analysis and Design of Structural Systems</td>
<td></td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>CE 508</td>
<td>Design of Wood Structures</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 509</td>
<td>Structural Engineering Laboratory</td>
<td></td>
<td></td>
<td>20</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.
<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>No. of Sections Offered in Current Year</th>
<th>Avg. Section Enrollment</th>
<th>Type of Class¹</th>
<th>Lecture</th>
<th>Lab.</th>
<th>Recit</th>
<th>Other (Specify)²</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 510</td>
<td>Open Channel Engineering</td>
<td>1</td>
<td>17</td>
<td>100</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 511</td>
<td>Environmental Improvement</td>
<td>1</td>
<td>17</td>
<td>100</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 512</td>
<td>Advanced Topics in Water Resources Engineering</td>
<td>2</td>
<td>17</td>
<td>100</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 515</td>
<td>Computer-Aided Design in Hydraulic and Environmental Engineering</td>
<td>1</td>
<td>12</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 516</td>
<td>Fundamentals of Ground-Water Hydrology</td>
<td></td>
<td></td>
<td>100</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CE 520</td>
<td>Geometric Design of Highways</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 522</td>
<td>Transportation Facility Design and Planning</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 523</td>
<td>Computer-Aided Design in Transportation and Highway Engineering</td>
<td>1</td>
<td>12</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SURV 312</td>
<td>Plane Surveying II</td>
<td></td>
<td>20</td>
<td>80</td>
<td></td>
<td>100</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.
<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>No. of Sections Offered in Current Year</th>
<th>Avg. Section Enrollment</th>
<th>Type of Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 528</td>
<td>Deep Foundations</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 529</td>
<td>Design with Geosynthetics</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 530</td>
<td>Geotechnical Engineering III</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 531</td>
<td>Advanced Soil Mechanics</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 532</td>
<td>Soil Dynamics</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 533</td>
<td>Advanced Foundations</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 534</td>
<td>Computer-Aided Design in Geotechnical Engineering</td>
<td></td>
<td></td>
<td>80, 20</td>
</tr>
<tr>
<td>CE 536</td>
<td>Soil Improvement</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>CE 455</td>
<td>Cost Estimates</td>
<td>2</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>CE 535</td>
<td>Monitoring of Construction Projects</td>
<td>2</td>
<td>23</td>
<td>80, 20</td>
</tr>
<tr>
<td>CE 538</td>
<td>Inspection of Projects</td>
<td>1</td>
<td>30</td>
<td>80, 10</td>
</tr>
<tr>
<td>CE 445</td>
<td>Civil Engineering Practice</td>
<td>1</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>CE 540</td>
<td>Civil Engineering Capstone Design I</td>
<td>2</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>CE 550</td>
<td>Civil Engineering Capstone Design II</td>
<td>2</td>
<td>18</td>
<td>100</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: visit to actual construction projects.
P. Discuss how the humanities and the social sciences "breadth and depth" requirements are being satisfied

The civil engineering program requires 27 credits-hours in the humanities and social sciences areas as an integral part of civil engineering program.

The humanities and social sciences are divided into two levels. At level I there are two (2) courses in Spanish language, two (2) courses in English language, and two (2) courses in the Socio-Humanistic field "Socio-Humanistic I, and Socio-Humanistic II", in order to spread the students knowledge in these areas. In the second level, and in order to intensify the students understanding of socio-humanistic topics, and to assure that civil engineers are fully aware of their social responsibilities and able to consider related factors in the decision-making process, the students in the civil engineering program are required to select additional two (2) courses in the following discipline areas: philosophy, history, literature, sociology, political science, and/or economics. Also, all students are required to take the course of professional engineering ethics, offered in the fourth year of study.

Q. Identify the part(s) of the curriculum in which probability and statistics are applied to engineering problems

The concepts of stochastic processes, random variables, probability and statistics are formally introduced in the course ENGI235 Probability and Statistics for Engineers, administrated by the Industrial Engineering Department of the PUPR. These concepts are applied in most of the CE program, both in the laboratory and the Theoretical CE courses, as described below:

Q.1 Civil Engineering Courses:

Basic concepts of probability and statistics are applied in Water Supply (CE413) and Environmental Engineering (CE416) courses. For instance, to interpret water and air quality data and standards the students must be familiar with parameters such as media, mean, representative population, standard deviation, long term trends, and moving average. Also, the concept of linear interpolation is applied to show in graphical form different types of scientific or engineering data.

Within the Environmental Engineering course (CE416) the student is exposed to the air pollution dispersion model, which is based on the assumption of a Gaussian probability distribution of the pollutant.

Q.2 Laboratory courses:

In the course ENGI340 Mechanics of Materials Laboratory, many of the experiments are devoted to demonstrate the linear elastic response of the structure. To compare experimental results with analytical results, minimum square curve fitting procedures are use to obtain the slope from the experimental points.

In the course CE331 Construction Materials Laboratory the application of statistics is found in the evaluation of the results of compression strength tests to concrete cylinders, where not only the mean value is important but also the variance, in order to determine the characteristic resistance of the concrete.

The application of probability and statistics are regularly applied in both geotechnical engineering laboratory courses. Simple averaging is performed when determining the plastic limit of fine soils and the linear trend concept is applied when determining the liquid limit of fine soils, a parabolic best fit is required to determine optimum water contents from compaction tests and a free-hand fit is performed on the stress-strain curve of unconfined compression results. Similar tasks are to be performed for the shear strength evaluation of soils in the CE-440 course.
A. In table XIV summarize the laboratories utilized for instruction related to this program, and describe their adequacy for instruction, condition, number of students stations, and square feet of space. If the same facility is used for more than one laboratory, list only once and describe the various uses. If any detailed explanation is necessary, provide it in response to the item below.
<table>
<thead>
<tr>
<th>Physical Facility Building and Room Number (1)</th>
<th>Purpose of Laboratory Including Courses Taught</th>
<th>Condition of Laboratory(2)</th>
<th>Adequacy for Instruction</th>
<th>Number of Students Stations</th>
<th>Area (sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Materials Laboratory, Room L-104</td>
<td>Conduct test on aggregates. Concrete, Steel-Course CE 331</td>
<td>See Section D below</td>
<td>Completely equipped and laboratory Manual written</td>
<td>4</td>
<td>1000 sf</td>
</tr>
<tr>
<td>Mechanics of Materials Laboratory, Room L-109</td>
<td>Conduct test on model to study behavior of materials. ENGI 340</td>
<td>See Section D below</td>
<td>Completely equipped and Laboratory Manual written</td>
<td>4</td>
<td>1000 sf</td>
</tr>
<tr>
<td>Geotechnical Laboratory, Room L-302</td>
<td>Conduct test on soil behavior, CE438 &amp; CE 440</td>
<td>See Section D below</td>
<td>Completely equipped for tests on Laboratory Manual written</td>
<td>4</td>
<td>1000 sf</td>
</tr>
<tr>
<td>Structural Engineering Laboratory Room L-102</td>
<td>Conduct test on behavior of structures CE 309</td>
<td>Requisition for equipment was submitted for approval</td>
<td>Not Available yet</td>
<td>-</td>
<td>900 sf</td>
</tr>
<tr>
<td>Environmental Engineering Laboratory Room L-103</td>
<td>CE 514</td>
<td>Purchase order for equipment has been already placed</td>
<td>Not Available yet</td>
<td>-</td>
<td>850 sf</td>
</tr>
<tr>
<td>Civil Engineering Simulation Laboratory, Room L-301</td>
<td>Requisition for equipment was submitted for approval</td>
<td>Not Available yet</td>
<td>Not Available yet</td>
<td>-</td>
<td>850 sf</td>
</tr>
</tbody>
</table>

**TOTAL Area 5,600 sf**

Note: Provide detailed explanation, if necessary, under response to questionnaire, section XII, item M.

Instructions

1. If same facility is used for more than one laboratory course, describe all under the "purpose" column. Do not count the same area more than once in the "area" column.
2. Condition includes but is not restricted to housekeeping and safety considerations.

II - 101
B. Provide an assessment of equipment and instrumentation available in each laboratory to meet instruction needs.

As mentioned in chapter XII, item M, laboratory courses in the civil engineering department are supportive of their corresponding theoretical courses. In this sense, laboratory manuals are designed to meet this precept. All the equipment in each laboratory has been selected to ensure that all tests described in the manuals can be performed to obtain the most trustworthy results that can give the student a clear answer that will be consistent with the theory learned in the class.

Item C will show a list of such equipment.

C. List new equipment and instrumentation installed in each laboratory course.

A list of the equipment available in each laboratory is presented at the end of this section. All the equipment is new since prior to 1990 the laboratories were conducted in facilities outside the PUPR, where a real was paid.

A new laboratory building was open for occupancy in August, 1994. Seven rooms, each with an approximate area of 1000 square feet, were assigned to the civil engineering department. These rooms will house bur laboratories, as follows:

1. Construction Materials Laboratory. This laboratory, which has been assigned to room L-104, was originally established in 1989. But, it was used as a complement to the Construction Materials course, when no laboratory course existed in the current curriculum (1986) at that time. It was introduced in the curriculum as a compulsory course in 1992. This laboratory has been updated, acquiring new equipment and replacing worn-out and lost equipment. A laboratory manual has been prepared.

2. Geotechnical Engineering Laboratory. As in the case of the Construction Materials Laboratory, the Geotechnical engineering laboratory, now assigned to room L-302, was establish in 1989 to serve the geotechnical engineering laboratory course (CE 438). It was fully equipped to serve the laboratory course. In 1992, an advanced course (CE 439-Geotechnical Engineering II) was added to the curriculum. Consequently a new laboratory course (CE 440-Geotechnical Engineering Laboratory II) was introduced. New equipment was acquired to up-date the laboratory, so that it could serve both courses. The same laboratory manual is used for both.

3. Mechanics of Materials Laboratory. In 1992, the revised curriculum included the Mechanics of Materials Laboratory course (ENGI 340). The necessary equipment was acquired and installed in room L-109. It is being used since the term that started in November 1995. The teaching staff prepared a draft of the laboratory manual.

4. Environmental Engineering Laboratory. This laboratory was assigned to room L-103, and will serve the Environmental Engineering Laboratory course (CE 514), a new addition in the 1992 curriculum. It is intended to conduct monitoring of the environment (air, water and sound) and perform hydraulic measurements. It will also include an experimental meteorological station. The equipment for this laboratory has been ordered and we expect to install it in the next two or three months. At the same time, the teaching staff is working in the preparation of the manual.

II - 102
5. Structural Engineering Laboratory. The structural laboratory, designed to serve the Structural Engineering Laboratory course (CE 509), has been assigned to room L-102. This course will guide students into the study of structural models of different types, to observe the behavior of various structural elements subjected to the effects of tension, compression, bending and defects produced by applied loads. The requisition for the required equipment has been already submitted officials for approval.

6. Civil Engineering Simulation Laboratory. This laboratory has been assigned to room L-103. It will not serve any particular course in the curriculum, it is meant to serve the students at the higher level, where sophisticated computer programs in structural, highway, environmental and geotechnical engineering will be used. It will also serve the students that are working in the capstone design project. We have already submitted a requisition for 12 state of the art computers to be used in the laboratory and we are in the process of defining the software to be acquired.

D. List the critical needs

All the laboratories are located in a new recently inaugurated building. The Geotechnical Engineering Laboratory, The Construction Materials Laboratory, and the Mechanics of Materials Laboratory have been fully equipped as of last fall, to meet the present requirements. Therefore, for these three laboratories no immediate needs are foreseeable with the exception that perhaps some equipment should be duplicated to accommodate the large section size actually assigned in excess.

The equipment for the Environmental Engineering Laboratory has been already ordered. Once received and installed, it will not be subjected to reevaluation in the next two or three years.

