## 3.4 Technical Cooperation

In parallel with this project, a project-type technical cooperation with the Faculty of Engineering of Thammasat University is being prepared. In June 1992 a basic study mission and in December 1992 a preliminary study mission were organized. The preparation is being made to start the technical cooperation project in 1994.

This basic design study was prepared taking into consideration the project-type technical cooperation. The equipment to be provided through this project has been restricted to educational and research equipment of the departments which are to participate in the project-type technical cooperation. In the selection of equipment advice of the persons involved in the project-type technical cooperation was taken into consideration so that the nature and specification of the equipment selected may not conflict with the purpose of the project-type technical cooperation.

When the project-type technical cooperation is effectively carried on with a long term perspective, it will certainly contribute to raising the level of education and research and to the development of the education system of the Faculty of Engineering of Thammasat University using the equipment provided through this project.

# CHAPTER 4 BASIC DESIGN

# Chapter 4 Basic Design

## 4.1 Design Policy

In the design of the equipment mentioned in "3.3.3 Outline of Equipment", the following criteria are employed.

(1) Equipment for Higher Engineering Education

We select equipment suitable for higher engineering education in line with the purpose of the project. The project will be designed to provide equipment which is fit into the curricula of the University, is helpful for the students to learn the fundamentals and applications of technology, helps train students who will become engineers useful for the industry and helps develop research capability of the teaching staff.

(2) Learning of Principles

Equipment should help the students to learn underlying principles and fundamentals of technology and is neither much too automated nor much too sophisticated.

(3) Quantity and Versatility

The quantity of equipment is decided based on the number of students. Equipment should be versatile as much as possible because some pieces of equipment are to be used in other departments than the one requested them.

(4) Ease of Operation and Maintenance

The maintenance of equipment must be not difficult in Thailand. Support services such as supply of parts and maintenance services should be available. Such equipment as requires difficult operation techniques should be avoided. The operation cost must be as low as possible.

(5) Consideration for Third Country's Products

In principle equipment manufactured by Japanese manufacturers has been selected. However, some manufacturers in European and North American countries manufacture equipment specialized for educational purposes. Some items of equipment requested are presumed to be such equipment. In case the third country's products meet educational requirements better than those made in Japan and their price is cheaper, they will be considered in the selection of equipment.

## 4.2 Study and Examination on Design Criteria

### 4.2.1 Natural Conditions

The temperatures and relative humidities in the laboratories in which equipment is placed are as follows:

| | Temperature | | Relative Humidity | |
|---|---|---|---|---|
| | Max. | Min. | Max. | Min. |
| Air conditioned room | 25°C | 15°C | 71 % | 58 % |
| Not air conditioned room | 42°C | 15°C | 90 % | 70 % |

### 4.2.2 Buildings and Utilities

(1) Buildings

The places where equipment is installed are the laboratories of the main building of the Faculty of Engineering and the three workshop buildings. The points to be considered in the placement of equipment are:

- Placement of the equipment, the weight of which exceeds the maximum allowable load of the floor.
- Placement of the equipment that needs the foundation on which the equipment is fixed.
- Placement of the equipment which vibrates when operated.
- Placement of the equipment which must be placed in an air conditioned room.

Some laboratories will accommodate some pieces of equipment which are a case or cases mentioned above in point. Some pieces of equipment must be installed in a laboratory on the ground floor and some in an air-conditioned room. When a laboratory needs remodeling or some works to accommodate equipment, the Thammasat University shall do the work.

(2) Electricity

Electricity is first distributed to a distribution board on each floor of the main building and in each workshop building from the transformer room in the main building of the Faculty of Engineering. Then it is distributed to individual rooms.

The electric power is supplied at:

3-phase AC 380 V ± 10 %
1-phase AC 220 V ± 10 %
Frequency 50 Hz

Power failures happen on the average once a week in some season of the year. The uninterruptable power supply will be needed in some equipment.

The fluctuations of voltage are within ±10 %. The equipment which requires allowance of ±5 % will be equipped with a voltage regulator.

(3) Water Supply

Water to be used in experiments is supplied from the deep tube wells in the Rangsit campus.

(4) Gases

Oxygen, nitrogen, carbon dioxide and argon gases are available in Thailand and are not needed to be imported.

## 4.3 Basic Plan

### 4.3.1 Equipment Plan

Equipment list based on the former section;"3.3.3 Outline of Equipment"and "4.1 Design Policy" is shown below.

Specifications such as capability, capacity and etc. are listed in for reference basis.

**(1) Electrical Engineering Department**

1) Electromechanical Energy Conversion Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 2.1.1 | Three-Phase Squirrel-Cage Induction Motor Laboratory Set | 1 | Squirrel-cage induction motor 1 KW<br>Pole changing induction motor 1 KW |
| 2.1.2 | Three-Phase Slipring Induction Motor Laboratory Set | 1 | Induction motor with slipring rotor 1 KW |
| 2.1.3 | DC Motor Laboratory Set | 1 | DC compound wound machine 0.75 KW<br>DC series wound machine 1 KW |
| 2.1.4 | DC Generator Laboratory Set | 1 | DC shunt wound machine 1 KW<br>DC shunt wound machine with fitted tachogenerator 800 KW |
| 2.1.5 | Single-Phase Motor Laboratory Set | 1 | Squirrel motor with running capacitor 0.75 KW<br>Squirrel motor with starting and running capacitor 0.75 KW |
| 2.1.6 | Three-Phase Synchronous Motor Laboratory Set | 1 | Synchronous machine with salient pole rotor 1 KW<br>Synchronous motor without excitation 1 KW |
| 2.1.7 | Three-Phase Synchronous Generator Laboratory Set | 1 | Synchronous machine with salient pole rotor 1 KVA<br>Synchronous machine without excitation |
| 2.1.8 | Transformer Laboratory Set | 1 | Single-phase transformer 250 VA<br>Three-phase transformer 300 VA |
| 2.1.10 | Power Electronic Equipments | 1 | Converter/inverter, input : 50 Hz, 3 ph, output: 0.5～400 Hz<br>SSR for DC, Controled range: DC 4～220 V, 10 A<br>SSR for AC, 3 $\phi$, AC 75～264 V, 8 A for 1.5 KW motor |
| 2.1.11 | Connecting leads | 1 | Vynyl resin coated wire, miscelloneous meters |

2) Electronics Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 2.2.1 | IC Design Software Package | 1 | For varioces steps of IC design process (running on PC/WS) |
| 2.2.2 | Circuit Schematic Simulation Software Packages | 1 | For analysis circuit in time domain (running on PC)<br>for analysis digital circuit by VHDL |
| 2.2.3 | PCB Layout System Equipments for PCB fabrication | 5 | For manual layout and design of PCBs (running on PC) |
| 2.2.4 | Prototpye PCBs Production System | 1 | Machine for making PCB prototype<br>Control terminal (PC with software) |
| 2.2.5 | Soldering Station | 1 | For mounting and removing chips |
| 2.2.6 | Plotter | 1 | AI size pen plotter |
| 2.2.7 | Supporting Materials Equipments for Circuit Board | 1 | Microprocessor chips, Bus card frame, Sensors, ICS, ACcessories, PCB production materials |

| ::No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 2.2.8 | Digital Storage Oscilloscope | 4 | Band width: 100 MHz<br>Channel : 4 channels |
| 2.2.9 | Function Generator | 2 | Frequency range : 1～50 MHz<br>output wave forms: sine, square, triangle, ramp, pulse |
| 2.2.10 | Logic Analyzer | 1 | Timing analysis, clock: max 200 MHz, 16 channels<br>State analysis, External clock: up tp 40 MHz<br>Input channels: 48 channels |
| 2.2.11 | Data Generator | 1 | Frequency range: 0.1 μHz to 100 kHz<br>Wave forms: Sine, square, triangle, sawloot, arbitrary |

3) Communication Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 2.3.1 | Signal Generator | 1 | Frequency range: 100 kHz～2 GHz<br>Modulation : AM, FM<br>Accuracy : ±1 dB |
| 2.3.2 | RF Vector Network Analyzer | 1 | Frequency range: 300 kHz～3 GHz<br>Resolution : 1 Hz<br>Output range : +5 dBm～-18 dBm |
| 2.3.4 | Frequency counter | 1 | Frequency range: 60 kHz～3 GHz<br>Counting time : <10ms, <0.1s, <1s, <10s, <100s<br>No. of display digits: 9 |
| 2.3.5 | High-frequency Analog Design Software Packages | 1 | Linear and non linear analysis<br>Library: S-parameter device etc. |
| 2.3.6 | EMC Measurement Systems | 1 | Consist of: Spectrum analyser, Preselector, Line inpedance stabilization network, Standard anternas, Plotter |
| 2.3.9 | Bit Error Rate Analyzer | 1 | Interface : RS-232-c/V-24, V-35, ISDN,<br>Data rates: max 64 k bps |

4) Instrumentation and Control System Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 2.4.1 | Experimental process unit | 1 | For pressure, temperature, flow and level measurement and control,<br>Tanks, measurent and controle equipment |
| 2.4.2 | Robotic unit | 1 | 5axis, Electrical servo drive,<br>Position repeatability: 0.3 mm |
| 2.4.3 | General-purpose DSP board | 2 | |
| 2.4.4 | Accessory boards | 1 | Analog I/O card,<br>32 channel digital I/O card, etc. |
| 2.4.5 | DSP software package | 1 | Time/frequency domain analysis, Digital filter design,<br>Real time spectrum analysis and digital recording (running on PC) |
| 2.4.6 | Arbitrary waveform generator | 1 | No. of analog channels: 2,<br>Program generator function, Graphical waveform programming<br>Interface: GPIB |
| 2.4.7 | FFT Analyzer | 1 | No. of input channels: 2<br>Frequency range: 10 mHz～100 kHz<br>Mode: Servo analysis mode<br>Spectrum measurement mode<br>Waveform measurement mode<br>Interface: GPIB |

(2) Industrial Engineering Department

1) Equipment for CNC Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 3.1.3 | CNC TURNING CENTER (CNC TURN-MILL CENTER) | 1 | Standard turning diameter : 160 mm<br>Maximum turning length : 500 mm<br>Spindle drive : 7.5/5.5 KW<br>Turret station : 10 |
| 3.1.4 | CNC-EDM-Wire Cutting | 1 | Axis travel X.Y.Z : 360 x 250 x 220 mm<br>Wire feedrate : 50~360 mm |
| 3.1.8 | CNC Vertical Machining Center | 1 | Table size : 900~450 mm<br>Spindle drive : 7.5/5.5 KW<br>Tool shunk : 40T |

2) Equipment for CAD/CAM Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 3.2 | CAD/CAM System<br>(Hardware) | 1 | |
| | Computer Workstation | 2 | Main memory : 64 MB, 3.5" FDD, 1 GB HDD<br>Display : 19" Calor, Keyboard and Mouse |
| | Personal Computer | 6 | CPU : 486, Clock : 50 MHz, Memory : 16 MB,<br>3.5" FDD, 120 MB HDD,<br>Display : 20" Color with VGA, Keyboard and Mouse |
| | Tape Drive | 1 | 150 MB cartridge tape drive |
| | CD Rom Drive | 1 | |
| | Plotter | 1 | A0 size, Pen and pencil plotter |
| | Laser Printer | 1 | A3 size |
| | Network Equipment | 1 | For system network, with network software |
| | (Software) | | |
| | CAD/CAM Software for Workstation | 1 | Base, 3D model, Solid model, Link mechanism,<br>Drafting, NC (lath, mill), Library, Robotics,<br>FEM model, Interface |
| | CAD/CAM Software for Personal Computer | 6 | Base, Drafting, NC program, Interface |

3) EquiEquipments for Precision Laboratory

| No. | Items | Qty | Remarks |
|---|---|---|---|
| 3.3.1 | Measurement Data Processing Unit | 1 | Data input:4 channels, No.of registered parts:32,<br>No. of Registered characterictics : 26/part,<br>with 9" CRT and Printer |
| | -Digital Instrument | 1 | Toolmaker microscope, Bench micrometer, Indicater<br>Caliper, Micrometer (outside, inside, thread, gear<br>etc.) Heghtmaster |
| 3.3.4 | Roundness Tester | 1 | Measurement diameter : Max. 280 mm,<br>Measurement hight : Max. 220 mm (outer dia)<br>Workpiece load : Max. 10 Kg |

(3) Civil Engineering Department

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 3.4.1 | Structural Loading System | 1 | Static hydraulic jack : 500 tf<br>Dynamic hydraulic jack: 50 tf<br>Hollow hydraulic jack : 10 tf<br>Self supporting loading frame : Beam<br>app. 4m(L)x400mm(W), 300 tfm |
| 3.4.5 | Universal Testing Machine | 1 | Manual control with standard glips,<br>Maximum capacity : 50 tf |

(4) Mechanical / Engineering Department

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 5.1 | Eddy Current Dynamometer | 1 | Absorption capacity : 100 PS<br>Rotation : 2,850～8,000 r.p.m. |
| 5.2 | Exhaust Gas Analyzes | 1 | Portable type, with data processing unit,<br>Test hem : CO, CO2, SO2, NO2, O2 |
| 5.3 | Diesel Engine Fule Pump Test Set | 1 | No. of cylinder : 12<br>Rotation : 50～3,500 r.p.m. |
| 5.4 | Internal Combustion Engine Test Bed | 1 | Diesel engine : 90 PS, 4 Cylinders,<br>Electric dynamometer : 100 PS |
| 5.5 | Steam Power Plant Test Set Complete | 1 | Boiler capacity : 180 Kg/h<br>Turbine output : 1 KW,<br>Fuel : LNG |
| 5.6 | Gas Turbine Plant Test Set Complete | 1 | Two shaft gas turbine, with data acquistion unit,<br>Max. output : App 4 KW |
| 5.7 | Pneumatic and Hydraulic Automatic Control System | 1 | For level, temperature, pressure and flow<br>Measuring and control |

(5) Chemical Engineering Department

(Group I)

1) Chemical Engineering Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 6.1.1 | Liquid-Liquid Extraction System | 1 | Colum : 50$\phi$ x1000mm(2 pcs), No.of discs:30/colum,<br>Settler, Receiver, Feed pumps (4 pcs) |
| 6.1.4 | Continuous Plate Distillation Unit | 1 | Colum : 32$\phi$, 10 plates x 2, 5 plates x 2<br>Continuous cherge, with control console |
| 6.1.7 | Stirred Liquid Phase Reaction Unit | 1 | Vessel capacity : 2.5 L<br>Controller (pH, DO, temperature, antiforming)<br>with microtube pump |
| 6.1.8 | Fluidized-bed Ractor | 1 | Reactor capacity : 2 L<br>Controller : pH, temperature, with tubing pump |
| 6.1.9 | Fixed-bed Reactor | 1 | Reactor capacity : 2 L,<br>Tanks : Glass made (5 pcs)<br>Controller (pH, level, temperature), with aeration unit |
| 6.1.10 | Stirrers Set | 3 | Rotation : (A) 20～1,200 r.p.m. (B) 10～600 r.p.m.<br>(C) 5～300 r.p.m.<br>Controller (torque, rotation) |
| 6.1.11 | Drum Dryer | 1 | Drum size : 315$\phi$ x 350 mm<br>Design steam pressure : 8 Kg/cm2 max. |
| 6.1.12 | Ball Mill Set | 1 | 2 line shaft type (2 sets)<br>Rotating speed : 170～340 r.p.m.<br>Tachometer, Stainless steelpots, Porcelain pots,<br>HD alunina balls, Sieve, Ultrasonic cleaner |

2) Analytical Chemistry laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 6.1.13 | Glassware for Analytical Chemistry Laboratory | 1 set | Desiccator, Buret, Pipet, Flask, Beaker, Reagent bottles, Thermometer etc. (60 sets) |

3) Organic Chemistry Laboratory

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 6.1.14 | Glassware for Organic Chemistry Laboratory | 1 set | Stillhead, Condensor, Colum, Packing, Flask, Tube, Funnel etc. (60 sets) |

(Group II)

Analytical Equipment

| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 6.2.4 | Scanning Electron Microscope | 1 | Magnification : x 150~200,000<br>Resolution : 4.5 mm (30 KV, WO = 8 mm)<br>Polaloid camera, Imageprinter, Sample preparation devices |
| 6.2.5 | UV-Visible Spectrophotmeter | 1 | Wave leugth range : 190~900 mm,<br>Resolution : 0.15 mm<br>Data processing units, Accessories for surface analysis |
| 6.2.7 | Gas Chromatograph | 1 | Colum oven ; Inner volume : 12 L,<br>Temperature control range : Ambient +10-℃~399℃<br>Detector ; FID, TCD |
| 6.2.8 | Thermal Analysis Instrument | 1 | Differential thermal analyser<br>Thermogravimetric analyser<br>Computer for Control |
| 6.2.10 | Fourier-Transform Infrared Spectro photo meter | 1 | Optical system : Single-beam optics<br>Wavelength range : 4,600~400/cm<br>Resolution : 2, 4, 8, 16/cm<br>Data sampling : He-Ne laser used |

**(6) Personal Computers**

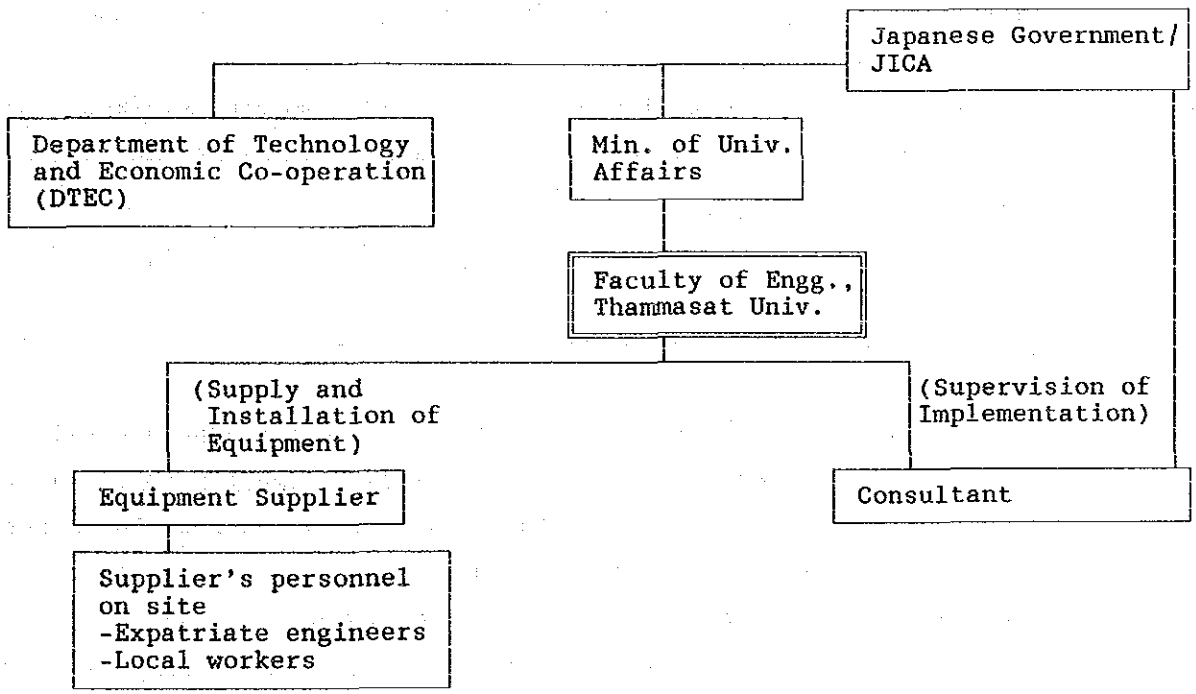
| No. | Items | Q'ty | Remarks |
|---|---|---|---|
| 7.1 | Personal Computers (for Electrical Eng. Dep.) | 5 | CPU : 486, Clock : 66 MHz, RAM : 16 MB<br>FDD : 5" (3.5") x 2, HDD : 200 MB<br>Display : 17", Laser Printer (A4 size)<br>Software : MS-DOS, MS-WINDOWS |
| 7.2 | Personal computers (for Mechanical Engg. Dep.) | 2 | |
| 7.3 | Personal Computers (for Chemical Engg. Dep.) | 2 | |

## 4.4 Implementation Plan

### 4.4.1 Implementation Method

The project consists of the works of buildings and facilities which are to be done by the Thai side and the provision of equipment through a Grant Aid of the Japanese Government. The executing agency, the Faculty of Engineering, the Thammasat University will enter into a contract with a Japanese consultant that executes the detailed design, the preparation of a tender, the tender evaluation and the supervision of execution of equipment installation in lien of the University. A chart of the project execution organizations is shown in Fig. 4.4.1.

