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

MECHANICAL ENGINEERING PROGRAM

Submitted by

POLYTECHNIC UNIVERSITY OF PUERTO RICO

June 22, 1995

to the
Engineering Accreditation Commission

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American Congress on Surveying and Mapping
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SELF-STUDY QUESTIONNAIRE
FOR REVIEW OF ENGINEERING PROGRAMS
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VOLUME II
MECHANICAL ENGINEERING PROGRAM

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XI. OBJECTIVES AND SELF-ANALYSIS

A. Preparation for evaluation

The Polytechnic University of Puerto Rico (PUPR) started in 1985 the preparation for the evaluation of the Accreditation Board of Engineering and Technology (ABET). On that time, Dr. Arthur F. Gould, professor of Industrial Engineering, evaluated the Institution and reported his findings based on the Industrial Engineering Program. Since the PUPR was planning to offer other engineering programs, the arrangements for accreditation were delayed. The Mechanical Engineering (M.E.) program was established in 1988, and in 1990 the PUPR resumed the preparation with the visit of Dr. Robert D. Kersten, Dean of Engineering at University of Central Florida, who evaluated all the engineering programs, including the M.E. program. Later, Dr. Joe Fowler, president of a private engineering firm, reevaluated the ME program in 1994. The recommendations of both consultants were submitted to the President of the University, the Dean of the Engineering Faculty and the Chair of ME Department. Most of their recommendations have been carried out.

A committee chaired by Professor Gilberto A. Vélez, Dean of Engineering Faculty, met regularly to coordinate the preparation of Volume I. Professor Vélez was responsible for Volume I, and Professor Manuel Bardález, the Mechanical Engineering Department Head, was responsible for completing Volume II of the Mechanical Engineering Program. During the preparation of this Volume, Professor Carlos I. Nieves coordinated the assigned M.E. faculty subcommittees to prepare the drafts for the various sections of Volume II, until August 1994. Then, Professor Jorge L. Martínez continued with this work. Professor Gilmer R. Burgos, M.E. Department Laboratory Coordinator, provided with the material regarding laboratory experiences and facilities and helped with the redaction of this document. Copies of the draft were distributed to the Dean and the Mechanical Engineering faculty for their review and comments. Their comments were incorporated in this final volume.

B. Program objectives

The Mechanical Engineering program aims to give students breadth and depth knowledge in mechanical engineering, mathematics, and social sciences. The students are prepared for entry level positions in industry and graduate studies in engineering and in other professional fields. Besides these objectives, the program emphasizes in the fulfilment of the following competences:
1. Communication skills through the writing of assignments in both requisite and elective courses, and report preparation and presentation in laboratory courses and design projects.

2. Computer usage by compelling the use of computer software in every course of the M.E. curriculum.

3. Design concept and methodology by incorporating open-ended design projects in several courses in the third, fourth, and fifth years.

4. Awareness of potentials and limitations of engineering and technology to solve the emerging problems of the society through Capstone Design courses. These courses have two focusses, one oriented to the construction of a prototype and the other to the interaction with the industry.

C. Assessment of program objectives

Currently, there is no institutional instrument to measure the assessment of the objectives of the program. The performance of our 140 graduates is well measured for their participation in the job market and scores obtained in the Fundamentals of Engineering Examination of the National Council of Examiners for Engineering and Surveying (NCEES). Formal statistical data is not available concerning the percentage of graduates who passes the Fundamentals examination or the exact amount of them who are currently working. However, many M.E. graduates come to the department requesting letters of recommendation to apply jobs or graduate studies, and Engineering-in-Training (EIT) Certifications. According to our best knowledge, all of them have passed the Fundamentals of Engineering Examination, and they are currently working.

D. Action to correct previous weaknesses

Since this is the first time that this program is submitted for accreditation, no deficiencies have been noted before by the Engineering Accreditation Commission (EAC) of ABET. However, several suggestions have been implemented to enhance the M.E. program. The following list summarizes the actions taken in response to the evaluation and recommendations submitted by external consultants:

1. More M.E. courses have been incorporated to the curriculum.
2. Experiences in engineering design have been reinforced throughout the five years of study.
3. Courses in Humanities and Social Sciences were also revised and distributed along the five years of study.
4. Professional Ethics in Engineering, and Probability and Statistics have been included as required courses.
5. Computer use is required in all M.E. courses.
6. New laboratory facilities have been built, and old laboratories have been updated.
7. Personnel computers and private offices are available for most of the full time faculty.
E. Major developments since previous visits

Since this is the first time this program is submitted for accreditation, this section is meaningless.

F. Plans for future development

ME department is developing an effective plan for the effective use of the available and future resources to offer a qualified undergraduate studies in mechanical engineering. The plan includes the following:

1. Faculty. First, one main commitment of the mechanical engineering department is to increase the number of full-time faculties with master or doctorate degrees in mechanical engineering, according to the number of students enrolled from the second year to the fifth year of studies. Secondly, the faculty teaching load is very high, as can be noticed in TABLE XVII. Despite this fact is an institutional concern, the M.E. Department is complaining to the administration of the university to analyze the possibility of reducing this excessive teaching load. Its reduction will allow the faculty to get properly involved into other important academic activities such as student counseling, research, laboratory development, seminars and workshops, interaction with industry, etc. In third place, starting the tenure track is essential to promote faculty retention. Also, a more competitive salary scale with significant difference in salary range among faculty ranks should be accomplished. Besides, a fringe benefit policy for the administrative staff of the university should be achieved.

2. Laboratories. Although the laboratory facilities, equipment and instrumentation, may be now considered as adequate for supporting the M.E. program requirements, recruiting skilled technicians to develop laboratory support activities are necessary for the in-house maintenance of machines and instruments, preparation of the consumable materials, and technical support to the laboratory instructors. In addition, it is essential to increase the number of equipment and instrumentation of M.E. laboratories keeping them up to date, and, to increase the workstations for the mechatronics and CAD/CAM laboratories.

3. Computational facilities. Since state-of-the-art in computational facilities changes very rapidly, the Computer Users Group, integrated by representant of all Departments, examines the computational needs of the department regularly and recommends appropriate upgrading of the computational facilities. The department intends to introduce, within available resources, the latest software and hardware for our undergraduate program. A branch of the Centralized Computational Laboratory of the university established in the M.E. facilities is strongly recommended.

4. Research. Another aim of the mechanical engineering department is to get the faculty and students involved into scientific and technological investigation with the necessary support of the university administration, private industry, and state or federal agencies. Since April 01,
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1995, four-full-time faculty members: Profs. : Manuel Bardalez, Gilmer R. Burgos, Jorge L. Martinez, and Eduardo J. Veras are working on a research project titled "Solar Passive Cooling of Buildings for Puerto Rico," supported by a $75,000.00 grant sponsored by the Energy Affairs Administration Office, a division of the Puerto Rico Department of Natural and Environmental Resources.

G. Program strengths

The primary strengths of the mechanical engineering program are:

1. A five-year curriculum. Since its beginning in 1988, the M.E. program has offered a five-year curriculum to provide a broad background in most of the mechanical engineering subjects. In this regard, our graduates are more competitive in the job market than those graduated from a four-year program. To maintain this advantage, the curriculum is periodically reviewed (i.e., 1992, 1994). Currently, the curriculum offers a good balance among socio-humanistic courses, basic and engineering sciences, mathematics, specialized courses, and design.

2. Faculty. The department faculty members are competent, enthusiastic, and committed to the excellence in undergraduate education. The faculty members properly represent the major areas of the mechanical engineering field (i.e., Thermal Sciences, Manufacturing and Machine Design). Also, the professional experience and the origin of the faculty members are assorted. For that reason, they expose the students to a variety of point of views, job related experiences, customs and criteria; that helps them to form their own engineering judgment.

3. Interaction with industry. The mechanical engineering students have considerable opportunity to interact with industry in the San Juan metropolitan area. Approximately 60% of the M.E. students of the fourth and fifth years are employed by the manufacturing industry, and technical services and sale business. This special fact, enriches our lectures with examples and situations of daily technical life. So that, the student can relate the concepts, processes and methods taught in class in a natural way. Furthermore, this relationship permits the local industry to explore the performance of our students and opens new job opportunities to students after graduation.

4. Time schedules of classes. M.E. courses are offered from 7:00 a.m. to 10:00 p.m. in a quarter system. Therefore, students can choose the schedule that better fits their needs and interests.

H. Program limitations

According to the M.E. faculty opinion, the principal limitations of the mechanical engineering program are:

1. Faculty size. The number of full time faculty members at the M.E. Department is small in comparison to the number of students served. Currently, the faculty/student ratio is six (6) full-time and four (4) part-time faculty members for approximately six hundred (600) students from
second year to fifth years, or equivalently, one instructor for eighty-five (85) students. Because of the limited faculty size, offering the necessary courses and the variety of elective courses covering the breadth and depth of subjects in mechanical engineering is very difficult.

2. **Faculty overloading.** Our six full-time faculties are heavy loaded with an average of fifteen (15) credits of teaching loads with twenty-two (22) contact hours per week during the quarter in a four-quarter-system-per-year basis, i.e., sixty credits (60) per year. A course of four hours and twenty minutes of lecture per week has a nominal "three credit-hours" value, consequently, fifteen credit-hours of teaching load represent 21 hours and 40 minutes of lecture per week. It is also required four (4) weekly hours for student tutorial, beyond time needed for grading, lecture preparation, correction of student design projects, and administrative work. This becomes a limitation for further activities related to the professional development, such as, research, training, new courses preparation, experimental testing, laboratory improvements, and attendance of seminars and conferences.

3. **Eleven-week quarter system.** Discussing all of the topics programmed for the subjects in our eleven-week-quarter system is very difficult because it is supposed that the total number of topics to be lectured is equivalent to the total number of topics to be taught in a typical sixteen-week-semester system. Although the number of hours dedicated to lecture could be equivalent in both systems, there is a substantial difference in the rate of lecturing. The student needs some time to mature the information and master all of the knowledge received in class.

4. **Faculty vacation period.** It is supposed that the faculty takes one-week vacation after the completion of each quarter, but actually, this time is used for final grading. In this regard, scheduling two semester terms and a noncompulsory shorter summer term per year would be very convenient, such that faculties can take a vacation of at least two-months per year. We strongly recommend the semester system because it provides enough time for the students to practice and mature the whole topics discussed in class and to properly carry out the design projects corresponding to the general engineering and specialization courses, in addition to the faculty vacation.

5. **M.E. Department Budget.** The Department of Mechanical Engineering does not have a budget assigned to be executed by the Department Head, and consequently, the process of acquisition of laboratory equipment, instrumentation, software, faculty development, and even some current operative expenses, is very slow and sometimes frustrating.

6. **Lacks of faculty participation in institutional academic decisions.** The M.E. faculty does not participate with the administrative board while decision making concerning important academic affairs, such as: tenure track plan, sabbatical plans, advancement in rank of faculty members, faculty development plan, and the possibility of the establishment of a faculty retirement plan.

7. **M.E. Department head teaching load.** Currently, the mechanical engineering department head has an assigned teaching load of six credits (8 hours and 40 minutes of contact hours weekly) per
quarter, or its equivalent, twenty-four credits per year. A reduction of the M.E. department head teaching load will yield the additional time required to be devoted to a better administration of the department.

8. **P.U.P.R. Centralized Computational Laboratory.** The tutors charged with the guidance of the students cannot support the M.E. students because they are neither M.E. instructors nor specialists in most of the mechanical engineering computer program applications. Additionally, our students claim that the computer center is frequently out of service or some programs do not run due to lack of server memory capacity or due to small number of program licenses. The computer center service hours are limited. The computational laboratory should be open to the M.E. students 24 hours a day, seven days a week. Students should be assigned with code numbers that make it possible for them to enter and leave the facility by entering the appropriate code and password. We strongly recommend establishing a branch of the centralized computer laboratory into the mechanical engineering facilities in the new engineering laboratory building.

9. **Insufficient administrative support services.** The M.E. Department requires additional clerical support to help relieve the extensive work load of the faculty members. Currently, there is only one secretary shared among the department head, the assistant to the department head in student affairs, the laboratory coordinator, and the M.E. faculty. Also, photocopying services is very limited because the M.E. Department does not have a photocopy machine; at this time there is only one photocopy machine shared among Civil, Electrical, Industrial, and Mechanical Engineering Departments, and other offices.

10. **Faculty permanence, salaries, and fringe benefits.** Currently, every M.E. faculty member is granted with contracts renewed annually. A tenure track system, retirement plan, sabbatical plan, summer vacation, and the normalized nine (9) month salary would be very conveniently established in the institution to retain the faculty.

I. **Support services**

1. **Library.** The PUPR centralized library provides adequate resources for the program in mechanical engineering. While the library may not have specific journals or reports in a particular field of mechanical engineering, the library staff is very cooperative in finding them through interlibrary loans. The library automation has progressed significantly in the past few years and when completed will give students and faculty on-line searches for various subject areas of knowledge. A new modern three-floor library building is currently in construction to better serve the students and faculty.

2. **Computers.** The PUPR does not have special computer laboratories for each engineering program, but it has centralized computer facilities that are shared for all of the students of the PUPR. Since this fact could be considered as a disadvantage for the senior mechanical engineering students, the department is recommending the accomplishment of the specialized
mechatronics and Cad/Cam laboratories with additional personal computers and workstations to serve as additional computer facilities for our students in the fourth and fifth year. The computer facilities of the PUPR are extensively described in Section VI of Volume I. The mechanical engineering related software packages available in the centralized Computer Center are as follows:

- Programming languages: C, Fortran, QuickBasic, GWBasic.
- Computer aided drawing and preliminary design: AutoCad, Design View, Card.
- Mechanical engineering simulations and design: Vissim, Ansys, ME30

ME faculty is involved in the evaluation of new applicable software packages in stress analysis, design of mechanical elements and systems, thermal systems design, vibration and system dynamics. The results of the evaluation will be submitted to the administration of the PUPR for approval of acquisition.

XII. COURSE REQUIREMENTS

A. Program modes and trends

The M.E. Department of the PUPR offers a five-year program pursuing the Bachelor of Science degree in Mechanical Engineering. Courses are offered mainly Monday through Thursday between 7:00 a.m. and 10:00 p.m.. Friday and Saturday mornings are available to offer some laboratory courses. Fridays are also used for other academic activities (e.g., seminars, meetings), and to recover lecture periods lost due to holidays (in this case, dates are specified by the academic calendar).

Usually, M.E. laboratories and capstone design courses are offered during the morning. Basic level courses of general engineering and M.E. courses are taught during the day and the evening. Technical electives and advanced M.E. courses are mostly offered during evenings. The offering of technical electives varies each quarter according to the specialization and schedule of the available professors.

The program is only offered on-campus. No off-campus or telecommunications courses are given. Co-op practice option is available to the interested students through a technical elective course. The co-op Program Coordinator is responsible for advertising the full or part time job opportunities, to identify possible candidates, and report work progress for faculty evaluation.

The student enrollment and the number of graduates throughout of the last five years have been as follow:
YEAR ENROLLMENT  (Growth)  GRADUATES (Total)
1990/91    552                      09 (09)
1991/92    775 (40.4%)             11 (20)
1992/93    884 (14.1%)             17 (37)
1993/94    999 (13.0%)             28 (65)
1994/95    899 (-10.0%)            75 (140)

As it can be noticed from the previous information, there has been a continuous growth in the enrollment of the M.E. Department, excepting during the last year (i.e., '94/95). An increase in the tuition costs effective explains this reduction on August 1994, and the change in the time schedule of the offerings from two hours per lecture period to two hours and ten minutes. It is recognized that the most critically affected lecture period was that offered from 4:00 p.m. to 6:00 p.m., which was changed to a schedule from 3:40 p.m. to 5:50 p.m.. This change has affected negatively to students who work during the daytime and study in the evening.

Following the enrollment trend of the last five years, and considering the improvement in the physical facilities, it is expected to maintain the current enrollment. A liberal forecasting could show a good possibility to reach an enrollment of 1,000. It is also expected that the number of graduates for 1995/96 is around 85.

B. Degree titles

The M.E. Department of the PUPR awards a Bachelor of Science degree in Mechanical Engineering (BSME) to those students who fulfill the minimum requirements established by the Institution. No other degree is currently offered.

C. Definition of a credit unit

The academic calendar at the PUPR consists of four quarter terms with each quarter term 12 weeks long, which includes one week for final examinations. For a three-credit course, there are two lecture periods per week of two hours and ten minutes each. That represents a total of 47 hours and 40 minutes per quarter for a three-credit course, or 15.89 hours per credit. This time is a little affected by the registration activities carried on the first week of the quarter, state and federal holidays, and Christmas and New Year's recess period. In consequence, for a three-credit course approximately 42 hours are actually devoted to teaching. For laboratory courses, one credit-hour represents a period of four hours of instruction per week. That corresponds to a net 40 hours per credit.

D. Curriculum course content

The current mechanical engineering curriculum requires 173 credits. The M.E. program is designed to provide the essential knowledge in the most common and general fields of the mechanical engineering career. To attain this goal, the experience in engineering design is integrated
throughout a balanced five-year curriculum to develop in the student a good engineering judgement. The content of the curriculum courses is distributed within the following categories:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>CREDITS</th>
<th>YEARS OF STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>21</td>
<td>0.6</td>
</tr>
<tr>
<td>Basic sciences</td>
<td>20</td>
<td>0.6</td>
</tr>
<tr>
<td>Humanities, social sciences and related studies</td>
<td>27</td>
<td>0.8</td>
</tr>
<tr>
<td>General engineering topics</td>
<td>37</td>
<td>1.0</td>
</tr>
<tr>
<td>Mechanical engineering topics</td>
<td>68</td>
<td>2.0</td>
</tr>
</tbody>
</table>

The mechanical engineering topics’ category includes nine (9) credits of elective courses selected by the student in consultation with the student's mentor. Remember that the M.E. curriculum is designed for a five-year program; therefore, a year of study represents a 20% (1/5) of the total number of credits required. The number of years of study shown above agrees with the definition of the credit unit at the PUPR (refer to Volume I, section VIII.B) which states that one-half year is equivalent to 18 credits.

An overview of the curriculum is shown on pages II-10 to II-14.
### SEQUENTIAL PROGRAM

<table>
<thead>
<tr>
<th>Course description</th>
<th>Credits</th>
<th>Pre-reqts.</th>
<th>Co-reqts.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST YEAR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>First term</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 111 ENGLISH READING AND WRITING</td>
<td>3</td>
<td>P.A.O. (*)</td>
<td></td>
</tr>
<tr>
<td>MATH 111 PRECALCULUS I</td>
<td>3</td>
<td>P.A.O.</td>
<td></td>
</tr>
<tr>
<td>SPAN 111 SPANISH READING AND WRITING</td>
<td>3</td>
<td>P.A.O.</td>
<td></td>
</tr>
<tr>
<td><strong>Second term</strong></td>
<td>3</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>ENGI 131 ENGINEERING GRAPHICS</td>
<td>2</td>
<td>MATH111</td>
<td>SCIE111</td>
</tr>
<tr>
<td>MATH 122 PRECALCULUS II</td>
<td>3</td>
<td>MATH111</td>
<td>SCIE112</td>
</tr>
<tr>
<td>SCIE 111 GENERAL CHEMISTRY I</td>
<td>4</td>
<td>MATH111</td>
<td>SCIE124</td>
</tr>
<tr>
<td>SCIE 112 GENERAL CHEMISTRY I, LABORATORY</td>
<td>0</td>
<td>MATH111</td>
<td>SCIE122</td>
</tr>
<tr>
<td><strong>Third term</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 146 FRESHMAN ENGINEERING DESIGN</td>
<td>3</td>
<td>ENGI131</td>
<td>SCIE124</td>
</tr>
<tr>
<td>MATH 133 CALCULUS I</td>
<td>3</td>
<td>MATH122</td>
<td>SCIE124</td>
</tr>
<tr>
<td>SCIE 122 GENERAL CHEMISTRY II</td>
<td>4</td>
<td>SCIE111</td>
<td>SCIE122</td>
</tr>
<tr>
<td>SCIE 124 GENERAL CHEMISTRY II, LABORATORY</td>
<td>0</td>
<td>SCIE111</td>
<td>SCIE122</td>
</tr>
<tr>
<td><strong>Fourth term</strong></td>
<td>3</td>
<td>MATH122</td>
<td></td>
</tr>
<tr>
<td>ENGI 220 COMPUTER PROGRAMMING AND ALGORITHMS</td>
<td></td>
<td>MATH133</td>
<td>SCIE214</td>
</tr>
<tr>
<td>MATH 144 CALCULUS II</td>
<td>3</td>
<td>MATH133</td>
<td>SCIE214</td>
</tr>
<tr>
<td>SCIE 213 PHYSICS I, MECHANICS</td>
<td>3</td>
<td>MATH133</td>
<td>SCIE214</td>
</tr>
<tr>
<td>SCIE 214 PHYSICS I, LABORATORY</td>
<td>1</td>
<td>MATH133</td>
<td>SCIE213</td>
</tr>
</tbody>
</table>

(*) Placement by Admissions Office.
## SECOND YEAR

### First term

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 235</td>
<td>PROBABILITY AND STATISTICS FOR ENGINEERS</td>
<td>3</td>
</tr>
<tr>
<td>MATH 215</td>
<td>CALCULUS III</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 235</td>
<td>PHYSICS II, HEAT, LIGHT, AND SOUND</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 236</td>
<td>PHYSICS II, LABORATORY</td>
<td>1</td>
</tr>
<tr>
<td>ENGI 220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 144</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 236</td>
<td></td>
<td></td>
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<tr>
<td>SCIE 235</td>
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</tbody>
</table>

### Second term

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 322</td>
<td>APPLIED MECHANICS, STATICS</td>
<td>3</td>
</tr>
<tr>
<td>MATH 226</td>
<td>CALCULUS IV</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 249</td>
<td>PHYSICS III, ELECTRICITY AND MAGNETISM</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 250</td>
<td>PHYSICS III, LABORATORY</td>
<td>1</td>
</tr>
<tr>
<td>ENGI 324</td>
<td>MECHANICS OF MATERIALS I</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 251</td>
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### Third term

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### Fourth term

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## THIRD YEAR

### First term

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<td>ME 311</td>
<td>APPLIED SOFTWARE FOR MECHANICAL ENGINEERS</td>
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<td>ME 331</td>
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II-11
Second term

EE 3000 CIRCUIT ANALYSIS I
ME 341 THERMODYNAMICS II
ME 342 KINEMATICS DESIGN

Third term

EE 3020 CIRCUIT ANALYSIS II
ME 343 PHYSICAL METALLURGY
ME 344 PHYSICAL METALLURGY LABORATORY
SOHU 251 SOCIO-HUMANISTIC STUDIES I

Fourth term

EE 4800 INDUSTRIAL ELECTRONICS
EE 4801 INDUSTRIAL ELECTRONICS LABORATORY
ME 410 STRESSES IN MACHINE ELEMENTS
SOHU 252 SOCIO-HUMANISTIC STUDIES II

FOURTH YEAR

First term

ME 411 DESIGN OF MACHINE ELEMENTS
ME 428 GAS DYNAMICS
ME 430 HEAT TRANSFER I

Second term

ENGI 449 ENGINEERING ECONOMICS
ME 421 DESIGN OF MECHANICAL SYSTEMS
ME 431 HEAT TRANSFER II

Third term

ME 432 DESIGN OF THERMAL SYSTEMS
ME 441 MECHANICAL ENGINEERING LABORATORY I
PHIL 441 PROFESSIONAL ETHICS IN ENGINEERING

II-12
Fourth term

ME  444  PROCESSES AND METHODS OF MANUFACTURING  3  ME343  ME445
    &ME444
    ME410

ME  445  MANUFACTURING LABORATORY  2  ME343  ME444
    &ME444
    ME344

SOCIO-HUMANISTIC ELECTIVE I  3

FIFTH YEAR

First term

ME  511  MECHANICAL ENGINEERING LABORATORY II  1  ME428  ME536
    &ME441

ME  535  AUTOMATIC CONTROL SYSTEMS  3  EE3020  ME535
    &ME432

ME  536  CONTROLS LABORATORY  1  EE3020  ME535
    &ME432

SOCIO-HUMANISTIC ELECTIVE II  3

Second term

ME  543  COMPUTER-AIDED DESIGN AND COMPUTER-AIDED MANUFACTURING  3  ME421  ME544
    &ME444
    ME415

ME  544  CAD/CAM LABORATORY  1  ME421  ME543
    &ME444

ELECTIVE COURSE I  3

Third term

ME  555  MECHANICAL ENGINEERING DESIGN PROJECT I  2  ME536  ME543
    ME544
    &ME544

ELECTIVE COURSE II  3

Fourth term

ME  560  MECHANICAL ENGINEERING DESIGN PROJECT II  2  ME536  ME543
    ME544
    &ME544

ELECTIVE COURSE III  3
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<td>INTERNAL COMBUSTION ENGINES</td>
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<td>POWER PLANT ENGINEERING</td>
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<td>INTRODUCTION TO NUCLEAR ENGINEERING</td>
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<td>ME 523</td>
<td>NUCLEAR REACTOR THEORY</td>
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<td>WASTE HEAT MANAGEMENT</td>
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<td>TURBOMACHINERY</td>
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<td>MEASUREMENT SYSTEMS</td>
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<td>DIMENSIONAL ANALYSIS AND THEORY OF MODELS</td>
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<td>ME 534</td>
<td>COMBUSTION THEORY AND APPLICATIONS</td>
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<td>MECHANICAL ENGINEERING PRACTICE</td>
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Rev.: 892; 1194; 595.
The course descriptions are detailed as follows.