However, there are two laboratories with immediate needs: the Structural Engineering Laboratory, and the Civil Engineering Simulation Laboratory. Both laboratories are still to be established. The faculty has already defined these laboratories and submitted the required equipment to the PUPR administration. Two requisitions were submitted for the Structural Engineering laboratory: one on September 28, 1994, and the other on October 3, 1994. The CE Department is waiting for their approval. The requisition for twelve computers to be used in the simulation laboratory was submitted on August 1, 1994; approval for this requisition is also pending.

E. Describe specific plans for the continued updating and development of the instructional laboratories of the program.

At this time, we have been working in the development of all laboratories necessary to support the laboratory courses in the 1994 revised curriculum. As stated before three, laboratories are operating satisfactorily. However, will be watchful to any significant changes in the registration of students and the demand for laboratory courses. Any needs that may arise as a consequence will be dealt with at that time. Addition at new laboratory course sections will be our first alternatives as long as it may solve the needs satisfactorily. Beyond this, we will expand the program facilities to deal with the problem.

F. Describe provisions for maintaining and servicing the laboratory equipment

We have elaborated an equipment maintenance plan, copy of which is included below:

Generally, the equipment used in the laboratories in the civil engineering department requires very little and easy maintenance, which could have a preventive character or in the case of failure, require repair services. Some other equipment, however, because of its more sophisticated nature, may require maintenance by a specialized technician. In some instances, in house maintenance may be performed by our technician, mainly because the
manufacturer provides enough, well-detailed, information to proceed; but, for other equipment, the maintenance may be complex enough to require servicing by an authorized, specialized technician. It is convenient to mention, at this time, that most of this specialized maintenance is of a periodic character, in most instances once every year. For this reason, it is not recommended that specialized technician be contracted on a permanent basis. Moreover, companies which offer these services in Puerto Rico have alerted us against the negotiation of yearly contracts, which would be burdensome to the institution, provided that the service is offered once every year. Following these guidelines, we have arranged with the supplier who has the qualified personnel to render these services or else, bring in the technicians to do the job. Services will be rendered during a pre-arranged period of time in the year. Cost of these services will be determined at the time the service is applied for.

Following is a list of the laboratories which are operating at this time and a relation of the equipment, in each of them, that will require this specialized service.

F.1 Construction Materials Laboratory

1. compression machine to test concrete cylindrical specimens. Brainard & Kilman model C-130, which was acquired in June, 1989. It has an electronic, digital read-out which requires calibration once every year. In the past, this service has been rendered by Tomás Cuerda, Inc. during the period of time between January and February every year. We intend to have Tomás Cuerda, Inc. to continue offering this service in the future. The laboratories coordinator will make the necessary arrangements to have this service performed.

2. Sieve shaker for coarse aggregates-Gilson model P-260. This equipment is very durable and it requires very little preventive maintenance. It is, however, subject to breakage. At such time, repairs will be handled by Tomás Cuerda, Inc.

3. Los Angeles abrasion machine-Soiltest model M-600, recently acquired.

F.2 Geotechnical Engineering Laboratory

1. CBR/UCC load frame-Brainard & Kilman model S-61035 - This machine include: a). S-type load cell, model E-216; b) linear displacement transducer E-310(2); c). digital transducer read-out, model E-400(2). This equipment requires calibration, at least, once every year. This maintenance will also be negotiated, at the time it is required, with Tomás Cuerda, Inc. The coordinator of the laboratories will apply for this service whenever needed.

2. Wall and bench type ovens - Brainard & Kilman, models GO-217 (wall type) and GO-220(bench type). Other than thorough cleaning after every use, these ovens require very little preventive maintenance. Failures and malfunctioning of the resistance units and door latches, will be serviced by Tomás Cuerda, Inc.

3. Sieve shaker for fine aggregates-Brainard & Kilman, model P-220 - This equipment is very durable and requires very little preventive maintenance. It is, however, subject to failure. At such time, Tomás Cuerda, Inc. will handle the repairs at the request of the coordinator of the laboratories.

4. Motorized Cathead - This equipment is used to bore into the ground to obtain soil samples at different depths. Preventive maintenance can be done in-house, except for two components: a). Briggs & Stratton gasoline engine, model AMC-2 and b) Briggs & Stratton centrifugal pump, model 12.120. These two components, besides preventive maintenance, light or heavy
repair service. In the past, Gregory Equipment Corporation, pump and tank manufacturers representatives in San Juan, Puerto Rico, have rendered repair service to this equipment and will continue to do so in the future. Again, these repairs are very sporadic; therefore, services will be rendered upon request by the coordinator of the laboratories.

5. Triaxial Load Frame-Soiltest, model T 1235A-Recently acquired.

F.3 Mechanics of Materials Laboratory

1. Combined tension and compression machine- Soiltest Versatester, model 1050, digitalized. Recently acquired.

2. Torsion Machine, Tecequipment, model SM.21-Recently acquired.

We will be consulting the manufacturers of all the equipment that has been acquired recently in relation with its maintenance. Once we are supplied this information and we establish our communication with the persons or entities that offer the type of maintenance required, we will be in a position to include them in our maintenance plans or programs.
### Geotechnical Laboratory Equipment

<table>
<thead>
<tr>
<th>QTY</th>
<th>MODEL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GO-217</td>
<td>Double wall oven</td>
</tr>
<tr>
<td>1</td>
<td>GO-220</td>
<td>Portable bench oven</td>
</tr>
<tr>
<td>5</td>
<td>G-535</td>
<td>Laboratory tongs</td>
</tr>
<tr>
<td>12</td>
<td>G-315</td>
<td>Dozen of Moisture Boxes</td>
</tr>
<tr>
<td>5</td>
<td>S-270</td>
<td>Liquid limit set (incl. 12 moist Boxes)</td>
</tr>
<tr>
<td>5</td>
<td>S-277</td>
<td>Plastin limit set (incl. 12 moist Boxes)</td>
</tr>
<tr>
<td>2</td>
<td>GW-111</td>
<td>Cent-o-gram scale 310 gr.</td>
</tr>
<tr>
<td>2</td>
<td>GW-115</td>
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<td>2</td>
<td>GW-120</td>
<td>Heavy Duty Balance</td>
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<td>S-61035</td>
<td>CBR/UCC Load Frame</td>
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<td>E-216</td>
<td>10,000 lb. load cell for CBR</td>
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<td>S-358</td>
<td>CBR Penetration piston</td>
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<td>Filter Screens</td>
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<td>S-35g</td>
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<td>G-30005</td>
<td>Stainless Mixing Pan 21&quot; x 13&quot; x 2&quot;</td>
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<td>24</td>
<td>G-30001</td>
<td>Tin Mixing Pan 8&quot; x 4&quot; 2.5&quot;</td>
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<td>S-30009</td>
<td>Galvanized Mixing Pan 18&quot; x 18&quot; x 2&quot;</td>
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<td>DR 90</td>
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<td>T-299</td>
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<td>50 mm fixed type consolidometer</td>
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<td>P-103</td>
<td>Sample ejectors</td>
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<td>5</td>
<td>CN-980</td>
<td>Field Density plate for volumeasure</td>
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<td>40032-1</td>
<td>Motorized cathead consisting of B&amp;S gasoline engine 5 HP, 4.5&quot; cathead, aluminum tripod, sheave safety hook and 75 ft. of manila rope</td>
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<td>21029-2</td>
<td>140# drive weight</td>
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<td>20031-42</td>
<td>guide and pull piece 2.5 x 36'</td>
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<td>110535</td>
<td>Pipe drive rings</td>
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<td>0201-109</td>
<td>NW X AW Drive head</td>
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<td>2 ft. NW casing</td>
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<td>4</td>
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<td>5 ft NW casing</td>
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<tr>
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<td>21005-2</td>
<td>2 ft. AW drill rod</td>
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<tr>
<td>4</td>
<td>21005-4</td>
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<td>110564-1</td>
<td>2.5/8 straight dropping bit</td>
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<td>110588-1</td>
<td>2.5/8 boulder buster</td>
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<tr>
<td>1</td>
<td>111181-4</td>
<td>AW pulling plate</td>
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<td>2168</td>
<td>Wrenches 24&quot; rigid</td>
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<td>2167</td>
<td>Wrenches 18&quot; rigid</td>
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<td>3616</td>
<td>AW hoisting plug</td>
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<td>21023-18</td>
<td>Water swivel</td>
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<td>22043-14</td>
<td>2&quot; rynac Spilt tube sampler</td>
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<td>22012-8</td>
<td>3&quot; thin wall tube sampler</td>
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<td>20037-19</td>
<td>Extra tubes for above</td>
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<td>14</td>
<td>90367.55</td>
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<td>110043.2</td>
<td>Set AW roth box to NW casing pin</td>
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<td>110203.2</td>
<td>Casing drive shoe</td>
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<td></td>
<td>NW Water T</td>
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<td>1</td>
<td>12.120</td>
<td>Waterpump, 120 gpm centrifugal pump/air cooler 2 HP engine</td>
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<tr>
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<td>Set of hose</td>
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II - 108
<table>
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<tr>
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<td>C-130</td>
<td>300,000 lbs. concrete compression machine w/digital readout and printer, console type w/extra digital readout for low loads</td>
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<td>2737</td>
<td>Attachment for beam tests</td>
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<td>Attachment for cubes</td>
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<td>C210R</td>
<td>Reusable cylinder molds 6 x 12</td>
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<td>C245</td>
<td>2&quot; Cube Molds</td>
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<td>3005</td>
<td>6&quot; X 6&quot; X 20' Beam Molds</td>
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<td>C335</td>
<td>Slump Cones</td>
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<td>C350</td>
<td>Tamping rods and</td>
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<td>C275</td>
<td>Capping Stand</td>
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<td>C290</td>
<td>100#/bag of capping compound</td>
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<td>4 quart melting pot for capping comp.</td>
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<td>Compressomenter for 6&quot; x 12&quot; cylinders</td>
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<td>Gilson test Master</td>
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<td>Density Basket</td>
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<td>Slotted Surcharged weight</td>
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<td>Compaction hammer</td>
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<td>S-35710</td>
<td>Straight Edge</td>
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<td>PCF-8RS</td>
<td>Set of sieves including: 2&quot;, 1.75&quot;, 1.5&quot;, 1&quot;,5&quot;, #4, #10, #20, #40, #80, #100, #200, Brass pan and brass cover</td>
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<td>ASTM Soil Hydrometer</td>
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<td>Spec, Gravity &amp; Absorption Test</td>
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<td>S-311</td>
<td>Modified Compaction Hammer</td>
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<td>Abrasion machine</td>
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<td>Sets of sieves, including brass pan &amp; cover</td>
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<td>Measurement of Strain</td>
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<td>HST 1/10</td>
<td>Shear Force</td>
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<td>2</td>
<td>HST 111W</td>
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<td>HST 2/6</td>
<td>Area-Moment Method</td>
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<td>HST 2/12</td>
<td>Column Buckling Failure</td>
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<td>HST 212W</td>
<td>Set of Weights for HST 2/12</td>
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<td>AP-376-1</td>
<td>Flat Specimen Grips</td>
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<td>Round Specimen Grips</td>
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<tr>
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<td>AP-378-3</td>
<td>Round Specimen Grips</td>
</tr>
<tr>
<td>1</td>
<td>AP-384</td>
<td>Shearing Fixture</td>
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</table>
A. Describe how this program assures the development of an understanding of the ethical, social, safety, and economic considerations in engineering practice. Give specific course numbers, instructors, and other specific information.

The students are introduced to these topics early in the program, in the ENGI146 Freshman Engineering Design course. Some real projects are presented, where the aspects of ethics and security are evidently important. Then the students are grouped in teams, and a set of questions is assigned to each team; the team looks for information, discuss as the possible responses, prepare drawings and graphical representations of their conclusions, and share the results with the rest of the class through an oral presentation. Also, a conference on ethics in engineering is offered by an engineering professional, where the students participate making questions to the guest speaker. Aspects of economy are undertaken during the development of the team project, where cost estimates regarding materials, equipment, and human resources have to be calculated.