Fig. 4.4.1 Project Implementation Organization



### 4.4.2 Points to be considered in the Execution

In the arrangement of equipment, it is necessary to conform to the performance capability of equipment designed in this basic design study and to install equipment in a proper way.

The buildings of the Faculty of Engineering, the Thammasat University have recently been completed, and have enough space to accommodate equipment and enough capacity of utilities. It is possible to install equipment to be provided through this project at any place in the buildings except for heavy equipment. However, it is necessary to plan the placement of equipment carefully lest the laboratories should be in a mess.

Some pieces of equipment cannot be prepared by one manufacturer. There is equipment which must be manufactured to special specifications. It is necessary to discuss thoroughly with suppliers about preparation of equipment.

The time of installation of equipment and dispatch of installation engineers must be arranged so as to avoid waiting time on the installation site.

### 4.4.3 Plan for Supervision of the Implementation

The consultant shall carry out the detail design and supervise the tendering procedure and the project execution. During the implementation of the work of the consultant may, whenever necessary, arrange for a supervisor to be present on the spot at the time of

- Approval of the manufacturing design of equipment.
- Pre-shipment inspection at a factory.
- Installation and inspection of equipment at delivery.

The consultant shall also be informed on the progress of works to be done in Thailand. When some delays are occasioned the consultant shall advise the Thai side of necessary steps to take if required.

### 4.4.4 Equipment Procurement Plan

(1) Procurement Plan

Procurement of equipment will be done under a lump sum contract with a supplier of equipment (trading company) which is a successful bidder in the competitive biding. In principle Japanese products will be procured. However, some third country products will be procured.

Personal computers can be purchased easily in Thailand and reliable maintenance and training services are available locally. Therefore it is desired to purchase computers in Thailand.

(2) Transportation

Equipment will be shipped from a port near the place of production all at once or separately at different times and landed at the port of Bangkok (Khlongtoey port). It will be transported on the road from the port of Bangkok to the Rangsit campus.

### 4.4.5 Scope of the Work

(1) Scope of the Work of the Japanese Side

1) Procurement of equipment and materials, and transportation and installation related hereto.

2) Electrical wiring work from a socket in the laboratory to the installed equipment (however, a socket must be close to the equipment to be installed and the wiring work from a power source to the socket shall be done by the Thai side).

3) Test operation and adjustment of equipment. Instruction of operation and maintenance of equipment.

4) Consulting services including preparation of tender documents, managing of tendering and supervision of the project implementation.

(2) Scope of the Work of the Thai side

1) Civil work for the buildings planned to install equipment, interior work of the building, foundation work of equipment, and relocation work of the existing equipment and facilities.

2) Electric work for receiving, transforming and distributing electric power.

3) Plumbing work for water and drainage, and fuel gas work.

4) Electric lighting work.

5) Air conditioning work.

6) Draft and ventilation work.

7) Telephone and communication facility work.

8) Utensils and furniture.

9) Chemicals and consumables.

10) To take necessary measures for the unloading, custom's clearance and inland transportation of equipment, and to bear all the expenses necessary hereto.

11) To proceed with approvals necessary to carry on the project.

12) To bear commissions to a foreign exchange bank officially recognized by the Japanese Government for the banking services based on the Banking Arrangement.

13) To accord Japanese nationals whose service may be required in connection with the project such facilities as may be necessary for their entry into Thailand and stay therein for the performance of their work.

14) To maintain and use properly the equipment purchased under the Grant Aid.

15) To bear all other expenses that are not included in the Grant Aid agreement but may be necessary to carry out the project.

### 4.4.6 Implementation Schedule

In the implementation of project through a Grant Aid of the Japanese Government, the project shall be executed in the following sequences.

(1) Detail Design

The consultant prepares the detailed design based on the basic design, prepares the tender documents, issues the public notice of tender invitation, gives advice to the University during the contract negotiations and witnesses the contract. It will take about three months from the detail design to the signing of contract.

(2) Manufacturing and Works

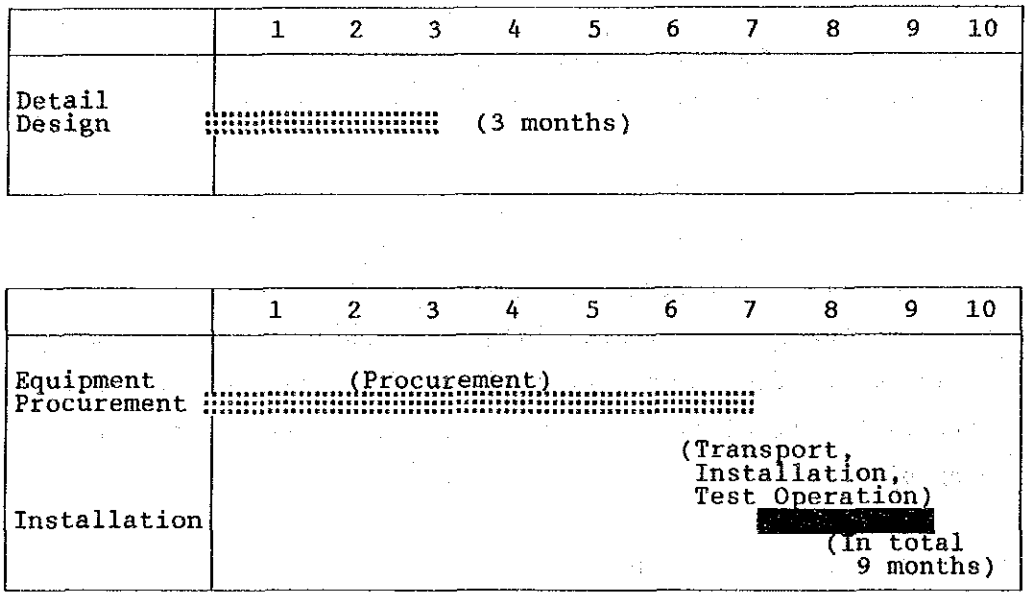
The supply contractor arranges the documents of approval for manufacturing of equipment, manufactures equipment, and ships the equipment to Thailand. The supply contractor executes all the works in Thailand (unloading, inland transportation and installation of equipment) until the test operations of equipment is completed at the installed site.

(3) Completion of the Work

In the presence of the University authorities, the consultant and other parties concerned, the installed equipment is test operated and confirmed that it conforms to the specifications, and then delivered to the Thai side. The Thai side issues certificates of the completion of the work to the supply contractor and the consultant. All the works will be completed in nine months after the contract is placed if the works go as planned.

The implementation schedule is shown in Fig. 4.4.2.

**Fig. 4.4.2 Implementation Schedule**




## 4.4.7 Costs for the Thai Side

The costs of the work to be born by the Thai side will be about 2.52 million Bahts. The breakdown is as follows:

| | (million Bahts) |
|---|---|
| Remodeling, repair, foundation work | 1.4 |
| Utility work | 0.05 |
| Air conditioning work | 0.42 |
| Office equipment, appliances | 0.23 |
| Others | 0.42 |
| Total | 2.52 |

# APPENDICES

## APPENDIX-1 MEMBERS OF THE BASIC DESIGN TEAM

### 1.1 Basic Design Study

| | |
|---|---|
| Dr. Nishino Fumio | Team Leader,<br>Univ. of Tokyo, Prof.<br>Department of Civil Engineering |
| Dr. Ito Michiaki | Engineering Education Specialist,<br>Nagaoka Univ. of Technology, Prof.<br>Department of Electrical Engineering |
| Mr. Ono Shuji | Project Coordinator,<br>JICA, Grant Aid Study & Design Department,<br>Second Basic Design Study Division |
| Mr. Nagasawa Kiko | Engineering Education Planner,<br>UNICO International Corporation |
| Mr. Kuroda Takashi | Educational Equipment Planner,<br>UNICO International Corporation |
| Mr. Kobari Teruo | Equipment Arrangement,<br>UNICO International Corporation |
| Mr. Yamauchi Hirofumi | Cost Estimator,<br>UNICO International Corporation |

## 1.2 Draft Report Explanation

| | |
|---|---|
| Dr. Ito Hiroshi | Team Leader,<br>Nagaoka Univ. of Technology, Prof.<br>Department of Mechanical Engineering |
| Mr. Fukuda Nobuhiro | Project Coordinator,<br>JICA, Grant Aid Study & Design Department,<br>Second Basic Design Study Division |
| Mr. Nagasawa Kiko | Engineering Education Planner,<br>UNICO International Corporation |
| Mr. Kuroda Takashi | Educational Equipment Planner,<br>UNICO International Cooperation |

## APPENDIX-2 SCHEDULE OF THE FIELD SURVEY

2.1 Basic Design Study Team (Jul.11 - Jul.28,1993)

| | | |
|---|---|---|
| 1. | Jul. 11th (Sun.) | Lv. Tokyo<br>(Mr. Nagasawa, Mr. Kuroda, Mr. Kobari,<br>Mr. Yamauchi)<br>Ar. Bangkok |
| 2. | Jul. 12th(Man.) | (Bangkok)<br>Courtesy meeting at JICA Thailand Office<br>(Rangsit)<br>Laboratory visit of Faculty of Engineering, TU. |
| 3. | Jul. 13th(Tue.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of<br>Engineering, TU. |
| 4. | Jul. 14th(Wed.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of<br>Engineering, TU. |
| 5. | Jul. 15th(Thu.) | (1) (Rangsit)<br>Meeting with the faculty staff of Faculty of<br>Engineering, TU.<br>(2) (Bangkok)<br>Courtesy meeting at MOUA |
| 6. | Jul. 16th(Fri.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of<br>Engineering, TU. |
| 7. | Jul. 17th(Sat.) | (Rangsit)<br>Team meeting<br>Visit to Hi-tech Industrial Estate |

| | | |
|---|---|---|
| 8. | Jul. 18th(Sun.) | (Rangsit)<br>Data arrangement |
| 9. | Jul. 19th(Mon.) | (Bangkok)<br>Visit at Chularongkorn University |
| 10. | Jul. 20th(Tue.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of Engineering, TU. |
| 11. | Jul. 21st(Wed.) | (1) (Rangsit)<br>Data Arrangement<br>(2) (Bangkok)<br>Visit at Japanese Chamber of Commerce, Bangkok<br>(3) Lv. Tokyo<br>(Dr. Nishino, Dr. Ito, Mr. Ono)<br>Ar. Bangkok |
| 12. | Jul. 22nd(Thu.) | (1) (Bangkok)<br>Courtesy call on MOUA and DTEC<br>(2) Visit at UNICEF<br>(3) Meeting at JICA Bangkok Office and the Embassy of Japan<br>(4) (Rangsit)<br>Meeting with the faculty staff of Faculty of Engineering, TU. |
| 13. | Jul. 23rd(Fri.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of Engineering, TU. |
| 14. | Jul. 24th(Sat.) | (Rangsit)<br>Data arrangement,<br>Preparation of draft of Minutes of Discussions |
| 15. | Jul. 25th(San.) | (Rangsit) |

| | | |
|---|---|---|
| | | Preparation of draft of Minutes of Discussions |
| 16. | Jul. 26th(Mon.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of Engineering, TU. |
| 17. | Jul. 27th(Tue.) | (Bangkok)<br>Signing of the Minutes of Discussions at Prachan Campus, TU.<br>Courtesy call on the Embassy of Japan and JICA Thailand Office |
| 18. | Jul. 28(Wed.) | Lv. Bangkok<br>Ar. Tokyo |

Legend :

DTEC : Department of Technical and Economic Cooperation

TU : Thammasat University

MOUA : Ministry of University Affairs

2.2 Draft Report Explanation Team (Sep.21 - Sep.28,1993)

| | | |
|---|---|---|
| 1. | Sep. 21st(Tue.) | Lv. Tokyo<br>Ar. Bangkok |
| 2. | Sep. 22nd(Wed.) | (Bangkok)<br>Courtesy meeting at JICA Thailand Office<br>Courtesy call on DTEC |
| 3. | Sep. 23rd(Thu.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of Engineering, TU. |
| 4. | Sep. 24th(Fri.) | (Rangsit)<br>Meeting with the faculty staff of Faculty of Engineering, TU. |
| 5. | Sep. 25th(Sat.) | (Rangsit)<br>-Team meeting<br>-Preparation of draft of Minutes of Discussions |
| 6. | Sep. 26th(Sun.) | (Rangsit)<br>-Data arrangement<br>-Visit to Nawanakorn Industrial Estate |
| 7. | Sep. 27th(Mon.) | (Bangkok)<br>Courtesy meeting at JICA Thailand Office and the Embassy of Japan<br>Signing of Minutes of Discussions at Prachan Campus, TU. |
| 8. | Sep. 28th(Tue.) | Lv. Bangkok<br>Ar. Tokyo |

## APPENDIX-3 LIST OF INTERVIEWED PERSONNEL

### Thammasat University

Associate Prof. SETABUTR, Noranit
Rector

Dr. POONPRASIT, Viboonpong
Vice Rector for International Affair

Ms. POKTHITIYUK, Yupin
Assistant to Vice Rector for International Affair

Mr. KATEKINTA, Sathaporn
Acting Dean, Faculty of Engineering

Dr. PRAPARNTANATORN, Somnuke
Assistant Dean for Administration
Head of Civil Engineering Dept.

Mr. KIJKANKANARAT, Taweesak
Head of Electrical Engineering Dept.

Mr. CHAROEPORN, Naris
Head of Industrial Engineering Dept.

Mrs. COOVATTANACHAI, Sunee
Head of Mechanical Engineering Dept.

Mr. DHUPATEMIYA, Pongtorn
Head of Chemical Engineering Dept.

Dr. WEESAKUL, Uruya
Assistant Dean for Research and Foreign Affairs
Lecturer of Civil Engineering Dept.

Mr. PISITPAIBOOL, Chaisak
Assistant Dean for Academic Affairs

Mr. SMITAKORN, Watanachai
Asistant Dean for student Affairs
Lecturer of Civil Engineering Dept.

Mrs. PANCHAT, Baisak
Assistant Dean for Planning and Development

Miss KATCHAMART, Sunisa
Lecturer of Civil Engineering Dept.

Mr. CHAIKUNCHUENSAKUN, Sotok
Lecturrer of Chemical Engineering Dept.

Mr. SUPPACHAI, Vorapojpisut
Lecturer of Electrical Engineering

Mr. TONGPRASITH, Annan
Lecturer of Electrical Engineering

Mr. MALEEVAN, Charkree
Lecturer of Electrical Engineering

Mr. TAECHANUKULCHAI, Veerawat
Lecturer of Electrical Engineering

Mr. AREE, Pichai
Lecturer of Electrical Engineering

Ms. SUNTAD, Vanee
Secretary of the Faculty of Engineering

**National Science and Technology Development Agency**

Prof. Dr. COOVATTANACHAI, Naksitte
Deputy Director(Former Dean, Faculty of Engineering, Thammasat University)

**Ministry of University Affairs**

Prof. Dr. SRISAAN, Wichit
Permanent Secretary

Prof. WATANACHAI, Kasem M.D.
Deputy Permanent Secretary

Dr. SUJATANOND, Chantavit
Director of Foreign Relations Division

Ms. KETANITINAN, Vandee
Chief of Asian Corporation Section,
Foreign Relations Division

**Department of Technical and Economic Cooperation (DTEC)**

Mr. SIRIVAT, Nipon

Mr. AMORNCHEWIN, Banchong

**Chulalongkorn University**

Dr. SMITRA, Tachai
Dean, Faculty of Engineering

Dr. SANEVERAPHUNSIRI, Viboon
Mechanical Engineering Dept.

Dr. PRASERTAEDAM, Piyasan
Chemical Engineering Dept.