**ENGI 325 ENGINEERING MECHANICS, DYNAMICS**

**1995 Catalog Data:** ENGI 325: Engineering Mechanics, Dynamics. Credits 3.
Kinematics and kinetics of particles. Kinematics and kinetics of rigid bodies.
Three-dimensional dynamics of rigid bodies.
Prerequisites: ENGI 322, & MATH 237.
Corequisite: ENGI 220.


**Coordinator:** Gilmer R. Burgos, Assistant Professor of M.E.

**Goals:** This course is designed to give engineering students an ability to solve
mathematical models which describe the effects of force and motion on
a variety of structures and machines.

**Prerequisites by Topic:**

2. Plane and solid geometry.
3. Trigonometry and analytic geometry.
4. Scalar and vector algebra.
5. Rectangular and polar coordinates.
7. Linear and angular impulse and momentum.

**Topics:**

1. Introduction to dynamics (1 two-hour class)
2. Kinematics of particles (3 two-hour classes)
3. Kinetics of particles (6 two-hour classes)
4. Kinetics of system of particles (2 two-hour classes)
5. Plane kinematics of rigid bodies (3 two-hour classes)
6. Plane kinetics of rigid bodies (3 two-hour classes)
7. Int. to three-dimensional dynamics of Rigid Bodies (1 two-hour class)
8. Tests (3 two-hour classes)
Computer Usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory Projects: None.

ABET Category Content:

Engineering science: 2.5 credits or 83.3%
Engineering design: 0.5 credits or 16.7%

ENGI 327 FLUID MECHANICS

Fluid Statics. Integral and Differential Analysis of Fluid Motion.
Incompressible Inviscid Flow. Dimensional Analysis and Similitude. Flow
in Open Channels.
Prerequisites: ENGI 325, SCIE 235, & SCIE 236.
Corequisite: ENGI 328.

Textbook: P.M. Gerhart, R.J. Gross, and J.I. Hochstein, Fundamentals of Fluid

R.W. Fox, and A.T. McDonald, Introduction to Fluid Mechanics, John
B.R. Munson, D.F. Young, and T.H. Okiishi, Fundamentals of Fluid

Coordinator: Jacinto Solano, Assistant Professor of M.E.

Goals: This course is designed to provide the engineering students with sufficient
theoretical background to understand and apply the basic concepts and laws
of fluid mechanics.

Prerequisites by topic:

1. Computer programming.
2. Integral and differential calculus.
3. Physics: Mechanics, Heat, and Sound
4. Rigid-body statics and dynamics.

Topics:
1. Introduction and Fundamental concepts (1 two-hour class)
2. Mechanics of Nonflowing Fluids (3 two-hour classes)
3. Fundamental Concepts for Flow Analysis (1 two-hour class)
4. The Finite Control Volume Approach to Flow Analysis (4 two-hour classes)
5. The Differential Approach to Flow Analysis (2 two-hour classes)
6. Organizing Information About Flow: Dimensional Analysis (2 two-hour classes)
7. Steady, Incompressible Flow in Pipes and Ducts (2 two-hour classes)
8. Steady, Incompressible External Flow (1 two-hour class)
9. Potential Flow and Boundary Layer Theory (1 two-hour class)
10. Liquid Flow in Open Channels (2 two-hour classes)
11. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: Correspond to ENGI 328 Fluid Mechanics Laboratory.

ABET category content:

Engineering science: 2.5 credits or 83.3%
Engineering design: 0.5 credits or 16.7%

Prepared by: Jacinto Solano  Date: Nov 2, 1994.
ENGI 328 FLUID MECHANICS LABORATORY


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to give engineering students the necessary experimental knowledge to complement the theory of Fluid Mechanics.

Prerequisites by Topic:

1. Working knowledge on computer software.
3. The Least Squares Method.
4. Fluid statics.
5. Fluid dynamics.

Laboratory Topics:

1. Introduction. Experimental errors. Error analysis. Statistical analysis of experimental data. (one four-hour class)
2. Statistical analysis in the Gravimetric Flow Measurement. (one four-hour lab session)
3. Hydrostatic Thrust on a Plane Surface. (one four-hour lab session)
4. Stability of a Floating Body. (one four-hour lab session)
5. Flow through Orifices and Nozzles. (one four-hour lab session)
6. Flow through a Venturi Meter. (one four-hour lab session)
7. Discharge over Weirs. (one four-hour lab session)
8. Friction Loss along a Pipe and Pipe Fittings. (one four-hour lab session)
9. Impact of a Jet. (one four-hour lab session)
10. Final Presentations. (one four-hour lab session)
11. Final Examination. (one four-hour comprehensive examination).

Computer Usage:

Every working team is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written in English using word processing programs. Numerical results should be calculated and plotted using the appropriate computer software.

ABET Category Content:

Engineering science: 1 credit or 100%

Prepared by: Gilmer R. Burgos

Date: Nov. 5, 1994.
ME 247 APPLIED NUMERICAL ANALYSIS


Coordinator: Eduardo Veras, Assistant Professor of M.E.

Goals: This course is designed to give sophomore engineering students an ability to derive numerical schemes, write programs, and correctly use existing software for numerical methods to solve mathematical, engineering, and scientific problems on a computer.

Prerequisites by topic:

1. Computer programming.
2. Matrix analysis.
4. Trapezoidal and Simpson Rules.

Topics:

1. Solving Nonlinear Algebraic Equations (2 two-hour classes)
2. Solving Sets of Linear Algebraic Equations (2 two-hour classes)
3. Interpolating Polynomials (2 two-hour classes)
4. Numerical Differentiation (2 two-hour classes)
5. Numerical Integration (2 two-hour classes)
6. Numerical Solution of Ordinary Differential Equations (2 two-hour classes)
7. Boundary-Value, and Characteristic-Value Problems (2 two-hour classes)
8. Numerical Solution of Partial-Differential Equations (4 two-hour classes)
9. Curve-Fitting and Approximation of Functions (1 two-hour class)
10. Tests (3 two-hour classes)

Computer usage:

Each student is required to solve eight computer projects covering the first nine topics. The computer projects may be solved by writing and running the corresponding computer program using any programming language, or by using the applicable computer software.

Laboratory projects: None

ABET category content:

Mathematics: 2.5 credits or 83.3%
Engineering science: 0.5 credits or 16.7%

ME 311 APPLIED SOFTWARE FOR MECHANICAL ENGINEERS


Textbook: None.


Manuals
DESIGN-VIEW User's Guide
VISSIM Reference Manual
MATHCAD User's Guide
MATLAB User's Guide
AUTOCAD User's Manuals and Tutorials.

Coordinator: Eduardo Veras, Assistant Professor of M.E.

Goals: This course is designed to develop the students' skills and ability to effectively use computer software in solving mechanical engineering problems. Modeling and computer simulations are emphasized.

Prerequisites by topic:

1. Computer programming.
2. DOS and UNIX operative systems for PCs and Workstations.

Topics:

1. Spreadsheets (2 two-hour computer lab sessions)
2. Design-View (3 two-hour computer lab sessions)
3. Vissim (4 two-hour computer lab sessions)
4. MathCad (2 two-hour computer lab sessions)
5. MathLab (2 two-hour computer lab sessions)
6. AutoCad (2 two-hour computer lab sessions)
7. Ansys (4 two-hour computer lab sessions)
8. Algor (3 two-hour computer lab sessions)
Computer usage:

Each of the five computer assignments of this course requires the intensive use of the computer by using the corresponding software discussed in the laboratory sessions.

Laboratory projects:

Every student is required to carry out five computer laboratory assignments by using the respective software. The computer projects are as follows:

1. Spreadsheet and Design-View application project.
2. Vissim application project.
3. MathCad and MathLab application project.
4. AutoCad application project.
5. Ansys and Algor application project.

ABET category content:

Engineering design: 0.5 credits or 16.7%
Other: 2.5 credits or 83.3%

ME 331 THERMODYNAMICS I


Coordinator: Jorge L. Martinez, Assistant Professor of M.E.

Goals: This course is designed to give students of mechanical engineering a clear understanding and firm grasp of the basic thermodynamic principles in order to develop their creativity and engineering judgment.

Prerequisites by topic:

1. Computer programming and applied software.
2. Integral and differential calculus.
5. Energy and momentum conservation laws.

Topics:

1. Basic concepts of Thermodynamics. (1 two-hour class)
2. Properties of pure substances. (3 two-hour classes)
3. The First Law of Thermodynamics (4 two-hour classes)
4. The Second Law of Thermodynamics and Entropy. (5 two-hour classes)
5. Second-Law Analysis of Engineering Systems. (2 two-hour classes)
6. Gas and Gas-Vapor Mixtures. (3 two-hour classes)
7. Air Conditioning Processes. (1 two-hour class)
8. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.5 credits or 83.3%
Engineering design: 0.5 credits or 16.7%

Prepared by: Jorge L. Martínez Date: Nov 1, 1994.
ME 341 THERMODYNAMICS II


Coordinator: Jorge L. Martínez, Assistant Professor of M.E.

Goals: This course is designed to provide students of mechanical engineering a detailed understanding of the applications of thermodynamic principles and ideal thermodynamic cycles in order to develop their engineering judgment.

Prerequisites by topic:

1. Computer programming.
5. Second law analysis.

Topics:

1. Polytropic Compression of Gases (2 two-hour classes)
2. Reciprocating Gas Compressors (1 two-hour class)
3. Chemical Reactions (3 two-hour classes)
4. Gas Power Cycles (8 two-hour classes)
5. Vapor and Combined Power Cycles (3 two-hour classes)
6. Refrigeration Systems (2 two-hour classes)
7. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.5 credits or 83.3%
Engineering design: 0.5 credits or 16.7%

Prepared by: Jorge L. Martínez Date: Nov 5, 1994.
ME 342 KINEMATICS DESIGN


Coordinator: Eduardo J. Veras, Assistant Professor of M.E.

Goals: This course is designed to provide the students of mechanical engineering with sufficient theoretical background to understand contemporary mechanism design techniques, and with powerful mechanism design tools.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Basic knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.

Topics:

1. Fundamentals of kinematics and mechanisms (1 two-hour class)
2. Computer-aided mechanism design (2 two-hour classes)
3. Displacement and Linkages analysis (1 two-hour class)
4. Velocity analysis (2 two-hour classes)
5. Acceleration analysis(1 two-hour class)
6. Dynamics of mechanisms (2 two-hour classes)
7. Cam Design (4 two-hour classes)
8. Gears and Gear Trains (2 two-hour classes)
9. Kinematic Synthesis (4 two-hour classes)
10. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credit or 66.7%
Engineering design: 1.0 credit or 33.3%

ME 343 PHYSICAL METALLURGY

Metal structure and crystallization. Plastic deformation. Phase diagrams.
Pre-requisites: ENGI 324, SCIE 122, & SCIE 124.
Corequisite: ME 344.


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to provide the students of mechanical engineering with the basic concepts and applications of the physical metallurgy.

Prerequisites by topic:

1. Computer programming and ability to use stored programs.
2. Inorganic Chemistry.
3. Calculus and Differential Equations.
5. Thermodynamics.

Topics:

1. Introduction (1 two-hour class)
2. The structure of crystalline solids (1 two-hour class)
3. Imperfections in solids (1 two-hour class)
4. Diffusion (1 two-hour class)
5. Mechanical properties of metals (2 two-hour classes)
6. Dislocations and mechanisms of strengthening in metals(2 two-hour classes)
7. Failure (2 two-hour classes)
8. Phase diagrams (3 two-hour classes)
9. Phase transformations in metals (1 two-hour class)
10. Thermal processing of metal alloys (2 two-hour classes)
11. Metal alloys (2 two-hour classes)
12. Corrosion of metals (1 two-hour class)
13. Tests (3 two-hour classes)

Computer usage:

Intensive computer usage is required for the open-ended design project assigned in class. Students are required to use appropriate computer software or to write and run their own computer programs.

Laboratory projects: Corrrespond to ME 344 Physical Metallurgy Laboratory.

ABET category content:

Engineering science: 2.5 credits or 83.3%
Engineering design: 0.5 credits or 16.7%

ME 344 PHYSICAL METALLURGY LABORATORY


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to give engineering students the necessary experimental knowledge to complement the theory learned in the Physical Metallurgy course.

Prerequisite by Topic:

1. Working knowledge of computer software.
2. Thermodynamics.
3. Mechanics of Materials
4. Physical Metallurgy

Laboratory Topics:

2. Microstructure. (1 four-hour lab session)
3. Hardness test. (1 four-hour lab session)
4. Phase Diagrams. (1 four-hour lab session)
5. Heat Treatments for Steel. (2 four-hour lab sessions)
6. Precipitation Hardening. (1 four-hour lab session)
7. Jominy Test. (1 four-hour lab session)
8. Tension Test. (1 four-hour lab session)
9. Final Presentations. (1 four-hour lab session)
10. Final Examination. (1 four-hour comprehensive examination)

Computer Usage:

Every working team is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written in English using word processing programs. The numerical results should be calculated and plotted using the appropriate computer software.

ABET Category Content:

Engineering Science: 1 credit or 100%

Prepared by: Gilmer R. Burgos

Date: March 1, 1995
ME 410 STRESSES IN MACHINE ELEMENTS


Coordinator: Eduardo Veras, Assistant Professor of M.E.

Goals: This course is designed to provide the students of mechanical engineering with the theoretical background to perform the stress analysis, which represents the basic stage of the mechanical design processes.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.

Topics:

1. Fundamental concepts and definitions (1 two-hour class)
2. Stresses (5 two-hour classes)
3. Deflection (3 two-hour classes)
4. Stiffness (3 two-hour classes)
5. Failure Prevention: materials (2 two-hour classes)
6. Steady Loading (5 two-hour classes)
7. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

ME 411 DESIGN OF MACHINE ELEMENTS


Coordinator: Eduardo Veras, Assistant Professor of M.E.

Goals: This course is designed to provide the students of mechanical engineering with the background necessary to perform the mechanical design of machine elements or components.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.

Topics:

1. Variable Loading (6 two-hour classes)
2. Design of Screws, Fasteners, and Connections (5 two-hour classes)
3. Welded, Brazed, and Bonded Joints (2 two-hour classes)
4. Mechanical Springs (3 two-hour classes)
5. Rolling Contact Bearings (2 two-hour classes)
6. Lubrication and Journal Bearings (1 two-hour class)
7. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%  
Engineering design: 1.0 credit or 33.3%

Prepared by: Eduardo Veras  
Date: Nov 5, 1994.
ME 421 DESIGN OF MECHANICAL SYSTEMS


Coordinator Hebert Jaramillo, Assistant Professor of M.E.

Goals This course is designed to provide the mechanical engineering students with the sufficient background to perform in an integrated manner the design of mechanical systems.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNFIX operative systems.
3. Mathematical differentiation and integration.
5. Stresses in machine elements.

Topics:

1. Gearing-General (4 two-hour classes)
2. Spur and Helical Gears (3 two-hour classes)
3. Bevel and Worm Gears (1 two-hour class)
4. Clutches, Brakes, Couplings and Flywheels (5 two-hour classes)
5. Flexible Mechanical Elements (3 two-hour classes)
6. Shafts, Axles, and Spindles (3 two-hour classes)
7. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 1.0 credit or 33.3%
Engineering design: 2.0 credits or 66.7%

ME 428 GAS DYNAMICS


Coordinator: Manuel Bardález, Associate Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with a knowledge and understanding of the fundamentals of compressible fluid flow and gas dynamics.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.
4. Ideal and Actual Gases Theories.
5. First and Second Laws of Thermodynamics.

Topics:

1. Fundamental Concepts and Definitions (2 two-hour classes)
2. Equations of Flow (4 two-hour classes)
3. Isentropic Flow (3 two-hour classes)
4. Normal Shock Waves (4 two-hour classes)
5. Adiabatic Frictional Flow in a Constant-Area Duct (2 two-hour classes)
6. Flow With Heat Interaction and Generalized Flow (3 two-hour classes)
7. Computational Fluid Dynamics (1 two-hour classes)
8. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

ME 430 HEAT TRANSFER I


Coordinator: Jorge L. Martínez, Assistant Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with a knowledge and understanding of the basic fundamentals of Heat Conduction and Thermal Radiation.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.
5. Thermodynamics.

Topics:

1. Introduction to Heat Transfer (2 two-hour classes)
2. Introduction to Conduction (2 two-hour classes)
3. One-Dimensional, Steady-State Conduction (4 two-hour classes)
4. Two-Dimensional, Steady-State Conduction (4 two-hour classes)
5. Transient Conduction (3 two-hour classes)
6. Radiation, Processes and Properties (2 two-hour classes)
7. Radiation Exchange Between Surfaces (2 two-hour classes)
8. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

Prepared by: Jorge L. Martínez     Date: Nov 5, 1994.
ME 431 HEAT TRANSFER II

1995 Catalog Data
ME 431: Heat Transfer II. Credits 3.
Prerequisite: ME 430.

Textbook:

References:

Coordinator:
Jorge L. Martínez, Assistant Professor of M.E.

Goals:
This course is designed to provide the mechanical engineering students with a knowledge and understanding of the basic fundamentals of Convective Heat Transfer and the design of Heat Exchanger.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.
5. Thermodynamics.
7. Thermal Conduction and Radiation.

Topics:
1. Introduction to Convection (4 two-hour classes)
2. External Flow (3 two-hour classes)
3. Internal Flow (3 two-hour classes)
4. Free Convection (3 two-hour classes)
5. Boiling and Condensation (3 two-hour classes)
6. Heat Exchanger (3 two-hour classes)
7. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

Prepared by: Jorge L. Martínez       Date: Nov 6, 1994.
ME 432 DESIGN OF THERMAL SYSTEMS

Prerequisite: ME 431.


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to provide senior students of mechanical engineering with the necessary tools to effectively use thermal energy and power through the design of optimum thermal systems.

Prerequisites by topic:

1. Computer programming, and applied software for engineers.
2. Differential and Integral Calculus.
3. Numerical Analysis for Engineers.
4. Thermodynamics.
5. Fluid Mechanics.

Topics:

1. Engineering Design (1 two-hour class)
2. Designing a Workable System (1 two-hour class)
3. Economic Analysis (2 two-hour classes)
4. Equation Fitting (2 two-hour classes)
5. Modeling Thermal Equipment (3 two-hour classes)
6. System Simulation (2 two-hour classes)
7. Optimization (2 two-hour classes)
8. Lagrange Multipliers (2 two-hour classes)
9. Steady-State Simulation of Large Systems (1 two-hour class)
10. Dynamic Behavior of Thermal Systems (2 two-hour classes)
11. Oral and written presentation of design projects (1 two-hour class)
12. Tests (3 two-hour classes)

Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

Estimated ABET category content:

Engineering science: 1.0 credit or 33.3%
Engineering design: 2.0 credits or 66.7%

ME 441 MECHANICAL ENGINEERING LABORATORY I

1995 Catalog Data: ME 441: Mechanical Engineering Laboratory I. Credits 1. Instrumentation, Calibration, Measurements, and data acquisition using devices related to the mechanical engineering field. Prerequisites: ENGI 235 & ME 431.


Coordinator: Jacinto Solano, Assistant Professor of M.E.

Goals: This course is designed to familiarize the student with the appropriate instrumentation for mechanical measurements and data acquisition.

Prerequisites by topic:
1. Computer programming, and applied software for engineers.
2. Numerical Analysis for Engineers.
3. Thermodynamics.

Laboratory topics:
2. Temperature Measurements. (2 four-hour lab sessions)
3. Pressure Measurements. (1 four-hour lab session)
4. Velocity Measurements. (1 four-hour lab session)
5. Flow Measurements. (1 four-hour lab session)
6. Heating Value Measurements. (1 four-hour lab session)
7. Thermal Radiation Measurements. (1 four-hour lab session)
8. Final Oral Presentations. (1 four-hour lab session)
9. Final Examination. (1 four-hour lab session)

**Computer usage:**

The student is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written in English using word processing programs. Numerical results should be calculated and plotted using the appropriate computer software.

**Estimated ABET category content:**

Engineering science: 1.0 credit or 100%

Prepared by: Gilmer R. Burgos  
Date: June 07, 1994.
ME 444 PROCESSES AND METHODS OF MANUFACTURING

Prerequisites: ME 343, ME 344, & ME 410.
Corequisite: ME 445.


Coordinator: Hebert Jaramillo, Assistant Professor of M.E.

Goals: This course is designed to provide students of mechanical engineering a detailed understanding of the manufacturing processes and operations, design considerations, product quality and manufacturing cost factors.

Prerequisites by topic:

1. Applied software for Mechanical Engineers.
2. Physical properties of materials.
4. Steels: production, properties, and applications.
5. Nonferrous Metals and Alloys: production, properties, and applications.

Topics:

1. Metal-Casting Processes (3 two-hour classes).
2. Rolling, Forging, Extrusion and Drawing (1 two-hour class).
3. Sheet-Metal Forming (1 two-hour class).
4. Forming and Shaping Plastics and Composite Materials (1 two-hour class).
5. Cutting Processes (4 two-hour classes).
6. Machining Centers, and Machine-Tool Structures (1 two-hour class).
7. Abrasive Processes and Finishing Operations (1 two-hour class).
9. Tribology (1 two-hour class).
10. Engineering Metrology (1 two-hour class).
11. Testing, Inspection, and Quality Assurance (1 two-hour class).
13. Tests (3 two-hour classes).

**Computer usage:**

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer program, and/or by using the corresponding computer software.

**Laboratory projects:** Correspond to ME 445 Manufacturing Laboratory.

**ABET category content:**

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

**Prepared by:** Hebert Jaramillo  
**Date:** Nov 7, 1994.
ME 445 MANUFACTURING LABORATORY


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to offer mechanical engineering students a practical and comprehensive knowledge of measurements instruments, machining, and welding manufacturing processes.

Prerequisites by Topic:

1. Physical Metallurgy.
5. Processes and Methods of Manufacturing.

Laboratory Topics:

1. Introduction. Safety Rules. (1 four-hour session)
3. Lathe Operation. Appropriate selection of gears for turning different kinds of materials. Tool bit preparation. Turning, facing, boring, cutting, and external and internal threatening practice. (2 four-hour lab sessions)
4. Milling machine operation and practice. (2 four-hour lab sessions)
5. Arc Welding process and practice. Safety rules. (2 four-hour lab sessions)
6. Oxy-acetylene welding and cutting process and practice. Safety rules. (1 four-hour lab session)
7. Project presentation and Final Written Examination. (1 four-hour lab session)

Computer Usage:

Each working team is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written using word processing programs. The numerical results should be calculated and plotted using the appropriate computer software.

ABET Category Content:

Engineering science: 2.0 credits or 100%

Prepared by: Gilmer R. Burgos  
Date: June 07, 1995.
ME 511 MECHANICAL ENGINEERING LABORATORY II

1995 Catalog Data: ME 511: Mechanical Engineering Laboratory II. Credits 1. Experience on the experimental analysis and performance of thermal devices related to the mechanical engineering field. Prerequisites: ME 428 & ME 441.


Coordinator: Jorge L. Martinez, Assistant Professor of M.E.

Goals: This course is designed to develop the ability of mechanical engineering students in the planning and design of tests for performance analysis and the presentation of results.

Prerequisites by Topics:

1. Computer programming, and applied software for engineers.
2. Numerical Analysis for Engineers.
3. Thermodynamics.

Laboratory Topics:

1. Introduction and Safety rules. (1 four-hour lab session)
2. Air Compressor Performance. (1 four-hour lab session)
3. Air-conditioning Simulation. (1 four-hour lab session)
4. Compressible Fluid Flow through convergent and convergent-divergent nozzles (1 four-hour lab session)
5. Cross Flow Heat Exchanger. (2 four-hour lab sessions)
6. Convective Heat Transfer in Pipes. (1 four-hour lab session)
7. Steam Boiler Performance. (1 four-hour lab session)
8. Oral presentations. (1 four-hour lab session)
9. Final examination. (1 four-hour lab session)

**Computer Usage:**

Every working team, composed of not more than four students, is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written using word processing programs. Numerical results should be calculated and plotted using the appropriate computer software.

**ABET Category Content:**

Engineering Science: 1.0 credits or 100%

**Prepared by:** Gilmer R. Burgos

**Date:** June 07, 1995.
ME 515 INTERNAL COMBUSTION ENGINES

A comprehensive study of ideal and actual internal combustion engine cycles.
Prerequisite: ME 431.


Carrol E. Goering, Engine and Tractor Power, American Society of
Colin R. Ferguson, Internal Combustion Engines: Applied
Edward F. Obert, Internal Combustion Engines and Air Pollution, Harper

Coordinator: Jacinto Solano, Assistant Professor of M.E.

Goals: This course is designed to let the mechanical engineering students broaden
and strengthen their previous thermodynamic knowledge of the spark-ignited
and diesel engines.