The main course dealing with the ethical and social aspects of the engineering profession is PHIL441 Professional Ethics in Engineering. This is a 3 credit required course within the CE program. This course is offered by two professors, Juan C Piug, assistant professor of CE, and Wilfredo Muñoz, associate professor of MEM. Both have engineering degrees and Juris Doctor at. The course covers the philosophical aspects of ethics and its implications to the professional responsibility in the field of engineering. Specifically, it reviews the principal laws governing the practice of engineering in Puerto Rico, the Code of Ethics for engineers, and the discussion of hypothetical and real cases.

The courses in construction engineering (CE 410 Construction Management, CE 455 Cost Estimates, CE 535 Monitoring of Projects, and CE538 Inspection of Projects) reflect the need of modern society for engineers to assist in the governance of technologically complex social problems. The effects of construction in the people close to its site and to the environment in general are taken into consideration when deciding what and where to construct a project. The economic and social effects of the project in the neighborhood when the project is constructed and operating determine its feasibility. Any project must be in benefit of the society. The injection of professionalism into the construction industry promotes the development of a social conscience in the construction enterprises. This is probably the most positive effect of construction engineering in the society as a whole.

B. Describe the opportunities on campus that are available to students for participation and membership in those technical, professional, and/or honor societies most closely associated with the program. Indicate support to these activities supplied by the engineering unit, department, and program faculty.

At present, there are two student chapters active at the Polytechnic University of Puerto Rico, which are specially attractive to civil engineering students regarding their professional insertion:

1. Student Chapter of the "Colegio de Ingenieros y Agrimensores de Puerto Rico" (College of Engineering and Land Surveyors of Puerto Rico).
2. Student Chapter of the Institute of Civil Engineers.

Students may participate in one or both chapters. Both groups provide opportunities to get acquainted and participate in conferences, seminars, and field trips.

In order to support the students association, there is a full-time professor that functions as a link between the technical student associations and the CE Department. Said professor has been named starting March '95 by the student affairs assistant to the CE Department head. The activities carried out include both technical and professional support to the associations in the form of periodical meetings to discuss their needs and make the required contacts with both the rest of the faculty and the industry.
C. Describe the ways in which interaction is enhanced between the students and practitioners in industry, government, and private practice.

The interaction between the CE students and the practitioners is promoted through several activities, as described below:

1. Many of the design courses are taught by practicing engineers, who act as part-time adjunct professors. The students are in touch with well-known CE practitioners and with relevant aspects of the common practice in PR.

2. Some of the CE courses use field visits as part of their implementation, allowing the students to interact with project director engineers, industry plant engineers, and the technical task force.

3. The students are encouraged to participate in the co-op programs, where they have the opportunity to work in a CE related area while studying, receiving inputs from both the faculty members and practicing engineers.

4. Many of the senior students that attend the PUPR are part-time students, who work in related CE areas (government agencies, construction enterprises, design firms, etc.). They interact with the other students and the faculty, both in the class and out of class, sharing their experiences.

5. Once a year, the PUPR organizes a job fair, where some private firms and government agencies (both local and federal) participate. Previous to the visit, the students have the opportunity to participate in some seminars where they learn how to prepare a resume, how to prepare for a job interview, how the government agencies are structured, etc.

D. Describe the encouragement given and arrangements made to have students take the Fundamental of Engineering Examination. If graduates are required to take the Fundamentals of Engineering Examination, so indicate.

The Fundamental of Engineering Examination (FEE) is not required as a requisite for graduation. However, the professors encourage the CE students at the last quarter of studies to take the FEE before graduation, to facilitate their movement to the professional life.
XV  INFORMATION REGARDING FACULTY MEMBERS

A. Complete Table XV, listing each member of the faculty of the program. Use as many sheets as necessary. An updated report is to be provided at the time of the visit.
<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 &amp; Year</th>
<th>Years of Experience</th>
<th>Professional Registration (Indicate State)</th>
<th>Level of Activity (high, med, low, none) in:</th>
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<tbody>
<tr>
<td>Balhan A. Alsaadi</td>
<td>36</td>
<td>As.Pr.</td>
<td>FT</td>
<td>PhD CE</td>
<td>Polytechnic University of Madrid, Spain/1988</td>
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<tr>
<td>Francisco Arencibia</td>
<td>50</td>
<td>Au.Pr.</td>
<td>FT</td>
<td>MSSC</td>
<td>UPR, 1985</td>
<td>15</td>
<td>PR (FE)</td>
<td>med</td>
</tr>
<tr>
<td>Omaira M. Collazos</td>
<td>29</td>
<td>Au.Pr.</td>
<td>FT</td>
<td>MECE</td>
<td>University of Puerto Rico at Mayaguez, 1993</td>
<td>5</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Dhama Delgado</td>
<td>41</td>
<td>Au.Pr.</td>
<td>FT</td>
<td>MA</td>
<td>University of Puerto Rico</td>
<td>13</td>
<td>PR (AIT)</td>
<td>low CAPR</td>
</tr>
<tr>
<td>Berardo Deschapelles</td>
<td>64</td>
<td>As.Pr.</td>
<td>FT</td>
<td>PhD CE</td>
<td>California Coast University, 1982</td>
<td>40</td>
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<td>high CIAPR</td>
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<tr>
<td>José A. Martínez</td>
<td>34</td>
<td>Au.Pr.</td>
<td>FT</td>
<td>MSCE</td>
<td>University of California at Berkeley</td>
<td>8</td>
<td>low</td>
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<tr>
<td>Auristela Mueses</td>
<td>27</td>
<td>Au.Pr.</td>
<td>FT</td>
<td>MSCE</td>
<td>University of Puerto Rico at Mayaguez, 1992</td>
<td>3</td>
<td>PR (EIT)</td>
<td>low</td>
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</table>

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.

(continued on next page)
# TABLE XV
## FACULTY ANALYSIS
### Program CIVIL ENGINEERING

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Rank</th>
<th>Full-time</th>
<th>Highest Degree</th>
<th>Institution from which Highest Degree Earned &amp; Year</th>
<th>Years of Experience</th>
<th>Professional Registration (Indicate State)</th>
<th>Level of Activity (high, med, low, none) in:</th>
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<tr>
<td>Gustavo E. Pacheco</td>
<td>31</td>
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<td>Juan C. Puig</td>
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<td>Au.Pr.</td>
<td>FT</td>
<td>MSCE JD</td>
<td>U.P.R. 1989 U.P.R. 1982</td>
<td>9</td>
<td>PR (ETT) PR (license)</td>
<td>low</td>
</tr>
<tr>
<td>Rodolfo Tardy</td>
<td></td>
<td></td>
<td>FT</td>
<td>MSCE</td>
<td>UPR</td>
<td></td>
<td></td>
<td>low</td>
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<tr>
<td>Félix Sánchez</td>
<td>70</td>
<td>As.Pr.</td>
<td>FT</td>
<td>MSCE</td>
<td>Cornell University</td>
<td>49</td>
<td>PR (PE)</td>
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<td>Wilma Torres</td>
<td>28</td>
<td>Au.Pr.</td>
<td>FT</td>
<td>MArch</td>
<td>University of Puerto Rico 1993</td>
<td>3</td>
<td>PR (ATT)</td>
<td>low, CAPR</td>
</tr>
<tr>
<td>José Borrageros</td>
<td></td>
<td></td>
<td>Pt</td>
<td>MSCE</td>
<td>Texas A&amp;M University, 1985</td>
<td>10</td>
<td>PR (PE)</td>
<td>med, low, high</td>
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<tr>
<td>Yamil Castillo</td>
<td>41</td>
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<td>PT</td>
<td>MSCE</td>
<td>University of Florida, 1988</td>
<td>18</td>
<td>PR (PE)</td>
<td>high, none</td>
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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.

(continued on next page)
TABLE XV
FACULTY ANALYSIS
Program CIVILENGINEERING

<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 &amp; Year</th>
<th>Years of Experience</th>
<th>Professional Registration (Indicate State)</th>
<th>Level of Activity (high, med, low, none) in:</th>
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</thead>
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<td>Professional Society (Indicate State)</td>
<td>Consulting/Summer Work in Industry</td>
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<td>Eugenio Dívila</td>
<td>52</td>
<td>Au.Pr.</td>
<td>PT</td>
<td>MSCE</td>
<td>State Univ. New York at Buffalo, 1977</td>
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<td>Héctor de Jesús</td>
<td>50</td>
<td>Au.Pr.</td>
<td>PT</td>
<td></td>
<td>State Univ. New York at Buffalo, 1974</td>
<td>15</td>
<td>PR (PE)</td>
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<tr>
<td>Juan González</td>
<td>48</td>
<td>Au.Pr.</td>
<td>PT</td>
<td>MSCE MBA</td>
<td>Lamar Univ. U.P.R., 1971</td>
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<tr>
<td>Eusebio Iglesias</td>
<td>59</td>
<td>As.Pr.</td>
<td>PT</td>
<td>PhD CE</td>
<td>Rensselaer Polytechnic Institute, New York, 1968</td>
<td>26</td>
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<tr>
<td>Wilfredo Lebrón</td>
<td>76</td>
<td>Au.Pr.</td>
<td>PT</td>
<td>MS CE</td>
<td>Institute Polytechnic, New York, 1993</td>
<td>23</td>
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<tr>
<td>Edilberto Ocasio</td>
<td>30</td>
<td>Au.Pr.</td>
<td>PT</td>
<td>M.Arch</td>
<td>University of Puerto Rico, 1991</td>
<td>8</td>
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<tr>
<td>Rafael Pérez Marchand</td>
<td>72</td>
<td>Au.Pr.</td>
<td>PT</td>
<td>BS CE, BS Arch</td>
<td>Citadel, South Carolina, 1949, Kansas State Univ., 1991</td>
<td>49</td>
<td>7</td>
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</table>

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.
B. In Table XVI summarize the course load and other activity for each faculty member for the current term (term in which Volume II is being developed) and the last full academic year (academic year prior to the visit). An updated report is to be provided at the time of the visit.
<table>
<thead>
<tr>
<th>Faculty Member (Name)</th>
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<th>Classes Taught (Course No./Credit Hrs.)</th>
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<tr>
<td></td>
<td></td>
<td>Current Term</td>
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<td>Research</td>
<td>Other</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Term</td>
<td>Year</td>
<td>Term</td>
<td>Year</td>
</tr>
</tbody>
</table>
| Ballan A. Alsadi            | FT       | Concrete Structure Design (CE 420/3), Advanced Structural Design (CE 425/3), | 20 | 20 | 20 | 30 | 60* | 50*
|                             |          | Civil Engineering Practice (CE 445/3)                                       |                              |                      |                      |                      |
| Francisco Arencibia         | FT       | Applied Numerical Analysis (CE 247/3)                                       | 100 | 100 | 0   | 0   | 0   | 0    |
|                             |          | Applied Mechanics Static (ENG 1 322/3)                                      |                              |                      |                      |                      |
| Omarin M. Collazos          | FT       | Applied Numerical Analysis (CE 247/3)                                       | 70 | 70 | 0 | 0 | 30** | 30** |
|                             |          | Mechanics of Materials I (ENG 324/3 x 2)                                     |                              |                      |                      |                      |
|                             |          | Mechanics of Materials Lab. (ENG 340/1)                                      |                              |                      |                      |                      |
| Dharma Delgado              | FT       | Engineering Graphics (ENG 131/2 x 3)                                        | 100 | 100 | 0 | 0 | 0 | 0 |
|                             |          | Freshmen Engineering Design (ENG 146/3 x 2)                                 |                              |                      |                      |                      |
| Bernardo Deschapeltes       | FT       | Advanced Structural Design (CE 425/3)                                       | 70 | 70 | 10 | 10 | 20*** | 20*** |
|                             |          | Foundation Engineering (CE 441/3)                                           |                              |                      |                      |                      |
|                             |          | Earthquake Engineering (CE 504/3)                                           |                              |                      |                      |                      |
| Jose A. Martinez            | FT       | Geotechnical Engineering I (CE 437/3)                                       | 70 | 70 | 10 | 10 | 20** | 20** |
|                             |          | Geotechnical Engineering Laboratory I (CE 438/1 x 2)                         |                              |                      |                      |                      |
|                             |          | Geotechnical Engineering II (CE 439/3)                                      |                              |                      |                      |                      |
|                             |          | Geotechnical Engineering Laboratory II (CE 440/1 x 2)                        |                              |                      |                      |                      |
| Aurora Maestas              | FT       | Applied Mechanics, Statics (ENG 322/3 x 3)                                 | 80 | 80 | 0 | 0 | 20** | 20** |
|                             |          | Environmental Engineering (CE 416/3 x 3)                                    |                              |                      |                      |                      |

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.
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.