Dr. KRUANGAM, Dusit
Electrical Engineering Dept.

Dr. TANTHAPANICHAKORN, Wiwut
EIRD of Chulalongkorn Univ.

Dr. LIMSUWAN, Ekasit
Civil Engineering Dept.

**Japanese Chamber of Commerce, Bangkok**

Mr. HADA Yoshiki
Secretary General

**Embassy of Japan**

Mr. TANAKA Nobuaki
Counsellor

Mr. TATE Itsushi
First Secretary

Ms. SATO Kuni
First Secretary

Mr. ORIHARA Mamoru
First Secretary

Mr. WATANABE Hiroshi
Second Secretary

**JICA Thailand Office**

Mr. OMOTE, Shinichiro
Resident Representative

Mr. ASHINO, Makoto
Assistant Resident Representative

Mr. OSAWA Hideo
Assistant Resident Representative

Mr. INAGAKI, Tomikazu
Technical Cooperation Coordination, DTEC (JICA Expert)

APPENDIX-4 Miniutes of Discussions

4-1 Basic Design Study

MINUTES OF DISCUSSION
ON
BASIC DESIGN STUDY
FOR
THE PROJECT FOR EXPANSION OF THE FACULTY OF ENGINEERING
AT THE THAMMASAT UNIVERSITY
IN THE KINGDOM OF THAILAND

In response to a request of the Government of the kingdom of Thailand, the Government of Japan decided to conduct a Basic Design study on the Project for Expansion of the Faculty of Engineering at Thammasat University(hereinafter referred to as"the Project"), and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Thailand a study team headed by Dr.Fumio Nishino, Professor, Tokyo University, and is scheduled to stay in the country from 11 July to 28 July, 1993.

The Team held discussion with the officials concerned of the Government of Thailand and conducted field surveys at the study area

In the course of discussions and field survey, both parties have confirmed the main items described on the attached sheets. The Team will proceed to further works and prepared the Basic Design Study Report.

Bangkok, 27 July, 1993

Prof. Fumio Nishno
Leader,
Basic design Study Team,
(JICA)

Prof.Noranit Setabutr
Rector
Thammasat University

P.P. Prof.Kasem Watanachai
Deputy Permanent Secretary
Ministry of University Affairs

ATTACHMENT

1. Objective of the Project

The objective of the Project is to supply the equipments for the Faculty of Engineering at Thammasat University.

Due to the shortage of engineers, the Thai industries have been facing great difficulties for technical development. The Faculty of Engineering of Thammasat University has been established to provide appropriate engineering education and training to its student.

The educational equipment will reinforce the teaching capability of the faculty of Engineering to supply its students and staff with high standards of knowledge.

2. Project Site

The site of the Project is located at Rangsit, Pathum-Thani; (Project area and site map are attached as ANNEX-I.)

3. Executing Agency

Responsible Agency: The Thammasat University

4. Items requested by the Government of Thailand are attached as ANNEX-II.

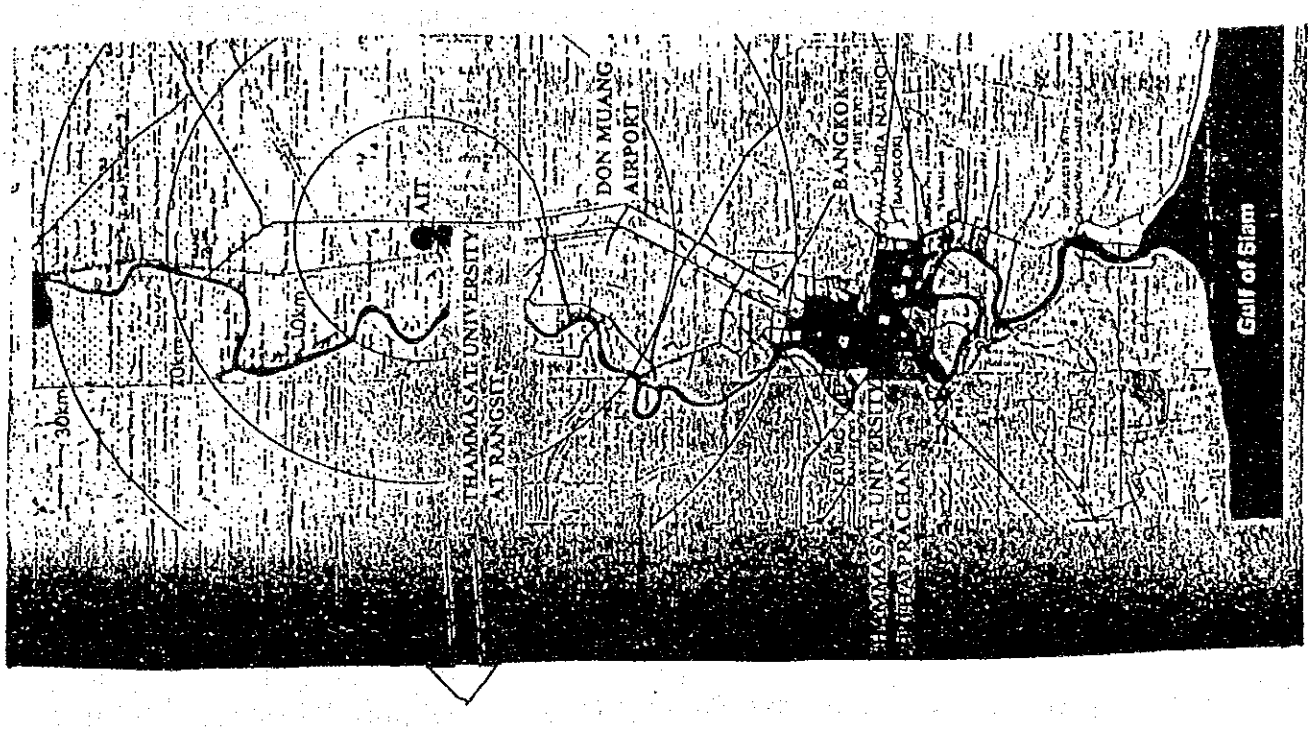
5. Japan's Grant Aid Program

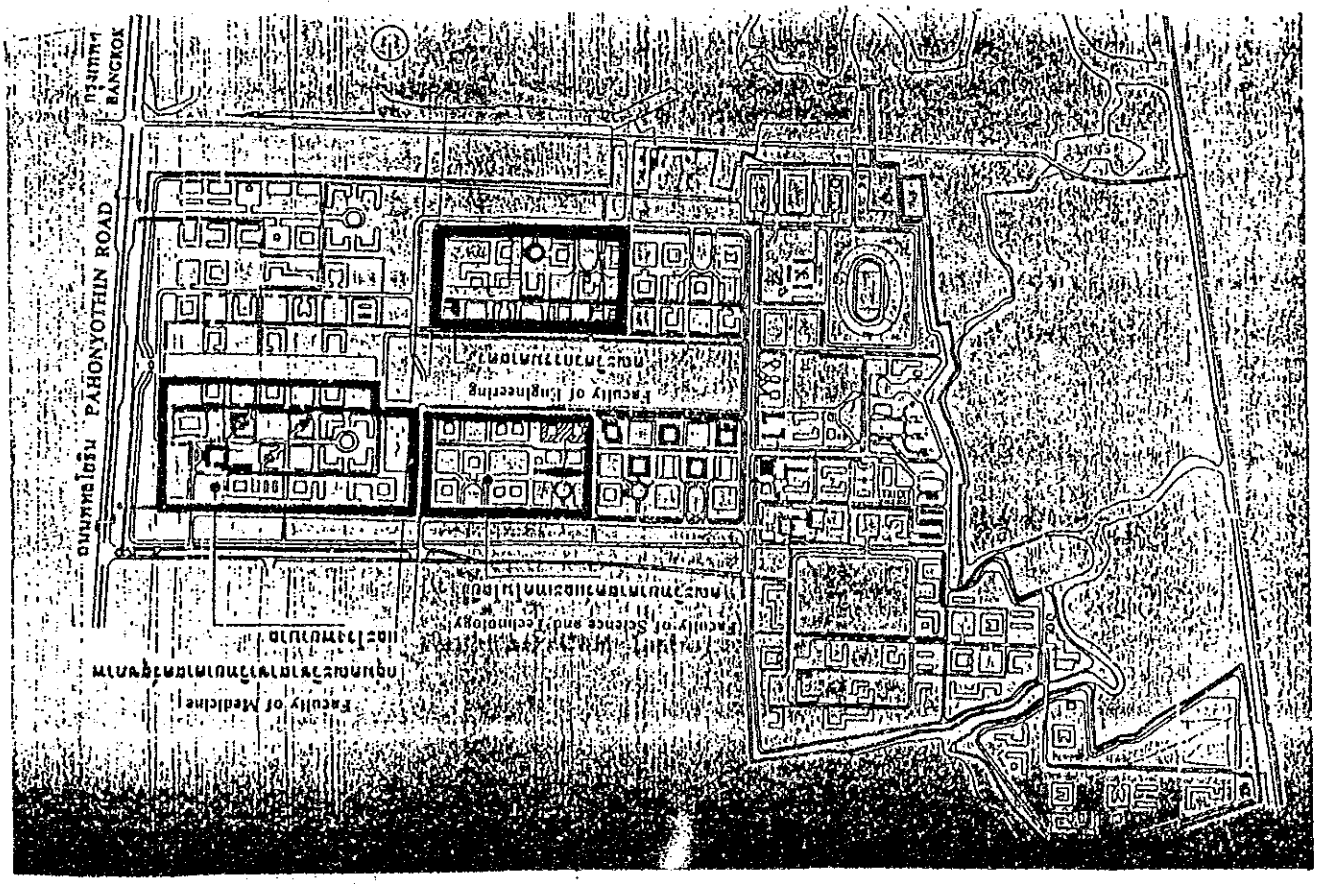
(1) The Government of Thailand has understood the system of Japanese Grant Aid explained by the team.

(2) The Government of Thailand will take necessary measures, described in ANNEX III, for smooth implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

ANNEX - I

LOCATION OF THE THAMMASAT UNIVERSITY, FACULTY OF ENGINEERING
AND
MAP OF THE THAMMASAT UNVERSITY AT RANGSIT



ANNEX II

SUMMARY OF REQUIRED EQUIPMENT LIST FROM EACH OF DEPARTMENT
UNDER
THE PROJECT FOR EXPANSION OF THE FACULTY OF ENGINEERING
AT THAMMSAT UNIVERSITY THE KINGDOM OF THAILAND

1. Shared Equipment

1.1 Audio-Visual facilities for 150 seat lecture auditorium

1.2 Video Library Equipment

1.3 Personal Computer and related facilities

1.4 Engineering Workstation Lab. Equipment(workstation & etc.)

1.5 25 Seats Project Coach

2. Electric Engineering Laboratory

2.1 Equipment for Electro-Mechanical Energy Conversion Lab.,

2.2 Equipment for Electronic Laboratory

2.3 Equipment for Communication Laboratory

2.4 Equipment for Instrumentation and Control System Laboratory

2.5 Personal Computers

3. Industrial Engineering

3.1 Equipment for CNC Laboratory

3.2 Equipment for CAD/CAM Laboratory

3.3 Equipment for Precision Laboratory

## 4. Civil Engineering

4.1 Structural Loadng System
Consist of:
a) Loading System
b) Loading Frame
c) Measuring Equipment
d) Machinery for Machine Shop

4.2 Computer and Software with printers

4.3 Instrument for Control Room of app.4 x 7 x 4m

4.4 Universal Material Testing Machine with Servo Valve Control

4.5 Universal Testing Machine

## 5. Chemical Engineering

(Group I)

5.1.1 Liquid-Liquid Extraction System
5.1.2 Fluid-Solid Extraction System
5.1.3 Process Control Test Set
5.1.4 Continuous Plate Distillation Unit
5.1.5 Batch Packed Distillation Unit
5.1.6 Spray Dryer
5.1.7 Stirred Liquid Phase Reaction Unit
5.1.8 Fluidized-bed Reactor
5.1.9 Fixed-bed Reactor
5.1.10 Stirrers Set
5.1.11 Drum Dryer
5.1.12 Ball Mill Set
5.1.13 Glassware for Analytical Chemistry Laboratory
5.1.14 Glassware for Organic Chemistry Laboratory
5.1.15 PCs

(Group II)

5.2.1 X-ray Diffractometer

5.2.2 X-ray Fluorescence Spectrometer
5.2.3 Ion-Chromatograph
5.2.4 Scanning Electron Microscope
5.2.5 UV-Visible Spectrophotometer
5.2.6 Atomic Absorption Spectrophotometer
5.2.7 Gas Chromatograph
5.2.8 Thermal Analysis Instrument
5.2.9 High Performance Liquid Chromatograph
5.2.10 Fourier-Transform Infrared Spectrophotometer

## 6. Mechanical Engineering

6.1 Eddy Current Dynamometers

6.2 Exhaust Gas Analyzer
6.3 Diesel Engine Fuel Pump Test Set

6.4 Internal Combustion Engine Test Bed for Variable Compression Ratio

6.5 Steam Power Plant Test Set Complete with Data Acquisition System

6.6 Gas Turbine Plant Test Set Complete with Data Acquisition System

6.7 Pneumatic Control System

6.8 Hydraulic Control System

6.9 Calorimeter for Determining the Capacity of the Air-conditioning System

6.10 Personal Computers

Remarks: Items requested by Thai side will be finalized through further study.

ANNEX-III

Necessary measures to be taken by the Government of the Kingdom Thailand are as follows;

1. To provide necessary permissions, license and other authorizations for smooth implementation of the Project.

2. To bear advising commission of the Authorization to pay(A/P) and payment commission to the Japanese foreign exchange bank for banking services based upon the Banking Arrangement(B/A)

3. To ensure prompt unloading, tax exemption, and custom clearance of the goods for the Project at port of disembarkation in Thailand.

4. To ensure prompt unloading and internal transportation of the goods purchased and/or imported under the Grant Aid for the Project.

5. To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contract such facilities as may be necessary for their entry into Thailand, and stay therein for the performance of their work.

6. To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in Thailand with respect to the supply of the products and services under the verified contracts.
7. To maintain and use properly and effectively the equipment and materials provided under the verified contracts.

8. To bear all the expenses other than those to be by the Grant, necessary for the transportation of the equipment.

9. To coordinate and solve any matters related which may arise with third party and inhabitants living in the Project area during implementation of the Project.

6. Schedule of the Study

(1) JICA will prepare the draft report in English and dispatch a mission in order to explain its contents in the end of September, 1993.

(2) In case that the contents of the report is accepted in principle by the Government of Thailand, JICA will complete thefinalreport and send it to the Government of Thailand by November, 1993.

# MINUTES OF DISCUSSIONS
# BASIC DESIGN STUDY
# ON
# THE PROJECT FOR EXPANSION OF THE FACULTY OF ENGINEERING
# AT THAMMASAT UNIVERSITY
# IN THE KINGDOM OF THAILAND

## (CONSULTATION ON DRAFT REPORT)

In July 1993, the Japan International Cooperation Agency (JICA) dispatched the Basic Design Study team on the Project for Expansion of the Faculty of Engineering at the Thammasat University (hereinafter referred to as "the Project"), to the Kingdom of Thailand, and through discussions, field survey, and technical examination of the results in Japan, has prepared the draft report of the study.

In order to explain and to consult the Thai side on the components of the draft report, JICA sent to Thailand a study team, which is headed by Prof. Dr. Hiroshi ITO, Mechanical Engineering Department Nagaoka University of Technology, and is scheduled to stay in the country from 21 September to 28 September, 1993.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Bangkok, September 27, 1993

伊藤 廣

Prof. Hiroshi ITO
Leader
Draft Report Explanation Team
JICA

Noranit Setabutr

Assoc. prof. Noranit Setabutr
Rector
Thammasat University

P.P. Chantavit Sujatanond

Prof. Kasem Watanachai

# ATTACHMENT

## 1. Components of draft report

The Government of Thailand has agreed and accepted in principle the components of the Draft Report proposed by the team with requests for some modifications in the equipment selection.

## 2. Department of Mechanical Engineering

The Government of Thailand has assured that the Department of Mechanical Engineering will increase its staff members and start its courses as scheduled before the equipment to be provided through this project is installed.

## 3. Japan's Grant Aid system

(1) The Government of Thailand has understood the system of Japanese Grant Aid explained by the Team.

(2) The Government of Thailand will take the necessary measures, described in ANNEX for smooth implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

## 4. Further Schedule

The team will make the final report in accordance with the confirmed items, and send it to the Government of Thailand by the end of November 1993.

伊藤

M.S.

## Annex: Necessary measures to be taken by the Government of Thailand in case Japan's Grant Aid is extended.

1. To provide necessary permissions, license and other authorization for smooth implementation of the Project.

2. To bear advising commission of the Authorization to pay (A/P) and payment commission to the Japanese foreign exchange bank for banking services based upon the Banking Arrangement (B/A).

3. To ensure prompt unloading, tax exemption, and custom clearance of the Project at the port of disembarkation in Thailand.

4. To ensure prompt unloading and internal transportation of the goods purchased and/or imported under the Grant Aid for the Project.

5. To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contract such facilities as may be necessary for their entry into Thailand and stay therein for the performance of their work

6. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Thailand with respect to the supply of the equipment and materials provided under the verified contract.

7. To maintain and use properly and effectively the equipment and materials provided under the verified contract.

8. To coordinate and solve any matters related which may arise with third party and inhabitants living in the Project area during implementation of the Project.

9. To bear all the expenses other than those to be borne by the Grant, necessary for the transportation and the installation of the equipment.

伊藤

N. S.



CS.