Prerequisites by topic:

1. Computer programming.
2. Stresses in machine elements.
3. Thermodynamics.
4. Gas dynamics.
5. Heat and mass transfer.

Topics:

1. Engine types and their operation (1 two-hour class)
2. Engine design and operating parameters (2 two-hour classes)
3. Properties of working fluids (1 two-hour class)
4. Ideal models of engine cycles (2 two-hour classes)
5. Gas exchange processes (2 two-hour classes)
6. S.I. engine fuel metering and manifold phenomena (1 two-hour class)
7. Charge motion within the cylinder (1 two-hour class)
8. Combustion in spark-ignition engines (2 two-hour classes)  
9. Combustion in compression-ignition engines (2 two-hour classes)  
10. Pollutant formation and control (1 two-hour class)  
11. Engine heat transfer (1 two-hour class)  
12. Engine friction and lubrication (1 two-hour class)  
13. Engine operating characteristics (2 two-hour classes)  
14. Tests (3 two-hour classes)  

**Computer usage:**  
The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.  

**Laboratory projects:** None.  

**ABET category content:**  
Engineering science: 2.0 credits or 66.7%  
Engineering design: 1.0 credits or 33.3%  

**Prepared by:** Jacinto Solano  
**Date:** Apr 26, 1995.
ME 516 MECHANICAL VIBRATIONS

Fundamentals of vibrations with application to simple machine and structural members. Harmonic motion, free and forced vibration, resonance, damping, and isolation. Single, multiple, and infinite degree-of-freedom systems.
Prerequisite: ME 421.


Coordinator: Eduardo J. Veras, Assistant Professor of M.E.

Goals: The student should become familiar with the characteristics of vibrating systems, with methods of analysis of single, multiple and infinite degrees of freedom systems, and with the importance of vibration in Mechanical design.

Prerequisites by topic:

1. Kinematics and dynamics of particles and rigid bodies.
2. Linear and angular velocity and acceleration.
4. Angular momentum principle.
5. Differential equations.
Topics:

1. Fundamentals of vibration (2 two-hour classes)
2. Free vibration of single degree of freedom systems (2 two-hour classes)
3. Harmonically excited vibration (2 two-hour classes)
4. Vibration under general forcing conditions (2 two-hour classes)
5. Two degrees of freedom systems (2 two-hour classes)
6. Multi degree of freedom systems (3 two-hour classes)
7. Determination of natural frequencies and mode shapes (1 two-hour class)
8. Continuous systems (2 two-hour classes)
9. Vibration control (3 two-hour classes)
10. Tests (3 two-hour classes)

Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credits or 33.3%

Prepared by: Eduardo J. Veras       Date: May 02, 1995.
ME 518 AIR CONDITIONING SYSTEMS DESIGN

A study of techniques used in the design of heating, ventilating, and air conditioning systems.
Prerequisite: ME 431.


Coordinator: Luis Gonzalez, Jr., Assistant Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with the fundamentals of the design techniques for heating, ventilating, and air conditioning systems, including the estimation of the thermal load, piping system, selection of components, and the automatic controls for the system.

Prerequisites by topic:

1. Working knowledge of DOS and UNIX operative systems.
3. Thermodynamics.

Topics:

1. Psychrometrics and Applied Psychrometrics (4 two-hour classes)
2. Comfort in air conditioning (2 two-hour classes)
3. Heat transfer in building sections (2 two-hour classes)
4. The cooling load (3 two-hour classes)
5. Fluid flow fundamentals and piping systems (2 two-hour classes)
6. Principles of room air distribution (2 two-hour classes)
7. Airflow in duct systems and fans (2 two-hour classes)
8. Automatic control systems and control components (2 two-hour classes)
9. Tests (3 two-hour classes)

Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credits or 33.3%

ME 519 REFRIGERATION SYSTEMS DESIGN


Coordinator: Manuel Bardález, Associate Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with the fundamentals of the design techniques for vapor-compression and absorption refrigeration systems.

Prerequisites by topic:

1. Working knowledge of DOS and UNIX operative systems.
3. Thermodynamics.

Topics:

1. Refrigerants and thermal principles (3 two-hour classes)
2. Heating and cooling load calculations (3 two-hour classes)
3. Vapor-compression cycle (2 two-hour classes)
4. Compressors (2 two-hour classes)
5. Condensers and evaporators (2 two-hour classes)
6. Expansion devices (1 two-hour class)
7. Vapor-compression-system analysis (2 two-hour classes)
8. Multi-pressure systems (1 two-hour class)
9. Absorption refrigeration (3 two-hour classes)
10. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

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<th>Category</th>
<th>Credits or Percentage</th>
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<tr>
<td>Engineering design</td>
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Prepared by: Manuel Bardález  
Date: Nov. 23, 1994.
ME 521 POWER PLANT ENGINEERING


Coordinator: Jacinto Solano, Assistant Professor of M.E.

Goals: This course is designed to provide senior students of mechanical engineering with the necessary tools to effectively use thermal energy and power through the design of optimum power plant systems.

Prerequisites by topic:

1. Computer programming, and applied software for engineers.
2. Differential and Integral Calculus.
3. Thermodynamics.

Topics:

1. Power plant thermodynamic cycles (1 two-hour class)
2. Fossil-fuel steam generators (2 two-hour classes)
3. Fuels and combustion (2 two-hour classes)
4. Turbines (2 two-hour classes)
5. The condensate-feedwater system (2 two-hour classes)
6. The circulating-water system (2 two-hour classes)
7. Gas-turbine and combined cycles (2 two-hour classes)
8. Geothermal energy (1 two-hour class)
9. Solar energy (2 two-hour classes)
10. Wind energy (1 two-hour class)
11. Environmental aspects of power generation (2 two-hour classes)
12. Tests (3 two-hour classes)

Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer program, and/or by using the corresponding computer software. Each of the design projects consists basically of a mathematical modeling of the respective power plant system, a computer simulation, and an intensive parametric analysis to get an optimized design of the power plant system.

Laboratory projects: None.

Estimated ABET category content:

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

ME 524 WASTE HEAT MANAGEMENT

Heat exchanger analysis. Waste heat recuperation at high, medium, and
low temperature. Simulation, optimization, and design of waste heat
recuperation equipment.
Prerequisite: ME 431.


References: V. Ganapathy, Waste Heat Boiler Deskbook, The Fairmont Press,
Adrian Bejan, Advanced Engineering Thermodynamics, John Wiley
Robert Goldstick, and Albert Thumann, Principles of Waste Heat

Coordinator: Jacinto Solano, Assistant Professor of M.E.

Goals: This course is designed to give the mechanical engineering
students a strong background in heat exchanger analysis, optimization
and design of waste heat recovery equipment.

Prerequisites by topic:

1. Computer programming, and working knowledge on available software.
2. Numerical analysis
3. Thermodynamics.

Topics:

1. Methods in heat exchanger analysis (4 two-hour classes)
2. Introduction to waste heat recovery (4 two-hour classes)
3. Introduction to boilers (1 two-hour class)
4. Simulation of waste heat boilers (3 two-hour classes)
5. Design of waste heat boilers (3 two-hour classes)
6. Second Law analysis of thermal systems (2 two-hour classes)
7. Entropy minimization on thermal system optimization (2 two-hour classes)
8. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer program, and/or by using the corresponding computer software. Each of the design projects consists of a mathematical modeling of the respective heat recovery system, a computer simulation, and an intensive parametric analysis, to get an optimized heat recovery system design.

Laboratory projects: None.

Estimated ABET category content:

- Engineering science: 2.0 credits or 66.7%
- Engineering design: 1.0 credit or 33.3%

Prepared by: Jacinto Solano

Date: Apr 26, 1995.
ME 525 TURBOMACHINERY

Prerequisite: ME 428.


Coordinator Manuel Bardález, Associate Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with a knowledge and understanding of the basic principles of turbomachine theory and the application of these principles to specific devices.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
3. Mathematical differentiation and integration.
5. Thermodynamics.

Topics:

1. Types of Turbomachines (1 two-hour class)
2. Basic Relations (2 two-hour classes)
3. Dimensionless Quantities (1 two-hour class)
4. Centrifugal Pumps, Fans, and Compressors (5 two-hour classes)
5. Axial-Flow Pumps, Fans, and Compressors (4 two-hour classes)
6. Gas, Steam, Hydraulic, and Wind Turbines (6 two-hour classes)
7. Tests (3 two-hour classes)
Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: None.

ABET category content:

- Engineering science: 2.0 credits or 66.7%
- Engineering design: 1.0 credit or 33.3%

ME 535 AUTOMATIC CONTROL SYSTEMS


Coordinator: Hebert Jaramillo, Assistant Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with a knowledge and a clear understanding of the basic principles of the analysis techniques used in the design of linear feedback control systems.

Prerequisites by topic:

1. Computer programming, and ability to use stored programs.
2. Working knowledge of DOS and UNIX operative systems.
4. Laplace Transforms.
6. Applied Mechanics, Dynamics.

Topics:

1. Introduction to control systems analysis. (2 two-hour classes)
2. Mathematical modeling of dynamic systems. (2 two-hour classes)
3. Basic control actions & industrial automatic controllers. (1 two-hour class)
4. Transient-response analysis & steady-state error analysis. (2 two-hour classes)
5. Root-Locus analysis. (2 two-hour classes)
6. Frequency-response analysis. (2 two-hour classes)
7. Design and compensation techniques. (2 two-hour classes)
8. Describing-Function analysis of nonlinear control systems. (2 two-hour classes)
9. Analysis of control systems in state-space. (2 two-hour classes)
10. Design of control systems by state-space methods. (2 two-hour classes)
11. Tests (3 two-hour classes)

**Computer usage:**

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

**Laboratory projects:** Correspon to ME 536 Controls laboratory.

**ABET category content:**

Engineering science: 2.0 credits or 66.7%
Engineering design: 1.0 credit or 33.3%

**Prepared by:** Hebert Jaramillo          **Date:** Nov 6, 1994.
ME 536 CONTROLS LABORATORY


Coordinator: Hebert Jaramillo, Assistant Professor of M.E.

Goals: This course is designed to develop skills of mechanical engineering students for analysis and design of mechanical control techniques associated with process plant, from single-loop analog control to multi-loop PLC systems.

Prerequisites by Topic:

1. Computer programming.
2. Solutions of Linear Ordinary Differential Equations.
3. Laplace Transforms.
5. Electric Circuit Analysis.
6. Controls theory.

Laboratory Topics:

1. Introduction. Understanding process duty and the plant hardware to achieve it. Using a PC connected to the plant to monitor measurements. (1 four-hour lab session)
2. Calibrating measurement sensors: temperature, flow, level, and power. (1 four-hour lab session)
3. Heat transfer measurements: losses and transfer coefficients. (1 four-hour lab session)
4. Simple process dynamics-first order; "dead time", mixed systems. (1 four-hour lab session)
5. Comparing control needs: flow, level, and temperature. (1 four-hour lab session)
6. On/Off and PID control actions. (1 four-hour lab session)
7. Connecting an industrial single-loop controller. Tuning an industrial controller. (1 four-hour lab session)
8. Introduction to SCADA: PC supervision of a controller. (1 four-hour lab session)
9. Direct Digital Control: using a PC with PID controllers in software. (1 four-hour lab session)
10. Oral Presentations. (1 four-hour lab session)
11. Final Comprehensive Examination. (1 four-hour lab session)

**Computer Usage:**

Every working team, composed of not more than four students, is required to submit weekly a written report corresponding to every laboratory experiment carried out. The report should be written using word processing programs. Numerical results should be calculated and plotted using the respective computer software.

**ABET Category Content:**

Engineering Science:  1.0 credits or 100.0%

**Prepared by:** Hebert Jaramillo  
**Date:** Feb. 07, 1995.
ME 543 COMPUTER-AIDED DESIGN AND
COMPUTER-AIDED MANUFACTURING


Coordinator: Eduardo J. Veras, Assistant Professor of M.E.

Goals: This course is designed to provide the mechanical engineering students with the fundamentals of computer-aided design and manufacturing, showing their analytical rigor and algorithmic nature independent of specific software implementation.

Prerequisites by topic:

1. Computer programming in C Language.
2. Working knowledge of DOS and UNIX operative systems.
5. Processes and Methods of Manufacturing.
Topics:

1. Introduction to CAD (1 two-hour class)
2. Methodology in Design and CAD/CAM (1 two-hour class)
3. Optimization and CAD (1 two-hour class)
4. Geometry Description (5 two-hour classes)
5. Solid Modeling (2 two-hour classes)
6. Finite-Element Method and CAD (3 two-hour classes)
7. Applications of CAD/CAM Technology (1 two-hour class)
8. Computer-Aided Manufacturing (3 two-hour classes)
9. Numerical Control Part Programming (2 two-hour classes)
10. Tests (3 two-hour classes)

Computer usage:

The solution of every open-ended design project assigned in class requires the intensive use of the computer through writing and running the respective computer programs, and/or by using the corresponding computer software.

Laboratory projects: Correspond to ME 544 CAD/CAM Laboratory.

ABET category content:

Engineering science: 1.5 credits or 50.0%
Engineering design: 1.5 credits or 50.0%

Prepared by: Eduardo J. Veras  
Date: Mar 5, 1995.
ME 544 CAD/CAM LABORATORY

Laboratory experimentation on Computer-Aided Design and Manufacturing.
Experimentation on each phase of the design process and the corresponding
automated manufacturing through CNC interphase to lathe and milling
machines.
Prerequisites: ME 421 & ME 445.
Corequisite: ME 543.

Textbook:  McManon C., and Browne J., CAD/CAM: From Principles to Practice,

References:  NauFara F., Ucello T., and Murphy D., The CNC Workbook, An
Introduction to Computer Numerical Control", Addison-Wesley
Farid M.L. Amirouche, Computer Aided Design and Manufacturing,
U. Rembold, B.O. Nnaji, and A. Storr, Computer Integrated
Dean L. Taylor, Computer-Aided Design, Addison-Wesley Publishing Co.,
T.C. Chang, R.A. Wysk, and H.P. Wang, Computer-Aided Manufacturing,
E. J. Hang, Computer-Aided Kinematics and Dynamics of Mechanical
Y.C. Pao, Elements of Computer-Aided Design and Manufacturing, John
Wiley and Sons, 1985.

Coordinator:  Eduardo J. Veras, Assistant Professor of M.E.

Goals:  This course is designed to give mechanical engineering students the
necessary working knowledge to design and manufacture a product, using
computers and numerical controlled machines.

Prerequisites by topic:

1. Working knowledge on computer graphics.
2. Working knowledge on finite element analysis.
3. Working knowledge on machine tool operation.
Topics and Laboratory Projects:

1. Introduction. Safety rules. Course description. (1 four-hour lab session)
2. CAD. Finite Element Analysis of Machine Components. (2 four-hour lab sessions)
3. NC Programming and simulation. NC Direct programming for a lathe and a milling machine. (2 four-hour lab sessions)
4. CNC Programming for a Lathe. Threading. (1 four-hour lab session)
5. Taper shaft. (1 four-hour lab session)
6. Fillet cutting. (1 four-hour lab session)
7. CNC Programming for a milling machine. Point to Point programming. (1 four-hour lab session)
8. Contouring. (1 four-hour lab session)
9. Final Oral Presentations. (1 four-hour lab session)
10. Final comprehensive Examination. (1 four-hour lab session)

Computer Usage:

The main feature of this course is the requirement of an intensive computer use to carry out the computerized mechanical design and the corresponding automated manufacturing. Students are required to submit weekly a written report corresponding to every laboratory session. The report should be written in English using a word processor program.

ABET Category Content:

Engineering Science: 1.0 credits or 100.0%

ME 546 MECHANICAL ENGINEERING PRACTICE

This industry-training course consists of a minimum of two-hundred hours of industry-based mechanical engineering practice for senior mechanical engineering students under the guidance and supervision of professional mechanical engineers from the industry.
Prerequisites: ME432, ME 543, & ME544.

Textbook: None.


Coordinator: Mechanical Engineering Department Head.

Goals: Provide mechanical engineering students with a hands-on experience with a senior level, industrially sponsored mechanical engineering practice that simulates an entry level industrial experience. The student is exposed to a real working environment at the manufacturing industry facilities for at least two-hundred hours under the supervision of a licensed mechanical engineer who assigns the mechanical engineering practitioner the duties, which include the required design projects for grading purposes.

Prerequisites by topic:

1. Machine and thermal design.
3. Automatic controls
Topics:

Since this course is offered in close cooperation with a sponsoring industrial company and as a consequence it is carried out by the senior level mechanical engineering student in the industry, the topics considered may vary according to the sponsoring industry requirements; some representative topics that should be included in the design projects are at least the following:

1. Mechanical engineering design and manufacturing processes
2. Design of thermal systems
3. Controls of mechanical systems
4. Project management
5. Economics in engineering
6. Written reports and oral presentations

Computer usage:

Emphasis is placed on engineering modeling and design in a computational environment. Systems and sub-systems developed around the design projects may include writing C, FORTRAN, or BASIC programs and using related software.

Laboratory projects:

The final report for the design project may include laboratory work to produce data. Intermediate and final design reviews are presented by the practitioner to the industrial sponsor supervisor and the engineering faculty.

ABET category content:

Engineering science : 2.0 credits or 66.7%
Engineering design : 1.0 credits or 33.3%

ME 555 MECHANICAL ENGINEERING DESIGN PROJECT I

1995 Catalog Data: ME 555 Mechanical Engineering Design Project I. Credits 2. Practice in engineering design through term-long projects chosen to integrate significant portions of material covered in prerequisite courses. Emphasizes creative solutions to current engineering design problems, teamwork, analysis, and synthesis. Lectures address the breadth of topics involved in engineering design from mathematical and analytical techniques to human-machine interactions, economics, computer modeling and simulation. Construction of prototypes by the design working teams using ME laboratories is also emphasized. Prerequisites: ME536, ME543, & ME544.

Textbook: None.


Coordinator: Eduardo J. Veras, Assistant Professor of M.E.

Goals: This course is designed to expose mechanical engineering senior students to a meaningful major engineering design experience and practice in the application of many mechanical design concepts, including system dynamics and control components. Students working in groups will develop the conceptual design, mathematical, computer modeling and simulation of prototype devices in response to requests from industrial sponsors, faculty members or student proposals. Emphasis is placed on creativity, application of engineering sciences to design, team work, communication (orally and written), and ethics.
Prerequisites by topic:

1. Domain of computer softwares.
2. Rate of return, present and future worth of money, and alternative evaluations.
3. Stress-strain relationships, failure criteria and safety factors.
4. Spatial visualization and orthographic projections.
5. Continuous systems, MDOF systems, modes and frequency responses.
6. Kinematics of particles and rigid bodies.
7. Laplace transform, transfer functions, stability and time-domain of control systems.
8. Material properties, machining, joining and manufacturing processes.

Topics:

1. Engineering design and manufacturing processes. (1 two-hour class)
2. Project management. (2 two-hour classes)
3. Economics in engineering. (2 two-hour classes)
4. Basics of Finite Element Analysis, FEA. (3 two-hour classes)
5. Descriptive geometry, dimensioning and tolerances. (2 two-hour classes)
6. Structural dynamics. (2 two-hour classes)
7. Kinematics design: analysis and synthesis. (2 two-hour classes)
8. Automatic control systems. (2 two-hour classes)
9. Manufacturing processes and methods. (2 two-hour classes)
10. Progress reports. (4 two-hour classes)

Computer usage:

Extensive use existing and programmed computer applications. Emphasis is placed on engineering modeling and design in a computational environment. Systems and sub-systems developed around the capstone design topics include writing C, FORTRAN, or BASIC programs and using software, running in the computer center network at the PUPR.

Laboratory projects:

Basically the laboratory projects of this course correspond to the construction of prototypes and their evaluation. The instructor assigns the projects to the design working groups every quarter, and they vary from quarter to quarter.

ABET category content:

Engineering design: 2.0 credits or 100.0%

ME 560 MECHANICAL ENGINEERING DESIGN PROJECT II

1995 Catalog Data: ME 560 Mechanical Engineering Design Project II. Credits 2.
Emphasis is placed on carrying out industry-based engineering design projects
which are performed in close cooperation with industry in Puerto Rico.
Prerequisites: ME536, ME543, & ME544.

Textbook: None.

References: A. Ertas, and J. C. Jones, The Engineering Design Process, John Wiley and
F.M.L. Amirouch, Computer-Aided Design and Manufacturing,
J. R. Meredith and S. I. Martel, Jr., Project Management: A Managerial Approach,
G. E. Dieter, Engineering Design: A Materials and Processing Approach,

Coordinator: Jorge L. Martínez, Assistant Professor of M.E.

Goals: Provide students with a hands-on experience with a senior level,
industrially sponsored design project that simulates an entry level industrial experience. The design team, with guidance from instructor and engineers from industry, must apply an efficient design methodology to produce an engineering design in response to requests of the industrial sponsor.

Prerequisites by topic:

1. Senior level.
3. Thermal design.
5. Domain of computer software.
6. Gantt Charts, PERT and CPM methods.
7. Rate of return, present and future worth of money, and alternative evaluations.

Topics:

1. Advanced engineering design and manufacturing processes (2 two-hour classes)
2. Project management. (4 two-hour classes)
3. Economics in engineering. (4 two-hour classes)
4. Oral presentation skills (4 two-hour classes)
5. Descriptive geometry, dimensioning and tolerances. (2 two-hour classes)
6. Working visits to the sponsor facilities (6 two-hours classes)

Computer usage:

Extensive use existing and programmed computer applications. Emphasis is placed on engineering modeling and design in a computational environment. Systems and sub-systems developed around the capstone design topics include writing C, FORTRAN, or BASIC programs and using software running in the computer center network at the PUPR.

Laboratory projects:

The final report for the design project may include laboratory work to produce data. Intermediate and final design reviews are presented by the design team to the industrial sponsor and the engineering faculty.

ABET category content:

Engineering design : 2.0 credits or 100.0%

Prepared by: Jorge L. Martínez       Date: March 6, 1995.
### E. Basic-level curriculum

Table XII shows the course requirements of the ME curriculum.

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<td><strong>TOTALS-ABET BASIC-LEVEL REQUIREMENT</strong></td>
<td><strong>37.5</strong></td>
<td><strong>65.0</strong></td>
<td><strong>25.0</strong></td>
<td><strong>21.0</strong></td>
</tr>
<tr>
<td></td>
<td><strong>OVERALL TOTAL FOR DEGREE</strong></td>
<td><strong>37.5</strong></td>
<td><strong>65.0</strong></td>
<td><strong>25.0</strong></td>
<td><strong>21.0</strong></td>
</tr>
<tr>
<td></td>
<td><strong>PERCENT OF TOTAL</strong></td>
<td><strong>21.7</strong></td>
<td><strong>37.6</strong></td>
<td><strong>14.4</strong></td>
<td><strong>12.1</strong></td>
</tr>
</tbody>
</table>

*Must satisfy one set of conditions*

- Minimum semester credit hours: 32 32 16 16
- Minimum quarter credit hours: 48 48 24 24
- Minimum percentage: 25 25 12.5 12.5
F. Alternative modes

The Mechanical Engineering program does not offer any alternative mode to the basic-level curriculum as presented in Sections XII.D and XII.E.

G. Advanced-level curriculum

Currently, no advanced-level or graduate program is offered by the Department of Mechanical Engineering at PUPR.

H. Advising system

The PUPR's advising system mainly consists of professional counseling, academic advisement and faculty mentoring. The system is designed to help every student before, and during registration, in the selection and sequence of required and elective courses. This assistantship is available throughout the five-year program.

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

The second and third year students receive the academic advisement from the Assistant to the ME Department Head for Student Affairs. The assistant insures the compliance of the current curriculum paying attention to the individual needs of each student. The same service is offered to the fourth and fifth year student by the full time faculty (i.e., faculty mentoring). At this level, a comprehensive analysis of the student record is required to verify the completion of the ME program requirements. This task is currently performed by the Assistant to the ME Director for Student Affairs, but mentors have been training in this duty.

For transfer students, the Admissions Office sends each record to the ME Department Head and his Assistant for Student Affairs to evaluate the courses needed to fulfil the requirements of the ME curriculum. This is done according to the current institution's policy for transfer credits.

I. Verification of student programs of study

The student's mentor reviews the student's schedule each quarter term to verify the student program of studies before the student registers. The registrar is responsible for confirming at the time of graduation that all of the requirements for the bachelor of science degree in mechanical engineering have been satisfied. The Department Head does not approve any degree plan which does not satisfy the ABET requirements.
J. Transfer credit

The current PUPR policy and procedure regarding transfer credits are as follows. Only those courses approved with a satisfactory grade (i.e., 'A', 'B' or 'C') in a recognized and accredited institution of higher education are considered. The course should have at least 75% of the content of the equivalent course in the PUPR, and it should be approved during the seven years before the date of admission.

For the courses approved in other colleges and/or universities, a maximum of 2/3 of the total credits of the program can be accepted, and no more than 50% of the specialized courses. For ME program, that represents a maximum of 86 credits of the program, and 34 credits of the ME courses. Exceptions can be made with the recommendation of the Dean of the Engineering Faculty.

Using the official transcript of the student, and the catalog of the institution where the student came from, the Admissions Office checks those courses that can be accepted as transfer credits. Then, the Admissions Office may report to the Department Head the equivalencies considered for approval.