*CE Department Direct
**Academic Advisement
***Consulting
<table>
<thead>
<tr>
<th>Faculty Member (Name)</th>
<th>FT or PT</th>
<th>Classes Taught (Course No./Credit Hrs.)</th>
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<tr>
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<td>Term</td>
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<tr>
<td><strong>Gustavo E. Pacheco</strong></td>
<td>FT</td>
<td>Applied Software for Civil Engineering (CE 246/3 x 2)</td>
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<td>Mechanics of Materials II (ENGL 335/3)</td>
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<td>Mechanics of Materials Lab (CE 340/1)</td>
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<tr>
<td><strong>Juan C. Puig</strong></td>
<td>FT</td>
<td>Water Resources Engineering (CE 318/3)</td>
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<td></td>
<td>Ethics in Engineering (PHIL 441/3 x 3)</td>
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<tr>
<td><strong>Félix Sánchez</strong></td>
<td>FT</td>
<td>Construction Materials (CE 330/3 x 2)</td>
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<td>Construction Management (CE 410/3)</td>
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<td>Inspection of Projects (CE 538/3)</td>
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<tr>
<td><strong>Reinaldo Torres</strong></td>
<td>FT</td>
<td>Engineering Graphics (ENGL 131/2 x 2)</td>
<td>100</td>
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<td>Freshman Engineering Design (ENGL 146/3 x 3)</td>
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<tr>
<td><strong>Wilma Torres</strong></td>
<td>FT</td>
<td>Engineering Graphics (ENGL 131/2 x 2)</td>
<td>100</td>
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<td></td>
<td></td>
<td>Freshman Engineering Design (ENGL 146/3 x 2)</td>
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<td></td>
<td>Análisis Intesivo de Tópicos relacionados con la Historia (HIST 599/3)</td>
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<tr>
<td><strong>José Borrageros</strong></td>
<td>PT</td>
<td>Wastewater Engineering (CE 446/3 x 2)</td>
<td>20</td>
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</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.
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.

**Academic Advising**

**Consulting**
### TABLE XVI

**FACULTY ACTIVITY SUMMARY, PROGRAM CIVIL ENGINEERING**

<table>
<thead>
<tr>
<th>Faculty Member (Name)</th>
<th>FT or PT</th>
<th>Classes Taught (Course No./Credit Hrs.)</th>
<th>Current Term</th>
<th>Total Activity Distribution</th>
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<td>Term</td>
<td>Year</td>
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<tr>
<td>Yamil Castillo</td>
<td>PT</td>
<td>Civil Engineering Capstone Design I (CE 540/2)</td>
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<td></td>
<td>Civil Engineering Capstone Design II (CE 550/2x2)</td>
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<tr>
<td>Eugenio Dávila</td>
<td>PT</td>
<td>Transportation Engineering (CE 447/3)</td>
<td>20</td>
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<td>Héctor de Jesús</td>
<td>PT</td>
<td>Water Supply Engineering (CE 413/3 x 2)</td>
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<td>Juan González</td>
<td>PT</td>
<td>Highway Design I (CE 321/3)</td>
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<td>Highway Design II (CE 322/3)</td>
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<tr>
<td>Eusebio Iglesias</td>
<td>PT</td>
<td>Steel Structures Design (CE 415/3)</td>
<td>20</td>
<td>20</td>
<td>0</td>
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<tr>
<td>Wilfredo Lebrón</td>
<td>PT</td>
<td>Construction Materials Lab. (CE 331/1)</td>
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<td>10</td>
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<tr>
<td>Edilberto Ocasio</td>
<td>PT</td>
<td>Engineering Graphics (ENGI 131/2 x 3)</td>
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<td>20</td>
<td>0</td>
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<td>Descriptive Geometry (ENGI 142/2 x 3)</td>
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<td>Theory of Structures I (CE 412/3)</td>
<td>70</td>
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<td></td>
<td></td>
<td>Theory of Structures II (CE 424/3)</td>
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<td></td>
<td>Mechanics of Materials I (ENGI 324/3 x 2)</td>
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</tbody>
</table>

**Instructions**

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4. Updated information is to be provided at the time of the visit.

**Academic Advisement**

***Consulting

II - 122
C. Show how the faculty assigned to this program satisfies ABET engineering criteria for faculty size and any applicable program criteria.

The civil engineering faculty consists of a total of sixteen (16) professors with at least Master Degree in one of the five civil engineering discipline areas: Structural Engineering, Geotechnical Engineering, Transportation Engineering, Environmental Engineering and Construction Engineering.

The faculty of civil engineering is young and competitive faculty with a strong academic background and experience in teach, research and professional activities. There are ten (10) full-time faculty member of which four (4) of them are registered professional engineers, and six (6) are in process to be registered professional engineers. ABET engineering criteria require a minimum of four (4) full-time faculty registered professional engineers. The civil engineering program, also has six (6) part-time professors who are registered professional engineers.

To meet ABET criteria and to improve the students in the civil engineering program professional and practice skills, the majority of courses which are primarily design are offered by the four (4) full-time and the six (6) part-time faculty members who are registered professional engineers.

D. Provide a curriculum vitae for all faculty members with the rank of instructor and above who have primary responsibilities for course work associated with the program. Include part-time and adjunct faculty members. If the institution maintains the same information in a different format than the format outlined below, the institution's format is acceptable as long as it is consistent for each curriculum vitae and contains the information listed below.

The curriculum vitae of all CE program faculty members are listed below in an alphabetic order:
1) Name and date of birth: Balhan Alsayeb Alsaadi. May 15, 1959

2) Academic rank: Full time, Associate Professor, Civil Engineering Department Head

3) Degrees with fields, institution, and dates

P.h. D. Civil Engineering: Polytechnic University of Madrid, Spain, 1988

M.S. Civil Engineering: "Train VUL A". Polytechnic University of Timisoara, Romania, 1984

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank: Years in service at the UPM: Five (5) years. Original appointment to the UPM: December, 1990. I Advanced in rank: None

5) Other related experience-teaching, industrial, etc.

5.1) Teaching Experiences:

University of Puerto Rico at Mayaguez. Full time Assistant Professor.
Civil Engineering Department.
Structural Analysis and Design, Numerical Methods for Civil Engineering.

Polytechnic University of Puerto Rico. Full time Associate Professor
Civil Engineering Department.
1991-1993

5.2) Research experience:

Polytechnic University of Madrid, Spain.
Participation and conduct research projects related to experimental and numerical models for structural systems.
1985-1989

Polytechnic University of Timisoara, Romania
Boundary Element of Structural diaphragms resisting forces induced by earthquake motions.
1982-1984

5.3) Administrative experience

1993 at present- Civil Engineering Department Head.

1991-1993 -Assistant of the Civil Engineering Department head

6) Consulting, patents, etc.

Technical consultant in the field of: Precast concrete (Reinforced and Prestressed concrete beams and columns), shell structures and highway. Bridges structures-ALVISA COMPANY-Precast Concrete Elements Madrid, Spain, 1984-1989

7) State in which registered: In progress

8) Principal publications of last five years

Several publications in Technical European Journals, South American and a lot of communications to the "European Committee for Concrete Elements", "Buckling and Instability"

Alsaadi, Balhan, "Comportamiento no lineal de soportes de Hormigón armado, aislados y pertenecientes a partículas instalacionales. Criteria de Dimensionamiento y distribución de armaduras."
Tesis Doctoral presentada en la Universidad Politécnica de Madrid, España


II - 124 Alsaadi, Balhan. Curriculum vitae


Alsadi Balhan, Corres Hugo, "Excentricidad Ficticia e", Fórmulas simplificadas para el Dimensionamiento de soportes de hormigón armado. Hormigón y Acero #160, Madrid, Espana, 1986

9) Scientific and professional Societies of which a member

10) Honors and awards

11) Subjects or courses taught during the most recent academic year; by terms

SEMI 532, Thesis in Civil Engineering
CE 425, Advanced Structural Design
CE 420, Concrete Structures Design

12) Other assigned duties

Thesis Academic Advisor

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

February 1994 Quality Education for Minorities (QEM)
Networks Technical Assistance Project (ITPA)
Proposal Development and Evaluation Workshop
N.S.F. February 1994, Washington, D.C.

November ABET Annual Meeting
3-6, 1993 New Orleans, Louisiana

April 20, 1994 The Pan-American Federation of Engineering Societies, UPADI; Seminar on Seismic Effect in the Structures in Puerto Rico", orator


May-August 1994 Workshop Director "NSF Proposal Development, Evaluation and Implementation in the Polytechnic University of Puerto Rico", Summer Seminar


February 1995 Proposal to the National Science Foundation on "Technological Integration of Mathematics and Engineering Science", CO-PI/PD.

14) Special duties of coop faculty: None
1) Name and date of birth: Francisco Arencibia Llanes, December 8, 1942

2) Academic rank: Full-time Assistant professor.

3) Degrees with fields, institution, and dates
   Master in Physics: University of Puerto Rico, 1985, Civil Engineer, Polytechnic University of Puerto Rico, 1982
   Arquitecto en Ejecución de Obras (equivalent to Site Engineer), University of Madrid, 1972

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank: Years in service at the UPPR: 10 (ten) years-Original appointment to the UPPR: First quarter 1982-1983-Advancement in rank: Assistant Professor

5) Other related experience - teaching, industrial, etc.
   - Final thesis academic advisor, UPPR, 1994 (5 students)
   - Curricular Review Committee, UPPR, 1993-1994
   - Students Grievances and Disciplinary Committee, UPPR 1992-1993
   - Lecture-College of Engineering of Puerto Rico, 1993

6) Consulting, patents, etc.
   Not applicable

7) State in which registered: Puerto Rico, Board of Examiners of Engineering, lic. #9120.