2.1 Share Equipment Requested from Japanese Government

2.1.1 Audio-Visual facilities

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | AUDIO-VISUAL FACILITIES FOR 150 SEATLECTURE AUDITORIUM | | | |
| | 1.1 AUDIO SYSTEM | | | |
| | -UHF Synthesized Wireless Microphone System | This system consists of the shown below: | 1 Set | In engineering courses, many courses are either pure theory or practical subject. Both video system and presentation system can assist not only for student to understand the hard-to-imagined picture but also for lecturers to exlplain that particular topic easier. Audio system can create the real environment for each presentation and also enhance the capability of audio vision of the meeting, conferrence or other activities. The educational videoes can be produced by the camera sets both indoor and outdoor and editing job can be completed in the studio by the video systems. |
| | | Handy type wireless 5 Sets | | |
| | | Microphone stand set 1 Set | | |
| | | Tie-clip type wireless 5 Sets | | |
| | | Antenna, antenna divider and for wireless mic. up to 8 1 Set | | |
| | -Dynamic Microphone | This system consists of the shown below: | 1 Set | |
| | | Uni-directional microphone 3 Sets | | |
| | | Microphone cable 1 Set | | |
| | | Microphone Stand Set 1 Set | | |
| | -Tape Recorder, Mixer and Power Amplifier | Cassette tape recorder 1 Set | | |
| | | 8-channel audio mixer 1 Set | | |
| | | Supplementary audio mixer 1 Set | | |
| | | Parametric Equalizer 1 Set | | |
| | | Dual-channel/mono power output power 50W+50W 100W monaural 2 Sets | | |
| | | Speaker and speaker holder | 2 Pairs | |
| | Cables and accessories | | 1 Set | |
| | VIDEO SYSTEM:- | | | |
| | Videocassette Records | | | |
| | | Recorder/Player, U-matic | 1 Set | |
| | | Player U-matic | 2 Sets | |
| | | Portable recorder, U-matic | 1 Set | |
| | | Frame code generator | 1 Set | |
| | | 14-inch colour video monitor | 3 Sets | |
| | | Mounting bracket | 3 Sets | |
| | | Remote control unit | 2 Sets | |
| | | RF Modulator | 2 Sets | |
| | | 33-pin interface board | 1 Set | |
| | | U-matic video cassette tape | 50 Pcs | |
| | | U-matic portable video cassette | 50 Pcs | |
| | | Connecting cable and | 1 Set | |
| | PRESENTATION SYSTEM:- | | | |
| | | Overhead projector | 2 Sets | |

2.1 Share Equipment Requested from Japanese Government

2.1.1 Audio-Visual facilities

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | Direct projector | 1 Set | |
| | | Slide projector with remote | 2 Sets | |
| | | PC-Viewer with overhead | 1 Set | |
| | | Stand screen 100*100 inch | 2 Sets | |
| | | Multi-scan projector with | 1 Set | |
| | CAMERA SET | | | |
| | Colour Video Camera | | | |
| | | 3-chip CCD colour video | 1 Set | |
| | | Electret condenser microphone | 1 Set | |
| | | 3-chip CCD colour video | 1 Set | |
| | | 3-chip CCD colour video | 1 Set | |
| | | Camera control unit | 1 Set | |
| | | Tripod with dolly | 1 Set | |
| | | Tripod adaptor | 1 Set | |
| | | 20-inch colour video monitor | 1 Set | |
| | | 14-inch colour video monitor | 1 Set | |
| | | Mounting bracket | 2 Sets | |
| | | Cable and accessories | 1 Set | |

2.1.2 Video Library

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 2. | VIDEO LIBRARY | | | |
| | Headphone | | 50 Sets | After filming the educational |
| | Multi-system color TV | 14-inch multi-system color TV | 25 Sets | video, student can be self-studied |
| | Multi-system VHS video players | Video signal PAL/NTSC | 25 Sets | in the private booth. And other |
| | Booths | | 25 Sets | video sources can be viewed in the |
| | Chairs | | 50 Sets | video library as well. |
| | Video-tape storage cabinets | | 6 Sets | |

2.1.3 Personal Computor Lab

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 3. | PERSONAL COMPUTER LAB<br>HARDWARE:-<br>Personal computer | <br><br>CPU Intel 80486DX2-66<br>RAM 8 MB<br><br>1*240 MB hard disk<br>EISA or Micro Channel bus<br>Three or more expansion slots<br>2 serial, 1 parallel and 1 mouse<br>101-key or 102-key keyboard<br>One mouse with mouse pad<br>SVGA color monitor 14"<br>SVGA 1024*768 at 256 color | <br><br>50 Sets | <br><br>Personal computers are widely used in all the engineering area in basic designing, analysis especially in computer graphic.<br>All of junior student will receive tremendous benefit from this computer lab.<br>The multi-system video projector can help lecturer to teach directly from the computer. |
| | LAN server | <br>CPU Intel 80486DX2-66<br>RAM 8 MB<br>1*1.44 MB+1*1.2 MB disk<br>1*2 GB SCSI-2 hard disk<br>Tape backup 120 MB<br>EISA or Micro Channel 32-bit<br>Five or more 32-BIT expansion<br>2 serial, 1 parallel and 1 mouse<br>101-key or 102-key keyboard<br>One mouse with mouse pad<br>SVGA color monitor 14"<br>SVGA 1024*768 at 256 color | 1 Set | |
| | Ethernet card and cables system for personal computer and LAN server | | | |
| | Line Printer (Speed 400 cps or more) | | | |
| | Dot-matrix printer | | | |
| | Pen and Pencil Plotter A0 Size | | | |
| | 100-inch Video Screen | | | |
| | Multi-scan Video Projector | | | |
| | Computer Screen Panel Projector | | | |
| | Audio System | | | |
| | LAN software | | | |

2.1.4 Engineering Wordstation Lab

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 4. | ENGINEERING WORDSTATION LAB | | | |
| | Workstation | | 10 Users | In final year of study, student |
| | UPS | | 1 Set | requires skill on workstation to |
| | Digitizer | | 2 Sets | analyse the complicated problem |
| | Plotter | | 1 Set | which can be useful in the job. |
| | General software | | | |
| | SOFTWARE | | | |
| | Electrical engineering | | | |
| | PSpice | Analysis electronic circuit | 15 Users | Most widely use in education. |
| | V System | Simulate digital circuit | 15 Users | IEEE's digital simulation language |
| | Mathematica | Powerful mathematic software | 10 Users | Symbolic manipulation feature |
| | Chemical engineering | | | |
| | ASPEN/SP | A steady-state chemical process refining, gas processing, generation, metallurgical, pulp, | 1 User | |
| | BATCHES/SE | A simulator is for managing and semicontinuous flow | 1 User | |
| | POLYGRAF | To design and simulate the enhanced properties. | 1 User | |
| | Civil engineering | | | |
| | ERDAS | Satellite image processing | 1 User | To use for processing data from satellite which can be used for the application of remate sensing in water resources engineering |
| | Architecture & engineering integrated software | A set of softwares on PC or and drafting system for building management | 1 User | To study structural behaviors by using computer simulation and to practice the design and construction of buildings by using |
| | Mechanical engineering | | | |
| | Mechanical Engineering Workbench | Provides an integrated software engineer to use during the verification phase of product is | 1 User | computer aided design. |
| | Pro/DETAIL | an optional module for engineering drawing capabilities drafting standards. | 1 User | |
| | Pro/ENGINEER | Is a CAD/CAM application that engineering automation tools driven, solid modeling | 1 User | |
| | Industrial engineering | | | |
| | LINDO | is an interactive computer and quadratic programming | 1 User | Educational documents and sheets |
| | Siman Simulation Language (Version 4.0) | is a general purpose process- | 1 User | can be produced by the document production system. |

2.1.5 Documents, Project Car and Journals

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 5. | DOCUMENT PRODUCTION SYSTEM | | | This system is selected for easily use and maintenance. |
| | Offset printing system | | 1 Set | |
| | Book binding machine | | | |
| | Heavy-duty photocopier | | 2 Sets | |
| | Colour photocopier | | 1 Set | |
| 6. | PROJECT CAR | | | This mini-bus is for a group of student to travel to seminar, or other activities. |
| | | Air-condition mini bus 25 seats | 1 Set | |
| | | | TOTAL | |

I. Electromechanical Energy Conversion Laboratory

| No. EL- | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.1 | Three-Phase Squirrel-Cage Induction Motor Laboratory Set | This set of equipment consists of | | |
| | | -Fuse 2amp and socket 16amp for controller | 1 Set | |
| | | -3 fuses and socket with fuse plugs for motor | 2 Sets | |
| | | -Circuit breaker, 3-pole 16A/500VAC | 1 Set | |
| | | -Reversing switch, 3-pole 16A/500VAC | 1 Set | |
| | | -Contactor 220V 50Hz, 3-pole 16A/400VAC, with auxiliary switch 2 make and 2 break contacts | 5 Sets | |
| | | -Over-current relays with auxiliary switch 1 make and 1 break contact, | | |
| | | -1.6A to 2.5A | 1 Set | |
| | | -2.5A to 4A | 1 Set | |
| | | -4A to 6.3A | 1 Set | |
| | | -Pushbotton switch ON : 1 make and 1 break contact OFF: 1 break and 1 make contact | 7 Sets | |
| | | -Two-circuit double interruption switch, 3-pole 16A/380VAC, switch position 0-I-II | 2 Sets | |
| | | -Eddy-current brake with electronic torque load cell 1.2Kw | 1 Set | |
| | | -Control unit for speed and torque measurement of the eddy current break | 1 Set | |
| | | -Three-phase squirrel-cage induction motor suitable for star-delta starting 380V, 50Hz, 1KW, 1500rpm. | 1 Set | |
| | | -Three-phase two speed pole-changing induction motor with squirrel-cage rotor 380V/50Hz 1KW, 1500rpm. | 1 Set | |
| | | -Dahlander circuit | 1 Set | |
| | | -Two separate windings | 1 Set | |
| | | -Baseframe for motor set two expermental machines | 2 Sets | |
| | | -Pilot lights 220VAC | 2 Sets | |
| | | -2 limit switchs, 1 break contact | 1 Set | |
| | | -Triple-pole ON/OFF switch 16A/500VAC | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. EL- | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | -Two-pole ON/OFF switch 16A/380VAC switch position 0-I-0-II | 1 Set | |
| | | -Pole-changing switch 16A/500V | | |
| | | -Dahlander circuit | 1 Set | |
| | | -Two separate windings | 1 Set | |
| | | -Star-delta switch, 3-pole 16A/500VAC | 1 Set | |
| | | -Contactor, 220V 50Hz, auxilary conductor 6A/380VAC 4 make and 4 break contacts | 3 Sets | |
| | | -Time relay, 30 sec., 2 contacts | 1 Set | |
| | | -Capacitor 450V, 3uF | 1 Set | |

I. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.2 | Three-Phase Slipring Induction Motor Laboratory Set | This set of equipments consists of | | |
| | | -Fuse 2A and socket 16A for controller | 1 Set | |
| | | -3 fuses and socket 16A with fuse plugs for motor | 1 Set | |
| | | -Contactor 220V 50Hz, 3-pole 16A/500VAC, with auxiliary switch 2 make and 2 break contacts | 3 Sets | |
| | | -Auxiliary contactor 6A/380V, 220V, 50Hz, 4 make and 4 break contacts | 1 Set | |
| | | -Over-current relays 1.6-2.5A with auxiliary switch, 1 make and 1 break contact | 1 Set | |
| | | -Time relay 30 sec., 2 contacts | 2 Sets | |
| | | -Pushbotton switch<br>ON : 1 make and 1 break contact<br>OFF: 1 break and 1 make contact | 7 Sets | |
| | | -Eddy-current brake with electronic torque load cell 1.2KW | 1 Set | |
| | | -Control unit for speed and torque measurement of the eddy current breake | 1 Set | |
| | | -Three-phase induction motor with slipring rotor, 380/220V, 50Hz, 1KW | 1 Set | |
| | | -Controller for three-phase induction motor with slipring rotor | 1 Set | |
| | | -Base frame to machine | 1 Set | |
| | | -Single-coil slide resistor 100ohms 2A | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.3 | DC Motor Laboratory Set | This set of equipments consists of | | |
| | | -Fuse 2A and socket 16A for controller | 1 Set | |
| | | -Incandescent lamp sockets | 3 Sets | |
| | | -3 fuses and socket with fuse plugs for motor | 4 Sets | |
| | | -Contactor 220V 50Hz, 3-pole 16A/500VAC with auxiliary switch 2 make and 2 break contacts | 3 Sets | |
| | | -Over-current relays 1.6-2.5A with auxiliary switch 1 make and 1 break contact | 1 Set | |
| | | -Time relay 30 sec., 2 contacts | 2 Sets | |
| | | -Pushbotton switch ON : 1 make and 1 break contact OFF: 1 break and 1 make contact | 5 Sets | |
| | | -2 pole on/off switch, switch position: 0-I-0-I, 16A 380V | 1 Set | |
| | | -Two-circuit double interruption switch 16A/380VAC, switch position: 0-I-0-II | 1 Set | |
| | | -Eddy-current brake with electronic torque load cell 1.2KW | 1 Set | |
| | | -Control unit for speed and torque measurement of the eddy-current brake | 1 Set | |
| | | -DC separate wound machine, 220V, 1500rpm, 1KW | 1 Set | |
| | | -Dc compound wound machine, 1500rpm 220V, 1KW | 1 Set | |
| | | -Controller for starting motor | 1 Set | |
| | | -Single coil slide resistor, 100ohm 2A | 1 Set | |
| | | -DC series wound machine, 220V, 1500rpm, 1KW | 1 Set | |
| | | -DC shunt wound machine, 1500rpm, 220V, 1KW | 1 Set | |
| | | -Base frame for two machines | 1 Set | |
| | | -Controller for starting of DC machine | 1 Set | |
| | | -Single-coil resistor 200ohms, 2A | 1 Set | |
| | | -Single-coil resistor 1000ohms, 1.5A | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.4 | DC Generator Laboratory Set | This set of equipments consists of | | |
| | | -Contactor 220V 50Hz, 3-pole 16A/500VAC with auxiliary switch 2 make and 2 break contacts | 3 Sets | |
| | | -Incandescent lamp sockets | 3 Sets | |
| | | -3 fuses and soket with fuse plugs for generator | 4 Sets | |
| | | -Over-current relays 1.6-2.5A with auxiliary switch, 1 make and 1 break contact | 1 Set | |
| | | -Time relay 30 sec., 2 contacts | 1 Set | |
| | | -Pushbotton switch ON : 1 make and 1 break contact OFF: 1 break and 1 make contact | 2 Sets | |
| | | -ON/OFF switch, 2-pole 16A/380V, switch position: 0-I-0-I | 3 Sets | |
| | | -Two-circuit double interruption switch, 3-pole 16A/380VAC,switch position 0-I-0-II | 1 Set | |
| | | -DC compound-wound machine, 1500rpm, 220V, 1KW | 1 Set | |
| | | -DC separate wound machine 220V, 1500rpm, 1KW | 1 Set | |
| | | -Controller for starting motor | 1 Set | |
| | | -Base frame for two machine | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.5 | Single-Phase Motor Laboratory Set | This set of equipments consists of | | |
| | | -Fuse 2A and socket 16A for controller | 1 Set | |
| | | -3 fuses and socket with fuse plugs for motor | 1 Set | |
| | | -Circuit breaker, 3-pole 16A/500VAC | 1 Set | |
| | | -Contactor 220V 50Hz, 3-pole 16A/500VAC, with auxiliary switch 2 make and 2 break contacts | 3 Sets | |
| | | -Capacitor, 450V, 3uF | 3 Sets | |
| | | -Pushbotton switch | | |
| | | ON : 1 make and 1 break contact | 4 Sets | |
| | | OFF: 1 break and 1 make contact | 1 Set | |
| | | -ON/OFF switch, 2-pole 16A/380V, switch position: O-I-O-I | 1 Set | |
| | | -Two-circuit double interruption switch, 3-pole 16A/380VAC, switch position: O-I-O-II | 1 Set | |
| | | -Eddy-current break with electronic torque load cell 1.2KW | 1 Set | |
| | | -Control unit for speed and torque measurement of the eddy current break | 1 Set | |
| | | -Single-phase squirrel-cage motor running capacitor, 1KW, 220V, 1500 rpm., 50Hz | 1 Set | |
| | | -Single-phase squirrel-cage motor running and starting capacitor, 1KW, 220V, 50Hz, 1500rpm. | 1 Set | |
| | | -Single-phase repulsion motor 220V, 50Hz, 1KW, speed control range from 0 to 3000rpm. | 1 Set | |
| | | -Universal motor, 220V, 50Hz, 1KW, 3000rpm. | 1 Set | |
| | | -Base frame for two machines | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.6 | Three-Phase Synchronous Motor Laboratory Set | This set of equipments consists of | | |
| | | -Fuse 2A and socket 16A for controller | 1 Set | |
| | | -3 fuses and socket with fuse plugs for motor | 2 Sets | |
| | | -Circuit breaker, 3-pole 16A/500VAC | 1 Set | |
| | | -Reversing switch, 3-pole 16A/500VAC | 1 Set | |
| | | -Contactor 220V 50Hz, 3-pole 16A/500VAC with auxiliary switch, 2 make and 2 break contacts | 3 Sets | |
| | | -Over-current relays with auxiliary switch 1 make and 1 break contact | | |
| | | -0.63 to 1.4A | 1 Set | |
| | | -1.6 to 2.5A | 1 Set | |
| | | -Time relay 30 sec., 2 contacts | 1 Set | |
| | | -Pushbotton switch ON : 1 make and 1 break contact OFF: 1 break and 1 make contact | 2 Sets | |
| | | -ON/OFF switch, 2-pole 16A/380V, switch position: 0-I-0-I | 1 Set | |
| | | -Two-circuit double interruption switch, 3 pole 16A/380VAC switch position: 0-I-0-I | 1 Set | |
| | | -Eddy-current break with electronic torque load cell 1.2KW | 1 Set | |
| | | -Control unit for speed and torque measurement of the eddy current break | 1 Set | |
| | | -Three-phase synchronous machine with salient pole rotor, 380V/220V for motor operation, 400/230V for generator operation, 1KW, 50Hz | 1 Set | |
| | | -Three-phase synchronous motor with no excitation (reluctance motor) 380V star, 50Hz, 1500rpm | | |
| | | -Base frame for two machines | 1 Set | |
| | | -Single-coil slide resistor 200ohms, 2A | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.7 | Three-Phase Synchronous Generator Laboratory Set | This set of equipments consists of | | |
| | | -Fuse 2A and socker 16A for controller | 1 Set | |
| | | -3 fuses 16A/380VAC fuse plugs for motor | 4 Sets | |
| | | -3 Incandescent lamp sockets | 1 Set | |
| | | -Time relay 30 sec., 2 contacts | 1 Set | |
| | | -Circuit breaker, 3-pole 16A/500VAC | 1 Set | |
| | | -Triple-pole ON/OFF switch 16A/500VAC | 3 Sets | |
| | | -Reversing switch, 3 pole 16A/500VAC | 1 Set | |
| | | -Contactor 220V 50Hz, 3-pole 16A 500VAC with auxiliary switch 2 make and 2 break contacts | 1 Set | |
| | | -Over-current relays 0.63-1A with auxiliary switch 1 make and 1 break contact | 1 Set | |
| | | -Push botton switch ON : 1 make and 1 break contact OFF: 1 break and 1 make contact | 2 Sets | |
| | | -Two pole ON/OFF switch 16A/380VAC, switch position: 0-I-0-I | | |
| | | -Two-circuit double interruption switch, switch position: 0-I-0-II | 4 Sets | |
| | | -Pilot lights | 6 Sets | |
| | | -DC shunt wound motor, 220V, 1KW, 1500rpm. | 1 Set | |
| | | -Three-phase synchronous machine with salient pole rotor, 380V/220V for motor operation, 400/230V for gererator operation, 1KW, 50Hz | 1 Set | |
| | | -Three-phase synchronous machine with no excitation (reluctance machine) 380V star, 50Hz, 1500rpm | 1 Set | |
| | | -Controller for starting DC motor | 1 Set | |
| | | -Single slide resistor, 1000ohms, 1.5A | 1 Set | |
| | | -Base frame for two machines | 1 Set | |
| | | -Synchroscope 380VAC | 1 Set | |
| | | -Phase-sequence indicator | 1 Set | |
| | | -Double frequency meter | 1 Set | |
| | | -Resistive load 6KW, 3-phase | 2 Sets | |
| | | -Inductive load 6KW, 3-phase | 1 Set | |
| | | -Capacitive load 6KW, 3-phase | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.8 | Transformer Laboratory Set | This set of equipments consists of | | |
| | | -Single-phase transformer<br>Primary voltage: 2 x 110V, 50Hz<br>Secondary voltage: 2 x 110V<br>Rated output: 2.5KVA | 1 Set | |
| | | -Three-phase transformer<br>Primary-phase voltage: 380V<br>Secondary-phasse voltage Y,Z = 380V, Delta = 220V<br>Rated output: 4KVA | 1 Set | |
| | | -Fuse with fuse pluge for 1 phase transformer | 1 Set | |
| | | -Fuses with fuse plugs for 3 phase transformer | 1 Set | |
| | | -Triple-pole, ON/OFF switch 3 phase transformer | 1 set | |
| | | -Two-pole, ON/OFF switch 1 phase transformer | 1 Set | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.9 | Amplidyne-Generator Laboratory Set | This set of equipments consists of | | |
| | | -Fuse 2A and socket 16A for controller | 4 Sets | |
| | | -3 fuses and socket with fuse plugs for motor | 4 Sets | |
| | | -Circuit breaker, 3-pole 16A/500VAC | 2 Sets | |
| | | -Contactor 220V 50Hz, 3-pole 16A/500VAC, with auxiliary switch 2 make and 2 break contactor | 2 Sets | |
| | | -Over-current relay 1.6-2.5A with 1 make and 1 brake contact | 3 Sets | |
| | | -Pushbotton switch | | |
| | | ON : 1 make and 1 break contact | 2 Sets | |
| | | OFF: 1 break and 1 make contact | 2 Sets | |
| | | -Three-phase squirrel cage induction motor star-delta starting 380V, 50Hz, 1KW | 1 Set | |
| | | -DC compound wound machine 150rpm. 220V 1KW | 2 Sets | |
| | | -Controller for starting DC motor | 1 Set | |
| | | -Amplidyne generator 1KW, 220V | 1 Set | |
| | | -Single slide resister 100ohm 1.5A | 1 Set | |
| | | -Base frame for two machine | 2 Sets | |

I. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.10 | Power Electronic Equipments | | | |
| 1.10.1 | Converter | This equipment is used for controlling speed of induction motor | 1 | |
| 1.10.2 | VVVF (Varied Voltage and Varied Frequency) | This equipment is used for controlling speed of induction motor and making torgue constant | 1 | |
| 1.10.3 | Chopper | This equipment is used for controlling speed of DC machine | 1 | |

1. Electromechanical Energy Conversion Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1.11 | Connecting leads | 2.5mm2 with 4mm safety plugs for 32A | | |
| | | length = 25cm, red | 240 | |
| | | length = 30cm, red | 240 | |
| | | length = 50cm, red | 240 | |
| | | length = 50cm, red | 240 | |
| | | length = 100cm, red | 120 | |
| | | length = 100cm, red | 120 | |
| | | length = 150cm, red | 180 | |
| | | length = 150cm, red | 180 | |

2. Electronic Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 2.1 | Printed Circuit Board (PCB) Design Fabrication, and Testing<br><br>Software Packages for PCBs design | A set of software packages on the PCs or the workstations analyses, designs, and simulates analog and digital circuits and making the PCB layout. | | This set of equipments is used as basic tools in dsigning, fabricating, and testing Printed Circuit Boards in order to make convenience and reliability of senior projects which need many prototype circuit boards. |
| 2.1.1 | IC Design Software Package<br><br>Workview Viewlogic Systems, Inc. | Software package on the workstation or PCs supports all the capabilities needed for every step of the IC design process. | 1 Set | |
| 2.1.2 | Circuit Schematic Simulation Software Packages<br><br>Design Center MicroSim Corp.<br><br>V-System/Windows Model Tech., Inc. | Software Package running on PC provides with an integrated environment to<br>1. analyze circuit in time domain (with 5,700 + parts library)<br>2. analyze digital circuit by VHDL | <br><br>1 Set<br><br>1 Set | |
| 2.1.3 | PCB Layout System<br><br>P-cad Personal CAD Systems, Inc.<br><br>Equipments for PCB fabrication | This system consists of<br>1. Software package provides manual layout and design of PCBs.<br>2. Personal computer uses with the software package | 5 Sets | |
| 2.1.4 | Prototpye PCBs Production System<br><br>LPKF-91 Antech Communication Co. (Thailand)<br><br>ECAM Antech Communmication Co. | This system consists of two parts:<br>1. Machine for making PCB prototpyes<br>This machine uses the milling and drilling process to produce copper routes on the PCBs.<br>2. Control terminal (Personal Computer with Hardware interface and Software) | 1 Set | |
| 2.1.5 | Soldering Station<br>MBT-201E PACE Inc. | The station consists of tools that are used in mounting and removing chips. | 1 Set | |

2. Electronic Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 2.1.6 | Plotter | This is used for plotting PCB layouts. It should have the following features:<br>-Supports up to A1 Size<br>-Supports HP-GL Languages | 1 Set | |
| 2.1.7 | Supporting Materials<br><br>Equipments for Circuit Board Testing | -Models of Microprocessors<br>-DSP chips<br>-Specified-Purpose ICs<br>-Specified-Purpose Sensors<br>-Materials for PCB production<br>-Micelleneous<br><br>the set of equipments are used for PCB testing process: | 1 Set | |
| 2.1.8 | Digital Storage Oscilloscope<br>HP-54601A Hewlett-Packard Co. | -Bandwidth at least 100MHz<br>-At least 4 Channels | 4 Sets | |
| 2.1.9 | Function Generator<br>HP-8116A Hewlett-Packard Co. | -Provides sine, square, triangle, ramp and pulse waveform<br>-Provides frequency up to 50MHz<br>-Supports AM, FM modulation<br>-Provides output up to 20V<br>-GPIB or HP-IB Supporting | 2 Sets | |
| 2.1.10 | Logic Analyzer<br>HP-1652B Hewlett-Packard Co. | -Timing Analysis Bandwidth>200MHz<br>-State Analysis Bandwidth>80MHz | 1 Set | |
| 2.1.11 | Data Generator<br>HP-8175A;option 005 HP Company | This programmable data generator is used for generating pulse waveform | 1 Set | |
| 2.2 | Microprocessor-Based Development system<br>HP-64700 Hewlett-Packard Co. | This system consists of card frame, emulator/analyzer with following emulator card list:<br>-AT&T DS032C<br>-8086/8087<br>-8051,DIP<br>-68000DIP<br>-TMS320C25, PGA<br>-Z80 | 1 Set | |

3. Communication Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 3.1 | Basic RF Communication Systems | This set of equipments consists of the equipments operating in RF range that covers Thailand's RF communication systems with the following items | | |
| 3.1.1 | Signal Generator | -Frequency range from 100kHz to 3GHz<br>-0.1Hz Frequency resolution<br>-AM, FM Modulation<br>-±0.1 dB level accuracy<br>-Harmonics <-20dB | 2 Sets | Hewlett Packard HP 8664A<br>ADVANTEST R4262 |
| 3.1.2 | RF Vector Network Analyzer | -Frequency range from 100kHz to 3GHz<br>-Frequency resolution 1Hz<br>-Output Power range from -20dB tp +5dBm | 1 Set | Hewlett Packard HP 8752A<br>ADVANTEST R3763A |
| 3.1.3 | Digital Power Meter | -2 or more channel<br>-100kHz to 110GHz frequency range<br>-Power range from -70 to +44dBm<br>-Accuravcy ±1.2% worst case | 1 Set | Hewlett Packard HP 437B |
| 3.1.4 | Frequency counter | -Frequency: 60MHz to 3GHz<br>-Frequency resolution: 1Hz<br>-Power measurement capability is an advantage | 1 Set | ADVANTEST R5362A<br>Hewlett Packard HP 5386A |
| 3.1.5 | High-frequency Analog Design Software Packages | -Linear and Nonlinear Analysis<br>-S-parameter Device Library<br>-GaAs MESFET Library<br>-BJT Chip Library<br>-Packed BJT Chip Library<br>-RF Element Library<br>-System Compoment Library | 1 Set | EESof Incorporated EESof |
| 3.1.6 | EMC Measurement Systems | -Portable Spectrum Analyzer with 9kHz to 1.8GHz frequency range<br>-Detector<br>-Line impedance stabilization network<br>-Transient Limiter<br>-Two calibrated magnetic-field probes | 1 Set | Hewlett Packard HP 84110B |

3. Communication Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | -Two standard antennas with automatic tracking systems<br>-Tripod<br>-Plotter | | |
| 3.2 | Basic Data Communication Instruments | | | |
| 3.2.1 | Protocol Tester | -At least 80MB Hard disk storage<br>-Physical Interface<br>RS-232-C/C.24<br>RS-449/V.36<br>V.35<br>ISDN BRI: RJ-45, TAE8+4C<br>ISDN BRI: RJ-45&Bantam, DB-9, RJ-14<br>-Up to 2.048 Mbps per test channel<br>-Protocols<br>ISDN<br>X.25, Frame Relay<br>SS #7<br>Group 4 Fax<br>SNA/SDLC, ISO/HDLC | 1 Set | Hewlett Packard HP PT500 |
| 3.2.2 | Transmission Impairment Measuring Sets | -Level/frequency up to 110kHz<br>-Signal-to-nise ratio<br>-Phase and amplitute jitter<br>-Three level impulse noise<br>-Attenuation and delay distortion | 1 Set | Hewlett Packard HP 4934A |
| 3.2.3 | Bit Error Rate Analyzer | -Interfaces: RS-232-C/V.24, V.35, ISDN<br>-Data rates: 50bps to 2.048Mbps or higher<br>-Cover wide range of test patterns | 1 Set | Hewlett Packard HP 37732A<br>ADVANTEST D3285<br>Tektronix CSA 807A |
| 3.2.4 | Vector Signal Generator | -Frequency range from 10MHz to 3GHz<br>-BPSK, QPSK, 8PSK, 16QAM, 256QAM digital modulation<br>-±0.1dB level accuracy | 1 Set | Hewlett Packard HP 8780A |

4. Instrumentation and Control System Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 4.1 | Conrtrol system laboratory | The following equipments are used as simulated process for presenting the performance of desired control systems.<br>The required specifications of these equipments can be summarized as follows:<br>-The process must be enough complicated so that it will show true performance of control systems during the presentation.<br>-The process should simulate the real process that are used in industries and must be constructed from industrial-type materials because this will make students familiar with true instruments in the industries. | | This set of equipments is used in subjects in the areas of Control Engineering. There are several courses in which the equipments are used:<br>-LE 304 Instrumentation and Control System laboratory<br>-LE 331 Feedback Control systems<br>-LE 432 Control systems<br>-LE 433 Nonlinear Control systems<br>-LE 434 Industrial Control and Instumentation<br>-LE 436 Robot and Automation<br>-LE 437 digital Control systems |
| 4.1.1 | Experimental process unit | -Constructed from industrial-type equipments<br>-Provides more than 4 loops<br>-Uses standard electrical control signal<br>-Covers all basic industrial measurement (Pressure, Temperature, Flow, Level)<br>-Simulates from real process in industries | 1 Set | |
| 4.1.2 | Robotic unit | -At least 4 axis<br>-0.1mm. accuracy<br>-Electrical or elctro-pneumatic type<br>-Uses optical encoder feedback in all axes<br>-Combined with robot vision and sensing system | 1 Set | |
| 4.2 | Signal Processing lab | The required equipments in this laboratory are general-purpose DSP boards and accessories that will be used in the study of digital signal processing algorithms, applications of DSP with several types of data | | This set of equipments is used in the Digital Singnal Processing subjects and for supporting other subjects that have to analyze and process data in digital form.<br>There are several courses in which |

4. Instrumentation and Control System Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | and evelopment of instruments that use DSP as processing unit. | | the equipments are used:<br>-LE 315 Signal and Systems<br>-LE 437 Digital Control Systems<br>-LE 438 Digital Signal Processing |
| 4.2.1 | General-purpose DSP board<br><br>PCS/DSP32C or PCS/320C30 from LSI | -Uses 32 bit floating point DSP chip from TI, AT&T or Motorola<br>-Provides 2 analog I/O channels with at least 12 bit resolution and 50kHz speed<br>-At least 256KB memory on board<br>-Uses with ISA or EISA bus<br>-Provides high-speed data transfer connection<br>-Combined with compiler, debugger and library | 2 Set | |
| 4.2.2 | Accessory boards<br><br>PC/CH4, PC/32DIO, PC/IMP32C PC/PA and PC/TEL32CS from LSI | This set of boards provides the additional functions for the DSP boards so that the use of DSP boards will expand to specific applications. This set of boards are listed as follows:<br>-A/D and D/A board with 12 bit resolution and 100kHz speed<br>-Digital I/O board<br>-Frame grabber board<br>-Audio board<br>-Telephone board | 1 Set | |
| 4.2.3 | DSP software package<br><br>Hypersignal-Windows from Hyper-ception | This is a software package which has the following features:<br>-Runs on PC<br>-Time/Frequency Domain Analysis<br>-Digital Filter Design<br>-Real Time Spectrum Analysis and Digital Recording | 1 Set | |
| 4.2.4 | Arbitrary waveform generator<br><br>AG1200 from YOKOGAWA<br>or HP8175A from Hewlett Packard<br>or AWG5502 from Tektronix | -At least 10MSa/s synthesize speed<br>-Capable to use mathematical function for program signal waveform<br>-Graphical waveform programming<br>-HP-IB or GPIB port | 1 Set | |
| 4.2.5 | FFT Analyzer | -Frequency range from 0.1Hz to | 1 Set | |

4. Instrumentation and Control System Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | TR9211C from ADVANTEST<br>or HP35665A from Hewlett Packard<br>or 2642A from Tektronix | 100kHz<br>-Spectrum, network and waveform analysis features<br>-Supports programmable analysis functions<br>-HP-IB or GPIB port | | |

4.4.1 Equipments for CNC Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | Vertical Machining Center | 1) Automatic tool cahnge with 30 Tools<br>2) Traverse (minimum)<br>X 600mm.<br>Y 400mm.<br>Z 400mm.<br>3) Spindle Power ≧ 11Kw<br>4) Controller with latest technological features similar to Fanuc-15M<br>5) Simultaniour 3-axes<br>6) Accessories:<br>a) Work holding devices like pneumatic vise modular fixture elements etc.<br>b) Tool holder and cutting tools<br>c) All standard accessories | 1 Unit | 1) Tool change system study<br>2) Big enough for cutting demonstration work piece (wider, longer but flat)<br>3) Enough for rough cutting<br>4) Follow the market of fanuc-Controller which booming in thailand<br>a) High accuraracy positioning of the fixed work piece<br>b) Very neccessary<br>c) Included |
| 2. | CNC Horizontal Machining Center | 1) Automatic tool change with 30 tools<br>2) Automatic pallet changer<br>3) Simultanious-4-axes 3-Linear-1 rotary<br>4) Traverse (apprx)<br>X 650mm.<br>Y 450mm.<br>Z 450mm.<br>5) Spindle power > 11Kw<br>6) CNC-controller the latest generation FANUC or OKUMA with built in tool management system<br>Accessories:<br>1) Inspection measuring probe<br>2) Automatic tool offset measurement<br>3) Wok holding fixtures<br>4) Tool holder and cutting tools<br>5) All standrand accessories | 1 Unit | 1) Automatic changing of many tools study<br>2) The one of production technology which the IE-students would have been advising the works in industries after completion their study.<br>3) Better than the primitive one<br>4) Preperation for industrial service<br>5) More power consumtion<br>6) Suitable for research work, study and conducting specific courses of training for companies<br>Accessories:<br>All neccessary |
| 3. | CNC Precision Surface Grinder | 1) This machine could be used for high precision surface finishing work up to 1 micron.<br>2) Working table apprx. 200 x 400 | 1 Unit | 1) For demonstrate the learner and let them hand on such a very fine production posibility<br>2) Proper size for CNC controlled |