K. Oral and written communication

Puerto Rico has two official languages (i.e., English and Spanish), therefore, PUPR students have an advantage over many students in the continental USA. Although, Spanish is widely spoken in most activities in Puerto Rico, engineering education is based on English. Most of the textbooks, technical reports, magazines, and journals read by the PUPR engineering students are written in this language. Also, the examinations for professional registration, which are prepared by the NCEES and administered by the Puerto Rico's Examination Board of Engineers, Architects and Surveyors, are in English. Since professional registration (i.e., Professional Engineer or Engineer-in-Training certification) is required by law to perform the engineering practice, a domain of the English language is a vital need.

Most of the classes in the PUPR are taught in Spanish, but the exams and projects' instructions are commonly prepared in English. Students are also encouraged to submit exam answers, laboratory and project reports in English.

To improve the oral and written communications skills, the following courses are provided:

ENGL 111  English Reading and Writing 3 credits (graduation requirement)
ENGL 251  Analysis of World Literature 3 credits (graduation requirement)

The following courses are designed for those students who show deficiencies in English at the time of the admission to the PUPR. Those courses are requirements of graduation for those who obtain a poor score in the English part of the aptitude test administered by the College Entrance Examination Board (CEEB).
ENGL 100  Preparatory English 3 credits
ENGL 110  English Grammar 3 credits

Also, some elective courses in English Literature are proposed for those who are interested.

LITE 441  American Literature 3 credits (optional)
LITE 541  Comparative Literature 3 credits (optional)

L. Computer experience

Computer is an integral part of the ME program, and students should use it throughout their five years of study. The following courses, which are required by the current ME Curriculum, are designed to provide an experience in the use of computers at different levels.

<table>
<thead>
<tr>
<th>COURSE</th>
<th>TOPIC</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 131</td>
<td>Engineering Graphics - Computer Aided Drafting</td>
<td>2</td>
</tr>
<tr>
<td>ENGI 220</td>
<td>Computer Programming and Algorithms - C language</td>
<td>3</td>
</tr>
<tr>
<td>ME 247</td>
<td>Applied Numerical Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ME 311</td>
<td>Applied Software for Mechanical Engineers</td>
<td>3</td>
</tr>
<tr>
<td>ME 543</td>
<td>Computer Aided Design and Manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>ME 544</td>
<td>CAD/CAM Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

Furthermore, most of the ENGI and ME courses require the completion of design projects that also need the computer usage. Therefore, students have to interact constantly with computer applications, and they are exposed to a broad sample of softwares and codes.

M. Laboratory experience

One aspect emphasized in the growth of the ME program has been the laboratory experience. Laboratory facilities and courses have been developed to provide a complementary assistance to the lecture taught during the class period. This development has been done trying to balance the most general areas of the ME field. The result of this development is the following list of laboratory courses that each ME student should take:
<table>
<thead>
<tr>
<th>LAB COURSE</th>
<th>TOPIC</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCIE 112</td>
<td>General Chemistry I</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 124</td>
<td>General Chemistry II</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 214</td>
<td>Physics: Mechanics</td>
<td>1</td>
</tr>
<tr>
<td>SCIE 236</td>
<td>Physics: Heat, Light and Sound</td>
<td>1</td>
</tr>
<tr>
<td>SCIE 250</td>
<td>Physics: Electricity and Magnetism</td>
<td>1</td>
</tr>
<tr>
<td>ENGI 328</td>
<td>Fluid Mechanics</td>
<td>1</td>
</tr>
<tr>
<td>EE 4801</td>
<td>Industrial Electronics</td>
<td>1</td>
</tr>
<tr>
<td>ME 344</td>
<td>Metallurgy</td>
<td>1</td>
</tr>
<tr>
<td>ME 441</td>
<td>Measurements in Thermal and Mech. Equip.</td>
<td>1</td>
</tr>
<tr>
<td>ME 445</td>
<td>Manufacturing (Welding and Machining)</td>
<td>2</td>
</tr>
<tr>
<td>ME 511</td>
<td>Performance of Thermal and Mech. Equip.</td>
<td>1</td>
</tr>
<tr>
<td>ME 536</td>
<td>Automatic Controls</td>
<td>1</td>
</tr>
<tr>
<td>ME 544</td>
<td>CAD/CAM</td>
<td>1</td>
</tr>
</tbody>
</table>

Only ENGI 328 and those laboratory courses with a ME code are managed by the ME Department. The others laboratories are served by other departments at the PUPR.

Safety rules and procedures of the ME laboratories are discussed prior to the use of the laboratory equipment. The development of these laboratories and their safety rules are in charge of the Laboratory Coordinator of the ME Department.

N. Engineering design experience

The required courses in the mechanical engineering program satisfy 22 credit-hours of design. The design content is distributed throughout the curriculum. In addition, during their fifth year, the students take three elective courses which will provide them with additional three credit-hours of design.

Issues related to aesthetics, ethics and social impact, economic factors, safety, and reliability are discussed in the mechanical engineering design projects, and also in the three elective courses. As part of the mechanical engineering design project the students are required to complete an economic analysis of the project.

A summary of the required design component, the quarter term and year in which they are taken in the program is detailed as follows:
## Mechanical Engineering Program

### Required Courses with Design Content

<table>
<thead>
<tr>
<th>Year/Term</th>
<th>Course</th>
<th>Course Credits</th>
<th>Design Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3</td>
<td>ENGI 146 Freshman Engineering Design</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>2/3</td>
<td>ENGI 324 Mechanics of Materials I</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>2/4</td>
<td>ENGI 325 Engineering Mechanics, Dynamics</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>3/1</td>
<td>ENGI 327 Fluid Mechanics</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>3/1</td>
<td>ME 311 Applied Software for ME</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>3/1</td>
<td>ME 331 Thermodynamics I</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>3/2</td>
<td>ME 341 Thermodynamics II</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>3/2</td>
<td>ME 342 Kinematics Design</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>3/3</td>
<td>ME 343 Physical Metallurgy</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>3/4</td>
<td>ME 410 Stresses in Machine Elements</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>4/1</td>
<td>ME 411 Design of Machine Elements</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>4/1</td>
<td>ME 428 Gas Dynamics</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>4/1</td>
<td>ME 430 Heat Transfer I</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>4/2</td>
<td>ME 421 Design of Mechanical Systems</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>4/2</td>
<td>ME 431 Heat Transfer II</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>4/3</td>
<td>ME 432 Design of Thermal Systems</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>4/4</td>
<td>ME 444 Processes and Methods of Mfg.</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>5/1</td>
<td>ME 535 Automatic Control Systems</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>5/2</td>
<td>ME 543 Computer Aided Design and Mfg.</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>5/2</td>
<td>Elective course I</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>5/3</td>
<td>ME 555 ME Design Project I</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>5/3</td>
<td>Elective course II</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>5/4</td>
<td>ME 560 ME Design Project II</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>5/4</td>
<td>Elective course III</td>
<td>3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Total Design credits in ME Program**: 25.0
### O. Course/Section Size

#### 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 Class&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Lab.</td>
<td>Recit.</td>
</tr>
<tr>
<td>ENGI 325</td>
<td>Engineering Mechanics, Dynamics</td>
<td>4/quarter</td>
<td>27</td>
<td>100%</td>
</tr>
<tr>
<td>ENGI 327</td>
<td>Fluid Mechanics</td>
<td>6</td>
<td>16</td>
<td>100%</td>
</tr>
<tr>
<td>ENGI 328</td>
<td>Fluid Mechanics Laboratory</td>
<td>6</td>
<td>13</td>
<td>100%</td>
</tr>
<tr>
<td>ME 247</td>
<td>Applied Numerical Methods</td>
<td>1</td>
<td>29</td>
<td>80%</td>
</tr>
<tr>
<td>ME 311</td>
<td>Applied Software for ME</td>
<td>1</td>
<td>27</td>
<td>50%</td>
</tr>
<tr>
<td>ME 331</td>
<td>Thermodynamics I</td>
<td>2</td>
<td>28</td>
<td>100%</td>
</tr>
<tr>
<td>ME 341</td>
<td>Thermodynamics II</td>
<td>1</td>
<td>21</td>
<td>100%</td>
</tr>
<tr>
<td>ME 342</td>
<td>Kinematics Design</td>
<td>1</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>ME 343</td>
<td>Physical Metallurgy</td>
<td>1</td>
<td>28</td>
<td>100%</td>
</tr>
<tr>
<td>ME 344</td>
<td>Physical Metallurgy Laboratory</td>
<td>2</td>
<td>10</td>
<td>100%</td>
</tr>
<tr>
<td>ME 410</td>
<td>Stresses in Machine Elements</td>
<td>1</td>
<td>21</td>
<td>100%</td>
</tr>
<tr>
<td>ME 411</td>
<td>Design of Machine Elements</td>
<td>1</td>
<td>20</td>
<td>100%</td>
</tr>
<tr>
<td>ME 421</td>
<td>Design of Mechanical Systems</td>
<td>1</td>
<td>23</td>
<td>100%</td>
</tr>
<tr>
<td>ME 428</td>
<td>Gas Dynamics</td>
<td>1</td>
<td>19</td>
<td>100%</td>
</tr>
<tr>
<td>ME 430</td>
<td>Heat Transfer I</td>
<td>1</td>
<td>14</td>
<td>100%</td>
</tr>
<tr>
<td>ME 431</td>
<td>Heat Transfer II</td>
<td>1</td>
<td>38</td>
<td>100%</td>
</tr>
</tbody>
</table>

<sup>1</sup> Type of Class

<sup>2</sup> Other (Specify)
<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>ME 432</td>
<td>Design of Thermal Systems</td>
<td>1/quarter</td>
<td>16</td>
<td></td>
<td>90%</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>ME 441</td>
<td>ME Laboratory I</td>
<td>2</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 444</td>
<td>Processes and Methods of Manufacturing</td>
<td>1</td>
<td>27</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 445</td>
<td>Manufacturing Laboratory</td>
<td>2</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 511</td>
<td>ME Laboratory II</td>
<td>2</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 515</td>
<td>Internal Combustion Engines</td>
<td>1</td>
<td>26</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 518</td>
<td>Air Conditioning Systems Design</td>
<td>1</td>
<td>25</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 521</td>
<td>Power Plant Engineering</td>
<td>1</td>
<td>25</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 525</td>
<td>Turbomachinery</td>
<td>1</td>
<td>10</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 526</td>
<td>Automatic Controls Systems</td>
<td>1</td>
<td>21</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 536</td>
<td>Controls Laboratory</td>
<td>1</td>
<td>16</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 543</td>
<td>Computer Aided Design</td>
<td>1</td>
<td>16</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
<td>Industry Practice</td>
</tr>
<tr>
<td>ME 544</td>
<td>CAD/CAM Laboratory</td>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 546</td>
<td>ME Practice</td>
<td>1</td>
<td>26</td>
<td>40%</td>
<td>40%</td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>ME 555</td>
<td>ME Design Project I</td>
<td>1</td>
<td>10</td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td>Industry based Project</td>
</tr>
<tr>
<td>ME 560</td>
<td>ME Design Project II</td>
<td>1</td>
<td>10</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**P. How the humanities and social sciences "breadth and depth" requirements are satisfied**

The ME curriculum is designed to spread the socio-humanistic courses along the five years of study. It is an objective to present these courses to the student as an integrated component of the program. In order to satisfy the breadth requirement, the curriculum contains the following courses.

<table>
<thead>
<tr>
<th>COURSE</th>
<th>TOPIC</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 251</td>
<td>Analysis of World Literature</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 251</td>
<td>Hispanic Literature</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 251</td>
<td>Socio-Humanistic Studies I</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 252</td>
<td>Socio-Humanistic Studies II</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 441</td>
<td>Professional Ethics in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

In addition, every student is required to select six (6) more credits from one of eight (8) topics to satisfy the depth criterion. These topics are: Economics, Politics, Psychology, Philosophy, History, Literature, Puerto Rican Studies, and Socio-humanistics related to Engineering.

**Q. Parts of the curriculum in which probability and statistics are applied to engineering problems**

ME program dedicates 3 credit-hours to the study of probability and statistics through ENGI 235 (Probability and Statistics for Engineers), which is taught by the Department of Industrial Engineering. This course is a requirement for all of the ME laboratory courses, where the knowledge of probability and statistics is applied. In some other courses as ME 410, 411 and 421 (i.e., Stress in Machine Elements, Design of Machine Elements, and Design of Mechanical Systems, respectively) the applications of probability and statistics are also required.
XIII. LABORATORY FACILITIES

A. In Table XIV summarize the laboratories used for instruction related to this program and describe their adequacy for instruction, condition, number of student stations, and square feet of space. If the same facility is used for more than one laboratory, list it only once and describe the various uses. If any detailed explanation is necessary provide it in response to the items below.

<table>
<thead>
<tr>
<th>Physical Facility (Bldg. &amp; Room No)</th>
<th>Purpose of Laboratory Inc. Courses Taught</th>
<th>Condition of Labs</th>
<th>Adequacy for Instruction</th>
<th>Number of Student Stations</th>
<th>Area (sq.ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L101</td>
<td>Thermology II Laboratory ME 511, ME 341, ME 432</td>
<td>Good</td>
<td>Adequate</td>
<td>1</td>
<td>964</td>
</tr>
<tr>
<td>L106</td>
<td>Physical Metallurgy Laboratory ME 343, ME 344</td>
<td>Updated 94</td>
<td>Good</td>
<td>5</td>
<td>942</td>
</tr>
<tr>
<td>L111</td>
<td>Manufacturing Laboratory ME 444, ME 445</td>
<td>Good</td>
<td>Good</td>
<td>5</td>
<td>1,944</td>
</tr>
<tr>
<td>L401 - L402</td>
<td>Fluid Mechanics Laboratory ENGI 328</td>
<td>Updated 94</td>
<td>Good</td>
<td>4</td>
<td>1,832</td>
</tr>
<tr>
<td>L403</td>
<td>Mechatronics Laboratory ME 535, ME 536</td>
<td>New</td>
<td>Adequate</td>
<td>2</td>
<td>942</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Area</td>
<td>6,624</td>
</tr>
</tbody>
</table>

II - 98
**TABLE XIV (Continued)**

**LABORATORY FACILITIES**

Program of Mechanical Engineering

<table>
<thead>
<tr>
<th>Physical Facility (Bldg. &amp; Room No)</th>
<th>Purpose of Laboratory Inc. Courses Taught</th>
<th>Condition of Labs</th>
<th>Adequacy for Instruction</th>
<th>Number of Student Stations</th>
<th>Area (sq.ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L404</td>
<td>Computer Aided Manufacturing Lab (CAM) ME 543, ME 544</td>
<td>New</td>
<td>Adequate</td>
<td>1</td>
<td>941</td>
</tr>
<tr>
<td>L406</td>
<td>Computer Aided Design Lab (CAD) ME 543, ME 544</td>
<td>New</td>
<td>Good</td>
<td>10</td>
<td>942</td>
</tr>
<tr>
<td>L408 - 409</td>
<td>Thermology I Laboratory ME 441, ME 511</td>
<td>Updated'94</td>
<td>Good</td>
<td>1</td>
<td>1,807</td>
</tr>
</tbody>
</table>

|                           |                                          |                  |                          | Total Area Grand Total    | 10,314       |
B. Provide an assessment of equipment and instrumentation available in each laboratory to meet instructional needs.

FLUID MECHANICS LABORATORY - This laboratory consists of 1,832 square feet located in Room L401-L402 Laboratory Bldg. The laboratory involves a wide range of equipment for the measurement and characterization of the flow of liquids, and the study of statics of fluids. Special interest is taken in the statistical analysis of experimental data and in the report writing. The laboratory is primarily used for students of Mechanical and Civil Engineering registered in ENGI 328 - Fluid Mechanics Laboratory.

PHYSICAL METALLURGY LABORATORY - This laboratory consists of 942 square feet located in Room L106 Laboratory Bldg. The laboratory is used for ME 344 - Physical Metallurgy Laboratory. Equipment includes sectioning, mounting, grinding, polishing, etching, and photo microscopy for macroscopic and microscopic examination of materials. Two furnaces for heat treatments, a Jominy Fixture, and Brinell and Rockwell Hardness Testers are available. A 10,000-pound ATS Universal Testing Machine with data analysis system and appropriate instrumentation for the characterization of Pb-Sn phase diagrams are also available.

MANUFACTURING LABORATORY - This Laboratory consists of 1,944 square feet located in Room L111 Laboratory Bldg. The laboratory is used for ME 445 - Manufacturing Laboratory. In this laboratory, students work on machining and welding processes. Five lathes, a milling machine, and appropriate tools and accessory equipment are available for the training in the machining processes. Students are required to machine a small mechanical assembly such as bolt and nut. Furthermore, five cubicles with an Arc-Welding machine and Oxy-Acetilene facilities each are available for the training in welding processes. This laboratory has a two-stage reciprocating compressor used in an experiment by students registered in ME 511 - Mechanical Engineering Laboratory II.

THERMOLOGY I LABORATORY - This laboratory consists of 1,807 square feet located in Room L408-L409 Laboratory Bldg. The laboratory is used by students in ME 441 - Mechanical Engineering Laboratory I - and by students in ME 511 - Mechanical Engineering Laboratory II. This facility includes a temperature measurement unit, calorimeter, viscosimeter, heat radiation unit, heat transfer apparatus, air duct with an air-conditioning unit, computer linked cross flow heat exchanger, nozzle pressure distribution unit, combustion analyzer, and diesel engine, electric home air conditioner, and solar energy simulators.

THERMOLOGY II LABORATORY - This laboratory consists of 964 square feet located in Room L101 Laboratory Bldg. The laboratory is used by students in ME 511 - Mechanical Engineering Laboratory II. A 10-BHP Fulton Boiler along with a condensate return system, water softener, and blow off separator is available.
COMPUTER AIDED DESIGN LABORATORY (CAD) - This laboratory consists of 942 square feet located in Room L406 Laboratory Bldg. This is a new laboratory that will be used by students in ME 544 - CAD/CAM Laboratory. This laboratory will aid the students in the total design process with the objective of to increase the productivity and to create a database for manufacturing. This laboratory will also be used by students in ME 543 - CAD/CAM, and ME 311 - Applied Software. The laboratory will be equipped with ten (10) PC Pentium 90, 16MB RAM, 15" SVGA Monitor and appropriate software such as AutoCad 12 for computer aided drafting, Design View for geometry analysis, Ansys for finite element analysis, and Bobcad Gold for interface with a CNC lathe/milling machine.

COMPUTER AIDED MANUFACTURING LABORATORY (CAM) - This laboratory is located in Room L404 Laboratory Bldg. This is a new laboratory that will be equipped with a CNC Lathe/Milling machine, and will be used by students in ME 544 - CAD/CAM Laboratory. In this facility students will be involved with the process of manufacturing machined parts in a production environment, as controlled and allocated by a computarized controller. Students will be required to design and machine actual mechanical components.

MECHATRONICS LABORATORY - This laboratory is located in Room L403 Laboratory Bldg. This is also a new laboratory that will be used by students in ME 536 - Controls Laboratory. The laboratory will include a Process Plant Trainer for the control of level, flow, and temperature, and a Pressure Control Unit. The system will use a PID controller, a PLC, and computer interface to study the different types of signals and controls.

The equipment described for CAD, CAM, and Mechatronics Laboratories there are not currently in our facilities but at this time they have been ordered.

C. List new equipment and instrumentation installed in each laboratory since the last EAC/ABET visit (or during the last six years if this is an initial evaluation)

The equipment and most relevant instrumentation installed in each laboratory are listed in the Laboratory Development Plan presented in Appendix A, from Table 7 to 13. Tools, spare parts, materials, furniture, and safety equipment are not listed there in order to present the most relevant equipment.

D. List the critical needs (equipment, space, staff, etc.) for each laboratory course and describe plans for satisfying these needs.

Despite the current laboratory equipment cover a wide range of experiments in the major areas of Mechanical Engineering, there is a need of equipment to fulfill an appropriate number of student stations per lab, and to cover specific areas in which there is a lack of equipment or for replacement. The equipment needed in the different laboratories for the following six years (1995-2001) are listed in the Laboratory Development Plan presented in Appendix A, from Table 15 to 20. Currently, the space for each laboratory is very suitable with enough for future growth.
E. Describe specific plans (including resources) for the continued updating and development of the instructional laboratories of the program. Include mechanisms for the timely replacement of obsolete equipment, the addition of equipment for increased section sizes, and plans for modifying present laboratory space and acquiring new space when it is required.

The laboratories of the Mechanical Engineering Department are found in a new laboratory building. The University constructed this building to be shared with the Civil, Electrical, and Industrial Engineering Departments. Currently, the space for each laboratory is adequate and suitable to house future equipment and we do not hope the number of students per section will be increased in the future.

The plan for acquisition of new equipment and replacement was mentioned in section D. The financial resources for this purpose are stated in Chapter VI Supporting Facilities of the Self Study Volume I.

F. Describe provisions for maintaining and serving laboratory equipment. Identify technicians and/or graduate students used to maintain a service this equipment.

The maintenance of most of the laboratory equipment, and the inventory of spare parts and materials, are performed under the supervision of the Laboratory Coordinator with the aid of two undergraduates. However, external maintenance is required for some equipment such as the Steam Boiler, Compressors, Lathes, Milling Machine, and Microscopes. In addition, external consultants are periodically hired for the inspection of equipment requiring certification of operation.

The Mechanical Engineering Department has the support of a full-time lab technician for mainly the Manufacturing Laboratory. He also supports the other laboratories as part of his duties. We have the service of a janitor by floor. Secretarial help is limited to typing of communications.
XIV. STUDENT DEVELOPMENT IN ENGINEERING PROFESSIONAL PRACTICE

A. Development of ethical, social, safety, and economic considerations in engineering practice

The ME program at the PUPR seeks to develop highly qualified professionals with an integrated vision of the general culture, ethics and social responsibilities. Through the socio-humanistic component of the ME curriculum, the student obtains an understanding of the general culture and society. As mentioned before, this component consists of the following courses:

<table>
<thead>
<tr>
<th>COURSE</th>
<th>TOPIC</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 111</td>
<td>English: Reading and Writing</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 111</td>
<td>Spanish: Reading and Writing</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 251</td>
<td>Analysis of World Literature</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 251</td>
<td>Hispanic Literature</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 251</td>
<td>Socio-Humanistic Studies I</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 252</td>
<td>Socio-Humanistic Studies II</td>
<td>3</td>
</tr>
</tbody>
</table>

In addition, six (6) credit-hours should be taken in one of the following topics: Economics, Politics, Psychology, Philosophy, History, Literature, Socio-humanistics related to Engineering, and Puerto Rican Studies.

The ethical and economical aspects of the engineering practice are discussed in detail in courses PHIL 441 and ENGI 449 (i.e., Ethics in Engineering and Engineering Economics, respectively). Meanwhile, common safety procedures are emphasized in laboratory courses.

Moreover, the design projects assigned throughout the junior and senior years provide the opportunity to expose the student to the ethical, legal, social, economical, and safety considerations in engineering design. This opportunity is higher through the experience in the capstone design projects, ME 555 and ME 560.

B. Participation and membership in technical, professional, and/or honor societies closely associated with the program.

At the present, the ME students have the opportunity to be student members of the professional organizations listed below.

- The Institute of Mechanical Engineers (IIM) of the Association of Engineers and Surveyors of Puerto Rico (CIAPR)
- American Society of the Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)
- Society of Automotive Engineers (SAE)
The PUPR and the corresponding society formally recognize these student chapters. To receive the recognition at the PUPR, each chapter should submit to the Dean of Students a written application including: the name of the organization, its objectives, the governing laws and rules (i.e., constitution), the list of members, and the plan of activities. Through the Dean of Students, the chapters may receive support for clerical work and supplies. Also, the facilities of the Institution are available to the chapters with the approval of the Dean of Students, the Dean of Administration and/or the Dean of the Engineering Faculty.

Each chapter receives support from the ME department through a faculty member, who acts as a counselor. The following professors are in charge of this duty.

<table>
<thead>
<tr>
<th>STUDENT CHAPTER</th>
<th>PROFESSOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>- IIM / CIAPR</td>
<td>Víctor González (part-time)</td>
</tr>
<tr>
<td></td>
<td>Jorge L. Martínez (full-time)</td>
</tr>
<tr>
<td>- ASHRAE</td>
<td>Luis González, Jr. (part-time)</td>
</tr>
<tr>
<td>- SAE</td>
<td>Jorge L. Martínez (full-time)</td>
</tr>
<tr>
<td></td>
<td>Eduardo Veras (full-time)</td>
</tr>
<tr>
<td></td>
<td>Jacinto Solano (full-time)</td>
</tr>
</tbody>
</table>

C. Interaction between students and practitioners in industry, government, and private practice

As mentioned in Section XI.G, the local industry employs around 60% of the students at the junior and senior level. Most of them are positioned somehow related to the engineering field. Furthermore, the ME program increases the student opportunities to interact with some future fellows through the capstone course, ME 560 - Project Design of Mechanical Engineering II, and the Mechanical Engineering Practice, ME 543. Since ME 560 is a graduation requirement, there is at least one course devoted to provide the exchange of ideas between the students and the practitioners.