8) Principal publications of last five years: None

9) Scientific and professional Societies of which a member
   College of Engineers of Puerto Rico

10) Honors and awards
    Not applicable

11) Subjects or courses taught during the most recent academic year; by terms
    The following table summarizes the requested data

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12) Other assigned duties:

Three credits release to coordinate project of outcome assessment for the following engineering courses: ENGI 322, ENGI 324, ENGI 335
13) Specific programs in which faculty members have participated to improve teaching and professional competence during last five years

Talk: "Seguridad en Presas" - College of Engineers of P.R., May 2-4, 1990

14) Special duties of co-op faculty

N/A.
1) Name and date of birth: José Borrageros Lezama, December 2, 1960

2) Academic rank:
   Part Time Assistant professor of Civil Engineering

3) Degrees with fields, institution, and dates:
   Master in Civil Engineering, Major Area of Study: Environmental Engineering, Magna Cum Laude, 1985, Texas A & M University, College Station, TX
   Bachelor in Science in Civil Engineering, University of Puerto Rico, Magna Cum Laude, 1984

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank:
   Years in service at the UPPR: Eight (8) years and three (3) quarters; Original appointment to the UPPR: February, 1986; Advancement in rank: None

5) Other related experience—teaching, industrial, etc.
   5.1) Teaching experience:
   Professor in charge of a training course conducted at Eli Lilly Industries, December 1994. WWTP: Process Control and Troubleshooting Guide for this pre-treatment Pharmaceutical Plant.
   Professor in charge of a training course conducted by ECO Corp. at EMEXPO '94, September, 1994
   Course: Operation of a WWTP: Process Control and Troubleshooting Guides
   Professor in charge of a training course conducted by Rafael Rios and Associates Caribbean Gulf Refinery Corp., January 1987 and September 1989
   Courses: Operation of the Caribbean Gulf Oil Refinery, Wastewater Treatment Plant

   5.2) Other professional experience:
   Assistant Monitor
   U.S. District Court for Puerto Rico
   Office of the PRASA Monitor
   August 1985 to present
   Research Assistant
   Texas Engineering Experimental Station
   Texas A & M University
   January 1984 to May 1985

6) Consulting, patents, etc.
   Consulting Engineer
   Capoceto, Martín and Associates
   May 1985 to August 1985

7) States in which registered
   Puerto Rico; License 9626

8) Principal publications of last five years:
   "Monitor's Quarterly Report", series of 37 reports
   November to present, identifying problems and evaluating conditions at PRASA's wastewater treatment plants, written and edited with R. Rios and O. Vega
9) Scientific and professional Societies of which a member

-Association of Engineers and Surveyors of Puerto Rico
-Institute of Civil Engineers of Puerto Rico
-Tau Beta Pi Engineering Honor Society
-Water Environmental Federation
  -Head of the Education and Students Committee, Puerto Rico Chapter, 1989-90
-Inter American Association of Sanitary and Environmental Engineering
  (Puerto Rico representative at the AIDS International Division of Education and Training, 1992)

10) Honors and awards

Etienne Totty Award to the Best Civil Engineering Student, Class of 1983-84; University of Puerto Rico
National Dean's List and College of Engineering Honor Diplomas, 1983-1984
Civil Engineering Most Distinguished Professor, 1990
Polytechnic University of Puerto Rico

11) Subjects or courses taught during the most recent academic year; by term

The following table summarized the requested data:

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>Number of Sections</th>
<th>Hours per week per section</th>
<th>Type</th>
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<tr>
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<tr>
<td>1994</td>
<td>ENGI 322</td>
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</tbody>
</table>

12) Other assigned duties:

None

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years


14) Special duties of co-op faculty

N/A
1) Name and date of birth: Osmair Mercedes Collazos Ordóñez; February 27, 1965

2) Academic rank: Full-time Assistant professor.

3) Degrees with fields, institution, and dates
   - B.S. Civil Engineering; University of Cali, Colombia; June 1984 - June 1989 (five-year Program).

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   - Years in service at the UPR: One (1) year; Original appointment to the UPR: March 1994; Advancement in rank: none

5) Other related experience - teaching, industrial, etc.
   5.1) Teaching experience:
   - Polytechnic University of Puerto Rico, Full Time Professor, Civil Engineering Department.
   - University of Puerto Rico at Mayagüez, Teaching Assistant; Civil Engineering Department; Mathematical Methods for Engineers Chair (INCI 4095); First Semester 1993/1994
   - University of Puerto Rico at Mayagüez, Laboratory Instructor; Civil Engineering Department.
     Fluids Mechanics Chair; First Semester 1990/1991.

   5.2) Research experience:
   - University of Puerto Rico at Mayagüez, Research Assistant; Civil Engineering Department.

   - University of Cali, Research Assistant; Civil Engineering Department; Research Topic: "Vial planning of Cali". March 1988.

   5.3) Industrial experience:
   - ECOCTIL, Popayán, Colombia - Project Manager; January 1990 - July 1990
   - FEDERACION NACIONAL DE CAFETEÑOS, Popayán, Colombia; Consultant Engineer; January 1989 - December 1989

6) Consulting, patents, etc.
   - None

7) State in which registered
   - Colombia, South America
   - In process to take the examinations in Puerto Rico.

8) Principal publications of last five years
   - Collazos, O. M. Seismic Analysis of liquid storage tanks. Project submitted in partial fulfillment of the requirements to the degree of Master of Engineering in Civil Engineering, University of Puerto Rico, Mayagüez Campus, Puerto Rico; December 1993.

9) Scientific and professional societies of which a member
   - American Society of Civil Engineers (A.S.C.E.)
10) Honors and awards

10.1) Honors and Accomplishments:

- Recognized by the Department of General Engineering for outstanding job as Laboratory instructor, University of Puerto Rico. (1990)
- Honor student of the Engineering Faculty, University of Cauca. (1987 - 1989)

10.2) Fellowships and Scholarships

Teaching and Research Assistantship, subsidized by Department of Civil Engineering, University of Puerto Rico at Mayaguez, Puerto Rico, August 1990 - December 1993.

11) Subjects or courses taught during the most recent academic year, by terms

The following table summarizes the requested data

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
<th>Type</th>
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<tr>
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<td>Numerical Analysis</td>
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<td>Engineering Mechanics: Statics</td>
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<td>4 hrs 20 min</td>
<td>recitation, day</td>
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<td></td>
<td>Materials of Construction. Laboratory</td>
<td>1</td>
<td>4 hrs</td>
<td>recitation, day</td>
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12) Other assigned duties:

CE Director Assistant in Academic Issues
Coordinator of general engineering course (CE 247): course description, etc.
Thesis reviewed.
Faculty meetings.
Office hours for students
Preparation and grading of tests

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

13.1) Special Projects

1992 - 1993 Computer programs to perform the design of Concrete structures. Analysis of Park. Confined Structures)

1990 Developed a computer program to analyze elastic spatial frames under static loads (nodal loads, concentrated in-span loads, and uniformly distributed in-span loads).

14) Special duties of co-op faculty

N/A.
1) Name and date of birth: Eugenio Dávila Mariani; December 6, 1992

2) Academic rank: Auxiliary Professor, Part-time

3) Degrees with fields, institution, and dates
   Master Science in Civil Engineering-Transportation; State University of New York at Buffalo; 1967
   Bachelor Science in Civil Engineering; University of Puerto Rico; Mayaguez Campus; 1977

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   Years in service at the UPPR: Three (3) years as part-time professor; Original appointment to the UPPR: May 28, 1991
   Advancement in rank: None

5) Other related experience-teaching, industrial, etc.
   None

6) Consulting, patents, etc.
   None

7) States in which registered
   Puerto Rico; License # 5147

8) Principal publications of last five years
   None

9) Scientific and professional Societies of which a member
   College of Engineers and Surveyors of Puerto Rico

10) Honors and awards
    None

11) Subjects or courses taught during the most recent academic year, by terms
    The following table summarized the requested data

    | 94-95 Academic Year |
    |---------------------|
    | Trimester | Course          | Number of Sections | Hours per week per section |
    |-----------|-----------------|--------------------|---------------------------|
    |           | Highway Design I| 1                  | 4                         |
    |           | Transportation  | 1                  | 4                         |

12) Other assigned duties:
    None

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years
    Attendance to programs as faculty member to improve teaching and professional competence

14) Special duties of co-op faculty: N/A
1) Name and date of birth: Dharma Delgado Loperena; January 11, 1953

2) Academic rank
   Full-time Auxiliary Professor of Civil Engineering

3) Degrees with fields, institution, and dates
   Master in Architecture; University of Puerto Rico; 1983
   B.S. in Environmental Design; University of Puerto Rico; 1981

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   Years in service at the UPR: 1981-1985 Part-time professor; 1990-1992 Part-time professor; 1992 to present Full Time Professor; Original appointment to the UPR: 1981; Advancement in rank: None

5) Other related experience-teaching, industrial, etc.
   5.1) Teaching experience:
   InterAmerican University of Puerto Rico: Science Department Remedial Mathematics, Part time professor; 1987
   University of Puerto Rico, Rio Piedras Campus, Extension Program Remedial Mathematics, Part time professor; 1986
   University of Puerto Rico: Architect-Planning and Development Office, 1984-1986

   5.2) Industrial Experience
   Eli Lilly Industries, Inc.: Project Engineering Department; Project Engineer; Administrative facilities planning, Construction coordination
   Olympic Committee of Puerto Rico: Recreational Departments; Design Team of Cosmo Velodrome for the VIII Pan American Games; Responsibility: Preliminary design; 1976
   Puerto Rico Public Housing Department: Low cost housing construction estimates, Documents completion for the Planning Board submittal; 1974-1976

6) Consulting, patents, etc.
   Consultant Services to Banco Popular; Corporate Real State Administration; Furniture and Space Management; 1992- to present
   First Baptist Church of Rio Piedras; 1994

7) States in which registered
   -Architect in Training, Puerto Rico Board

8) Principal publications of last five years
   N/A

9) Scientific and professional Societies of which a member
   N/A

10) Honors and awards
    American Institute of Architects and American Institute of Architects foundation Scholastic Award for Scholarly Pursuit in the field of Architecture; 1974-1976

II - 133
Delgado, Dharma Curriculum Vitae
11) Subjects or courses taught during the most recent academic year, by terms

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
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<td></td>
<td>CE 410</td>
<td>2</td>
<td>2.20</td>
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12) Other assigned duties:

- Office hours for students
- Coordinator for ENGI 131, 142, 146 (1993-1994)
- Member of the Editorial Board of the PUPR
- Member of the Academic Council of the PUPR

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

- Quality Customer Services Workshop, People's System Furniture: Illumination Seminar-Steelcase, 1992
- M.P.M. Mejoras practicas de Manejo, Departamento Ambiental Eli Lilly, 1991
- Eli Lilly Industries, Inc.-house training for project engineering development, 2 hours weekly; Essential Skills for an Effective Presentation-Compendium, Inc.; Effective Communication, People's, 1989-1991
- Planning with System Furniture, Steelcase, Grand Rapids, MI, 1989
- Effective Negotiation, Dr. Chester Karras Seminars, 1989
- How to Handle Multiple Priorities, Fred Pryor Seminars, 1989
- Project Management, Fred Pryor, 1989
- Performance Excellence Lecture, Eli Lilly Training Center, 1989
- Basic Auto Cad, Computer Gallery Learning Center, 1988

14) Special duties of co-op faculty

N/A
1) Name and date of birth: Bernardo Deschapelles Duque, December 24, 1929

2) Academic rank: Full-time Associate Professor of Civil Engineering

3) Degrees with fields, institution, and dates
   Chemical Engineer, University of Havana, 1952
   Civil Engineer, University of Havana, 1954
   Master of Science Engineering, California Western University, 1981
   Doctor of Philosophy Engineering, California Coast University, 1983

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   Years in service at the UPUR: Fifteen (15) years; Original appointment to the UPUR: About 1978; Advancement in rank: Part-time Assistant Professor to Full-time Associate Professor

5) Other related experience-teaching, industrial, etc.
   5.1) Teaching experience:
   University of Puerto Rico, Rio Piedras, PR; Civil Engineering Graduate School; Part-time professor; 1978-1989

   5.2) Industrial Experience
   Lecture in the Continuing Education Program; Puerto Rico Institute of Civil Engineering, in subjects related to Structural Engineering 1983-1994
   Member of the Earthquake Committee; Puerto Rico Institute of Civil Engineers; 1984-1994
   Invited Professor to lecture at the Graduate School of the "Instituto Tecnológico de Santo Domingo", Dominican Republic; 1986-1989

6) Consulting, patents, etc.
   Consulting Engineer for the firm Hernández and Hernández, Hato Rey, PR, 1965-1982
   Consulting Engineer for the firm Hernández and Associates, Hato Rey, PR, 1982-1988
   Consulting Engineer for the firm Molina, García y Asociados, Hato Rey, PR, 1988-1994

7) States in which registered
   Puerto Rico, license PE 04972
   New York, license PE 43377
   Florida, license PE 39283

8) Principal publications of last five years


9) Scientific and professional Societies of which a member

- Association of Professional Engineers of Puerto Rico
- Secretary of the Earthquake Commission of the Puerto Rico
- Institute of Civil Engineers
- American Society of Civil Engineers
- American Concrete Institute
- Earthquake Engineering Research Institute
- Council on Tall Buildings and Urban Habitat. Member of Committee 21C (Elastic Analysis)

10) Honors and awards

-Honorary Member of the Dominican Society of Engineers and Architects (1978). First recipient of such honor.
-Civil Engineer of the Year (1989), award annually bestowed by the Puerto Rico Institute of Civil Engineers.
-Life Member Status in the American Society of Civil Engineers (Beginning Jan. 1994)
-Appointed academician, Academy of Arts and Sciences of Puerto Rico (Sept. 1994).