4.4.1 Equipments for CNC Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | mm. with all neccessary standrad accessories<br>3) Magnetic paper filter<br>4) Controller<br>5) Automatic oil temperature regulator<br>6) Serveral types of form grinding wheels and balancing unit<br>7) Magnatic table<br>8) Blower unit for grinding dry workpiece<br>9) All standard accessories | | machine<br>3)-9) Study the working principle of all standard equipments will increase the students experiences |
| 4. | CNC TURNING CENTER (CNC TURN-MILL CENTER) | 1) Min 3-axes (X,Z, and "C")<br>2) With rotary tools e.g. 6-fixed; 6-rotary<br>3) Chuck dia. ~250mm. (hydralic operated)<br>4) Strokes Xmin 300mm. Zmin~600mm.<br>5) With tailstock<br>6) Spindle moter ≧ 11Kw<br>7) Slant bed contruction<br>8) Turret preferably VDI-Type<br>9) Controller fanuc<br>Accessories:<br>1) CNC-Controlled stedy rest<br>2) Automatic tool offset measurement with probes<br>3) Gantry robot for loading unloading the work pieces<br>4) Tool holders and cutting tools<br>5) All standard accessories | 1 Unit | 1) Study of the principle of the latest axes control system.<br>2) To study the driving system of the rotary tools holder<br>3) Appropriate size for<br>4) CNC macining center<br>5) To study how the automatic tailstock of machine can be controlled by programming<br>6) Appropriate power<br>7)-9) Very preferably machine feature in industries in Thailand.<br>Accessories<br>1),2),3),4) Quit neccessary for study and research work.<br>5) Standard acc. normally included. |
| 5. | CNC-EDM-Wire Cutting | -Overal size:1800 x 1000 x 1500mm.<br>-Wire dia: 0.05-0.33mm<br>-Max. wire feed rate:250mm/sec.<br>-CNC control system closed loop<br>-Allowing to use larger program (up to 1MB, approx 2500m of tape)<br>-Automatic second cut function<br>-Ability for cutting a different top and bottom shapes and defferent top and bottom radiaus<br>-Semi-automatic wire take up device<br>-All standrad accessories | 1 Unit | Studying, researching technology transfering of wire cutting. technology should have been handing on the real and industrial size machine. Too small more diffcult to get the good quality of cutting the speciment (workpiece) |

4.4.1 Equipments for CNC Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 6. | CNC-EDM-Sink Machine | -CNC controller<br>-3-axes simultaneous maching full factory automation such as:<br>a) Mirror/supper fine finish<br>b) Orbital<br>c) Automatic selection of m/c conditions multiple<br>d) 'c'-axis machining<br>e) Programable tool chang tooling kit<br>f) Manual handle<br>g) Dielectric-fluid temperature control unit<br>h) Automatic tool changer<br>i) Automatic dielectric fluid injection/suction<br>j) A-axis unit<br>k) All standrad accessories | 1 Unit | The same result as wire cutting machine |
| 7. | Robot and off-line Robotic Programming | 1) Small size, lowcost, high speed<br>2) Articulated type<br>3) AC-servo drive with abolute position detection<br>4) Repeatability ±0.1mm. or better<br>5) Max. load capacity at wrist ≧ 5Kg<br>6) Application:<br>-Abundant control function<br>-High reliability achieved through NC mass production<br>-Can be equiped with the software serve by high speed microprocessor for artifical<br>7) Off-line robot programming<br>-High performance UNIX work-station<br>-High speed automatic colision detection<br>-Full scale 3-D shape modeling<br>-Large capacity database managment | 1 Unit | -Robot are being introduced into the factory in increasing numbers<br>-Support the faculty in analysing the application of robots in the manufactoring industry<br>-Machining/Machinery Handling/Flame-cutting/Cleaning/ Assembling/Handling moulding parts<br>7) Study the robot charatoristic and creation of application programs |
| 8. | CNC-CMM<br>(Co-ordinate Measuring Machine) | 1) Manul/CNC Modes<br>2) Z spindle made by special meterial for overcoming thermal expansion.<br>3) At Z spindle using air balance | 1 Unit | -Supporting the quality control of the workpiece produced by NC, machines-analyzing and solving a<br>-Analyzing and solving a specific measurement problems by part |

4.4.1 Equipments for CNC Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | method<br>4) Hardware: HP. IBM personal computer and compatibles and Micropak<br>5) Software: Geopak, Scanpak, Statpak or others.<br>6) Measuring range X 700 Y 600 Z 600mm.<br>7) Resolution 0.0005mm or better<br>8) Guiding: air bearing<br>9) Table size: 900 x 1500mm $>$, MAT: granite flatness $\leq$ 20 micron.<br>10)Max. workpiece high $\geq$ 700mm.<br>11)Overalldim. W 1500 D 1800 H 2800mm. or better<br>12) With all standard Accessories | | production<br>-Too less specialist as well as engineer who know or study in depth concerning the quality control by means of using special equipment like CNC-CMM as we required |

4.4.2 Equipments for CAD/CAM Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | Computer Workstation | -64 MB main memory<br>-1.44 MB Floppy Disk Drive<br>-1.05 GB Hard Disk<br>-At least 19 inch color monitor<br>-Keyboard & mouse | 4 Units | These equipments will be used for supporting CAD/CAM Laboratory which will upgrade the quality of engineering geaduates and enhance the research and development for CAD/CAM technology |
| 2. | Personal Computer | -CPU is 486 intel<br>-At least 50 MHz of speed<br>-16 MB Memory<br>-1.44 MB, 3.5 inch floppy disk drive<br>-At least 120 MB hard disk<br>-20 inch color monitor with super VGA card<br>-Keyboard & mouse | 10 Units | |
| 3. | Tape Drive | -150 MB Cartidge Tape Drive | | |
| 4. | CD Rom Drive | Can be use to read software program form CD | 1 Unit | |
| 5. | Plotter | -Can use many colors and joint pencil togerther<br>-A0 size | 1 Unit | |
| 6. | Laser Printer | -At least A3 size | 1 Unit | |
| 7. | Network Equipment | Network equipments are the equipments which can used connect total hardware is in CAD/CAM laboratory. They are consisted:<br>-Ethernet hub can be upto 15 ports<br>-Ethernet Card for 10 units PC<br>-Communication software between computer workstation and Personal Computer | 1 Set | |

4.4.2 Equipments for CAD/CAM Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 8. | CAD/CAM Software for Workstation | The CAD Soft ware which the details are as follows:<br>-Can be used to creat engineering drawing using standard geometric, such as points, lines, curves, circles and more<br>-Dimension and Text capacities is Internation Standards Organization (ISO), JIS ANSI, DIN or user defined standards.<br>-Can creates 3 demension design, construct, deform and blend complex, sculptured of the system.<br>-To create complex solids from wireframe, surface or solid elements which are associative foe detail drafting<br>-To analize mass properties, interference and general quality of design and machinability and then can perform interference chaecks between solids and/or polyhedral surfaces<br>-The software has the function which users can interactively define many image parameters | 1 Set | |
| 8. | CAD/CAM Software for Warkstation (Continued) | The CAM Software which the detail are as follows:<br>-Can be used control the NC-Machine, (Lathe, Drilling, Milling, Machining Center, Wire Cut and EDM) define tool paths for various opertions such as strating-ending, rough cutting, grooving, threading and tool changing<br>-To simplify the machine tool programming process by simulating many poerations<br>-To create NC-Programs directly from 2D and 3D which are created, in form of Automatically Programmed Tool (APT) source programs or Direct Cutting Location File (CLFILE) output | | |

4.4.2 Equipments for CAD/CAM Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | -To visulize NC tool paths (on the Graphics screen) and simulated the movement of cutting tools<br>-To provide the potion to perform contouring pocketing or surface machine in simple 2-axis or in complex 3-to 5-axis environments<br>-This software can Interactively robots and robots cells by using a wireframe, surface or solid representation model and spacifying the appropriate joint types and their limits and then simulate the grasping or releasing of tools or objecs. In the other, it can calculate static loads on joints and show that robot is strong enough for a specfic task<br>-Can create, modify and anslyze finite element models to evaluate a design<br>-These datas are created by the software, can be transfered to IGES be standard data that other CAD/CAM system can use these data. Another wayis recieves the data of the others CAD/CAM<br>-To store a wide varity of components for both 2D and 3D application and more. | | |
| 9. | CAD/CAM Software for Personal Computer | CAD software has the specification are as the following<br>-Can use on PC which using intel 486 processor<br>-To create engineering drawing using standard geometic (ISO, JIS, ANSI and more) and 3-dimension geometric models, to sculpt and shape models using NURB (Non Uniform Rational B-Spline) and Brizer surface, To verify and visualize designs using both faceted and smooth shading techniques and to dociment | 10 Units | -To study for basic concept in creating the NC programming |

4.4.2 Equipments for CAD/CAM Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | designs for manufacturing and assembly by generating high-quality engineering drawings.<br>-Can transfers and receives the data on DXF and IGES formats CAM software which the details are as follows:<br>-To create tool path and NC program for CNC machine which is 2 1/2 axis and 3 axis, then simulates and show the working of cutting tools on the geometric desig<br>-To create G-code which suitable for CNC controller is used<br>-Can transfers and receives the data on DXF and IGES formats and download completed part programs directly to CNC machines. | | |

4.4.3 Equipments for Precision Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | Central Measuring Network. Consist of : | | | Many Company in Thailand has set the metrology laboratories and try to up-grade the measurment method The "Central Measuring Net-Work" is one which would have been taught and transfered this measuting technology to the engineers and the related personel |
| 1.1 | Personal Computer | | 2 Sets | |
| 1.2 | Digimatic Instrument | | 1 Set | |
| 1.2.1 | Toolmaker Microscope with Video Image Edge Sensor | Like Mitutoyo (TM 301) | 1 Set | |
| 1.2.2 | Digimatic Bench Micrometer | Measuring Range:0-5mm | 1 Set | |
| 1.2.3 | Digimatic Indicator with Stand | Measuring Range:25mm | 2 Sets | |
| 1.2.4 | Digimatic Depth Gauge | Measuring Range:0-150mm | 2 Sets | |
| 1.2.5 | Digimatic Depth Micrometer | Measuring Range:0-150mm | 2 Sets | |
| 1.2.6 | Digimatic Holtest | Dia.25-Dia. 30mm | 1 Set | |
| 1.2.7 | Digimatic Height Gauge | With bidirectional touch signal probe. Measuring Range:0-300mm | 1 Set | |
| 1.2.8 | Digimatic Caliper | Measuring Range 0-150mm<br>0-300mm | 1 Set<br>1 Set | |
| 1.2.9 | Laser Scan Micro Meter | Measuting Range 0.3-30mm | 1 Set | |
| 1.2.10 | Digimatic Micrometer | Measuring Range 0-25mm | 1 Set | |
| 1.2.11 | Digimatic Screw Micrometer | Measuring Range 0-25 (60Deg.)mm<br>Measuring range 0-25 (55Deg.)mm | 1 Set<br>1 Set | |
| 1.2.12 | Digimatic Disc Micrometer | Measuring Range 0-25mm | 1 Set | |
| 1.2.13 | Digimatic Gear Micrometer | Measuring range 0-25mm | 1 Set | |
| 1.2.14 | Digimatic Inside Micrometer | Measuring Range 25-50mm | 1 Set | |
| 1.2.15 | Digimatic Height Master | Measuring Range 10-310mm | 1 Set | |
| 2. | Digimatic Multi Unit | Receives data from upto six digimatic guage and performs GO/NG judgments on the measurement data individually or collectively | 3 Sets | |
| 3. | Micrometers | | | |
| 3.1 | Outside Micrometer Sets | Measuring Range:0-300mm (5pcs.) | 1 Set | |
| 3.2 | Outside Micrometer Sets, Caliper | Measuring Range:0-300mm (5pcs.) | 1 Set | |
| 3.3 | Screw Thread Micrometer, Fixed Anvil | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.4 | Point Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.5 | Crimp Height Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.6 | Tube Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.7 | Sheet Metal Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.8 | Blade Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.9 | Disc Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.10 | Gear Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.11 | V-Anvil Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.12 | Side Milling Cutter Tooth | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.13 | Wire Micromenters | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 3.14 | Hub Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |

4.4.3 Equipments for Precision Laboratory

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 3.15 | Groove Micrometers | Measuring Range:0-50mm (1pc.) | 1 Set | |
| 3.16 | Limit Micrometers | Measuring Range:0-50mm (2pcs.) | 1 Set | |
| 4. | Gages and Others Equipments | | | |
| 4.1 | Small Hole Gages | Measuring Range:3-13mm | 1 Set | |
| 4.2 | Telescoping Gages | Measuring Range:8-150mm | 1 Set | |
| 4.3 | Optical Flats | Measuring Range:0.1um | 1 Set | |
| 4.4 | Optical Flats | Measuring Range:0.2um | 1 Set | |
| 4.5 | Micrometer Stands | | 4 Sets | |
| 4.6 | Dial Height Gages | | 2 Sets | |
| 4.7 | Dial Height Gages | Measuring Range:0-250mm | 1 Set | |
| 4.8 | Depth Micrometer | Measuring Range:0-300mm | 1 Set | |
| 4.9 | Vernier Depth Gages | Measuring Range:0-30mm | 1 Set | |
| 4.10 | Dial Indicator | | 2 Sets | |
| 4.11 | Calibration Tester | | 1 Set | |
| 4.12 | Mini Magnetic Sands | | 1 Set | |
| 4.13 | Universal Magnetic Stands | | 1 Set | |
| 4.14 | Comparator Stands | | 1 Set | |
| 4.15 | V-Blocks | | 2 Sets | |
| 4.16 | Granite Surface Plates | | 2 Sets | |
| 4.17 | Square Gauge Block | | 1 Set | |
| 5. | Roundness Tester | 1) Incorporates powerful software with wide range of evaluation parameters<br>2) Roundness valuation notched workpiece measurement coaxiality and consentricity measurements.<br>3) Automatic tilt compensation function electrically align the axis of turn table and workpiece<br>4) Digital display of the Parameter Values<br>5) Optical Sensor Unit<br>6) Max workpiece standrs<br>7) Personal Computer is:<br>-CPU is 486intel<br>-At least 50MHz of speed<br>-8MB Memory<br>-1.44MB,3.5 inch floppy disk drive<br>-At least 120MB hard disk<br>-14 inch color monitor with super VGA card<br>-Keyboard & mouse<br>8) Dot Printer 36 pin | 1 Unit | |

5.4 Equipment Requested from Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | Structural Loading System<br>Consists of:<br>a) Loading System(1.1)<br>b) Loading Frame(1.2-1.3)<br>c) Measuring Equipment (1.4-1.7)<br>d) Machinenary for Machine Shop(1.8-1.9) | As specified belows. | 1 Set | The system shall be applied to study the structural behaviors of various kinds of structures and their parts under static and Dynamic load.<br>The types of structures include Reinforced Concrete, Prestressed Concrete, Steel and Steel-Concrete Structures. The structures and their parts intended to be studied are as follows.<br>-Prestressed Concrete Slab.<br>-Frame and Truss<br>-Beam, Column, Slab.<br>-Actual Parts of Structure. |
| A) Loading System | | | | As shown below |
| 1.1 | (a) Static Hydraulic Jack and Pumping Unit | -One 10tf with 200mm ram stroke(or more)Hydraulic Jack<br>-One 100tf with 200mm ram stroke(or more)Hydraulic Jack<br>-One 200tf with 200mm ram stroke(or more)Hydraulic Jack<br>-One 500tf with 50mm ram stroke(or more)Hydraulic Jack<br>-One Electric Hydraulic Pump with Minimum of 30 l/min Delivery Rate with Constant Different Pressure<br>-Each Size of Male and Female Couplers must be Supplied with One 10m and One 5m Hoses for Connecting between Jack & Pump | 1 Set | Applying load to structures or parts of structures |
| | (b) Dynamic Hydraulic Jack and Control Unit | -One 20tf with 200mm ram stroke(or more)Pulse Type Hydraulic Jack<br>-One 50tf with 200mm ram stroke(or more)Pulser Type Hydraulic Jack<br>-One Pulser Type Electric Hydraulic Pump with minimum of 30 l/min Delivery Rate<br>-Each Size of Male and Female Couplers must be Supplied with | 1 Set | Applying load to structures or parts of structures |

5.4 Equipment Requested from Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | One 10m and One 5m Hoses for Connecting between Jack & Pump | | |
| | (c) Hollow Hydraulic Jack | -Two 10tf Hollow Hydraulic Jacks with about 40mm Displacement<br>-One 30tf Hollow Hydraulic Jack with about 60mm Displacement<br>-Two 2-Speed Hand Pumps for Low and High Flow of appr. 700 bar Max. Pressure supplied with Pressure Gauge<br>-Male and Female Couplers of Jacks and Pumps must be Compatible, Connecting Hose should be about 2m in Length | | Preparation of Specimens |
| | (d) Connecting Adaptors | Each Two Pieces of High Strength Adaptors with Both End Female Threaded Couplers for Connecting of:<br>-6mm to 15mm Dia.Male Screw<br>-9mm to 15mm Dia.Male Screw<br>-15mm to 15mm Dia.Male Screw<br>-19mm to 28mm Dia.Male Screw<br>-22mm to 28mm Dia.Male Screw<br>-25mm to 28mm Dis.Male Screw<br>-28mm to 28mm Dia.Male Screw | | Preparation of Speciments |
| B) Loading Frame | | | | As shown below. |
| 1.2 | Self Supporting Steel Frame | Enable to withstand Multi-Loading Conditions i.e.<br>-Column (appr. 4m Height with Cross Section of 400 x 400mm.)<br>-Beam (appr. 6m Long 400mm Wide and 300tf-m Capacity)<br>-Slab (appr. 3m x 6m in size and 40tf Capacity) | 1 Set | Supporting and setting up for the loading test. |
| 1.3 | Electric Crane | Two Sets of 3tf, very Low Speed Electric Crane for Frame Assembling and Experimental Set up | | |
| C) Measuring Equipment | | | | |
| 1.4 | Load Cell | -Two Hollow Core 10tf Load Cells<br>-One Hollow Core 50tf Load Cell | 1 Set | Detect load of the actuator |