The student chapters of the engineering societies also promote the communication between students and professional engineers. This communication is mainly carried out along the chapter activities, such as, field trips, technical talks and social meetings.

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

The Commonwealth of Puerto Rico through law PR 173 establishes the following requirements for the engineering practice in Puerto Rico:
- To be granted with a bachelor degree in engineering from a recognized university.
- To be registered in the Department of State of the Commonwealth of Puerto Rico.
- To be an active member of the Association of Engineers and Surveyors of Puerto Rico (CIAPR)

The professional registration is awarded to those who have passed the examinations prepared by the NCEES, and administered by the Puerto Rico's Examination Board of Engineers, Architects and Surveyors. Those who passed the Fundamentals of Engineering Examination obtain an Engineer-in-Training Certification from the Department of State of Puerto Rico, and they are legally allowed to perform most of the duties of an engineer. However, to be considered as a fully professional engineer with the right to certify any engineering design, the applicant should pass (in the ME case) the Mechanical Engineering Examination prepared by the NCEES. In the last case, the applicant obtains a Professional Engineer License.

Although, PUPR is not yet accredited by ABET, the Department of State of the Commonwealth of Puerto Rico recognizes the Institution, and allows to the PUPR graduates to take the examinations required for their registration. Also, although the Fundamentals of Engineering Examination is enough to fulfil the legal requirements to practice engineering, the ME Department encourages its student to take both examinations when possible.
### XV. INFORMATION REGARDING FACULTY MEMBERS

#### TABLE XV: FACULTY ANALYSIS
Program MECHANICAL ENGINEERING

<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 (Show State)</th>
<th>Level of Activity (high, med, low, none) in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bardález M.</td>
<td>53</td>
<td>Asso. Prof.</td>
<td>FT</td>
<td>MSME</td>
<td>UPR MC 1992</td>
<td>15</td>
<td>PE (PR) PE (PERU)</td>
<td>CIAPR(Low) ASME(Low) NSPE(Low) Low</td>
</tr>
<tr>
<td>Burgos, G.</td>
<td>33</td>
<td>Asst. Prof.</td>
<td>FT</td>
<td>MSME</td>
<td>UPR MC 1992</td>
<td>5</td>
<td>PE (PERU)</td>
<td>ASME(Low) Med Low</td>
</tr>
<tr>
<td>Clavell, O</td>
<td>60</td>
<td>Asso. Prof.</td>
<td>PT</td>
<td>MSCE</td>
<td>Michigan 1966</td>
<td>28</td>
<td>PE (FR)</td>
<td>ASCE(Low) CIAPR(Low) Low High</td>
</tr>
<tr>
<td>Cruz, A.</td>
<td>33</td>
<td>Asst. Prof.</td>
<td>FT</td>
<td>BSME</td>
<td>UPR MC 1987</td>
<td>8</td>
<td>EIT (PR)</td>
<td>CIAPR(Low) None Med</td>
</tr>
<tr>
<td>González, L.</td>
<td>41</td>
<td>Asst. Prof.</td>
<td>PT</td>
<td>MSME</td>
<td>Georgia Tech 1980</td>
<td>15</td>
<td>PE(PR)</td>
<td>ASHRAE(Low) CIAPR(Low) ASME(Low) None High</td>
</tr>
<tr>
<td>González, V.</td>
<td>40</td>
<td>Asst. Prof.</td>
<td>PT</td>
<td>MSME</td>
<td>G. Wash. 1982</td>
<td>15</td>
<td>PE(PR)</td>
<td>CIAPR(Low) None Low</td>
</tr>
<tr>
<td>Jaramillo, H.</td>
<td>33</td>
<td>Asst. Prof.</td>
<td>FT</td>
<td>MSME</td>
<td>UPR, MC 1993</td>
<td>10</td>
<td>PE(Colombia)</td>
<td>ASME(Low) Med Low</td>
</tr>
<tr>
<td>Martínez, J.</td>
<td>27</td>
<td>Asst. Prof.</td>
<td>FT</td>
<td>MSME</td>
<td>UPR MC 1994</td>
<td>1</td>
<td>PE(PR)</td>
<td>ASHRAE(Low) CIAPR(Low) ASME(Low) Med Low</td>
</tr>
</tbody>
</table>
TABLE XV (Continued)
FACULTY ANALYSIS
Program MECHANICAL ENGINEERING

| Name  | Age | Rank   | FT or PT | Highest Degree | Institution from which Highest Degree Earned & Year | Years of Experience | Professional Registration (Indicate State) | Level of Activity (high, med, low, none) in: | Professional Society (Indicate Society) | Research | Consulting/Summer Work in Industry |
|-------|-----|--------|----------|----------------|-------------------------------------------------|--------------------|------------------------------------------|--------------------------------------------|---------------------------------------|-----------------------------|
| Nieves, C. | 24  | Asst. Prof. | FT | MSME | Stanford Univ. 1994 | 1 | 1 | 1 | EIT(PR) | ASME(Low) | Low | None |
| Pérez, F. | 33  | Asst. Prof. | PT | BSME | UPR, MC 1986 | 10 | 10 | 10 | EIT(PR) | CIAPR(Low) | None | Low |
| Solano, J. | 26  | Asso. Prof. | FT | MSME | UPR, MC 1995 | 1 | 2 | 2 | PE(PR) | CIAPR(Low) ASME(Low) SAE(Low) | Med | Low |
| Veras, E. | 31  | Asst. Prof. | FT | MSME | UPR, Mayaguez 1992 | 5 | 4 | 3 | PE (Dominican Republic) | ASME(Low) SAE(Low) | Med | Low |

Prepared: March, 1995
<table>
<thead>
<tr>
<th>Faculty Member (Name)</th>
<th>FT or PT</th>
<th>Classes Taught (Course No./Credit Hrs.) Current Term</th>
<th>Total Activity Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Teaching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Term</td>
</tr>
<tr>
<td>Bardález, Manuel</td>
<td>FT</td>
<td>ME 410, ME 428, ME 525, ME 546; 12 Credit-hours</td>
<td>60</td>
</tr>
<tr>
<td>Burgos, Gilmer R.</td>
<td>FT</td>
<td>ENGI 328, ME 343, ME 344, ME 432; 10 Credit-hours</td>
<td>60</td>
</tr>
<tr>
<td>Clavell, Orlando</td>
<td>PT</td>
<td>ENGI 327, ENGI 328; 8 Credit-hours.</td>
<td>50</td>
</tr>
<tr>
<td>Cruz, Alba L.</td>
<td>FT</td>
<td>ENGI 327, ENGI 333; 12 Credit-hours</td>
<td>100</td>
</tr>
<tr>
<td>González, Luis</td>
<td>PT</td>
<td>ME 518; 3 Credit-hours</td>
<td>25</td>
</tr>
<tr>
<td>González, Victor</td>
<td>PT</td>
<td>ME 341; 3 Credit-hours</td>
<td>25</td>
</tr>
<tr>
<td>Jaramillo, Hebert</td>
<td>FT</td>
<td>ME 311, ME 421, ME 444, ME 445, ME 535; 16 Credit-hours</td>
<td>100</td>
</tr>
<tr>
<td>Martínez, Jorge L.</td>
<td>FT</td>
<td>ME 331, ME 430, ME 431, ME 511, ME 560; 13 Credit-hours</td>
<td>60</td>
</tr>
<tr>
<td>Nieves, Carlos L.</td>
<td>FT</td>
<td>On leave</td>
<td></td>
</tr>
<tr>
<td>Pérez, Frank</td>
<td>PT</td>
<td>ENGI 333; 6 Credit-hours</td>
<td>50</td>
</tr>
<tr>
<td>Solano, Jacinto</td>
<td>FT</td>
<td>ENGI 327, ENGI 328, ME 331, ME 441, ME 515; 16 Credit-hours</td>
<td>100</td>
</tr>
<tr>
<td>Veras, Eduardo</td>
<td>FT</td>
<td>ME 247, ME 342, ME 411, ME 543, ME 555; 14 Credit-hours.</td>
<td>80</td>
</tr>
</tbody>
</table>
C. Show how the faculty assigned to this program satisfies ABET engineering criteria for faculty size and any applicable program criteria.

There are eight full-time and four part-time faculty members in the ME program. Faculty members expertise and area of interest covers at least one of the following fields:

1. Thermal Sciences
2. Mechanical Elements and Machine Design
3. Manufacturing Processes
4. Computer Aided Design and Manufacturing (CAD/CAM)

In addition, all of the full-time professors are involved in teaching and student advising. As it may notice, the full-time faculty size exceeds the ABET minimum requirement.

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.
1. **NAME AND DATE OF BIRTH:**
   Manuel Bardález Alvarado, 7/20/41.

2. **ACADEMIC RANK:**
   Associate Professor; Full-time.

3. **DEGREES:**

4. **NUMBER OF YEARS SERVICE THIS FACULTY:**
   Six (6) years. Appointed August 1989. Dates of advancement in rank:
   Associate Professor: Jan 15, 1991

5. **OTHER RELATED EXPERIENCE:**
   Instructor, General Engineering Department, University of Puerto Rico, Mayaguez Campus. Course taught: Fluid Mechanics Laboratory, Jun 89-Jul 89.


   Instructor, Mechanical Engineering Department, University of Puerto Rico, Mayaguez Campus, Course taught: General Thermodynamics, Aug 87-Jul 88.

   Associate Professor, Mechanical Engineering Department, National University of Engineering, Lima-Perú, 1974-1987.

   Director of the University Extension and Social Projection Office at the National University of Engineering, 1984-1987.

6. **CONSULTING, PATENTS:**

7. **STATE(S) IN WHICH REGISTERED:**
   Puerto Rico, No. 12299 PE
   Lima-Perú, No. 195490
8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:


9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:

American Society of Mechanical Engineers, ASME Member, 1995.
National Society of Professional Engineers, NSPE Member, 1992-present.
Sociedad de Ingenieros del Peru, SIP, Lima-Peru, Member, 1980-present.

10. HONORS AND AWARDS:

Appointed Director of the Mechanical Engineering Department at the Polytechnic University of Puerto Rico, Feb 1991.

Promoted to the rank of Associate Professor of the Polytechnic University of Puerto Rico, Jan 1991.

Granted a teaching and research assistantship from the University of Puerto Rico, Mayaguez Campus to pursue graduate studies leading to a Master of Sciences Degree in Mechanical Engineering, Aug 1987.

Re-elected as an Associate Professor Representative to the Government Board of the National University of Engineering, Lima-Peru, Apr 1987.

Appointed Director of the Office of Social Projection and Community Diffusion of the National University of Engineering, Lima-Peru, Sep 1984.

Elected Associate Professor Representative to the Government Board of the National University of Engineering, Lima-Peru, Apr 1984.

Appointed Assistant Professor of the National University of Engineering, Lima-Peru, Sep 1974.

11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

Mechanical Engineering Department Head 38/wk
PUPR Academic Council 1/wk
PUPR Editorial Board 1/wk
Evaluator, PR Council on Higher Education 1/wk
New Engineering Laboratory Facilities Committee 1/wk

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:

Invited Participant, Pan-American Congress of Mechanical Engineering Associations, October 1994.

14. SPECIAL DUTIES OF CO-OP FACULTY:

Evaluator of projects submitted by mechanical engineering students who are enrolled in the PUPR Co-Op Program.
NAME AND DATE OF BIRTH:

ACADEMIC RANK:
Assistant Professor, Full-time.

DEGREES:
MSME, University of Puerto Rico, Mayaguez Campus, 08/91 - 07/93.
BSME, National University of Trujillo, Trujillo-Perú, 09/79-09/86.

NUMBER OF YEAR SERVICE THIS FACULTY:

OTHER RELATED EXPERIENCE:
Polytechnic University of Puerto Rico, Laboratory Coordinator of Mechanical Engineering Department, and Assistant Professor, June 1994-Present


National University of Santa, Department of Mechanical Engineering. Part time Associate Professor. Taught Fluid Mechanics., Feb 1990-June 1990.


6. CONSULTING, PATENTS:
None

7. STATES IN WHICH REGISTERED:
Lima, Perú.

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:


9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
American Society of Mechanical Engineers, ASME.
Phy Kappa Phy

10. HONORS AND AWARDS:
Grant ed a teaching and research assistantship from the University of Puerto Rico, Mayaguez Campus to pursue graduate studies leading to a Master of Sciences Degree in Mechanical Engineering, Aug 1991.

Ranked in the first place in a class of 77 students at The National University of Trujillo, Department of Mechanical Engineering, Trujillo-Perú, Aug 1979-Aug 1986.
11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

M.E. Department Laboratory Coordinator: Jul 1994-Present.
Mentoring, 30 M.E. students, 4 hrs/week; Nov 94-Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:

None

14. SPECIAL DUTIES OF CO-OP FACULTY:

None
1. NAME AND DATE OF BIRTH:
   Orlando Clavell Pumarejo, 9/27/1935.

2. ACADEMIC RANK:
   Associate Professor, Part-time.

3. DEGREES:
   M.S.C.E., University of Michigan, Ann Arbor, Michigan, 1966
   B.S.C.E., C.A.A.M., Mayaguez, P.R., 1959.

4. NUMBER OF YEAR SERVICE THIS FACULTY:
   Nineteen years. Appointed Aug 1976. Dates of advancement in rank:
   Associate Professor: Aug 1993
   Assistant Professor: 1984

5. OTHER RELATED EXPERIENCE:
   Teaching. Staff and Faculty Battery, Fort Sill Okla, 1960-61.


   Engineer in Charge of design revision of aqueduct and sewer projects submitted for
   approval to P.R.A.S.A. Industry, 1959-63.


   Engineer in design of sanitation projects at P.R.S.S.A., 1965-68.

   Chief Sanitary design division at P.R.A.S.A. in charge of 18 engineers and 14 draftmen
   design, 1969-76.

6. CONSULTING, PATENTS:
   Consulting for private and public on sewers and sanitary projects. Have design several
   storm and sanitary sewers actually in use. Have design several sewage treatment plants
   actually in use, 1976-94.

   Consulting for private and public on sewers and sanitary projects. Research to determine
   design parameters for sanitary and hydraulic projects in Puerto Rico. Revision of P.R.A.S.A.
   design guideline, 1994.
7. STATES IN WHICH REGISTERED:
Puerto Rico and Florida.

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
While working in P.R.A.S.A. a series of articles where published in the dominical newspaper on ways to control water pollution.

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
Puerto Rico Society of engineers.
Puerto Rico Engineer College
A.I.D.I.S.
A.W.P.C.F.

10. HONORS AND AWARDS:
Candidate for Manuel A. Pérez Award

11. COURSES TAUGHT THIS YEAR:
Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:
Coordinator for final exams of Fluid Mechanics.
Student advising

13. SPECIFIC PROGRAM TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:
Training evaluation and evaluation
Cost elective analysis in sanitary projects
Value Engineering Seminar

14. SPECIAL DUTIES OF CO-OP FACULTY:
None
NAME AND DATE OF BIRTH:
Alba Loyda Cruz Moya, 3/4/1962

ACADEMIC RANK:
Assistant Professor, Full-time.

DEGREES:
MEM (in progress, part-time), Polytechnic University of P.R., March 94-Present.
BSME, University of Puerto Rico, Mayaguez Campus, 1985.

NUMBER OF YEARS SERVICE THIS FACULTY:

OTHER RELATED EXPERIENCE:
Elevator Inspector: Inspect all aspects of security and equipment of the elevators to comply with ANSI 17.1 and special rule number 5 Advising clients on their particular needs. Expertise in court trials, Guaynabo P.R., May 92-Present

Curriculum Committee President, member of Discipline Committee, and Academic Senate.
Roosevelt Mail Station Corp., Hato Rey, PR, Jan 91-Jan 93. President: Design and implement the marketing plan and select the personnel. Supervise the daily workload.

May '90 to Feb. '91, Hato Rey Community Hospital
Hato Rey, PR, May 90-Feb 91.
Plant Operations Manager and Security Official: Supervise the Plant Operations Dept., develop and coordinate preventive maintenance schedules of equipment. Construction layouts. In charge of the hospital security. Design and implement emergency escape drills and train all personnel to do special functions.

Baxter - Travenol Laboratories, Toa Alta, PR, Mar 86-Jun 87. Production Supervisor: Supervise all departments (third shift); packaging, assembly line and extrusion. Supervise and distribute the daily workload.

Engineer Assistant: Standardize pneumatic cylinders of all the plant machinery. Inventory control. Improve the design of the machinery reduce company costs.

6. CONSULTING, PATENTS:
Consulting in elevators area:
Modifying of the unit to improve the performance.
Modifying of the unit to accomplish with ADA Regulations.
Expertise in court trials.

7. STATE(S) IN WHICH REGISTERED:
Puerto Rico (EIT)

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
Hato Rey Community Hospital Security Manual

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
Currently member of the Engineer and Land Surveyor Society of P.R.
Currently member of the Professional Society for the Prevention of Accidents
Secretary - American Society of Heating, Refrigerating & A/C Engineers, Inc.
Student Council Chapter

10. HONORS AND AWARDS:
Honors:
First and only woman Elevator Inspector in Puerto Rico.
First and only woman Plant Operation Manager in the hospital area.

Awards:
Dean Honor List award - Engineering Faculty, University of P.R, Mayaguez Campus.
General Electric Foundation Co. student grant.
Merit certificate for academy excellence from Metropolitan Consumer Coop.

11. COURSES TAUGHT THIS YEAR:
Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:
Mentoring, 30 M.E. students, 4 hours/week, Nov 94 - Present.

II - 119
13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL
   COMPETENCE:

   Lead Inspector Trainee Program, 1994
   Prevention of Contamination of TB In Working Area, 1993
   Non Structural Earthquake Hazard Mitigation, 1991
   Professional Administration Internal Mail Room.
   Inspection of Elevators and Related Equipment.
   Computer Assisted Design Laboratory MSIP Project, 1990
   First Annual Conference of Security and Occupational Health of P.R.

14. SPECIAL DUTIES OF CO-OP FACULTY:

   None
1. NAME AND DATE OF BIRTH:
   Víctor A. González Lizardo, 1/25/1955.

2. ACADEMIC RANK:
   Assistant Professor, Part-time.

3. DEGREES:
   BSME, University of Zulia, Venezuela, 1979.

4. NUMBER OF YEARS SERVICE THIS FACULTY:

5. OTHER RELATED EXPERIENCE:
   General Superintendent, Power Purchase Contracts Administration, Planning and Research Division, P.R. Electric Power Authority (PREPA), San Juan P.R., 1/1/1995 - Present.
   Specialist, Power Generation Studies, Planning and Research Division, P.R. Electric Power Authority (PREPA), San Juan P.R., 1992-1994.
   Analysis Engineer II, Demand Side Programs, P.R. Electric Power Authority (PREPA), San Juan, P.R., 1986-1992.
   Teacher Assistant, University of Zulia, Venezuela, 1976-1980.

6. CONSULTING, PATENTS:

7. STATE IN WHICH REGISTERED:
   Commonwealth of Puerto Rico.
8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:


Conversion of Units 5 & 6 of San Juan Steam Plant into Combined Cycles, April 1993.


Cool Storage Systems, presented at COPIMERA mini-congress, San Juan, P.R., April 1989.

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:

Institute of Mechanical Engineers, College of Engineers and Surveyors of Puerto Rico (CIAPR).
Institute of Mechanical Engineers, College of Engineering of Venezuela.

10. HONORS AND AWARDS:

Second Best Grade Point Average in Class, Mechanical Engineering, University of Zulia, Venezuela, July 1979.

11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

Advisor for the project, "Study for the Implementation of a Cogeneration System at San Pablo Hospital in Bayamón, 1994. Two hours per week.

Institute of Mechanical Engineers Student Chapter Advisor, 1990-Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:


"Generation Planning Seminar", Offered by IEEE, April 1994

"Interactive Teaching in the Classroom", Seminar offered by UPPR, December 1993.


14. CO-OP DUTIES:

None
1. NAME AND DATE OF BIRTH:
   Luis González, Jr., 8/3/53.

2. ACADEMIC RANK:
   Assistant Professor; Part-time.

3. DEGREES:
   MSME, Georgia Institute of Technology, 1980.
   BSME, Georgia Institute of Technology, 1975.

4. NUMBER OF YEARS SERVICE THIS FACULTY:
   Five years. Appointed Aug 1990. Dates of advancement in rank:
   Assistant Professor, Sep 1993
   Instructor, Aug 1990

5. OTHER RELATED EXPERIENCE:
   Lecturer: School of Engineering UPR-Mayaguez Campus, 1982-1983.

6. CONSULTING, PATENTS:
   Consulting engineering in private practice, since 09/1981, offering complete engineering
   services in HVAC, refrigeration, plumbing and solar systems design, engineering
   economic and energetic studies for commercial, institutional, industrial, residential, and
   military construction projects.

7. STATE(S) IN WHICH REGISTERED:
   Puerto Rico, PE, since 1981.
   Georgia, EIT, since 1975.

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
   None.

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
   ASHRAE, ASME, SAE, CSI, NFPA, ASPE, ASEE, CIAPR.

10. HONORS AND AWARDS:
    Dean List Georgia Tech (7 quarters)
    Scholarship Georgia Tech Alumni Club of P.R.
    Scholarship Economic Development Administration of P.R.
11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

ASHRAE Student Chapter advisor.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:


14. SPECIAL DUTIES OF CO-OP FACULTY:

None.
NAME AND DATE OF BIRTH:
Hebert Jaramillo Burgos, 5/10/1962

ACADEMIC RANK:
Assistant Professor, Full-time

DEGREE:
MSME, University of Puerto Rico, Mayaguez Campus, Jan 1991-Dec 1993.
BSME, Universidad del Valle, Cali-Colombia, Apr 1981-Dec 1986.

NUMBER OF YEARS SERVICE THIS FACULTY:

OTHER RELATED EXPERIENCE:
FANALCA S.A. Cali, Colombia, Service Engineer. Received waste recollectors from
assembly. Checked their hydraulic equipment, trained customers on operations and
maintenance of hydraulic equipment, Jan 1989-Dec 1990.

PINSKY S.A. Cali, Colombia, Maintenance Engineer, Maintence Department.
Maintenance of hydraulic and pneumatic systems of heavy machinery,

RITA S.A., Cali, Colombia, Service Engineer. Service Department. Design and

CONSULTING, PATENTS:
None

STATE(S) IN WHICH REGISTERED:
Republic of Colombia.

PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
Automatic Dimensioning and Tolerances, A Tool for Design and Manufacturing. (with
Dr. David Serrano) Paper under development, to be submitted to CAD Journal.

Automatic Dimensioning and Tolerances, Proceedings of 27th Pan-American Congress of
Engineering, San Juan, Puerto Rico., October 1993.

Automatic Dimension and Tolerances, Proceedings Graduated Students ASME Technical
9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
   ASME, since 1991.

10. HONORS AND AWARDS:
   None

11. COURSES TAUGHT THIS YEAR:
   Table XVII summarizes the term, course section, type, time schedule, and class size
taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:
   Mentoring, 30 M.E. students, 4 hours/week, Nov 94 - Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL
    COMPETENCE:

14. CO-OP DUTIES:
   None
1. NAME AND DATE OF BIRTH:
Jorge L. Martínez Rodríguez, 4/2/67

2. ACADEMIC RANK:
Assistant Professor, Full-time

3. DEGREES:
MSME, University of Puerto Rico, Mayaguez Campus, 1994
BSME, University of Puerto Rico, Mayaguez Campus, 1990

4. NUMBER OF YEARS SERVICE THIS FACULTY:

5. OTHER RELATED EXPERIENCE:
Mechanical Engineer, ALCOA Technical Center, Pittsburgh PA, Summer 1991.
Mechanical Engineer, ALCOA Technical Center, Pittsburgh, PA., 1990.
Instructor of Physics Laboratory, University of Puerto Rico, Mayaguez,

6. CONSULTING, PATENTS:
None

7. STATE(S) IN WHICH REGISTERED:
Puerto Rico.

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
Reduction of Electrical Costs using Cold Storage: A Preliminary Study Based on University Campus as a Model (Conference presented in the 2nd International Conference: Energy for the Americas, ENERGEX, San Juan PR, Sep 1991

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
American Society of Mechanical Engineers (ASME)
10. HONORS AND AWARDS:

Recipient of ASHRAE "Grant-In-Aid" Fellowship, 1992
B.S.M.E. Magna Cum Laude - U.P.R. Mayaguez Campus, 1990.

11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

Outcomes Assesment Comission (3 hours weekly during Summer Quarter 1993).
Laboratory Development Plan for Mechanical Engineering Department (3 hours weekly) (Spring Quarter 1993-1994).
Assistant to the Director in Student Affairs (12 hours weekly)
Volume II of Self Study for Mechanical Engineering Director (12 Hours weekly) (Fall and winter quarter 1994-95).
ME Representant in Curriculum Committee, 1994-96.
Mentoring, 2nd. and 3rd. year M.E. students, 6 hours/week, Nov 94 - Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:

Professional Society Activities as follows:
Total Quality Management in Higher Education, Jun 1993
Seminar of Steam Boiler Plants, Jan 1994

14. CO-OP DUTIES

None.
1. NAME AND DATE OF BIRTH:

Carlos I. Nieves Ortega, 5/1/70

2. ACADEMIC RANK:

Assistant Professor, Full time

3. DEGREES:

MSME, Stanford University, Stanford, CA, 1994
BSME, Georgia Institute of Technology, Atlanta, GA, 1992
Associate Degree in Mechanical Engineering, University of Puerto Rico, Bayamón, PR, 1990

4. NUMBER OF YEARS SERVICE THIS FACULTY:


5. OTHER RELATED EXPERIENCE:

Teaching Assistant, Stanford University, 1992-93.
Teaching Assistant, Georgia Institute of Technology, 1991-92.
Research Technician, Hercules Inc.(Aerospace), Cumberland, Maryland, Summer 1991.