11) Subjects or courses taught during the most recent academic year, by terms

<table>
<thead>
<tr>
<th>Trimester</th>
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<th>number of sections</th>
<th>Hours per week per section</th>
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<tr>
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</table>

12) Other assigned duties: Thesis Academic Advisor

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

- Conference on Building Restoration, July 19-21, 1989. University of Puerto Rico, Mayaguez Campus; National Science Foundation

- Study group sent to San Francisco by the local Puerto Rico Institute of Civil Engineers to evaluate the structural damage caused by the Loma Prieta earthquake (second week of Nov. 1989)

- Computer Workshop on the Seismic Analysis, Design and Retrofitting of Bridges, March 23-26, 1992; University of California, Berkeley


- Study group sent to Los Angeles by the local Puerto Rico Institute of Civil Engineers to evaluate the structural damage caused by the Northridge earthquake (second week of Feb. 1994).

14) Special duties of co-op faculty
N/A
1) **Name and date of birth:** Héctor L. de Jesús Rodríguez; December 8, 1944

2) **Academic rank:** Part Time, Assistant professor of Civil Engineering

3) **Degrees with fields, institution, and dates**

   - Mechanical Engineering (Professional Degree); Mayaguez Campus-Mayaguez, Puerto Rico; September 1962-September 1969
   - Master of Science Degree (MS)-Environmental Engineering, State University of New York at Buffalo; September 1974-September 1975

   Three continuous years in Doctoral Science certified by State University of New York at Buffalo. Research accepted but thesis not submitted. (Environmental Engineering); September 1978-September 1981

4) **Number of years in service on this faculty, including date of original appointment and dates of advancement in rank**

   - **Years in service at the UPR:** Fifteen (15) years as part-time Assistant; Original appointment to the UPR: First Quarter 1976-1977
   - **Advancement in rank:** None

5) **Other related experience-teaching, industrial, etc.**

   5.1) **Teaching experience:**

   - State University of New York at Buffalo-Teaching Assistant in the Laboratory; Department of Civil Engineering;
     September 1978-September 1981

   5.2) **Research experience:**

   - State University of New York at Buffalo-Part Time Research Assistant; Department of Civil Engineering
     Research Topic: Sediment Transport in the Cattatogueous River, Buffalo, New York; Last Semester 1975

   - State University of New York at Buffalo-Full Time Research Assistant; Department of Civil Engineering; Research Topic: Optimization of the Physical, Chemical Treatment of Combined Municipal Industrial Wastes; Town of Tonawanda Wastewater Treatment Plant(Unpublished thesis); September 1979-September 1981

   5.3) **Industrial Experience:**

   None

6) **Consulting, patents, etc.**

   None

7) **States in which registered**

   Puerto Rico
   Colegio de Ingenieros y Agrimensores de Puerto Rico
   Licence No. 05833-Professional Engineer

8) **Principal publications of last five years**

   None

9) **Scientific and professional Societies of which a member**

   - American Water Works Association
   - Colegio de Ingenieros y Agrimensores de Puerto Rico

10) **Honors and awards**
10.1) Honors and Accomplishments:
Manuel A. Pérez Award-August 1989

10.2) Fellowships and Scholarships
Research Fellowship, subsidized by Puerto Rico Aqueduct and Sewer Authority
September 1978-September 1981

11) Subjects or courses taught during the most recent academic year, by terms
The following table summarized the requested data

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<tr>
<th>94-95 Academic Year</th>
</tr>
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<tr>
<td>Trimester</td>
</tr>
<tr>
<td>First trimester</td>
</tr>
<tr>
<td>August-November 1994</td>
</tr>
</tbody>
</table>

12) Other assigned duties:
None

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

13.1) Special Projects
Process control in wastewater treatment plant with candidate students for bachelor degree
1990-1991

13.2) Graduate Courses Taken: None

13.3) Other Extra-Curricular Courses, Seminars, Congresses, and Conference Attended

AWWA/WPCA Seminar
Water Pollution Control in the 1990
Philosophy and Technology
Caribe Hilton Hotel, February 1985

Belt Filter Press Workshop
Ashbrook-Simon-Hartley, Milano, Italy-1988

Municipal Sewage Treatment Plant
Sludge Management; May 21-June 2, 1989; New Orleans, Louisiana

Effluent Chlorination Seminar
August 22 and 23, 1991
Presented by Charles H. Haas
of Environmental Engineering
Drexel University, Philadelphia, PA

14) Special duties of co-op faculty
N/A
1) Name and date of birth: Eddier Garcia Garcia, May 30, 1943

2) Academic rank

Full Time Assistant professor of Civil Engineering

3) Degrees with fields, institution, and dates

Bachelor in Mathematics
Mayaguez Campus-Mayaguez, Puerto Rico
1966

Bachelor in Civil Engineering
Polytechnic University of Puerto Rico
1978

Master in Business Administration
World University
1981

Master in Construction Management
Polytechnic University of Puerto Rico
In process

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank

Years in service at the UPRR: Fourteen (14) years part time, professor auxiliary

Original appointment to the UPRR: First Quarter 1979

Advancement in rank: None

5) Other related experience-teaching, industrial, etc.

5.1) Teaching experience:

Technologic Institute of PR, Director of Civil Technology
1985 to present

Technical Inf's consultants
1979-1985
Consultant Engineer in accident reconstruction, estimates, structural failures, steel construction inspection, etc.

6) Consulting, patents, etc.

None

7) States in which registered

Puerto Rico

8) Principal publications of last five years

None

9) Scientific and professional Societies of which a member

CIAPR
Capítulo de Ingenieros Civiles
10) Honors and awards

None

11) Subjects or courses taught during the most recent academic year, by terms

The following table summarized the requested data

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<tr>
<th>Trimester</th>
<th>Course</th>
<th>Number of Sections</th>
<th>Hours per week per section</th>
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</table>

12) Other assigned duties:

Preparation of prontuarios
Comité de Curriculos

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

Seminars in CIAPR
Seminar in UPPR

14) Special duties of co-op faculty

N/A
1) Name and date of birth: Juan González Juarbe, October 3, 1946

2) Academic rank: Part-time Assistant professor.

3) Degrees with fields, institution, and dates

   Associate of Arts Degree-Engineering; Engineering Canal Zone College; 1967

   Bachelor of Science in Civil Engineering; University of Texas; 1969

   Master of Civil Engineering; Lamar University, Texas; 1971

   Master of Business Administration; University of Puerto Rico; 1990

   Electrician Course; Isabela Electrician School; 1983

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank

   Years in service at the UPR: One (1) year; Original appointment to the UPR: Second quarter 93-94 academic year. Advancement in rank: none

5) Other related experience – teaching, industrial, etc.


   Civil Engineer Supervisor; Puerto Rico Industrial Development Co.; 1973-1975

   Civil Engineer; US Coast Guard; New Orleans, La.; 1976-1978

   Civil Engineer; US Army Corps of Engineers; San Juan, PR; 1978-1987

   General Engineer; General Services Administration; San Juan, PR; 1987 to present

6) Consulting, patents, etc.

   Consulting Engineering Work; Tippets-Abbott-McCarthy-Stratton; San Juan, PR; 1971-1973

   Structural Engineer; Passaliqua Company; 1976

7) State in which registered

   Louisiana - 15845 Professional Engineer
   Puerto Rico - 6302 Professional Engineer

8) Principal publications of last five years

   -Denso Tape - US Coast Guard
   -Marine Boreas - US Coast Guard
   -Maintenance and Operation Evaluation PRASA STPS
   -US Army Corps Engineers
   -Project Management: Monitoring and Control; University of Puerto Rico

9) Scientific and professional societies of which a member

   -College of Engineers and Surveyors of Puerto Rico
   -Federal Executive Association
   -OSHA - Federal Occupational Safety
   -Institute of Transportation Engineers
10) Honors and awards

- General Services Administration Superior Performance Award; 1989-1993
- MBA 2nd highest grade point average; 1990
- Scout Master Service Award; 1989
- 1,500 hours accumulated sick Leave Award
- 15 years Federal Service Pin Award

11) Subjects or courses taught during the most recent academic year, by terms

The following table summarizes the requested data

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<tr>
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<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
<th>Type</th>
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<td>August-November 94</td>
<td>Highway Design II</td>
<td>1</td>
<td>4 hrs 20 min</td>
<td>lecture</td>
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12) Other assigned duties:

Four hours visiting

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

Taken course in Curriculum Design University of Puerto Rico Graduate School of Education
1/94-5/94

14) Special duties of co-op faculty

N/A.
1) Name and date of birth: Eusebio Iglesias

2) Academic rank: Auxiliary Professor, Part-time

3) Degrees with fields, institution, and dates
   B.S. Civil Engineering (Magna Cum Laude), College of Agricultural and Mechanic Arts, University of Puerto Rico; 1963
   M.S. Civil Engineering, Structural Field; Rensselaer Polytechnic Institute, New York; 1966
   Ph.D. Civil Engineering, Structural Field; Rensselaer Polytechnic Institute, New York; 1968

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   Years in service at the UPPR: Original appointment to the UPPR: Advancement in rank: None

5) Other related experience-teaching, industrial, etc.
   5.1) Teaching Experience
       Professor of Engineering, University of Puerto Rico, Mayaguez Campus; 1964-1965, 1968-1969

   5.2) Industrial Experiences

6) Consulting, patents, etc.
   Consulting Engineering for the New York Department of Public Works; Albany, New York; In charge of computer application to structural and engineering problems, 1966-1968
   Assistant Secretary of Construction Area, Department of Public Works, Puerto Rico; 1969-1971
   Consulting Engineer for the Department of Public Work, Puerto Rico.
   In charge of Engineering Research. Partner of the firm IGLESIAS VAZQUEZ DEL NIDO
   Consulting Engineers
   1971-1972
   Partner of the firm IGLESIAS VAZQUEZ DEL NIDO BONNET
   Architects Engineers Planners
   1972-1974
   Partner of the firm IGLESIAS VAZQUEZ AND ASSOCIATES
   Engineers, Architects, Planners.
   Professor of Engineering
   Polytechnic University of Puerto Rico
   1974 to present

7) States in which registered
   Registered Professional Engineer, Commonwealth of Puerto Rico

8) Principal publications of last five years

9) Scientific and professional Societies of which a member
Colegio de Ingenieros y Agrimensores de Puerto Rico

Tau Beta Pi Honor Association

The Society of the Sigma Xi (Devoted to the promotion of Research in Science)

American Public Works Association

American Society of Civil Engineers

Water Pollution Control Federation

10) Honors and awards

11) Subjects or courses taught during the most recent academic year, by terms

The following table summarized the requested data

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>Number of Sections</th>
<th>Hours per week per section</th>
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<td>CE 415</td>
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</table>

12) Other assigned duties:

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

14) Special duties of co-op faculty
1) Name and date of birth: José Alfredo Martínez Gómez; July 1, 1960

2) Academic rank: Full-time Assistant professor of Civil Engineering

3) Degrees with fields, institution, and dates

   Master of Science, Geotechnical Engineering; University of California, Berkeley; December, 1987
   B.S. Civil Engineering; Albert Einstein University, El Salvador; September, 1984

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank

   Years in service at the UPRR: Two (2) years; Original appointment to the UPRR: August 30, 1993; Advancement in rank: None

5) Other related experience—teaching, industrial, etc.