5.4 Equipment Requested from Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | -One 100tf Load Cell<br>-One 200tf Load Cell<br>-One 500tf Load Cell | | |
| 1.5 | Data Logger | Computer Interface Data Logger<br>-Strain Range Appr. +/-40000 x 1Exp - 6<br>-Input at Least 50 Points (Built-in at Least 10 Points)<br>-Supplied with RS-232C Interface<br>-One Internal Printer<br>-Display At Least 20 Digits x 2Lines<br>-Progammable Setting<br>-With Self Diabnosis Functions<br>-About 6000 Point Data Memory Protection<br>-Measuring Speed 0.08 Sec/Point or Better<br>-Programmable Timer<br>-Automatic Scanning | 1 Set | Detect stroke of the actuator |
| 1.6 | Displacement Tranducer | Strain Gauge Type Tranducer<br>-10 pieces of 5mm Displacement<br>-10 pieces of 10mm Displacement<br>-10 pieces of 30mm Displacement<br>-10 pieces of 50mm Displacement<br>-10 pieces of 100mm Displacement<br>-5 pieces of 200mm Displacement | 1 Set | Control the actuator functions and movements |
| 1.7 | Dial Gauge | Indicator to 1/100mm Dial Gauge<br>-2 Pieces of 5mm Displacement<br>-2 Pieces of 10mm Displacement<br>-2 Pieces of 30mm Displacement<br>-2 Pieces of 50mm Displacement<br>-2 Pieces of 100mm Displacement<br>-2 Pieces of 200mm Displacement<br>-10 Magnetic Base | 1 Set | Control actuator movements |
| D) Machinery for Machine Shop | | | | As shown below |
| 1.8 | Concrete Specimen Cutting Machine | -Power: > 3HP<br>-Cutting Dpth > 200mm | 1 Set | To cut the tested specimen |
| 1.9 | Portable Concrete Core Drill | -Run by Electricity<br>-Core size: up to 200mm | 1 Set | To drill the tested specimen |
| 2. | Computer and Software | As specified belows | 1 Set | The system shall be applied to study |
| 2.1 | Stuctural Analysis and Desig Software | Earthquake Analysis and Design on sun based Workstation | 1 License | Structural Analysis |
| 2.2 | Personal Computer | IBM Compatible | 5 Sets | Data Processor |

5.4 Equipment Requested from Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | -Intel 486 DX2-66 Based<br>-VESA LOCAL BUS<br>-8MB RAM<br>-1.2MB FDD + 1.4MB FDD<br>-Appr. 200MB HDD<br>-17 in Super VGA noninterlaced Monitor & Super VGA Graphics Card | | |
| 2.3 | Color Buble Jet Printer | -Up to A4 Size | 1 Set | |
| 2.4 | Laser Printer | -A4 Size<br>-Ram >= 2MB<br>-Speed at least 8 Pages/min | 1 Set | Report |
| 3. | Instrument for Control Room of app. 4 x 7 x 4m | Consists of 2.1 and 2.2 | 1 Set | For curing concrete specimen |
| 3.1 | Cooling System | -20-27 Degree Celsius Controllable | 1 Set | Temperature Control |
| 3.2 | Vaporizer and Humidity Controller | -In accordace with ASTM C31<br>-Pressure of Water: up to 6 bar<br>-Water Atomising: app. 4 l/hr | 1 Set | Humidity Control |
| 4. | Universal Material Testing Machine with Servo Valve Control | Consists of 3.1 to 3.5 | 1 Set | The system shall be applied to study Mechanical Properties of Construction Materials |
| 4.1 | Loading Unit | - +/-20tf Dynamic Load<br>- +/-30tf Static Load<br>- +/-25mm Max. Stroke<br>-Load and Stroke controllable<br>-Strong Columns Loading Frame with Actuator at Top<br>-Load Accuracy +/- 1% of Indicated Value<br>-Complete with Stroke Detedctor and Load Cell | 1 Set | |
| 4.2 | Load Cell | -One 20tf<br>-One 5tf<br>-One 500Kg.<br>-Load Amplifier<br>-Actual Load Type Load Calibration Device | | |
| 4.3 | Hydraulic Power Supply | -Servo Valve Hydraulic Pump for 4.1 | 1 Set | |
| 4.4 | Computer Control System | -Interface for IBM Compatible Computer<br>-Loading Wave Form:<br>Standard: Sine, Triangular etc.<br>User Define: Random etc. | | |

5.4 Equipment Requested from Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | -Load and Stroke Control<br>-Automatic Switching of Control Variables<br>-Overload Protection at Mounting and Removing of Specimen<br>-Safety device<br>-Basic Loading Test Program<br>-Fatique Test Program<br>-Fatuque Bending Tost Program | | |
| 4.5 | Grip | -Splitflange Type Grip for up to 35mm Dia. Round Bar with Max. Dynamic Load of +/-20tf<br>-Compression Plate Jig wit Max. Dynamic Load of -20tf<br>-Non-Shift Grip for Plate Speciments without Bolt Holes for 0-20mm Thick Specimen with Max. Dynamic Load of 10tf | 1 Set | |
| 5. | Universal Testing Machine | Consists of 5.1 to 5.4 | 1 Set | The system shall be applied to study Mechanical Properties of Construction Materials in Compulsory Coarses |
| 5.1 | Loading Unit<br>* UH 50B wide Type | -50tf Manual Control Universal Testing Machine<br>-Appr. 80 Max. Loading Speed<br>-Appr. 250mm Ram Stroke<br>-Appr. 1200mm. Column to Column Distance<br>-Appr. 800 x 650mm Effective Table Area<br>-Digital Display and Analog Meter<br>-Automatic Range Switching<br>-Digital Load Display<br>-Load Calibration Device | | |
| 5.2 | Load Cell | -One 50tf<br>-One 5tf<br>-Load Amplifier<br>-Actual Load Type Load Calibration Device | | |
| 5.3 | Hydraulic Power Supply | -Suitable for 5.1 | 1 Set | |
| 5.4 | Grip<br>* UH-B50 | -Grip for Rods with 12-50mm Dia.<br>-Grip for Plate with 0-45mm Thick<br>-120mm Dia. Lower Compression | 1 Set | |

5.4 Equipment Requested from Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | Plate | | |
| | * 343-02376-02 and 343-02377-04 | -20tf Grip for Therad Specimen | | |
| | * 343-01833-01 | -30-70mm Grip Face for Pipe Specimen | | |
| | * 343-02783-03 | -2tf Grip for Wood Specimen | | |
| | * 343-00455-02 | -120mm dia. Upper Spherical Compression Plate | | |
| | * 343-02785-03 | -10tf Compression Test Jig for Wood | | |
| | * 343-02784-03 | -10tf Bending Test Jig for Wood | | |
| | * 341-17310-03 | -2tf Shearing Test Jig for Wood Specimen | | |
| | * 343-10025-13 | -3tf Brinell Hardness Test Jig | | |
| | * 343-02786-03 | -0.5tf Grip for Plywood | | |
| | * 343-02789-03 | -Hardness Test Jig for Wood | | |

6.4.2 Equipment List

Group I

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | Liquid-Liquid Extraction System | This system is composed of two extractors with reciprocating-plate columns. The number of madreporite plates for each extractor is about 30. Four tubing pumps are needed as accessaries. | 1 | The reciprocating-plate columns have been found to be suitable for processing mixtures with emulsifying tendencies. This system will be used in "Chemical Engineering Laboratory 3". Two extractors are required. One is used for extracting operation while the other is used for regenerating solvent. |
| 2. | Fluid-Solid Extraction System | A desktop type of supercritical gas extractor that can perform extraction process with supercritical fluid and a separation process from the fluid. | 1 | Supercritical gas has an excellent dissolubility to dessolve and extract a specific substance from a mixture. The supercritical gas extractor can be widely used in many fields and is very suitable for student-use laboratory due to its safety compared to other extractors. This system will be used in "Chemical Engineering Laboratory 3". |
| 3. | Process Control Test Set | Consists of 3 level loops, 1 pressure loop, and 1 computer control loop. Equipments and specification in each loop are described in the Appendix. | 1 | Nowaday, a chemical engineer must be familiar with the basic building blocks of automatic control systems including transducers, transmitter or amplifiers, controllers, and final control elements. Moreover, he must also understand topics such as computer engineering, signal processing, and data communications etc. "The Process Control Set" will serve for this purpose. |
| 4. | Continuous Plate Distillation Unit | A contnuous plate distillation unit with bubble cap tray column. The distillation column is made of glass and has a size of at least 10mm in diameter and 10 plates. Each plate has a nozzle for vapour or liquid sample take-off as well as temperature measurement. Also incorporated in this system | 1 | Plate distillation is the most basic type of distillation and is widely used in chemical industries in many ways, for example, the refinery of crude oil. Moreover, a distillation unit is a very good equipment for studying mass transfer. This equipment will be used in "Chemical Engineering |

6.4.2 Equipment List

Group I

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | is the continuous take-off of buttom and distillate and re-feed by measn of dosing pumps. The distillation control console contains all necessary measuring and control devices for safe, exact, and reproducible operation of the unit. | | Laboratory 2" and will give some concepts in scaling up to a pilot plant scale destellation unit. |
| 5. | Batch Packed Distillation Unit | A batch packed distillation unit with vacuum system. The distillation column is more than 1m high and gas a diameter at least 15mm. The heating source is at least 500W of mantle heater. The control unit with a temperature recorder of a system is independent of the body. | 1 | In recent years, packed-column distilation units are widely used in the chemical industries due to its low pressure drop and low cost of operation. This unit will be used in "Chemical Engineering Laboratory 3" together with the continuous plate distillation unit, so that the students can see the difference between a distillation with plate column and that with packed column. |
| 6. | Spray Dryer | A spray dryer with a nozzle injection feed system. The drying chamber has a diameter at least 450mm to make sure that the spray must be dried before reaching the chamber. The dryer can produce fine particle of 40-100 micrometre, and has a capacity for water evaporation at least 3 l/h. The collecting system is composed with a cone and a cyclone with an air draftler for drafting the product to the collecting pot. The nozzle has an automatic orifice cleanout system, and the drying chamber, cyclone, and the product vessel container are all made of superhard glass. | 1 | This equipment will mainly be used in the "Chemical Engineering Laboratory 2" for studying the drying phenomena, and in reseach in the field of heat and mass transfer. It can also be used for study of drying processyin order to develop the laboratory scale to the pilot or industrial scale. |
| 7. | Stirred Liquid Phase Reaction Unit | A reaction unit consisting of a fermenter, a process control for controlling pH, DO, temperature, agitating and foaming, a control box, an aeration unit, two | 1 | Chemical reaction experiment is indispensible for chemical engineering education. One of the most important industrial reactor type is stirred liquid phase |

6.4.2 Equipment List

Group I

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | microtube pumps, and other accessaries such as electrodes and joints. A fermentor has a capacity of 2.3.1, a water jacket in itself, a magneticallycoupled stirring shaft. | | reactor. This unit facilitates a range of studies of reactor and reaction behaviours including homogenerous and gas/liquid reactions. It will be used in "Chemical Engineering Laboratory 2" |
| 8. | Fluidized-bed Ractor | A fluidized-bed reactor consisting of a 2-litre fluidezed bed-fixed bed reactor, a pH controller, two microtube pumps, a peristaltic pump, and other accessaries such as flow arranging bulbs. | 1 | It has been found advantageous to carry out many solid-catalyzed reaction in fluidized beds. The circulation of the bed and the uniform agitation with in it presents the occurrance of dazed regions. In order to demonstrate this phenomenon, a fluidized-bed reactor system is necessary for chemical engineering students to perform such and experiment. |
| 9. | Fixed-bed Reactor | A fixed bed reactor consisting of a 2-litre fluidized bed-fixed bed reactor, a pH controller, an aeration unit, a level controller, and two microtube pumps. | | It has been recognized that enzymatic catalyzed reaction can be conducted by using immobilized carrier. This technique is suitable for expensive enzyme. Immobilized carrier can be operated as fixed-bed fashion in order to let chemical engineering students be familiar with fixed-bed reaction, this set of experiment is indispensible. Furthermore, it can show the differnce between two kinds of solid-catalyzed reactions; fixed-bed and fluidized-bed |
| 10. | Stirrers Set | A set of 3 stirrers, and 24 propellers. Each stirrers has different stirring speed range; around 20-1,200rpm, around 10-600rpm, and around 5-300rpm. All stirrers are equipped with a control box that can show speed and torque in digital display. 24 propellers are of different type; 3 propellers for each type. All are 10mm in diameter and can | | This stirrers set allows the studens to study the effect of many factors in stirring, such as type of propellers and stirring speed. This stirrers set be used in "Chemical Engineering Laboratory 1" |

6.4.2 Equipment List

Group I

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | be used with the stirrers. | | |
| 11. | Drum Dryer | A drum dryer that can be used with steam pressure at least 5Kg/sq.cm. Drum size is 300-500mm. in both diameter and length. Accessaries such as knife and cake-receiving plates are also included. | 1 | Drum dryer is used to study the phenomena of drying process. It is one of the drying equipment usually used with the slurry or pastes. This set will be used in "Chemical Engineering Laboratory 2" |
| 12. | Ball Mill Set | Consists of<br>1) 2 Ball-Mill Rotating Machines Each rotating machine has two lines and can rotate 240mm. Ball-Mill pots at the same time; 2 pots for each line. The maximum speed is at least 300rpm, and the minimum speed is not more than 200rpm. The tachometer may be separated from the machines.<br>2) 9 Stainless Steel Pots<br>Dia. 90-100mm. x 4<br>Dia. 150-180mm. x 3<br>Dia. 300-320mm. x 2<br>3) 10 Forcelain Pots<br>Dia. 90-100mm. x 4<br>Dia. 150-180mm. x 3<br>Dia. 240-300mm. x 1<br>4) HD Alumina Balls<br>Dia. 10,15,20,25,30,40,50,60mm. 5Kg each<br>5) Glass Ball<br>Approximate diameter 2.5,5,10, 15mm. 5Kg each.<br>6) Sieves and a sieve shaker Sieves has at least 45mm height. ASTM or JIS standard. 30 sizes; mesh sizes rangeing from felow 0.04mm to more than 5mm. A sieve shaker is an electromagentic drive approximately 3,000 oscillations per minute and can locate sieves mentioned above 7 sieves at the same time. | 1 | This ball mill set allows the sudent to study effect of various factors of ball mill unit, such as speed, pot size, and ball size. This set is used in "Chemical Engineering Laboratory I" |

6.4.2 Equipment List

Group I

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | 7) 2 Ultrasonic cleaning bath Contains heater and timer and has a shortest side longer than a sieve diameter mentioned above more than 3cm.<br>8) A sieve Cleaner An electrical brush for sieve cleaning. | | |
| 13. | Glassware for Analytical Chemistry Laboratory | This set contains glassware needed for Analytical Chemistry Laboratory such as desiccators, burettes and volumetric pipetters, for 60 students. Details are in the Appendix. | | This set is planned for 2nd year students. It can be used in "Analytical Chemistry Laboratory" and "Physical Chemistry Laboratory" in the first and the second semester respectively. |
| 14. | Glassware for Organic Chemistry Laboratory 60 sets | 1 set at least contains 15 items of glassware that can composed to be assemblies such as vacuum distillation assemly, and an assembly with reflux, stirring, addition and drying.<br>1) 250ml round bottom flask<br>2) Plain stillhead<br>3) Liebing condensor<br>4) Bend adaptor with vacumm connection<br>5) 100ml pear shape flask<br>6) Plan column<br>7) Packing for plain cloumn<br>8) Allihn condensor<br>9) 100ml dropping funnel<br>10) Three-neck 250ml round bottom flask<br>11) 2 Drying tubes.<br>12) 450mm stirrere shaft (with blade)<br>13) Stopper<br>14) Cone/Screwcap Adapter<br>15) 5 Clips<br>If not available, the allihn condensor can be eliminated. | | It is the main equipment for Orgnic Chemistry Laboratory. Each items of each set can be composed to various assemblies such as vacuum distillation assembly, fractional distillation assembly, and an assembly with reflux, stirring, addtion and drying. |
| 15. | Personnel Computors | A 486 PC. | 3 | For the department laboratories and administration. |

6.4.2 Equipment List

Group II

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | X-ray Diffractometer | A fully automated X-ray powder diffractometer system consisting of more than 2kw X-ray generator, horizontal tube shield with 2 shutters, CPU controlled wide angle goniometer, scintillation counter, Cu X-ray diffraction tube, PC or 32-bit work-station that can run on MS DOS or MS WINDOWS 3.1, water-circulated chilling system, diffracted beam monochrometer qualitative analysis softweare, laser printer, and other necessary accessaries. | 1 | The X-ray diffractometer is a main analytical instrument that is widely used in all material laboratories. By this equipment the crystallinity of the substance can be studied. This equipment can be widely used by the chemical engineering students, especially in field of catalyst, in doing reserach as well as students in other departments such as industrial and civil engineering. |
| 2. | X-ray Fluorescence Spectrometer | A sequential X-ray spectrometer consisting of X-ray generator, 5 analyzing crystal (LiF200, Ge, TAP, PET, LiF200 (PC)), 2 detectors; one for heavy elements, the other for light elements, 3kW X-ray target, standard software, fundamental parameter software, PC to use with the softwares, and other standard and needed accessaries. | 1 | This equipment is also a main analytical instrument. It can be used to determine both quantitative and qualitative analysis of nearly all elements for soild substances. It can serve all the departments in the Faculty because it can be used in many fields such as ceremics (glass and cement), steel, chemical and environmental engineering for chemical analysis. |
| 3. | Ion-Chromatograph | Ion chromatograph is composed of the followings: degasser, high pressure delivery pump (i.e. 200 Kg/cm2), sample injection unit, temperature-controlled column oven, conductivity detector, and a data integrator. | 1 | Ion chromatograph is mainly used in biochemical and environmental engineering. |
| 4. | Scanning Electron Microscope | A Scanning electron microscope with at least 100,000 times of magnification. This microscope has some automatic functions, for example an automatic function for focusing. This item also includes needed accessaries such as polaroid camera, image printer cool water recirculator and specimen preparing equipment. | 1 | This equipment is a microscope that has a magnification up to 300,000. It can be used in many fields such as in field of catalyst for chemical engineering, in field of concrete technology for civil engineering, and it can be used to study specimens of industrial and electrical engineering such as metals and ICs. |