6. CONSULTING PATENTS:

None

7. STATE(S) IN WHICH REGISTERED:

Puerto Rico(EIT)

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:

None

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES

Association of Engineers and Surveyors of Puerto Rico (CIAPR)
American Society of Mechanical Engineers (ASME)

10. HONORS AND AWARDS:

National Science Foundation Excellence Award, 1992.
Georgia Tech's OMED Excellence Award, 1991.
Tau Beta Pi Engineering Honor Society.
11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

Coordinator for preparation of Self Study for Mechanical Engineering Program Volume II, 12 hours per week, quarter Mar 94/Jun 94, and quarter Jun 94/Aug 94. Mentoring, 30 M.E. students, 4 hours/week, Aug 95 - Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:


14. CO-OP DUTIES:

None.
1. NAME AND DATE OF BIRTH:
   Jacinto Solano Rodriguez, 10/21/68

2. ACADEMIC RANK:
   Assistant Professor, Full time

3. DEGREES:
   MSME, University of Puerto Rico, Mayaguez Campus, 1995
   BSME, University of Puerto Rico, Mayaguez Campus, 1991

4. NUMBER OF YEARS SERVICE THIS FACULTY:
   Two years. Appointed Jun 1993.

5. OTHER RELATED EXPERIENCE:
   Public Building Authority, Mayaguez, P.R.: Supervisor of inspection and supervision
   of the public schools painting and reconstruction, May 92 - Aug 92.
   Mechanical Engineering Department, University of Puerto Rico, Mayaguez, P.R.:  
   Laboratory Instructor, taught Mechanical Engineering Laboratory I, Aug 91 - May 92.

6. CONSULTING, PATENTS:
   None

7. STATE(S) IN WHICH REGISTERED:
   Puerto Rico

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
   None

9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:
   American Society of Mechanical Engineers (ASME)
   Association of Professional Engineers and Surveyors of Puerto Rico (CIAPR)
   Society of Automotive Engineers (SAE)

10. HONORS AND AWARDS:
    None
11. COURSES TAUGHT THIS YEAR

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

Mentoring, 30 students, 4 hours per week, Nov 94 - Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:

None

14. CO-OP DUTIES:

None.
1. NAME AND DATE OF BIRTH:
   Eduardo J. Veras Jorge, 8/3/63

2. ACADEMIC RANK:
   Assistant Professor, Full time

3. DEGREES:
   MSME, University of Puerto Rico, Mayaguez Campus, 1992
   EME(Electro-Mechanical Engineer,Professional Degree), School of Engineering
   Sciences, Pontificia Universidad Católica Madre y Maestra, Dominican Republic, 1987

4. NUMBER OF YEARS SERVICE THIS FACULTY:

5. OTHER RELATED EXPERIENCE:
   Laboratory Instructor(Fluid Mechanics Lab), UPR-Mayaguez Campus, 1990-91.
   Production's Maintenance Engineer, E. León Jiménez Industries (Filial of Philip Morris
   Laboratory Instructor(General Physics II), School of Physics and Exact Sciences,
   Pontificia Universidad Católica Madre y Maestra, Dominican Republic, 1988
   Instructor, School of Physics and Exact Sciences, Pontificia Universidad Católica
   Mechanical Maintenance Engineer, Arts and Lithographic Design, Dominican

6. CONSULTING, PATENTS:
   None

7. STATE(S) IN WHICH REGISTERED:
   Dominican Republic

8. PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS:
   "A Conceptual Design Generator and Evaluator using OOP, Neural Nets and
   Optimization" (with Dr. David Serrano), Paper under development, to be submitted to
   CAD Journal.


9. SCIENTIFIC AND PROFESSIONAL SOCIETIES:

American Society of Mechanical Engineers (ASME)
Society of Automotive Engineers (SAE)

10. HONORS AND AWARDS:

Honor Diploma, awarded by Santiago Commercial Academy, for devotion to studies, Dominican Republic, 1981.

First best GPA among the graduation candidates, Santiago Commercial Academy, Dominican Republic, 1981.

"Medalla al Mérito" (Highest Honor), for obtaining the first best GPA among the graduation candidates foreign language, Advanced Studies Institute, Dominican Republic, 1980.

11. COURSES TAUGHT THIS YEAR:

Table XVII summarizes the term, course section, type, time schedule, and class size taught by the M.E. faculty during the last four quarters.

12. OTHER ASSIGNED DUTIES:

Participation in the Preparation of ABET Self-Study Questionnaire, Vol. II. Mentoring, 30 M.E. students, 4 hours per week, Nov 94 - Present.

13. SPECIFIC PROGRAMS TO IMPROVE TEACHING AND PROFESSIONAL COMPETENCE:


14. CO-OP DUTIES:

None.
<table>
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<tr>
<th>Faculty</th>
<th>Courses Lected</th>
<th>Credits</th>
<th>Room</th>
<th>Time Schedule</th>
<th>Class size</th>
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<td>1. BARDALEZ, Manuel, (FTP) (Department Head)</td>
<td>ME546/39</td>
<td>3</td>
<td>L-454</td>
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<td>2. BURGOS, Gilmer R. (FTP) (Lab. Coordinator)</td>
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<td>3. CRUZ, Alba L. (FTP)</td>
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<td>5. JARAMILLO, Hebert (FTP)</td>
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<td>11. VERAS, Eduardo (FTP)</td>
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<td>2. BURGOS, Gilmer (FTP)  (Lab. Coordinator)</td>
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<td>ME341/09</td>
<td>3</td>
<td>M-314</td>
<td>M-W 3:40P-5:50P</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>ME432/24</td>
<td>3</td>
<td>L-405</td>
<td>K-T 8:00P-10:00P</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>ME445/39</td>
<td>1</td>
<td>L-401</td>
<td>by agreement</td>
<td>01</td>
</tr>
<tr>
<td>3. CLAVELL, Orlando (PTP)</td>
<td>ENGI327/22</td>
<td>3</td>
<td>P-105</td>
<td>K-T 5:50P-8:00P</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>ENGI328/15</td>
<td>1</td>
<td>L-401</td>
<td>W 11:00A-3:00P</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>ENGI328/17</td>
<td>1</td>
<td>L-401</td>
<td>W 3:00P-7:00P</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>ENGI327/07</td>
<td>3</td>
<td>P-104</td>
<td>M-W 1:30P-3:40P</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>ENGI333/09</td>
<td>3</td>
<td>P-104</td>
<td>M-W 3:40P-5:50P</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>ENGI346/20</td>
<td>3</td>
<td>P-103</td>
<td>K-T 3:40P-5:50P</td>
<td>15</td>
</tr>
<tr>
<td>5. GONZALEZ, Jr. Luis (PTP)</td>
<td>ME518/22</td>
<td>3</td>
<td>P-210</td>
<td>K-T 5:50P-8:00P</td>
<td>24</td>
</tr>
<tr>
<td>6. GONZALEZ, Victor (PTP)</td>
<td>ENGI346/22</td>
<td>3</td>
<td>P-108</td>
<td>K-T 5:50P-8:00P</td>
<td>13</td>
</tr>
<tr>
<td>7. JARAMILLO, Hebert (FTP)</td>
<td>ENGI333/03</td>
<td>3</td>
<td>P-204</td>
<td>M-W 9:10A-11:20A</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>ME247/06</td>
<td>3</td>
<td>P-104</td>
<td>K-T 11:20A-1:30P</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>ME311/05</td>
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<tr>
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<td>ME444/09</td>
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<td>M-318</td>
<td>by agreement</td>
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<td>8. MARTINEZ, Jorge (FTP)</td>
<td>ENGI327/20</td>
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<td>P-104</td>
<td>K-T 3:40P-5:50P</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>ME331/07</td>
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<td>P-106</td>
<td>M-W 1:30P-3:40P</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>ME430/22</td>
<td>3</td>
<td>L-405</td>
<td>K-T 5:50P-8:00P</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>ME431/21</td>
<td>3</td>
<td>L-407</td>
<td>M-W 5:50P-8:00P</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>ME441/39</td>
<td>1</td>
<td>L-408</td>
<td>by agreement</td>
<td>01</td>
</tr>
<tr>
<td>9. PEREZ, Alfredo (FTP)</td>
<td>ME342/08</td>
<td>3</td>
<td>P-106</td>
<td>K-T 1:30P-3:40P</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>ME343/20</td>
<td>3</td>
<td>P-109</td>
<td>K-T 3:40P-5:50P</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>ME344/02</td>
<td>1</td>
<td>L-106</td>
<td>T 7:00A-11:00A</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>ME534/07</td>
<td>3</td>
<td>502</td>
<td>M-W 1:30P-3:40P</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>ME555/03</td>
<td>2</td>
<td>504</td>
<td>M-W 9:10A-11:20A</td>
<td>15</td>
</tr>
<tr>
<td>10. PEREZ, Frank (PTP)</td>
<td>ENGI333/08</td>
<td>3</td>
<td>P-105</td>
<td>K-T 1:30P-3:40P</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>ENGI333/20</td>
<td>3</td>
<td>P-105</td>
<td>K-T 3:40P-5:50P</td>
<td>21</td>
</tr>
<tr>
<td>11. SOLANO, Jacinto (FTP)</td>
<td>ENGI327/03</td>
<td>3</td>
<td>P-205</td>
<td>M-W 9:10A-11:20A</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>ENGI327/09</td>
<td>3</td>
<td>P-105</td>
<td>M-W 3:40P-5:50P</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>ENGI328/16</td>
<td>1</td>
<td>L-401</td>
<td>T 11:20A-3:00P</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>ENGI328/29</td>
<td>1</td>
<td>L-401</td>
<td>F 8:00A-12:00M</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>ME515/22</td>
<td>3</td>
<td>P-209</td>
<td>K-T 5:50P-8:00P</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>ME521/24</td>
<td>3</td>
<td>L-407</td>
<td>K-T 8:00P-10:10P</td>
<td>20</td>
</tr>
<tr>
<td>12. VERAS, Eduardo (FTP)</td>
<td>ME247/05</td>
<td>3</td>
<td>P-205</td>
<td>M-W 11:20A-1:30P</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>ME311/06</td>
<td>3</td>
<td>502</td>
<td>K-T 11:20A-1:30P</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>ME410/20</td>
<td>3</td>
<td>P-107</td>
<td>K-T 3:40P-5:50P</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>ME411/21</td>
<td>3</td>
<td>L-405</td>
<td>M-W 5:50P-8:00P</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>ME555/04</td>
<td>2</td>
<td>502</td>
<td>K-T 9:10A-11:20A</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>ME560/03</td>
<td>2</td>
<td>504</td>
<td>M-W 9:10A-11:20A</td>
<td>06</td>
</tr>
</tbody>
</table>
LABORATORY DEVELOPMENT PLAN
1995-2001

by

GILMER R. BURGOS
Assistant Professor & Laboratory Coordinator

JUNE, 1995
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A. HISTORICAL DATA

The Department of Mechanical Engineering of Polytechnic University of Puerto Rico was established in 1988. The first approved curriculum required the Department offer the laboratory courses listed in Table 1. Initially, only the Fluid Mechanics Laboratory course was offered in our campus with limited facilities and equipment. Modern Manufacturing Methods and Processes and Mechanical Engineering Laboratory courses were offered outside, in facilities from the Electric and Power Authority of Puerto Rico.

<table>
<thead>
<tr>
<th>Code</th>
<th>Laboratory Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 328</td>
<td>Fluid Mechanics Laboratory</td>
</tr>
<tr>
<td>ME 433</td>
<td>Modern Manufacturing Methods and Processes I</td>
</tr>
<tr>
<td>ME 441</td>
<td>Mechanical Engineering Laboratory I</td>
</tr>
<tr>
<td>ME 443</td>
<td>Modern Manufacturing Methods and Processes II</td>
</tr>
<tr>
<td>ME 511</td>
<td>Mechanical Engineering Laboratory II</td>
</tr>
</tbody>
</table>

Table 1. Laboratory courses offered by the Department of Mechanical Engineering according to the first approved curriculum.

In 1992, the curriculum was revised joining the contents of ME 433 and ME 443, Modern Manufacturing Methods and Processes Laboratory I and II, into only one course named ME 445 Manufacturing Laboratory, and including ME 344 Physical Metallurgy Laboratory. This curriculum
update and the increased registration compel the institution to accustom additional laboratory facilities in our campus, as listed in Table 2. So that, all laboratory courses have been offered in our campus since 1993. In the Thermal Sciences and Fluid Mechanics Laboratory were offered the laboratory courses of ENGI 328, ME 441 and ME 511. In the Manufacturing Laboratory and Physical Metallurgy Laboratory were offered ME 445 and ME 344 laboratory courses, respectively.

**Table 2. Laboratory Facilities for the Department of Mechanical Engineering in 1993**

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Area (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Sciences and Fluid Mechanics Laboratory</td>
<td>1,640</td>
</tr>
<tr>
<td>Physical Metallurgy Laboratory</td>
<td>610</td>
</tr>
<tr>
<td>Manufacturing Laboratory</td>
<td>2,060</td>
</tr>
<tr>
<td>Total</td>
<td>4,310</td>
</tr>
</tbody>
</table>

In a very short time, these facilities became inappropriate for instruction. The increasing students' population and the desire for improvement the quality of service demanded new and better laboratories. To reply this requirement, a new laboratory building was built. In August of 1994, all laboratory equipment was moved to this new facility.

In October 28, 1994, the curriculum of Mechanical Engineering was updated again. According to this new curriculum, two new laboratory courses were introduced to strengthen the student's theoretical knowledge, ME 536 Controls Laboratory and ME 544 Computer Aided Design and Computer Aided Manufacturing Laboratory (CAD/CAM Laboratory).
The number of students served for the Department from 1988 to 1994 is shown in Table 3. It must be noted that ENGI 328 Fluid Mechanics Laboratory is a laboratory course offered not only to students of Mechanical Engineering but also to students of Civil Engineering.

**Table 3. Students served for the Mechanical Engineering Laboratories from 1988 to 1994**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 328</td>
<td>95</td>
<td>194</td>
<td>185</td>
<td>227</td>
<td>227</td>
<td>240</td>
<td>255</td>
<td>1423</td>
</tr>
<tr>
<td>ME 344</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>39</td>
<td>49</td>
<td>88</td>
</tr>
<tr>
<td>ME 433</td>
<td>0</td>
<td>18</td>
<td>19</td>
<td>25</td>
<td>58</td>
<td>20</td>
<td>0</td>
<td>140</td>
</tr>
<tr>
<td>ME 441</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>8</td>
<td>31</td>
<td>42</td>
<td>33</td>
<td>164</td>
</tr>
<tr>
<td>ME 443</td>
<td>0</td>
<td>12</td>
<td>23</td>
<td>24</td>
<td>42</td>
<td>27</td>
<td>0</td>
<td>128</td>
</tr>
<tr>
<td>ME 445</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>ME 511</td>
<td>0</td>
<td>0</td>
<td>38</td>
<td>17</td>
<td>32</td>
<td>32</td>
<td>18</td>
<td>136</td>
</tr>
<tr>
<td>ME 536</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ME 544</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total per year</td>
<td>95</td>
<td>224</td>
<td>315</td>
<td>301</td>
<td>389</td>
<td>400</td>
<td>377</td>
<td></td>
</tr>
</tbody>
</table>

Since creation, the Department of Mechanical Engineering has been devoted to improve the quality of instruction offered to its students. Laboratories were progressively set up with basic and updated equipment covering different areas of the program. A total of $467,941 was invested for Laboratory equipment acquisition from 1987 to June, 1995 as shown in Table 4.
Table 4. Allotted Money in Dollars for Laboratory Equipment Acquisition from 1987 to 1995

<table>
<thead>
<tr>
<th>Year</th>
<th>Fluid Mechanics</th>
<th>Metallurgy</th>
<th>Thermology I and II</th>
<th>Manufacturing</th>
<th>CAD/CAM</th>
<th>Mechatronics</th>
<th>Total per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987-88</td>
<td>19,686</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>19,686</td>
</tr>
<tr>
<td>1988-89</td>
<td>0</td>
<td>41,021</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>41,021</td>
</tr>
<tr>
<td>1989-90</td>
<td>0</td>
<td>0</td>
<td>19,850</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>19,850</td>
</tr>
<tr>
<td>1990-91</td>
<td>0</td>
<td>17,000</td>
<td>21,617</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>38,617</td>
</tr>
<tr>
<td>1991-92</td>
<td>0</td>
<td>0</td>
<td>6,628</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6,628</td>
</tr>
<tr>
<td>1992-93</td>
<td>0</td>
<td>1,195</td>
<td>47,783</td>
<td>31,642</td>
<td>0</td>
<td>0</td>
<td>80,620</td>
</tr>
<tr>
<td>1993-94</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15,989</td>
<td>0</td>
<td>0</td>
<td>15,989</td>
</tr>
<tr>
<td>1994-95</td>
<td>45,367</td>
<td>35,410</td>
<td>65,655</td>
<td>0</td>
<td>46,362</td>
<td>52,736</td>
<td>245,530</td>
</tr>
<tr>
<td>Total</td>
<td>65,053</td>
<td>94,626</td>
<td>161,533</td>
<td>47,631</td>
<td>46,362</td>
<td>52,736</td>
<td>467,941</td>
</tr>
</tbody>
</table>
B. CURRENT LABORATORY STATUS

According to the modified Curriculum of Mechanical Engineering approved on October 28 of 1994, the Department currently has to offer the laboratory courses listed in Table 5.

Table 5. Laboratory Courses in the current Curriculum of Mechanical Engineering.

<table>
<thead>
<tr>
<th>Code</th>
<th>Laboratory Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 328</td>
<td>Fluid Mechanics Laboratory</td>
</tr>
<tr>
<td>ME 344</td>
<td>Physical Metallurgy Laboratory</td>
</tr>
<tr>
<td>ME 441</td>
<td>Mechanical Engineering Laboratory I</td>
</tr>
<tr>
<td>ME 445</td>
<td>Manufacturing Laboratory</td>
</tr>
<tr>
<td>ME 511</td>
<td>Mechanical Engineering Laboratory II</td>
</tr>
<tr>
<td>ME 536</td>
<td>Controls Laboratory</td>
</tr>
<tr>
<td>ME 544</td>
<td>CAD/CAM Laboratory</td>
</tr>
</tbody>
</table>

In these laboratory courses, students receive an insight into hydraulics, metallography, materials' properties, measurement systems, instrumentation, thermal processes, process control, classical manufacturing processes, and computer aided design and computer aided manufacturing processes. The syllabuses for these laboratory courses are shown in Appendix A.1.
B.1 Current Laboratory Facilities

Currently, the Department has eight (8) laboratory facilities with a total net area of 10,314 ft², distributed as shown in Table 6. These laboratory facilities are found in the first and fourth floors of the new laboratory building, and are provided with the necessary furniture and safety equipment. Figures 1 to 8 depict the layouts of each laboratory and Figures 9 and 10 show the schematics of these floors. These facilities are not only available to offer laboratory courses but also to help the faculty and students in their academic work and design projects.

Table 6. Current Laboratory facilities.

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Area (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-401 Fluid Mechanics</td>
<td>1,832</td>
</tr>
<tr>
<td>L-403 Mechatronics</td>
<td>942</td>
</tr>
<tr>
<td>L-404 CAM</td>
<td>941</td>
</tr>
<tr>
<td>L-406 CAD</td>
<td>942</td>
</tr>
<tr>
<td>L-408 Thermology I</td>
<td>1,807</td>
</tr>
<tr>
<td>L-101 Thermology II</td>
<td>964</td>
</tr>
<tr>
<td>L-106 Physical Metallurgy</td>
<td>942</td>
</tr>
<tr>
<td>L-111 Manufacturing</td>
<td>1,944</td>
</tr>
<tr>
<td>Total</td>
<td>10,314</td>
</tr>
</tbody>
</table>
Figure 1. Fluid Mechanics Laboratory Layout
Figure 2. Mechatronics Laboratory Layout
Figure 3. Computer Aided Manufacturing Laboratory

\text{AREA} = 942 \text{ FT}^2
Figure 4. Computer Aided Design Laboratory Layout
Figure 5. Thermology I Laboratory Layout
Figure 6. Thermology II Laboratory Layout
Figure 7. Physical Metallurgy Laboratory Layout
Figure 8. Manufacturing Laboratory Layout
B.2 Equipment

Tables 7 to 13 list the current equipment available in the Laboratories of the Department of Mechanical Engineering for both teaching and projects.

Table 7. Fluid Mechanics Laboratory Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Purchase Date</th>
<th>Units</th>
<th>Unit Price ($)</th>
<th>Total Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gravimetric Hydraulic Bench</td>
<td>06/87</td>
<td>1</td>
<td>3,400</td>
<td>3,400</td>
</tr>
<tr>
<td>2</td>
<td>Gravimetric Hydraulic Bench</td>
<td>06/94</td>
<td>3</td>
<td>5,500</td>
<td>16,500</td>
</tr>
<tr>
<td>3</td>
<td>Stability of a Floating Body</td>
<td>06/94</td>
<td>4</td>
<td>795</td>
<td>3,180</td>
</tr>
<tr>
<td>4</td>
<td>Center of Pressure Apparatus</td>
<td>06/94</td>
<td>3</td>
<td>1,589</td>
<td>4,767</td>
</tr>
<tr>
<td>5</td>
<td>Venturi Meter</td>
<td>06/87</td>
<td>1</td>
<td>1,635</td>
<td>1,635</td>
</tr>
<tr>
<td>6</td>
<td>Venturi Meter</td>
<td>06/94</td>
<td>2</td>
<td>1,918</td>
<td>3,836</td>
</tr>
<tr>
<td>7</td>
<td>Flowmeter Demonstration Rig</td>
<td>04/87</td>
<td>1</td>
<td>2,713</td>
<td>2,713</td>
</tr>
<tr>
<td>8</td>
<td>Losses in Piping Systems</td>
<td>08/94</td>
<td>1</td>
<td>8,574</td>
<td>8,574</td>
</tr>
<tr>
<td>9</td>
<td>Head Loss in pipe</td>
<td>04/87</td>
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<td>2,375</td>
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<td>10</td>
<td>Losses in Bends</td>
<td>06/87</td>
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<td>2,373</td>
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<tr>
<td>11</td>
<td>Orifice Apparatus</td>
<td>06/87</td>
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<td>1,750</td>
<td>1,750</td>
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<tr>
<td>12</td>
<td>Orifice Apparatus</td>
<td>06/94</td>
<td>2</td>
<td>2,315</td>
<td>4,630</td>
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<tr>
<td>13</td>
<td>Set of Optional Orifices</td>
<td>06/94</td>
<td>2</td>
<td>562</td>
<td>1,124</td>
</tr>
<tr>
<td>14</td>
<td>Impact of a Jet</td>
<td>04/87</td>
<td>1</td>
<td>1,568</td>
<td>1,568</td>
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<tr>
<td>15</td>
<td>Flow over a Notch</td>
<td>06/87</td>
<td>1</td>
<td>1,936</td>
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<tr>
<td>16</td>
<td>Flow over a Notch</td>
<td>06/94</td>
<td>1</td>
<td>2,756</td>
<td>2,756</td>
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<tr>
<td>17</td>
<td>Free and Forced Vortex Apparatus</td>
<td>04/87</td>
<td>1</td>
<td>1,936</td>
<td>1,936</td>
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<tr>
<td></td>
<td><strong>Total ($)</strong></td>
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Table 8. Metallurgy Laboratory Equipment