   5.1) Teaching experience:

         Albert Einstein University, El Salvador; -Part-time assistant professor of Civil Engineering and Architecture; August, 1988-April, 1990;
                -Part-time teacher's assistant; August 1982-June, 1986

   5.2) Industrial Experience

         Delasun Construction Corp., Hato Rey, Puerto Rico: Construction Project Manager; April, 1990-August, 1993

6) Consulting, patents, etc.

         Tahal Consulting Engineers of Israel, El Salvador Branch:

         -Geotechnical engineer, construction phase of the greater San Salvador area master sewer/water disposal plan.; July, 1989-April, 1990
         -Auxiliary engineer, analysis of structures and earthworks for the design phase of the greater San Salvador area master sewer/water disposal plan; November 1983-February 1986

         Agency for the International Development, US-AID:

         -Supervisory engineer for the construction of schools in El Salvador rural areas; August 1988-July 1989

7) States in which registered

         -El Salvador, Central America
         -Puerto Rico: in the process of full accreditation of foreign university credits.

8) Principal publications of last five years

   "Design of Retaining Structures in High Seismic Risk Areas", graduation work to obtain the Master of Science degree; Berkeley, California, January, 1988.


9) Scientific and professional societies of which a member

         -American Society of Civil Engineers, ASCE
         -Panamerican Union of Engineering Societies, UPADI
         -Berkeley Geotechnical Society
         -Salvadoran Society of Civil Engineers, ASIA
         -Salvadoran Society of Seismic Engineering
         -Puerto Rico Civil Engineers Institute
10) Honors and awards
   - Fulbright Scholarship for Graduate Studies, Berkeley, California 1986-1988
   - Salvadoran Society of Civil Engineering Award for C.E. graduate with highest G.P.A., 1984
   - Albert Einstein University, Highest Honors for the Civil Engineering class of 1984

11) Subjects or courses taught during the most recent academic year, by terms

<table>
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<th>94 - 95 academic year</th>
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<tr>
<td>Trimester</td>
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<td>CE 439</td>
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<td>CE 440</td>
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<td>ENGI 247</td>
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</table>

12) Other assigned duties:

   Office hours for students: 5
   Faculty meetings, lecture preparation: 11
   Preparation and grading of tests: 2

13) Specific programs in which faculty members have participated to improve teaching and professional competence during last five years
   - One-on-One assistance to CE students to program and operate portable microcomputers, 1993-1995.
   - Preparation of geotechnical engineering laboratory course instructions on video, 1994.
   - Participation in the laboratory improvement program, selection of equipment for advanced geotechnical engineering applications, 1994.
   - Attending technical conferences offered by the local engineering society, 1994.
   - Preparation of course curriculum development proposal to the National Science Foundation, Jan. 1995.

14) Special duties of co-op faculty

   N/A
1) Name and Date of Birth: Autistela Mueses Pérez; October 10, 1967

2) Academic Rank: Assistant professor. (Full-time).

3) Degrees with fields, institutions and dates

Master of Science in Civil Engineering; Major: Environmental and Water Resources, University of Puerto Rico at Mayagüez; August 1989 - July 1992 (Two-year Program); GPA: 3.77/4.00

Bachelor in Civil Engineer (Professional Degree); Major: Civil Engineer, Instituto Tecnológico de Santo Domingo, School of Engineering Sciences, Dom. Rep.; July 1984 - October 1987 (Three-year and a quarter Program); GPA: 3.43/4.0

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank; Years in service at the UPPR: Two (2) years; Original appointment to the UPPR: Second quarter 92-93 academic year; Advancement in rank: None

5. Other related experience - teaching, industrial, etc.

5.1) Teaching experience:


5.2) Industrial Working Experience:


5.3) Research Experience:

University of Puerto Rico at Mayagüez, Research Assistant; Civil Engineering Department; Research Topic: Continuous Flash Flood Simulation in a Tropical Basin; Second Semester 1989/90 - Second Semester 1991/92.

University of Puerto Rico at Mayagüez, Research; Electrical Engineering Department; Research Topic: Description and Classification of Drainage Patterns Using and Expert System; Second Semester 1990/91.

6) Consulting and Patents


7) State(s) in which Registered

Civil Engineering License in Dominican Republic; Engineering in Training - PR

8) Principal publications of last five years

None

9) Scientific and Professional Societies of which a member

American Society of Civil Engineering (A.S.C.E.) - Student Chapter
10) Honors and Awards

10.1) Honors and Accomplishments:


"Diploma Patricia M. Paredes" (Honor Diploma), awarded by San Judas Tadeo High School, for first best GPA among the graduation candidates, Dom. Rep., 1984.


11) Courses and courses taught during the most recent academic year; by terms

The following table summarizes the requested data:

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>Number of sections</th>
<th>Hours per week per section</th>
<th>Type</th>
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<td>Engineering Mechanics-Statcs</td>
<td>2</td>
<td>4 hrs 20 min</td>
<td>lecture, day</td>
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12) Other assigned duties

- Development of Environmental and Water Resources Laboratory
- Thesis
- Courses Program Preparation
- Student Curriculum Changes
- Participation in the Development of ABET Self-study Questionnaire, Vol. I and II

13) Specific Programs in which faculty member has participated to improve teaching and professional competence during last five years

14) Special Duties of Co-op Faculty

N/A
1) **Name and date of birth:** Gustavo E. Pacheco Crosetti; October 1, 1963;

2) **Academic rank:** Full-time Assistant Professor;

3) **Degrees with fields, institution, and dates**

   Master of Science in Civil Engineering; Major: Structures. Minor: Soil Mechanics; University of Puerto Rico at Mayaguez; August 1990 - July 1993 (two-year Program) GPA: 4.00/4.00

   Graduate Courses and Seminars; Major: Structures. Minor: Mathematics; School of Physics and Exact Sciences, National University of Córdoba, Argentina; March 1988 - July 1990.

   Civil Engineer (Professional Degree); Major: Structures. Minor: Soil Mechanics, Transportation; School of Physics and Exact Sciences, National University of Córdoba, Argentina; March 1982 - March 1988 (Six-year Program), GPA: 8.65/10.00

4) **Number of years in service on this faculty, including date of original appointment and dates of advancement in rank**

   Years in service at the UPR: One (1) year; Original appointment to the UPR: First quarter 93-94 academic year; Advancement in rank: none

5) **Other related experience - teaching, industrial, etc.**

5.1) **Teaching experience:**

   **Polytechnic University of Puerto Rico, Full Time Professor; Civil Engineering Department; Mechanics of Materials I, II, and Laboratory, Theory of Structures II, Computer Matrix Analysis of Framed Structures, and Highway Engineering I Chairs (INGE324, INGE335, INGE340, CSE24, CSE500, and CSE321); First Quarter 1993/1994 - Present.**

   **University of Puerto Rico at Mayaguez, Teaching Assistant; Civil Engineering Department; Mathematical Methods for Engineers Chair (INCI 4055), Second Semester 1991/1992.**

   **University of Puerto Rico at Mayaguez, Laboratory Instructor.; Civil Engineering Department, Soil Mechanics Chair. (INCI 4095); First Semester 1990/1991.**

   **National University of Córdoba, Argentina, Instructor; School of Physics and Exact Sciences, Theoretical Mechanics Chair. Second Semester 1989.**

   **National University of Córdoba, Argentina, Instructor; School of Physics and Exact Sciences, Principles of Programming Chair, Second Semester 1989 - First Semester 1990.**

   **National University of Córdoba, Argentina, Instructor; School of Physics and Exact Sciences, Basic Language Programming Course. Fall 1988.**

   **National University of Córdoba, Argentina, Teaching Assistant; School of Physics and Exact Sciences, Transportation I Chair. Second Semester 1986, First and Second Semester 1987, First Semester 1988.**

   **National University of Córdoba, Argentina, Teaching Assistant; School of Physics and Exact Sciences. Stability of Constructions II Chair; Second Semester 1986.**

5.2) **Research experience:**

   **University of Puerto Rico at Mayaguez, Research Assistant; Civil Engineering Department; Research Topic: "Synthesis of the Nonlinear Behavior of Mallitory Steel Buildings" (Linear and Non-linear Static Analysis of Spatial Steel Frames. Computer and Computer Graphics Applications); Second Semester 1990/91 - Second Semester 1992/93.**

   **National University of Córdoba, Argentina, Full-time Research Assistant.; School of Physics and Exact Sciences. Research Topic: "Analysis and Design of Thin-walled Structures" (Non-linear Analysis and Design of Reinforced Concrete Thin-walled Beam-shells Considering Material Non-linear Behavior and Concrete Cracking); First Semester 1988 - First Semester 1990.**

   **National University of Córdoba, Argentina, Research Assistant.; School of Physics and Exact Sciences, Research Topic: Matrix Analysis of Plane Frame Structures; Second Semester 1986.**
National University of Córdoba, Argentina. Research Assistant; School of Physics and Exact Sciences, Research Topic: Geometric Design of Two-Lane Roadways, Capacity of Two-Lane Roadways, and Simulation of the Motion of an Isolated Vehicle; Second Semester 1986 - First Semester 1988.

5.3) Industrial experience: None.

6) Consulting, patents, etc.: Computers and Systems Engineering Consulting; Associate Consultant, 1994 - present.

7) State in which registered: In process to take the examinations in Puerto Rico.

8) Principal publications of last five years:
    Almirantar, L.; Pacheco, G., Ciceres, A. UFR-Build User Manual, Civil Infrastructure Research Center (CIRC), University of Puerto Rico, Mayagüez Campus, Puerto Rico; August 1994.
    Pacheco, G. E. Synthesis of the Nonlinear Behavior of Multiistory Steel Buildings, Thesis submitted in partial fulfillment of the requirements to the degree of Master in Science in Civil Engineering, University of Puerto Rico, Mayagüez Campus, Puerto Rico; July 1993.

9) Scientific and professional societies of which a member
    -American Society of Civil Engineers (A.S.C.E.)
    -TAU BETA PI, National Engineering Honor Society
    -Phi Kappa Phi, Honor Society

10) Honors and awards
    10.1) Honors and Accomplishments:
    -Member of TAU BETA PI, National Engineering Honor Society, 1992.
    -Member of Phi Kappa Phi, Honor Society, 1992.
    -Third best GPA among the Civil Engineering graduation candidates, School of Physics and Exact Sciences, National University of Córdoba, Argentina, 1988.
    -"Premio Anual Hormix" (Honor Diploma), awarded by Hormix SA, Concrete Manufacturer Company, to stimulate the study of Concrete Technology, 1988.
    -"Suplente de Segunda Escala" (University Award), for obtaining the third best GPA among the two last year students in the career of Civil Engineering, and the fifth best GPA among the two last year students in all Engineering Fields, School of Physics and Exact Sciences, National University of Córdoba, Argentina, 1987.
    -"Diploma al Mérito" (Honor Diploma), awarded by the Center of Professional Engineers of Córdoba, Argentina, for devotion to studies, 1987.
    -First best GPA in the admission exam to the Institute of Mathematics, Astronomy and Physics, National University of Córdoba, Argentina, 1982.
    -Third best GPA in the admission exam to the School of Physics and Exact Sciences, National University of Córdoba, Argentina, 1982.
    -"Medalla al Mérito" (High School Award), for obtaining the second best GPA among the graduation candidates in high school studies, 1981.
10.2) Fellowships and Scholarships

- Teaching and Research Assistantship, subsidized by Department of Civil Engineering, University of Puerto Rico at Mayaguez, Puerto Rico, August 1990 - July 1993.
- Teaching and Research Assistantship, subsidized by Structural Department, School of Physics and Exact Sciences, National University of Córdoba, Córdoba, Argentina, July 1986 - November 1986.