<table>
<thead>
<tr>
<th>Item</th>
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<th>Units</th>
<th>Unit Price ($)</th>
<th>Total Price ($)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Specimen Mount Press and accessories</td>
<td>03/90</td>
<td>1</td>
<td>1,325</td>
<td>1,325</td>
</tr>
<tr>
<td>2</td>
<td>Isomet Low Speed Saw</td>
<td>03/90</td>
<td>1</td>
<td>2,495</td>
<td>2,495</td>
</tr>
<tr>
<td>3</td>
<td>Handimet 2 Roll Grinders</td>
<td>03/90</td>
<td>2</td>
<td>875</td>
<td>1,750</td>
</tr>
<tr>
<td>4</td>
<td>Polimet I Specimen Polisher</td>
<td>03/90</td>
<td>2</td>
<td>2,240</td>
<td>4,480</td>
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<td>5</td>
<td>Work Table for Roll Grinders</td>
<td>03/90</td>
<td>1</td>
<td>3,000</td>
<td>3,000</td>
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<tr>
<td>6</td>
<td>Work Table for Polishers</td>
<td>03/90</td>
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<td>8</td>
<td>Ney Furnace</td>
<td>07/92</td>
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<td>1,195</td>
<td>1,195</td>
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<td>9</td>
<td>Fisher Furnace</td>
<td>01/94</td>
<td>1</td>
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<td>3,995</td>
</tr>
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<td>10</td>
<td>Metallurgical Microscope and accessories</td>
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<td>3,212</td>
<td>16,060</td>
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<td>Metallograph and accessories</td>
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<td>Brinell Hardness Tester</td>
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<td>Brinell Microscope</td>
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<td>420</td>
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<td>14</td>
<td>Rockwell Hardness Tester</td>
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<td>6,100</td>
<td>6,100</td>
</tr>
<tr>
<td>15</td>
<td>Universal Testing Machine</td>
<td>05/94</td>
<td>1</td>
<td>21,235</td>
<td>21,235</td>
</tr>
<tr>
<td>16</td>
<td>Acquisition and Analysis Software Package for Universal Testing Machine</td>
<td>05/94</td>
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<td>4,220</td>
<td>4,220</td>
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<td>Flatbed Recorder</td>
<td>05/94</td>
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<td>5,460</td>
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<tr>
<td>18</td>
<td>Jominy Fixture</td>
<td>01/94</td>
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<td>500</td>
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<tr>
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<td><strong>Total ($)</strong></td>
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<td>Item</td>
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<td>Total Price ($)</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------</td>
<td>---------------</td>
<td>-------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>1</td>
<td>Temperature Measurement Unit</td>
<td>08/94</td>
<td>1</td>
<td>12,637</td>
<td>12,637</td>
</tr>
<tr>
<td>2</td>
<td>Heat Transfer Apparatus</td>
<td>04/92</td>
<td>1</td>
<td>26,045</td>
<td>26,045</td>
</tr>
<tr>
<td>3</td>
<td>Multi-Purpose Air Duct</td>
<td>08/90</td>
<td>1</td>
<td>16,015</td>
<td>16,015</td>
</tr>
<tr>
<td>4</td>
<td>Nozzle Pressure Distribution Unit</td>
<td>02/92</td>
<td>1</td>
<td>11,250</td>
<td>11,250</td>
</tr>
<tr>
<td>5</td>
<td>Computer Linked Cross Flow Heat Exchanger and accessories</td>
<td>08/94</td>
<td>1</td>
<td>25,868</td>
<td>25,868</td>
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<tr>
<td>6</td>
<td>Heat Radiation Unit</td>
<td>08/94</td>
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<td>17,052</td>
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<tr>
<td>7</td>
<td>Bomb Calorimeter</td>
<td>12/91</td>
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<td>3,320</td>
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<tr>
<td>8</td>
<td>Plain Oxygen Calorimeter and Acc.</td>
<td>06/95</td>
<td>1</td>
<td>8,900</td>
<td>8,900</td>
</tr>
<tr>
<td>9</td>
<td>2-stage Reciprocating Compressor</td>
<td>02/92</td>
<td>1</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>10</td>
<td>Diesel Engine Simulator</td>
<td>07/89</td>
<td>1</td>
<td>7,100</td>
<td>7,100</td>
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<tr>
<td>11</td>
<td>Solar Energy Simulator</td>
<td>07/89</td>
<td>1</td>
<td>7,450</td>
<td>7,450</td>
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<tr>
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<td>Electric Home Air Conditioner Simulator</td>
<td>07/89</td>
<td>1</td>
<td>5,300</td>
<td>5,300</td>
</tr>
<tr>
<td>13</td>
<td>Bacharach Combustion Analyzer</td>
<td>02/90</td>
<td>1</td>
<td>3,350</td>
<td>3,350</td>
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<tr>
<td>14</td>
<td>Motorized Psychrometer</td>
<td>02/90</td>
<td>1</td>
<td>309</td>
<td>309</td>
</tr>
<tr>
<td>15</td>
<td>Digital Stroboscope Tachometer</td>
<td>02/90</td>
<td>1</td>
<td>495</td>
<td>495</td>
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<tr>
<td>16</td>
<td>Xenon Stroboscope Tachometer</td>
<td>02/90</td>
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<td>145</td>
<td>145</td>
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<tr>
<td>17</td>
<td>Velometer</td>
<td>02/90</td>
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<td>1,303</td>
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<td>18</td>
<td>Viscosimeter</td>
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Total ($): 151,047
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<th>Unit Price ($)</th>
<th>Total Price ($)</th>
</tr>
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<tbody>
<tr>
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<td>7,358</td>
<td>7,358</td>
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<tr>
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<td>Condensate Return System</td>
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<td>1,200</td>
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<tr>
<td>3</td>
<td>Water Softener</td>
<td>02/92</td>
<td>1</td>
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<td>730</td>
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<tr>
<td>4</td>
<td>Cooling Tower</td>
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<td>Donation</td>
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<td>5</td>
<td>Blow off Separator</td>
<td>11/94</td>
<td>1</td>
<td>1,198</td>
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<td><strong>Total ($)</strong></td>
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### Table 11. Manufacturing Laboratory Equipment

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<tr>
<th>Item</th>
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<th>Units</th>
<th>Unit Price ($)</th>
<th>Total Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lathe</td>
<td>02/92</td>
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<td>2,800</td>
<td>2,800</td>
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<tr>
<td>2</td>
<td>Lathe</td>
<td>11/92</td>
<td>4</td>
<td>3,295</td>
<td>13,180</td>
</tr>
<tr>
<td>3</td>
<td>Milling Machine</td>
<td>02/92</td>
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<td>4,200</td>
<td>4,200</td>
</tr>
<tr>
<td>4</td>
<td>Multihead Drill</td>
<td>02/92</td>
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<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>5</td>
<td>Surface Grinder</td>
<td>02/92</td>
<td>1</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>6</td>
<td>Vertical Band Saw</td>
<td>02/92</td>
<td>1</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>7</td>
<td>Horizontal Band Saw</td>
<td>02/92</td>
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<td>150</td>
</tr>
<tr>
<td>8</td>
<td>Radial Saw</td>
<td>02/92</td>
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<td>120</td>
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<tr>
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<td>Punch Press</td>
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<td>2,000</td>
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<td>Bench Grinder</td>
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<td>423</td>
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<td>DusKollector</td>
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<td>582</td>
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<td>Arc Welding Machine</td>
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<td>Mechanical Tool Set</td>
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<td>Welding Table</td>
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<td>Total Price ($)</td>
</tr>
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<td>------------------------------------</td>
<td>---------------</td>
<td>-------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>1</td>
<td>PC Pentium 90, 16 MB</td>
<td>04/95</td>
<td>10</td>
<td>3,208</td>
<td>32,080</td>
</tr>
<tr>
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<td>CNC Lathe/Milling Machine</td>
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<td>10,800</td>
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<tr>
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<tr>
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<td>AutoCad Licences</td>
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<td>9,735</td>
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<tr>
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<td>WeCan Licences</td>
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<td>16</td>
<td>5,000/16</td>
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<tr>
<td>6</td>
<td>Worktables</td>
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Table 13. Mechatronics Laboratory Equipment

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<th>Units</th>
<th>Unit Price ($)</th>
<th>Total Price ($)</th>
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<tbody>
<tr>
<td>1</td>
<td>Process Plant Trainer</td>
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<td>18,856</td>
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<tr>
<td>2</td>
<td>Industrial PLC Unit (Allen-Bradley)</td>
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<td>8,975</td>
<td>8,975</td>
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<tr>
<td>3</td>
<td>Industrial PID Controller (Honeywell)</td>
<td>06/95</td>
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<td>4,179</td>
<td>4,179</td>
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<tr>
<td>4</td>
<td>Ladder Logic Software</td>
<td>06/95</td>
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<td>915</td>
<td>915</td>
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<tr>
<td>5</td>
<td>Data Acquisition Card</td>
<td>06/95</td>
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<td>1,411</td>
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</tr>
<tr>
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<td>Genesis Runtime Software License</td>
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<td>1,539</td>
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<tr>
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<td>Basic Electrical Console</td>
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<tr>
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<td>Pressure Control Accessory</td>
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<td>Adaptor</td>
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<td>Total ($)</td>
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<td>52,736</td>
</tr>
</tbody>
</table>

Minor equipment, tools, spare parts, materials, furniture, and safety equipment are not listed here in order to present the most relevant equipment.
B.3 Students Served.

The number of sections of Laboratory courses offered by the Department depends on the students' demand and on the availability of instructors. The recommended number of students per section is not more than sixteen. As an example of the students' enrollment, in the MAR 95/JUN 95 term, the Department served to two hundred seven (207) students. These students were registered in fourteen (14) sections of five (05) different laboratory courses as listed in Table 14.

Table 14. Students' Served for the Mechanical Engineering Laboratories in MAR 95/MAY 95 Term.

<table>
<thead>
<tr>
<th>Code</th>
<th>Laboratory Course</th>
<th>No of Sections</th>
<th>No of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 328</td>
<td>Fluid Mechanics Laboratory</td>
<td>6</td>
<td>83</td>
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<tr>
<td>ME 344</td>
<td>Physical Metallurgy Laboratory</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>ME 441</td>
<td>Mechanical Engineering Laboratory I</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>ME 445</td>
<td>Manufacturing Laboratory</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>ME 511</td>
<td>Mechanical Engineering Laboratory II</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
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<td>14</td>
<td>207</td>
</tr>
</tbody>
</table>

ME 536 Controls Laboratory and ME 544 CAD/CAM Laboratories have not been offered yet because these laboratory courses were included recently in our curriculum. At this time, we are setting the CAD laboratory and we have ordered the equipment for the CAM and Mechatronics laboratories. So, we are in the process of accomplishment.
B.4 Laboratory Equipment Maintenance

The maintenance of most of the laboratory equipment, and the inventory of spare parts and materials, are done in house under the supervision of the Laboratory Coordinator with the aid of the laboratory technician and two undergraduates. However, external maintenance is required for some equipment such as the Steam Boiler, Compressors, Lathes, Milling machine, and Microscopes. In addition, external consultants are periodically hired for the inspection of equipment requiring certification for operation. In Appendix A.2 are listed some contracts for external maintenance.
B.5 Other Support

The Mechanical Engineering Department has the support of a technician who does the in house maintenance of the equipment and offers technical support during the Manufacturing lab sessions. The Department also has the service of a janitor. The Laboratory Coordinator does not have secretary although he shares one with the Director of the Department and her help is only limited to the typing of memorandums.
C. LABORATORY DEVELOPMENT PLAN

Despite our laboratories are furnished with the necessary equipment and instrumentation, we plan to buy some equipment to strengthen some areas and to broaden others, and to replace equipment for obsolescence as listed in Tables 15 to 20. The commitment of the Polythecnic University of Puerto Rico regarding the future investments on the Mechanical Engineering Laboratory Development Plan for the years 1995-96, 96-97, 97-98, 98-99, and 99-2000 is stated in Chapter VI Supporting Facilities of the Self Study Volume I.

Currently, the space for each laboratory is adequate and suitable to house future equipment acquisition, so we are not considering a physical expansion in the next few years. Also as part of the plans, another full-time technician must be hired to support other laboratories than Manufacturing. A handyman and a secretary should be hired also.
Table 15. Equipment Acquisition Plan for 1995-1996

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Description</th>
<th>Model</th>
<th>Supplier</th>
<th>Unit Price ($)</th>
<th>Units</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Mechanics</td>
<td>Flow over a Notch</td>
<td>H6</td>
<td>TecQuipment</td>
<td>2,756</td>
<td>1</td>
<td>2,756</td>
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<tr>
<td></td>
<td>Pipe Friction</td>
<td>H7</td>
<td>TecQuipment</td>
<td>2,264</td>
<td>1</td>
<td>2,264</td>
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<tr>
<td></td>
<td>Center of Pressure App.</td>
<td>H11</td>
<td>TecQuipment</td>
<td>1,589</td>
<td>1</td>
<td>1,589</td>
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<tr>
<td></td>
<td>Jet Trajectory &amp; Flow Through an Orifice</td>
<td>H33</td>
<td>TecQuipment</td>
<td>3,375</td>
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<td>3,375</td>
</tr>
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<td></td>
<td><strong>Sub-Total ($)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>9,984</strong></td>
</tr>
<tr>
<td>Thermology I</td>
<td>Strain Gauges and Data Acquisition System</td>
<td></td>
<td>Omega</td>
<td>10,000</td>
<td>1</td>
<td>10,000</td>
</tr>
<tr>
<td>Thermology II</td>
<td>Boiler Instruments and Installation</td>
<td></td>
<td>Feliu</td>
<td>8,000</td>
<td>1</td>
<td>8,000</td>
</tr>
<tr>
<td>Physical Metallurgy</td>
<td>Extensometer</td>
<td></td>
<td>ATS</td>
<td>2,800</td>
<td>1</td>
<td>2,800</td>
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<tr>
<td></td>
<td>Grinder/Polisher</td>
<td>49-1850-160</td>
<td>Buehler</td>
<td>3,740</td>
<td>3</td>
<td>11,220</td>
</tr>
<tr>
<td></td>
<td>Table for Grinder/Polisher</td>
<td>48-8183</td>
<td>Buehler</td>
<td>3,840</td>
<td>1</td>
<td>3,840</td>
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<tr>
<td></td>
<td>Fume Hood</td>
<td></td>
<td>Buehler</td>
<td>8,000</td>
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<tr>
<td></td>
<td>Abrasive Cutter</td>
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<td>Abrasimet</td>
<td>6,770</td>
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<tr>
<td></td>
<td><strong>Sub-Total ($)</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>32,630</strong></td>
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<tr>
<td>Manufacturing</td>
<td>Milling Machine</td>
<td></td>
<td>Bridgeport</td>
<td>18,000</td>
<td>1</td>
<td>18,000</td>
</tr>
<tr>
<td></td>
<td>Various Tools and Acc.</td>
<td></td>
<td>Superior</td>
<td>4,000</td>
<td>1</td>
<td>4,000</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-Total ($)</strong></td>
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<td></td>
<td></td>
<td><strong>22,000</strong></td>
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<td></td>
<td><strong>Total ($)</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>82,614</strong></td>
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<tr>
<td>Laboratory</td>
<td>Description</td>
<td>Model</td>
<td>Supplier</td>
<td>Unit Price ($)</td>
<td>Units</td>
<td>Price ($)</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------</td>
<td>----------</td>
<td>--------------</td>
<td>----------------</td>
<td>-------</td>
<td>-----------</td>
</tr>
<tr>
<td>Thermology I</td>
<td>Pressure Measurement Instruments</td>
<td></td>
<td>Omega</td>
<td>5,250</td>
<td>1</td>
<td>5,250</td>
</tr>
<tr>
<td>Thermology II</td>
<td>Dynamometer 1.5 Kw at 3,600 rpm (Computer Linked)</td>
<td>Master 2000</td>
<td>TecQuipment</td>
<td>29,774</td>
<td>1</td>
<td>29,774</td>
</tr>
<tr>
<td></td>
<td>Diesel Engine</td>
<td>Merlin 02</td>
<td>TecQuipment</td>
<td>12,210</td>
<td>1</td>
<td>12,210</td>
</tr>
<tr>
<td></td>
<td>Automatic Fuel Gauge</td>
<td>2000/01</td>
<td>TecQuipment</td>
<td>6,894</td>
<td>1</td>
<td>6,894</td>
</tr>
<tr>
<td></td>
<td>Turbine Air Flow Meter</td>
<td>2000/01</td>
<td>TecQuipment</td>
<td>918</td>
<td>1</td>
<td>918</td>
</tr>
<tr>
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<td>Sub-Total</td>
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<td>Physical Metallurgy</td>
<td>Universal Impact Tester for Metals</td>
<td>84</td>
<td>Tinius Olsen</td>
<td>21,000</td>
<td>1</td>
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</tr>
<tr>
<td>Manufacturing</td>
<td>Lathe 14&quot;x40&quot;</td>
<td>Dynapath</td>
<td>Ferreteria Abraham</td>
<td>20,000</td>
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</tr>
<tr>
<td>CAD/CAM</td>
<td>CNC Milling Machine</td>
<td>Dynapath</td>
<td>Ferreteria Abraham</td>
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<td>Model</td>
<td>Supplier</td>
<td>Unit Price ($)</td>
<td>Units</td>
<td>Price ($)</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------</td>
<td>---------------</td>
<td>--------------</td>
<td>----------------</td>
<td>-------</td>
<td>-----------</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>Centrifugal Pump</td>
<td>Merlin 03</td>
<td>TecQuipment</td>
<td>9,093</td>
<td>1</td>
<td>9,093</td>
</tr>
<tr>
<td></td>
<td>Turbine water Flowmeter</td>
<td>2000/03</td>
<td>TecQuipment</td>
<td>869</td>
<td>1</td>
<td>869</td>
</tr>
<tr>
<td></td>
<td>Sub-Total</td>
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<td></td>
<td></td>
<td></td>
<td>9,962</td>
</tr>
<tr>
<td>Thermology II</td>
<td>Merlin Variable Compression Ratio Engine</td>
<td>Merlin 11</td>
<td>TecQuipment</td>
<td>32,164</td>
<td>1</td>
<td>32,164</td>
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<tr>
<td>Physical Metallurgy</td>
<td>Image Analysis System</td>
<td>Omnimet 3</td>
<td>Buehler</td>
<td>38,295</td>
<td>1</td>
<td>38,295</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Oven for Preserving Welding Electrodes</td>
<td>Miller</td>
<td>Ferreteria Abraham</td>
<td>1,500</td>
<td>1</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td>Horizontal Band Saw</td>
<td>Kalamazoo</td>
<td>Superior Tools</td>
<td>4,500</td>
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<td>4,500</td>
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<td>Sub-Total</td>
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<td></td>
<td></td>
<td></td>
<td>6,000</td>
</tr>
<tr>
<td>CAD/CAM</td>
<td>PC Pentium 120, 32MB RAM, 850 MB local bus IDE hard drive, Diamond Stealth 64 Video PCI local bus graphics card with 4MB VRAM, 17&quot; SVGA color Monitor</td>
<td>Pantera</td>
<td>Zeos</td>
<td>4,145</td>
<td>10</td>
<td>41,145</td>
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<td>Total ($)</td>
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<td></td>
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<td>Model</td>
<td>Supplier</td>
<td>Unit Price</td>
<td>Units</td>
<td>Price</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------</td>
<td>---------</td>
<td>-------------</td>
<td>------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>Merlin Twin Water Turbine Module</td>
<td>Merlin 09</td>
<td>TecQuipment</td>
<td>24,781</td>
<td>1</td>
<td>24,781</td>
</tr>
<tr>
<td></td>
<td>Turbine water Flow meter</td>
<td>2000/08</td>
<td>TecQuipment</td>
<td>869</td>
<td>1</td>
<td>869</td>
</tr>
<tr>
<td></td>
<td>Sub-Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25,650</td>
</tr>
<tr>
<td>Thermology II</td>
<td>Merlin Steam Plant Module</td>
<td>Merlin 12</td>
<td>TecQuipment</td>
<td>27,391</td>
<td>1</td>
<td>27,391</td>
</tr>
<tr>
<td>Physical Metallurgy</td>
<td>10,000 in-lb LO-TORQ Torsion Testing Machine</td>
<td>290</td>
<td>Tinius Olsen</td>
<td>41,435</td>
<td>1</td>
<td>41,435</td>
</tr>
<tr>
<td></td>
<td>Tinius Olsen Data System</td>
<td>DS-50/2-Pentium 90</td>
<td>Tinius Olsen</td>
<td>15,795</td>
<td>1</td>
<td>15,795</td>
</tr>
<tr>
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<td>Sub-Total</td>
<td></td>
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<td></td>
<td></td>
<td>57,230</td>
</tr>
<tr>
<td>Mechatronics</td>
<td>Remote Set Point Control Accessory</td>
<td>PCT17</td>
<td>Armfield</td>
<td>7,125</td>
<td>1</td>
<td>7,125</td>
</tr>
<tr>
<td></td>
<td>Digital Multimeter and Accessories</td>
<td>HP 3458A</td>
<td>Hewlett Packard</td>
<td>7,595</td>
<td>1</td>
<td>7,595</td>
</tr>
<tr>
<td></td>
<td>Sub-Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td><strong>Total ($)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>124,991</strong></td>
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</table>
### Table 19. Equipment Acquisition Plan for 1999-2000

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Description</th>
<th>Model</th>
<th>Supplier</th>
<th>Unit Price</th>
<th>Units</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Mechanics</td>
<td>Air Flow Bench</td>
<td>AF10</td>
<td>TecQuipment</td>
<td>13,949</td>
<td>1</td>
<td>13,949</td>
</tr>
<tr>
<td></td>
<td>Multitube Manometer</td>
<td>AF10a</td>
<td>TecQuipment</td>
<td>4,385</td>
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<tr>
<td></td>
<td>Drag Force Apparatus</td>
<td>AF12</td>
<td>TecQuipment</td>
<td>4,995</td>
<td>1</td>
<td>4,995</td>
</tr>
<tr>
<td></td>
<td>Boundary Layer Apparatus</td>
<td>AF14</td>
<td>TecQuipment</td>
<td>4,804</td>
<td>1</td>
<td>4,804</td>
</tr>
<tr>
<td></td>
<td>Flow Round a Bend</td>
<td>AF15</td>
<td>TecQuipment</td>
<td>3,422</td>
<td>1</td>
<td>3,422</td>
</tr>
<tr>
<td></td>
<td>Round Turbulent Jet Apparatus</td>
<td>AF13</td>
<td>TecQuipment</td>
<td>3,768</td>
<td>1</td>
<td>3,768</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-Total</strong></td>
<td></td>
<td></td>
<td><strong>35,323</strong></td>
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</tr>
<tr>
<td>Thermology I</td>
<td>Instrumentation for Flow, Velocity, and</td>
<td></td>
<td>Omega</td>
<td>20,000</td>
<td>1</td>
<td>20,000</td>
</tr>
<tr>
<td></td>
<td>Power Measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD/CAM</td>
<td>CNC Lathe</td>
<td></td>
<td>Dynapath</td>
<td>30,000</td>
<td>1</td>
<td>30,000</td>
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<td><strong>Total ($)</strong></td>
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<td></td>
<td><strong>125,514</strong></td>
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Table 20. Equipment Acquisition Plan for 2000-2001

<table>
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<tr>
<th>Laboratory</th>
<th>Description</th>
<th>Model</th>
<th>Supplier</th>
<th>Unit Price</th>
<th>Units</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Mechanics</td>
<td>100mmx300mmx4m Flow Channel</td>
<td>TE36</td>
<td>TecQuipment</td>
<td>53,078</td>
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<td></td>
<td>Set of seven models for 100mmx300mm channel</td>
<td>TE36/1</td>
<td>TecQuipment</td>
<td>9,415</td>
<td>1</td>
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<td>Sub-total</td>
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<td></td>
<td></td>
<td>62,493</td>
</tr>
<tr>
<td>Thermology I</td>
<td>Noise Abatement Apparatus</td>
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<td>TecQuipment</td>
<td>12,000</td>
<td>1</td>
<td>12,000</td>
</tr>
<tr>
<td>Physical Metallurgy</td>
<td>Mounting Press</td>
<td>20-1420-160</td>
<td>Buehler</td>
<td>6,720</td>
<td>1</td>
<td>6,720</td>
</tr>
<tr>
<td>CAD/CAM</td>
<td>Transverse Robot</td>
<td>83-202</td>
<td>Emco</td>
<td>30,000</td>
<td>1</td>
<td>30,000</td>
</tr>
<tr>
<td>Mechatronics</td>
<td>Instrumentation</td>
<td></td>
<td>Omega</td>
<td>15,000</td>
<td>1</td>
<td>15,000</td>
</tr>
<tr>
<td>Total ($)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>126,213</td>
</tr>
</tbody>
</table>
APPENDIX

A.1 Syllabus for the Laboratory Courses
POLYTECHNIC UNIVERSITY OF PUERTO RICO
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION
ENGI 328 FLUID MECHANICS LABORATORY


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to give engineering students the necessary experimental knowledge to complement the theory of Fluid Mechanics.

Prerequisites by topic:
1. Working knowledge on computer software.
3. The Least Squares Method.
4. Fluid statics.
5. Fluid dynamics.

Laboratory projects:
1. Introduction. Experimental errors. Error analysis. Statistical analysis of experimental data. (one four-hour class)
2. Statistical analysis in the Gravimetric Flow Measurement. (one four-hour lab session)
3. Hydrostatic Thrust on a Plane Surface. (one four-hour lab session)
4. Stability of a Floating Body. (one four-hour lab session)
5. Flow through Orifices and Nozzles. (one four-hour lab session)
6. Flow through a Venturi Meter. (one four-hour lab session)
7. Discharge over Weirs. (one four-hour lab session)
8. Friction Loss along a Pipe and Pipe Fittings. (one four-hour lab session)
9. Impact of a Jet. (one four-hour lab session)
10. Final Presentations. (one four-hour lab session)
11. Final Examination. (one four-hour comprehensive examination).

**Computer Usage:**

Every working team is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written in English using word processing programs. Numerical results should be calculated and plotted using the appropriate computer software.

**ABET Category Content:**

Engineering science: 1 credit or 100%

**Prepared by:** Gilmer R. Burgos  
**Date:** Nov. 5, 1994.
POLYTECHNIC UNIVERSITY OF PUERTO RICO
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION
ME 344 PHYSICAL METALLURGY LABORATORY

Laboratory experimentation on physical and mechanical characteristics of
metals and alloys.
Prerequisite: ENGI 235.
Corequisite: ME 343.