11) Subjects or courses taught during the most recent academic year, by terms

The following table summarizes the requested data:

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
<th>Type</th>
</tr>
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<tbody>
<tr>
<td>First trimester</td>
<td>Mechanics of Materials II</td>
<td>2</td>
<td>4 hrs 20 min</td>
<td>recitation, day</td>
</tr>
<tr>
<td>August-November 94</td>
<td>Applied Software for Civil Engineering</td>
<td>1</td>
<td>4 hrs 20 min</td>
<td>recitation, day</td>
</tr>
<tr>
<td></td>
<td>Theory of Structures II</td>
<td>1</td>
<td>4 hrs 20 min</td>
<td>recitation, day</td>
</tr>
</tbody>
</table>

12) Other assigned duties:

NSF proposal development workshop participant; ABET volume II coordinator; Coordinator of general engineering structural courses (ENCI 322, ENCI 324, ENCI 333); Mechanics of materials laboratory coordinator (equipment acquisition proposal, etc.); CE students thesis reviewer; Faculty meetings, Mentoring program for 4th and 5th years students.

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

13.1) Special Projects

1992-1993 Developed UPR-BUILD Building Analysis System, Advanced Analysis of Multistory Steel Buildings Part. Interactive graphical-menu oriented computer program that integrates the definition (preprocessing stage), the structural analysis (processing stage), and the results interpretation (postprocessing stage) for multistory buildings.

13.2) Graduate Courses Taken at the University of Puerto Rico

ENCI 6695 SPECIAL PROBLEMS: FLUID STRUCTURE ITERATION
(With special applications to analyze the behavior of dams subjected to earthquake motions)
Civil Engineering Department, Mayaguez Campus.
Prof. Carlos A. Prato, Ph.D. Massachusetts Institute of Technology (1968).
Three credit hours - Three hours of lecture per week.

13.3) Graduate Courses Taken at the University of Cordoba, Argentina

INTRODUCTION TO NONLINEAR VIBRATIONS
School of Physics and Exact Sciences, Department of Structures.
Prof. Dean T. Mook, Ph. D. University of Michigan (1966).
June 1989.

13.4) Other Extra-Curricular Courses, Seminars, Congresses, and Conferences Attended

FINITE ELEMENT THEORY AND PRACTICE (Non-presential Course)
University of Madrid, Spain.
October 1994 - July 1995

14) Special duties of co-op faculty: N/A.
1) Name and date of birth: Juan C. Puig Hernández; October 29, 1960

2) Academic rank: Full-time, Assistant Professor.

3) Degrees with fields, institution, and dates

   - B.S. Environmental Engineering, University of Florida, Gainesville, FL; April 1983
   - M.S. Civil Engineering, University of Puerto Rico, Mayaguez, PR; May 1989
   - J.D.; University of Puerto Rico, Rio Piedras, PR; May 1992

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank

   Years in service at the UPR: One (1) year, Original appointment to the UPR: June 1993; Advancement in rank: none

5) Other related experience - teaching, industrial, etc.

   5.1) Teaching experience:

   Polytechnic University of Puerto Rico, Full Time Professor, Civil Engineering Department, Full-time hydrologist with the U.S. Geological Survey. Responsibility included project chief of water resources studies, application of ground-water flow models, water quality sampling, writing of technical reports and project proposals, and participate at technical and scientific conference and seminars. 1985 to 1993

   University of Puerto Rico at Mayaguez, Instructor and research assistant; 1983 to 1985

6) Consulting, patents, etc.

   Emmissary to Costa Rica to assist U.S. Corps of Engineers in a water supply project; Summer 1989

7) State in which registered

   Puerto Rico, RPT-11001, P.R. Engineers and Surveyors Professional Association.
   Puerto Rico, Lic. 11589, P.R. Bar Association

8) Principal publications of last five years


9) Scientific and professional Societies of which a member

   - Asociación Interamericana de Ingeniería Sanitaria y Ambiental
   - Puerto Rico Bar Association
   - Puerto Rico Engineers and Surveyors Professional Association.
10) **Honors and awards**


11) **Subjects or courses taught during the most recent academic year; by terms**

<table>
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<th>Trimester</th>
<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
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<td>CE 318</td>
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<td>CE 416</td>
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<td>PHIL 441</td>
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12) **Other assigned duties:**

- Review students thesis and evaluate presentations (1 hrs/wk)
- Prepare and update courses outlines (2hrs/wk)
- Assist at faculty meetings (2hrs/wk)
- Coordinate preparation of documents for the ABET accreditation process (2hrs/wk)
- Office hours for students (4hrs/wk)
- Lecture preparation (10 hrs/wk)
- Grading and evaluation (4hrs/wk)
- Assist in the development of the environmental engineering laboratory (2 hrs/wk)
- Participate in the mentoring program for 4th and 5th years students

13) **Specific programs in which faculty members have participated to improve teaching and professional competence during last five years**

- **December 1992** Training offered by The National Ground Water Association, "Practical Optimization Modeling for Ground Water".
- **February 1989** Training offered by the U.S. Geological Survey (USGS) "Analytical Methods to Determine Aquifer Properties and to Predict Aquifer Response".
- **March 1987** Training offered by USGS, "Modeling of Ground-Water Flow Using Finite-Difference Methods".

14) **Special duties of co-op faculty**

N/A
1) Name and date of birth: Félix Sánchez López, June 27, 1924

2) Academic rank: Associate Professor

3) Degrees with fields, institution, and dates
   Master of Science in Civil Engineering; Major: Construction Management, Feb. 1958-Feb. 1959 (one-year program);
   Minor: City Planning; B.S. Civil Engineering; University of Puerto Rico at Mayaguez; 1941-1945 (Four-year program)

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   Years in service at the UPR: Twelve (12) years, Original appointment to the UPR: October, 1983; Advanced in rank: 1990, Director
   Civil Engineering Department, Associate Professor.

5) Other related experience - teaching, industrial, etc.
   5.1) Teaching experience:
   Polytechnic University of Puerto Rico, Part-time professor, Oct. 1983 to Jan. 1990; Full-time Professor, Jan 1990 to present;
   Construction Management (CE 410), Construction Materials (CE 330), Construction Materials Laboratory (CE 331), Inspection of
   Projects CE 38; Construction Estimates (CE 455).
   5.2) Research experience:
   None
   5.3) Industrial Experience

6) Consulting, patents, etc.
   None

7) State in which registered
   Puerto Rico

8) Principal publications of last five years
   None

9) Scientific and professional Societies of which a member
   Puerto Rico College of Surveyors of Engineers

10) Honors and awards
    10.1) Honors and Accomplishments:
    Recognized by the Class of 1991 of the Polytechnic University of Puerto Rico for dedicated of outstanding performance as professor
    10.2) Fellowships and Scholarships
    None
11) Subjects or courses taught during the most recent academic year; by terms

The following table summarizes the requested data:

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<th>Trimester</th>
<th>Course</th>
<th>Number of Sections</th>
<th>Hours per week per section</th>
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<td>Second Trimester</td>
<td>Materials of Construction</td>
<td>2</td>
<td>4 hours 20 min</td>
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<td>Nov. 94-March 1995</td>
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<tr>
<td></td>
<td>Materials of Construction Lab</td>
<td>1</td>
<td>4 hours 20 min</td>
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</table>

12) Other assigned duties:

- Mentor of 3rd and 4th years students
- Thesis reviewer
- Faculty meetings
- Office hours for students
- Preparation and grading of test

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

13.1) Special Projects

1992-1993 Revision of Civil Engineering Curriculum

14) Special duties of co-op faculty

N/A
1) Name and date of birth: Rodolfo A. Tardy; September 8, 1957

2) Academic rank: Professor Auxiliary, Full-Time.

3) Degrees with fields, institution, and dates
   Master of Science in Engineering; University of Puerto Rico; Mayagüez, Campus; 1988

4) Number of years in service on this faculty, including date of original appointment and dates of advancement in rank
   Years in service at the UPRR: Six (6) years; Original appointment to the UPRR: November 1989; Advancement in rank: September, 1994

5) Other related experience - teaching, industrial, etc.
   Federal Aviation Administration; Field Engineering, Chicago, IL; 1985-1986
   U.S. Department of HUD; Construction Analyst, Puerto Rico; 1986-1995

6) Consulting, patents, etc.
   None

7) State in which registered
   Puerto Rico, License # 11584

8) Principal publications of last five years
   "Efecto de la dovela del refuerzo principal durante la transferencia del esfuerzo cortante através de las grietas". Master thesis

9) Scientific and professional Societies of which a member
   Colegio de Ingenieros de Puerto Rico

10) Honors and awards
    None

11) Subjects or courses taught during the most recent academic year; by terms
    The following table summarizes the requested data

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
<th>Type</th>
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<tbody>
<tr>
<td>First trimester</td>
<td>Structural Analysis</td>
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<td>4 hrs 20 min</td>
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<tr>
<td>August-November 94</td>
<td>Structural Steel Design</td>
<td>1</td>
<td>4 hrs 20 min</td>
<td>lecture</td>
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<tr>
<td></td>
<td>Mechanics of Materials</td>
<td>1</td>
<td>4 hrs 20 min</td>
<td>lecture</td>
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</table>

12) Other assigned duties:
    None

13) Specific programs in which faculty members has participated to improve teaching and professional competence during last five years

14) Special duties of co-op faculty: N/A.
1) **Name and date of birth:** Wilma L. Torres Gavino; July 10, 1966

2) **Academic rank:**
   Full-time Assistant professor of Civil Engineering

3) **Degrees with fields, institution, and dates:**
   - Master in Architecture; Escuela de Arquitectura; Universidad de Puerto Rico; Recinto de Rio Piedras; 1993
   - Bachelor Degree in Environmental Design; Escuela de Arquitectura; Universidad de Puerto Rico; Recinto de Rio Piedras; 1990

4) **Number of years in service on this faculty, including date of original appointment and dates of advancement in rank:**
   - Years in service at the UPRR: One (1) year; Original appointment to the UPRR: June 1993; Advancement in rank: None

5) **Other related experience-teaching, industrial, etc.:**
   - 5.1) **Teaching experience:**
     - Escuela de Arquitectura, Universidad de Puerto Rico; Professor and Coordinator; Architectural Seminar Summer 1994

6) **Consulting, patents, etc.:**
   - School of Architecture Program, Polytechnic University of Puerto Rico; November, 1993 to present

7) **State in which registered:**
   - In progress

8) **Principal publication of last five years:**
   - Thesis: "Necrópolis, la Ciudad Dormida"
   - "Arquitectura y Arquitectos en Ciudad de México"
   - "La Manida Final (cuento), Antologia de Español", Universidad Politécnica 1993

9) **Scientific and professional Societies of which a member:**
   - Colegio de Arquitectos de Puerto Rico 1994

10) **Honors and awards:**
    - 1st place, 4to Certamen Literario (1993), Polytechnic University of Puerto Rico
    - Ambassador of School of Architecture and Colegio de Arquitectos of P.R., in México 1991

11) **Subjects or courses taught during the most recent academic year, by terms:**

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Course</th>
<th>number of sections</th>
<th>Hours per week per section</th>
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12) **Other assigned duties:**

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<tbody>
<tr>
<td>Office hours for students</td>
<td>5</td>
</tr>
<tr>
<td>Faculty meetings, lecture preparation</td>
<td>7</td>
</tr>
<tr>
<td>Preparation and grading of test</td>
<td>2</td>
</tr>
<tr>
<td>Consulting for the School of Architecture</td>
<td>5</td>
</tr>
<tr>
<td>Preparation of projects</td>
<td>5</td>
</tr>
</tbody>
</table>

13) **Specific programs in which faculty members has participated to improve teaching and professional competence during last five years**

- Updating and upgrading of course contents.
- Coordinator of School of Architecture Program.

14) **Special duties of co-op faculty**

N/A