University of Puerto Rico, Department of Mechanical Engineering, 1995.
In preparation.


Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to give engineering students the necessary
experimental knowledge to complement the theory learned in the Physical
Metallurgy course.

Prerequisite by topic:
1. Working knowledge of computer software.
2. Thermodynamics.
3. Mechanics of Materials
4. Physical Metallurgy

Laboratory Topics:
2. Microstructure. (1 four-hour lab session)
3. Hardness test. (1 four-hour lab session)
4. Phase Diagrams. (1 four-hour lab session)
5. Heat Treatments for Steel. (2 four-hour lab sessions)
6. Precipitation Hardening. (1 four-hour lab session)
7. Torsion Test. (1 four-hour lab session)
8. Tension Test. (1 four-hour lab session)
9. Final Presentations. (1 four-hour lab session)
10. Final Examination. (1 four-hour comprehensive examination)

Computer Usage:

Every working team is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written in English using word processing programs. The numerical results should be calculated and plotted using the appropriate computer software.

ABET Category Content:

Engineering Science: 1 credit or 100%

Prepared by: Gilmer R. Burgos  Date: March 1, 1994
POLYTECHNIC UNIVERSITY OF PUERTO RICO
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION
ME 441 MECHANICAL ENGINEERING LABORATORY I

1995 Catalog Data: ME 441: Mechanical Engineering Laboratory I. Credits 1.
Instrumentation, Calibration, Measurements, and data acquisition using
devices related to the mechanical engineering field.
Prerequisites: ENGI 235 & ME 431.


References: J. W. Dally, W. F. Riley, and K. G. McConnell, Instrumentation for
T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard, Mechanical
R.S. Figliola, and D.E. Beasley, Theory and Design for Mechanical
Ernest O. Doebelein, Measurement Systems: Application and Design,
Martin S. Ray, Engineering Experimentation: Ideas, Techniques, and
Robert P. Benedict, Fundamentals of Temperature, Pressure, and Flow

Coordinator: Jacinto Solano, Assistant Professor of M.E.

Goals: This course is designed to familiarize the student with the appropriate
instrumentation for mechanical measurements and data acquisition.

Prerequisites by topic:
1. Computer programming, and applied software for engineers.
2. Numerical Analysis for Engineers.
3. Thermodynamics.

Laboratory Topics:
   Analysis. (1 four-hour lab session)
2. Temperature Measurements. (2 four-hour lab sessions)
3. Pressure Measurements. (1 four-hour lab session)
4. Velocity Measurements. (1 four-hour lab session)
5. Flow Measurements. (1 four-hour lab session)
6. Heating Value Measurements. (1 four-hour lab session)
7. Thermal Radiation Measurements. (1 four-hour lab session)
8. Final Oral Presentations. (1 four-hour lab session)
9. Final Examination. (1 four-hour lab session)
Computer Usage:

The student is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written in English using word processing programs. Numerical results should be calculated and plotted using the appropriate computer software.

ABET Category Content:

Engineering science: 1.0 credit or 100%

Prepared by: Gilmer R. Burgos               Date: June 07, 1994.
POLYTECHNIC UNIVERSITY OF PUERTO RICO
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION
ME 445 MANUFACTURING LABORATORY

Experience on machine-shop processes. Turning, drilling, boring and milling
operation. Oxi-fuel and electric arc welding systems.
Prerequisites: ME 343, ME 344, & ME 410.
Corequisite: ME 444.


References: Krar Stephen, and J.W. Oswald, Technology of Machine Tools,
1989.
P.K. Wright, and D.A. Bourne, Manufacturing Intelligence,

Coordinator: Gilmer R. Burgos, Assistant Professor of M.E.

Goals: This course is designed to offer mechanical engineering students a practical
and comprehensive knowledge of measurements instruments, machining, and
welding manufacturing processes.

Prerequisites by topic:
1. Physical Metallurgy.
5. Processes and Methods of Manufacturing.

Laboratory Topics:
1. Introduction. Safety Rules. (1 four-hour session)
   session)
3. Lathe Operation. Appropriate selection of gears for turning different kinds of materials. Tool bit
   preparation. Turning, facing, boring, cutting, and external and internal threatening practice. (2
   four-hour lab sessions)
4. Milling machine operation and practice. (2 four-hour lab sessions)
5. Arc Welding process and practice. Safety rules. (2 four-hour lab sessions)
6. Oxy-acetylene welding and cutting process and practice. Safety rules. (1 four-hour lab session)
7. Project presentation and Final Written Examination. (1 four-hour lab session)
Computer Usage:

Each working team is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written using word processing programs. The numerical results should be calculated and plotted using the appropriate computer software.

ABET category content:

Engineering science: 2.0 credits or 100%

Prepared by: Gilmer R. Burgos  Date: June 07, 1995.
POLYTECHNIC UNIVERSITY OF PUERTO RICO
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION
ME 511 MECHANICAL ENGINEERING LABORATORY II

1995 Catalog Data: ME 511: Mechanical Engineering Laboratory II. Credits 1. Experience on the experimental analysis and performance of thermal devices related to the mechanical engineering field. Prerequisites: ME 428 & ME 441.


Coordinator: Jorge L. Martinez, Assistant Professor of M.E.

Goals: This course is designed to develop the ability of mechanical engineering students in the planning and design of tests for performance analysis and the presentation of results.

Prerequisites by topic:
1. Computer programming, and applied software for engineers.
2. Numerical Analysis for Engineers.
3. Thermodynamics.

Laboratory Topics:
1. Introduction and Safety rules. (1 four-hour lab session)
2. Air Compressor Performance. (1 four-hour lab session)
3. Air-conditioning Simulation. (1 four-hour lab session)
4. Compressible Fluid Flow through convergent and convergent-divergent nozzles (1 four-hour lab session)
5. Cross Flow Heat Exchanger. (2 four-hour lab sessions)
6. Convective Heat Transfer in Pipes. (1 four-hour lab session)
7. Steam Boiler Performance. (1 four-hour lab session)
8. Oral presentations. (1 four-hour lab session)
9. Final examination. (1 four-hour lab session)
Computer Usage:

Every working team, composed of not more than four students, is required to submit weekly a written report corresponding to every lab experiment carried out. The report should be written using word processing programs. Numerical results should be calculated and plotted using the appropriate computer software.

**ABET Category Content:**

Engineering Science: 1.0 credits or 100%

**Prepared by:** Gilmer R. Burgos  
**Date:** June 07, 1995.
POLYTECHNIC UNIVERSITY OF PUERTO RICO
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION
ME 536 CONTROLS LABORATORY

1995 Catalog Data: ME 536. Controls Laboratory. Credits 1.
Experimental analysis and response in process control technology of
mechanical systems.
Prerequisites: EE 3020, & ME 432. Corequisite: ME535.

Textbook: W.J. Grantham, and T.L. Vincent, Modern Control Systems, Analysis and

References: P. R. Bélanger, Control Engineering, A Modern Approach, Saunders
W. A. Wolovich, Automatic Control Systems, Basic Analysis and Design,
S. Thompson, Control Systems Engineering and Design, John Wiley and
Sons, 1989.

Coordinator: Hebert Jaramillo, Assistant Professor of M.E.

Goals: This course is designed to develop skills of mechanical engineering students
for analysis and design of mechanical control techniques associated with
process plant, from single-loop analog control to multi-loop PLC systems.

Prerequisites by topic:
1. Computer programming.
2. Solutions of Linear Ordinary Differential Equations.
3. Laplace Transforms.
5. Electric Circuit Analysis.
6. Controls theory.

Laboratory Topics:
1. Introduction. Understanding process duty and the plant hardware to achieve it. Using a PC
   connected to the plant to monitor measurements. (1 four-hour lab session)
2. Calibrating measurement sensors: temperature, flow, level, and power. (1 four-hour lab session)
3. Heat transfer measurements: losses and transfer coefficients. (1 four-hour lab session)
4. Simple process dynamics-first order; "dead time", mixed systems. (1 four-hour lab session)
5. Comparing control needs: flow, level, and temperature. (1 four-hour lab session)
6. On/Off and PID control actions. (1 four-hour lab session)
7. Connecting an industrial single-loop controller. Tuning an industrial controller. (1 four-hour lab
   session)
8. Introduction to SCADA: PC supervision of a controller. (1 four-hour lab session)
9. Direct Digital Control: using a PC with PID controllers in software. (1 four-hour lab session)
10. Oral Presentations. (1 four-hour lab session)
11. Final Comprehensive Examination. (1 four-hour lab session)
Computer Usage:

Every working team, composed of not more than four students, is required to submit weekly a written report corresponding to every laboratory experiment carried out. The report should be written using word processing programs. Numerical results should be calculated and plotted using the respective computer software.

ABET Category Content:

Engineering Science: 1.0 credits or 100.0%

Prepared by: Hebert Jaramillo

Date: Feb. 07, 1995.
Laboratory experimentation on Computer-Aided Design and Manufacturing. Experimentation on each phase of the design process and the corresponding automated manufacturing through CNC interphase to lathe and milling machines.
Prerequisites: ME 421 & ME 445.
Corequisite: ME 543.


Coordinator: Eduardo J. Veras, Assistant Professor of M.E.

Goals: This course is designed to give mechanical engineering students the necessary working knowledge to design and manufacture a product, using computers and numerical controlled machines.

Prerequisites by topic:
1. Working knowledge on computer graphics.
2. Working knowledge on finite element analysis.
3. Working knowledge on machine tool operation.

Topics and Laboratory Projects:
1. Introduction. Safety rules. Course description. (1 four-hour lab session)
2. CAD. Finite Element Analysis of Machine Components. (2 four-hour lab sessions)
3. NC Programming and simulation. NC Direct programming for a lathe and a milling machine. (2-four-hour lab sessions)
4. CNC Programming for a Lathe. Threading. (1 four-hour lab session)
5. Taper shaft. (1 four-hour lab session)
6. Fillet cutting. (1 four-hour lab session)
7. CNC Programming for a milling machine. Point to Point programming. (1 four-hour lab session)
8. Contouring. (1 four-hour lab session)
9. Final Oral Presentations. (1 four-hour lab session)
10. Final comprehensive Examination. (1 four-hour lab session)

**Computer Usage:**

The main feature of this course is the requirement of an intensive computer use to carry out the computerized mechanical design and the corresponding automated manufacturing. Students are required to submit weekly a written report corresponding to every laboratory session. The report should be written in English using a word processor program.

**ABET Category Content:**

Engineering Science: 1.0 credits or 100.0%

**Prepared by:** Alfredo Pérez

**Date:** Feb. 07, 1995.
A.2 Contracts for External Maintenance
QUOTATION

DATE: March 23, 1995

TO: Universidad Politecnica de P.R.
Hato Rey College
Ave. Ponce de Leon
San Juan, Puerto Rico

Attn: Mr. Gilbert Burgos
Dept. of Mechanical Engineering

We are pleased to quote in reply to your inquiry the following Annual Repair, Clean and Calibration Service Contract on your Six (6) Binocular Microscopes.

A- Officially, service will be scheduled for twice annually.

B- Emergency service calls will be attended within a period of one to four working days and at no extra service charge.

C- Service will not include spare parts in the price quoted. However, ARM SCIENTIFIC CO. does carry a good supply of spare parts in stock and we also have the necessary means of obtaining Original Parts from Manufacturers. We shall advise Purchasing as well as the Engineering Department; the price of these items for an approval to proceed with the repair of the Instrument. The Purchasing Department has the flexibility, if needed by, to request and or buy said items from other sources. ARM SCIENTIFIC CO. has the obligation to install and calibrate, when needed, these parts at no extra service charge.

D- Univ. Politecnica shall give us a list stating the Serial and or Property Control Number on each Microscope and where the same are located.

E- ARM SCIENTIFIC COMPANY, INC. shall give you a written and comprehensive report as to the conditions and or comments regarding each Microscope.

F- Total Cost on Annual Service Contract will be: $270.00
G- Payment Terms: We will invoice $155.00 twice annually; Net 30 Days after invoice is presented.

H- Service can be rendered at your premises as well as our service shop, in order not to interfere with your working schedule, work can be performed during weekends or holidays.

I- ARM SCIENTIFIC COMPANY, INC. has sufficient insurance coverage to protect Univ. Politecnica as well as ourselves against any unforeseen incident such as theft, breakage or lost while in transit or in our possession.

J- This contract shall be effective immediately after notice.

[Signature]
HERIBERTO CRUZ
Manager Technical Servs.
INVOICE

INVOICE NUMBER: 4872
INVOICE DATE: May 30, 1995

SOLD TO
Universidad Politecnica de P.R.
Hato Rey College
Ave. Ponce de Leon
San Juan P.R.

SHIP TO
Prof. Gilmer Burgos
Dept. of Mechanical Engineering

SHIP VIA: 
SHIP DATE: 
DUE DATE: 5/30/95
TERMS: Net 30 Days

CUST. I.D.: 
P.O. NUMBER: verbal
P.O. DATE: 5/26/95
OUR ORDER NO.: MS 605 95
SALESMAN: 

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>ORDERED</th>
<th>SHIPPED</th>
<th>UOM</th>
<th>UNIT PRICE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ea.</td>
<td>Repair, Clean, Calibration and General Maintenance service on your six (6) Microscopes.</td>
<td>$135.00</td>
<td>$135.00</td>
<td></td>
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<td></td>
</tr>
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</table>

Total $135.00

Gilmer R. Burgos
05/30/95
6:35 pm

Furst Service.
Microscope Checkup Report

Date: May 30, 1995

Customer Name: UNO Poblacional de PR

Customer P.O. No. UNO

ARM No. MS-60545

Symbols: (VG) VERY GOOD (G) GOOD (F) FAIR (B) BAD (O) MISSING

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<thead>
<tr>
<th>PROPERTY #</th>
<th>SERIAL #</th>
<th>EYEPIECES</th>
<th>OBJECTIVES</th>
<th>COMMENTS</th>
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<td>VG</td>
<td>10x 40x 100x</td>
<td></td>
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<tr>
<td></td>
<td>2714</td>
<td>VG</td>
<td>10x 40x 100x</td>
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<td>2719</td>
<td>VG</td>
<td>10x 40x 100x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2720</td>
<td>VG</td>
<td>10x 40x 100x</td>
<td></td>
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<tr>
<td></td>
<td>2777</td>
<td>VG</td>
<td>10x 40x 100x</td>
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<td>2732</td>
<td>VG</td>
<td>10x 40x 100x</td>
<td>20x VG</td>
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Additional Comments: 

Approved & Received By: ___________________________ Date: 5/30/95

Serviced By: ___________________________ Date: 5/30/95
To: Universidad Politecnica  
Departamento de Ingenieria  
Hato Rey, P. R.  
Attention: Prof. Gilmer Burgos

Quotation No.: SER-419  
Date: April 23, 1995  
Quoted from Price List Dated: Valid for 30 days  
FOB Point: Bridgeport, CT, Goshen IN, & San Juan, P. R

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SERVICE TO A BRIDGEPORT MILLING MACHINE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Model Ser. I STD, 2J Head</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Based on our preliminary inspection. The machine needs the following repairs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top Head Area:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needs the replacement of the motor, pulleys, bearings, bushings, snap-rings, keys, drive belts and other parts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Head Back Gear area:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needs new bearings.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Head Lower Housing:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needs new bearings, spacers, keepers, locknut, quill skirt, clock spring and wiper.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Table Area and Machine Base:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needs new leadscrew nuts for X &amp; Y screws, retaining screws, wipers and a good cleaning. The ways and gibbs do show wear. Once we have removed the table and cleaned all the slides, at that time will determine if its necessary to replace the gibbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A point that we want to clarify is that the machine may have other defective parts that at this moment we can't determine.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>After the repairs are completed the machine will give you good service for several years, providing that the ways or slides aren't worn out.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Following is our estimate of the required parts and services:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Evaluation Visit:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provided as a service to the customer.</td>
<td>N/C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Top Head Area:</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>11181977 Wave spring washer</td>
<td>4.75</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>11180252 Fafnir bearing</td>
<td>101.39</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>11180848 Snap ring</td>
<td>4.02</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>12180056 Spindle pulley bearing sliding housing</td>
<td>20.48</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>11170262 Bearing</td>
<td>@57.24</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>11182124 Plastic Insert</td>
<td>@7.46</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>11182120 Belt</td>
<td>120.57</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>11550001 Motor 2 HP</td>
<td>715.00</td>
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<tr>
<td>10</td>
<td>1</td>
<td>12550007 Key, pulley</td>
<td>20.00</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>12550006 Stationary motor vari-disc</td>
<td>125.55</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>12550029 Adjustable motor vari-disc assembly</td>
<td>260.00</td>
</tr>
</tbody>
</table>
To: Universidad Politecnica  
Departamento de Ingenieria  
Hato Rey, P. R.  

Attention: Prof. Gilmer Burgos  

Quotation No: SER-419  
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<th>Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>HEAD BACK GEAR</strong></td>
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</tr>
<tr>
<td>13</td>
<td>2</td>
<td>Ball bearing</td>
<td>44.84</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>Timing belt</td>
<td>78.50</td>
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<tr>
<td></td>
<td></td>
<td><strong>Head Lower Housing:</strong></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>NO. 06 Locknut</td>
<td>28.78</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>W. 06 Lockwasher</td>
<td>18.49</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>Bearing</td>
<td>24.49</td>
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<tr>
<td>18</td>
<td>1</td>
<td>Bearing, Spindle Matched Pair, Set</td>
<td>275.00</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>Bearing spacer set</td>
<td>70.68</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>Clock spring</td>
<td>74.14</td>
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<td>21</td>
<td>1</td>
<td>Quill skirt</td>
<td>23.00</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>Felt, oil strainer</td>
<td>20.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Machine Base &amp; Table Area:</strong></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>4</td>
<td>Table, Felt Wipers</td>
<td>14.59</td>
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<td>24</td>
<td>2</td>
<td>Knee, Felt Wipers</td>
<td>8.17</td>
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<td>25</td>
<td>2</td>
<td>Washer head screw</td>
<td>4.94</td>
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<tr>
<td>26</td>
<td>2</td>
<td>Retaining screw</td>
<td>9.61</td>
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<tr>
<td>27</td>
<td>1</td>
<td>Nut, X Axis Screw, Set</td>
<td>74.00</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>Nut, Y Axis Screw, Set</td>
<td>74.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parts Total</td>
<td>2,456.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Repair Service Charges:</strong></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>Labor to replace the above parts, 24 hours at $65.00</td>
<td>1,560.00</td>
</tr>
<tr>
<td>30</td>
<td>3</td>
<td>Travel charges Hato Rey</td>
<td>75.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Labor Charges</td>
<td>1,785.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Cost to perform the above repairs parts &amp; labors</td>
<td>4,241.90</td>
</tr>
</tbody>
</table>

A new Bridgeport mill cost $11,000 to $22,000 depending on the accessories. A Taiwanese mill cost $7,000 to $9,000.

Parts leadtime is 3 to 4 days, after the placing the order at the factory. Repair time is 3 days, after the arrival of the parts.

**ADDITIONAL PARTS OR SERVICES:**
There is always the possibility that during our service, we may find that additional parts or services are required and they weren't included in our service. If this occur will inform you of our findings, as well as the additional cost involved, if any.
To: Universidad Politecnica  
Departamento de Ingeniería  
Hato Rey, P. R. 

Attention: Prof. Gilmer Burgos

<table>
<thead>
<tr>
<th>Item</th>
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<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SERVICE TO A CLAUSING VARIABLE SPEED LATHE, MODEL 5914 SERIAL # 512333</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>This machine have a vibration problem that in the variable speed drive. Secondly it needs a good preventive maintenance service. With regards to the vibration problem, we need to disassemble the vari-speed drive to identify the defective parts. Our preventive maintenance service consist of cleaning all the slides, adjusting the gibbs, adjusting the headstock brake, oil change, replacement of all the drive belts and servicing all the lube points, including the gears. A point that we want to clarify is that the machine may have other defective parts that at this moment we can't determine.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Replacement Parts:</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>TBD</td>
<td>TBD.A.</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>TBD</td>
<td>TBD.A.</td>
</tr>
<tr>
<td>33</td>
<td>1</td>
<td>Oil</td>
<td>TBD.A.</td>
</tr>
<tr>
<td>34</td>
<td>1</td>
<td>Oil</td>
<td>TBD.A.</td>
</tr>
<tr>
<td>35</td>
<td>1</td>
<td>Oil</td>
<td>TBD.A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repair Service Charges:</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>1</td>
<td>Labor to disassemble the vari-speed drive and to perform the preventive maintenance program. 18 hours at $65.00</td>
<td>1,170.00</td>
</tr>
<tr>
<td>37</td>
<td>2</td>
<td>Travel charges to Hato Rey</td>
<td>$75.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Labor Charges</td>
<td>150.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1,320.00</td>
<td></td>
</tr>
</tbody>
</table>

Parts leadtime is 3 to 15 days, after the placing the order at the factory. Repair time is 2 days, after the arrival of the parts.

SERVICE TO A FREJOTH LATHE, TYPE F1-900 AE/G, SER. # 9360
We have preliminary inspected this machine and needs the following repairs and services:
A. There is a problem with the longitudinal power feed of the carriage. It seems that when engage it momentarily works and then it stops altogether. We need to disassemble either the power feed unit or the carriage gearbox to identify the defective parts.
B. New drive parts are needed.
C. All the oil must be changed.
D. The chuck needs to be inspected, isn't working properly.
TO: UNIVERSIDAD POLITECNICA DE P.R.

ATTN: MANUEL BARDALEZ P.E.
DIRECTOR DEPTO. ING. MECANICA
TEL: 754-8000 EXT. 323

JOB: MANTENIMIENTO CALDERA

DATE 2-27-95  TERMS NET 30 DAYS
YOUR INQUIRY DATED P05-0147
PROPOSED SHIPPING DATE TO BE SHIPPED VIA
SALESPERSON CARLOS J. BAUZA

HERE IS OUR QUOTATION ON THE GOODS NAMED, SUBJECT TO THE CONDITIONS NOTED:

CONDITIONS: The prices and terms on this quotation are not subject to verbal changes or other agreements unless approved in writing by the Home Office of the Seller. All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Prices are based on costs and conditions existing on date of quotation and are subject to change by the Seller before final acceptance. Typographical and stenographic errors subject to correction. Purchaser agrees to accept either average or shortage not in excess of ten percent to be charged for pro-rata. Purchaser assumes liability for patent and copyright infringement when goods are made to Purchaser’s specifications. When quotation specifies material to be furnished by the purchaser, ample allowances must be made for reasonable spoilage and material must be of suitable quality to facilitate efficient production. Conditions not specifically stated herein shall be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser’s formal order will not be binding on the Seller.

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servicio de mantenimiento para los siguientes Equipos:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(A) Caldera Fulton modelo FB-010-A.</td>
<td></td>
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<tr>
<td>(B) Tanque de condensado Fulton 33 galones y su bomba de 1/2 HP.</td>
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<tr>
<td>(C) Ablandador de agua Ecowater Industrial System modelo: ESLL60F.</td>
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<tr>
<td>Precio Total Mensual $150.00</td>
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SERVICIO INCLuye LO SIGUIENTE:

(A) Todo trabajo mecánico o eléctrico en el equipo arriba indicado.
(B) Limpieza del quemador y niveles de agua de la caldera.
(C) Cotejo del funcionamiento de la bomba y limpieza del nivel de agua del tanque de condensado.
(D) Cotejo del funcionamiento del "timer" y cotejo del nivel de sal y válvulas del ablandador de agua.
(E) Cotejar en general del funcionamiento de los equipos arriba mencionado.
(F) Reparación del equipo arriba mencionado siempre que sea necesario.
(G) Todo servicio se efectuará en días laborables de lunes a viernes de 8:00 AM a 5:00 PM.
(H) Mínimo de una (1) visita cada tres meses.
TO: UNIVERSIDAD POLITECNICA DE P.R.

ATTN: MANUEL BARDALEZ P.E.
DIRECTOR DEPTO. ING. MECANICA
TEL: 754-8000 EXT. 323

JOB: MANTENIMIENTO CALDERA

HERE IS OUR QUOTATION ON THE GOODS NAMED, SUBJECT TO THE CONDITIONS NOTED:

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<tr>
<td>(I)</td>
<td>Descuento en las piezas que estén en nuestro inventario de un 15% para la reparación de los equipos.</td>
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<tr>
<td>(J)</td>
<td>Limpieza general de la caldera para su inspección anual.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SERVICIO NO INCLUYE:

(A) Piezas ó equipos.
(B) Trabajo de instalación, remoción ó reinstalación de los equipos arriba indicado.
(C) Trabajos en líneas de vapor, agua, condensado ó combustible ó aislación.
(D) Trabajo eléctrico fuera de los equipos.
(E) Trabajo en la chimenea.
(F) Trabajo en el refractario de la caldera.
(G) Cualquier otro servicio fuera del equipo arriba mencionado.
(H) Servicio fuera de horas 6 días laborables.
(I) Permiso ó certificados.

QUOTE VALID FOR 30 DAYS.

BY: [Signature]