6.4.2 Equipment List

Group II

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 5. | UV-Visible Spectrophotmeter | A UV-Visible spectrophotometer, consisting of a spectophotrometer main unit and a data processor unit. The main unit consists of a monochromator that has a resolution at least 0.15nm, for wavelength range 190-900nm. The data processing unit consists of a personal computer and other accessaries such as keyboard and mouse. Other fundamental accessaries such as a specular reflectance attachment (for using with a solid sample) are included in this system. | 1 | UV-Visible spectrophotometer is a very common analytical instument. It is used for study of photo absorbance in ultraviolet and visible range of the substances. |
| 6. | Atomic Absorption Spectrophotometer | A flame/furnace dual application atomic absorption spectrophtotmeter that the burner and the furnace are housed in one compact unit and the switching between flame and furnace analysis can be done easily by software. This spectrometer has a system that automatically optimize the flame analysis condition. This item includes all needed fundamental accessaries. | 1 | Like an X-ray fluorescence spectrophotometer, atomic absorption spectrophotometer(AA) is also a chemically analysis instrument, but it is used for a solution sample. It is especially used in an analysis, both qualitative and quantitative, for heavy metal elements such as platinum and mercury of the sample. This equipment will mainly serve for chemical engineering students, and civil engineering students in field of environmental engineering. |
| 7. | Gas Chromatograph | A computer-controlled gas chroma tograph with two injection ports. One of the injection ports is connected to the auto gas-sampling valve. There are two types of detectors in the system; FID and TCD. The sampling gas can be detected and analyzed by each detector at the same time. Both the injection ports and the detectors can be easily used with either packed or capillary column by only changing the adapter head. The injection mode can split the | 1 | Gas chromatograph is an analytical instrument that is used to identify the composition of a gas or volatile liquid sample. It can be used in nearly all of the students' laboratory in the Department. Moreover, it can be used in research in many field especially in field of petrochmecal engineering. |

6.4.2 Equipment List

Group II

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| | | gas in the split ratio of 1:10 to 1:50. | | |
| 8. | Thermal Analysis Instrument | Stand-alone thermal analysis instruments including 4 thermal analyzers; differential scanning calorimeter (DSC), thermogravimetric analyzer(TG), differential thermal analyzer(DTA), and thermomechanical analyzer(TMA), interfaced with a system controller unit. Each thermal analyzer has its own operation functions including a detector, a temperature and gas control, and computer interface. A system controller consists of a controller and a personal computer. All needed fundamental accessaries are also included in this system. | 1 | Thermal analysis instrument is used to study property canges of a substance when it is treated with heat. It can be used widely in polymer and catalyst engineering. Also it is used to study phase transition of metals in field of industrial engineering. |
| 9. | High Performance Liquid Chromatograph | High Performance Liquid Chromatograph (HPLC) is composed of the followings: degasser, high pressure delivery pump(i.e.200 kg/cm2), sample injection unit, pre-column, interchangable chromatogaphic column, temperature-controlled column oven, detector(i.e.variable wavelength UV-Vis unit), and integrator or data processor. | 1 | HPLC is popularly used in routine analysis and/or quality checking. It can be mainly used in field of biochemical, food, and environmental engineering. |
| 10. | Fourier-Transform Infrared Spectrophotmeter | A fourier-transform Infrared Spectrophotometer with softwares, a 32 bit computer, and other needed accessaries. | 1 | This equipment can be used in many fields of study on parts that concern with organic chemistry. Like atomic absorbance spectrophotmeter, this equipment will mainly serve for chemical engineering students and civil engineering students in field of environmental engineering. |

7.4 Equipment Requested from the Japanese Government

| No. | Item of Equipment | Specification | Amount Request | Utility |
|---|---|---|---|---|
| 1. | Eddy Current Dynamometer | The capacity of dynamometer to absorb power must not less than 100hp | 1 | For the purpose teaching, research, and giving consultancy services. |
| 2. | Exhaust Gas Analyzes | Portatble unit complete with analyzer units for CO, CO2, hydrocarbon, SO2, NOx. Data acquistion unit is included. | 1 | ditto |
| 3. | Diesel Engine Fule Pump Test Set | The test set has the ability to perform the calibration, adjustment and testing of the distributor type pump of the 12-cylinder engine. | 1 | ditto |
| 4. | Internal Combustion Engine Test Bed for Variable Compression Ratio | Four cylinder engine with the output power not less than 90hp and the electric dynamometer. | 1 | ditto |
| 5. | Calorimeter for Determining the Capacity of the Air-Conditioning System with Capacity not Less than 3 TR | The test set consist of following<br>-Indoor room with cooling coil, dehumidifer, humidifier, heating coil<br>-Outdoor room with compresser, condenser<br>-Air duct system<br>-Measuring insturments and control | 1 | ditto |
| 6. | Steam Power Plant Test Set Complete with Data Acquisition System | The test set has the electrical power output of not less than 1KW | 1 | ditto |
| 7. | Gas Turbine Plant Test Set Complete with Data Acquisition System | The test set has the electrical power output of not less than 5KW | 1 | ditto |
| 8. | Pneumatic Control System | | 1 | ditto |
| 9. | Hydraulic Control System | | 1 | ditto |
| 10. | Textbooks, Videotapes and Standards in Mechnical Engineering | | 1 | For the Faculty of Engineering library |

## APPENDIX-6 Course Planning

### COURSE PLANNING FOR ELECTRICAL ENGINEERING STUDENTS

#### First Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 1** | |
| LE 121 | Computer for Engineers | 2 |
| CE 102 | Introduction to Engineering | 1 |
| ME 111 | Engineering Drawing I | 2 |
| SC 124 | Chemistry for Engineers I | 4 |
| SC 133 | Physics for Engineers I | 4 |
| MA 101 | Mathematics I | 3 |
| EL xxx | English Course x | 3 |
| | Total | 19 |
| | **Semester 2** | |
| IE 121 | Material Science I | 3 |
| IE 158 | Engineering Tools & Operations | 2 |
| ME 112 | Engineering Drawing II | 2 |
| MA 102 | Mathematics II | 3 |
| SC 125 | Chemistry for Engineers II | 2 |
| SC 134 | Physics for Engineers II | 4 |
| EL xxx | English Course x | 3 |
| | Total | 19 |

#### Second Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 3** | |
| LE 201 | Basic Electrical Engineering Laboratory | 1 |
| LE 211 | Electrical Circuit Analysis | 3 |
| LE 221 | Digital Circuit Design | 3 |
| IE 261 | Engineering Statistics | 3 |
| CE 202 | Engineering Mechanics I | 3 |
| AE 211 | Thermodynamics I | 3 |
| MA 203 | Mathematics III | 3 |
| | Total | 19 |
| | **Semester 4** | |
| LE 212 | Basic Electronic Circuits and Devices | 3 |
| LE 242 | Electromechanical Energy conversion I | 3 |
| ME 221 | Engineering Mechanics II | 3 |
| ME 241 | Mechanics of Fluids I | 3 |
| MA 204 | Mathematics IV | 3 |
| MA 305 | Numerical Methods | 3 |
| | Total | 18 |

## Third Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 5** | |
| LE 202 | Electromechanical Energy Conversion Laborator I | 1 |
| LE 301 | Electronic Circuits Laboratory | 1 |
| LE 302 | Electromechanical Energy Conversion Laboratory II | 1 |
| LE 311 | Measurement and Instrumentations | 3 |
| LE 312 | Network Theory | 3 |
| LE 313 | Electronic Circuits | 3 |
| LE 314 | Physics Electronics | 3 |
| LE 341 | Electromechanical Energy Conversion II | 3 |
| LE 351 | Electromagnetics Theory | 3 |
| | Total | 21 |
| | **Semester 6** | |
| LE 303 | Telecommunication engineering Laboratory | 1 |
| LE 304 | Instrumentations and Control systems Laboratory | 1 |
| LE 322 | Microprocessors | 3 |
| LE 331 | Feedback Control Systems | 3 |
| LE 352 | Principles of Communications | 3 |
| LE 353 | Communication Networks and Transmission Lines | 3 |
| LE xxx | Technical Electives | 3 |
| ME 391 | Fundamentals of Mechanical Engineering | 3 |
| | Total | 20 |
| LE 305 | Industrial Training (Not less than 240 hours) | 0 credit |

## Fourth Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 7** | |
| LE 401 | Project I | 2 |
| LE 441 | Power Systems | 3 |
| LE xxx | Technical Electives | 3 |
| LE xxx | Technical Electives | 3 |
| IE 201 | Engineering Management | 3 |
| IE 302 | Engineering Economy | 3 |
| TU xxx | Social Sciences Electives | 3 |
| | Total | 20 |
| | **Semester 8** | |
| LE 402 | Project II | 3 |
| LE xxx | Technical Electives | 3 |
| LE xxx | Technical Electives | 3 |
| TU xxx | Humanities Electives | 2 |
| xx xxx | Free Electives | 3 |
| | Total | 14 |

COURSE PLANNING FOR INDUSTRIAL ENGINEERING STUDENTS

## First Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 1** | |
| LE 121 | Computer for Engineers | 2 |
| CE 102 | Introduction to Engineering | 1 |
| ME 111 | Engineering Drawing I | 2 |
| MA 101 | Mathematics I | 3 |
| SC 124 | Chemistry for Engineers I | 4 |
| SC 133 | Physics for Engineers I | 4 |
| EL xxx | English Course x | 3 |
| | Total | 19 |
| | **Semester 2** | |
| IE 121 | Material Science I | 3 |
| IE 158 | Engineering Tools & Operations | 2 |
| ME 112 | Engineering Drawing II | 2 |
| MA 102 | Mathematics II | 3 |
| SC 125 | Chemistry for Engineers II | 2 |
| SC 134 | Physics for Engineers II | 4 |
| EL xxx | English Course x | 3 |
| | Total | 19 |

## Second Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 3** | |
| IE 201 | Engineering Management | 3 |
| IE 261 | Engineering Statistics | 3 |
| LE 241 | Introduction to Electrical Engineering | 3 |
| CE 202 | Engineering Mechanics I | 3 |
| AE 211 | Thermodynamics I | 3 |
| MA 203 | Mathematics III | 3 |
| TU xxx | Social Sciences Electives | 3 |
| | Total | 21 |
| | **Semester 4** | |
| IE 222 | Material Science II | 3 |
| IE 263 | Experimental Design | 3 |
| CE 221 | Mechanics of Solids I | 3 |
| ME 221 | Engineering Mechanics II | 3 |
| ME 241 | Mechanics of Fluids I | 3 |
| MA 204 | Mathematics IV | 3 |
| MA 305 | Numerical Methods | 3 |
| | Total | 21 |

## Third Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 5** | |
| IE 231 | Industrial Safety | 3 |
| IE 302 | Engineering Economy | 3 |
| IE 311 | Work Study | 3 |
| IE 351 | Manufacuring Process & Technology I | 3 |
| IE 362 | Quality Control | 3 |
| IE 444 | Environmental Control | 3 |
| | Total | 18 |
| | **Semester 6** | |
| IE 303 | Industrial Cost Analysis & Budgeting | 3 |
| IE 332 | Value Engineering | 3 |
| IE 352 | Manufacturing Process & Technology II | 3 |
| IE 353 | Automation | 3 |
| IE 354 | Basic Instrumentation | 3 |
| IE 364 | Operations Research I | 3 |
| IE xxx | Technical Electives | 3 |
| | Total | 21 |
| IE 390 | Industrial Training (Not less than 180 hours) | 0 credit |

## Fourth Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 7** | |
| IE 412 | Production Planning & Control | 3 |
| IE 413 | Project Feasibility Study | 3 |
| IE 433 | Industrial Plant Design | 3 |
| IE 492 | Industrial Engineering Project I | 1 |
| IE xxx | Technical Electives | 3 |
| ME 302 | Mechanical Engineering Laboratory I | 2 |
| IE 331 | Tool Engineering | 3 |
| | Total | 18 |
| | **Semester 8** | |
| IE 494 | Industrial Engineering Project II | 2 |
| IE xxx | Technical Electives | 3 |
| IE xxx | Technical Electives | 3 |
| TU xxx | Humanities Electives | 2 |
| xx xxx | Free Electives | 3 |
| | Total | 13 |

# COURSE PLANNING FOR CIVIL ENGINEERING STUDENTS

## First Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 1** | |
| LE 121 | Computer for Engineers | 2 |
| CE 102 | Introduction to Engineering | 1 |
| ME 111 | Engineering Drawing I | 2 |
| MA 101 | Mathematics I | 3 |
| SC 124 | Chemistry for Engineers I | 4 |
| SC 133 | Physics for Engineers I | 4 |
| EL xxx | English Course x | 3 |
| | Total | 19 |
| | **Semester 2** | |
| IE 121 | Material Science I | 3 |
| IE 158 | Engineering Tools & Operations | 2 |
| ME 112 | Engineering Drawing II | 2 |
| MA 102 | Mathematics II | 3 |
| SC 125 | Chemistry for Engineers II | 2 |
| SC 134 | Physics for Engineers II | 4 |
| EL xxx | English Course x | 3 |
| | Total | 19 |

## Second Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 3** | |
| CE 202 | Engineering Mechanics I | 3 |
| CE 231 | Concrete Technology I | 2 |
| LE 241 | Introduction to Electrical Engineering | 3 |
| IE 201 | Engineering Management | 3 |
| IE 261 | Engineering Statistics | 3 |
| AE 211 | Thermodynamics I | 3 |
| MA 203 | Mathematics III | 3 |
| | Total | 20 |
| | **Semester 4** | |
| CE 201 | Civil Engineering Laboratory | 1 |
| CE 211 | Surveying I | 3 |
| CE 221 | Mechanics of Solids I | 3 |
| ME 221 | Engineering Mechanics II | 3 |
| ME 241 | Mechanics of Fluids I | 3 |
| MA 204 | Mathematics IV | 3 |
| MA 305 | Numerical Methods | 3 |
| | Total | 19 |

## Third Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 5** | |
| CE 311 | Surveying II | 3 |
| CE 321 | Structural Analysis I | 3 |
| CE 351 | Soil Mechanics I | 3 |
| CE 371 | Hydrology | 2 |
| CE 372 | Hydraulic Engineering I | 3 |
| ME 322 | Mechanics of Solids II | 3 |
| TU xxx | Social Sciences Electives | 3 |
| | Total | 20 |
| | **Semester 6** | |
| CE 322 | Structural Analysis II | 3 |
| CE 331 | Reinforced Concrete Design I | 3 |
| CE 341 | Construction Engineering & Management | 3 |
| CE 352 | Soil Mechanics II | 3 |
| CE 361 | Highway Engineering | 3 |
| CE 362 | Highway Materials | 2 |
| CE 373 | Environmental Engineering | 3 |
| | Total | 20 |
| CE 399 | Industrial Training on Civil Engineering (Not less than 200 hours) | 0 credit |

## Fourth Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 7** | |
| CE 312 | Engineering Geology | 3 |
| CE 421 | Timber and Steel Design | 3 |
| CE 431 | Reinforced Concrete Design II | 3 |
| CE 291 | Seminar | 1 |
| CE xxx | Technical Electives | 2 |
| CE xxx | Technical Electives | 3 |
| IE 302 | Engineering Economy | 3 |
| | Total | 18 |
| | **Semester 8** | |
| CE 499 | Civil Engineering Project | 3 |
| CE xxx | Technical Electives | 3 |
| CE xxx | Technical Electives | 2 |
| TU xxx | Humanities Electives | 2 |
| xx xxx | Free Electives | 3 |
| | Total | 13 |

COURSE PLANNING FOR MECHANICAL ENGINEERING STUDENTS

## First Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 1** | |
| LE 121 | Computer for Engineers | 2 |
| ME 111 | Engineering Drawing I | 2 |
| CE 102 | Introduction to Engineering | 1 |
| MA 101 | Mathematics I | 3 |
| SC 124 | Chemistry for Engineers I | 4 |
| SC 133 | Physics for Engineers I | 4 |
| EL xxx | English course x | 3 |
| | Total | 19 |
| | **Semester 2** | |
| ME 112 | Engineering Drawing II | 2 |
| IE 121 | Material Science I | 3 |
| IE 158 | Engineering Tools & Operations | 2 |
| MA 102 | Mathematics II | 3 |
| SC 125 | Chemistry for Engineers II | 2 |
| SC 134 | Physics for Engineers II | 4 |
| EL xxx | English Course x | 3 |
| | Total | 19 |

## Second Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 3** | |
| ME 201 | Basic Mechanical Engineering Laboratory | 1 |
| LE 201 | Basic Electrical Engineering Laboratory | 1 |
| LE 211 | Electrical Circuit Analysis | 3 |
| IE 201 | Engineering Management | 3 |
| IE 261 | Engineering Statistics | 3 |
| CE 202 | Engineering Mechanics I | 3 |
| AE 211 | Thermodynamics I | 3 |
| MA 203 | Mathematics III | 3 |
| | Total | 20 |
| | **Semester 4** | |
| ME 202 | Automotive Technology | 2 |
| ME 221 | Engineering Mechanics II | 3 |
| ME 241 | Mechanics of Fluids I | 3 |
| LE 212 | Basic Electronic Circuits and Devices | 3 |
| CE 221 | Mechanics of Solids I | 3 |
| MA 204 | Mathematics IV | 3 |
| MA 305 | Numerical Methods | 3 |
| | Total | 20 |

## Third Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 5** | |
| ME 302 | Mechanical Engineering Laboratory I | 2 |
| ME 322 | Mechanics of Solids II | 3 |
| ME 323 | Mechanics of Machines | 3 |
| ME 331 | Thermodynamics II | 3 |
| ME 342 | Mechanics of Fluids II | 3 |
| IE 358 | Manufacturing Process | 3 |
| TU xxx | Social Sciences Electives | 3 |
| | Total | 20 |
| | **Semester 6** | |
| ME 303 | Mechanical Engineering Laboratory II | 2 |
| ME 313 | Mechanical Design I | 3 |
| ME 324 | Mechanical Vibrations | 3 |
| ME 332 | Heat Transfer | 3 |
| LE 202 | Electromechanical Energy Conversion Laboratory | 1 |
| LE 242 | Electromechanical Energy Conversion I | 3 |
| TU xxx | Humanities Electives | 2 |
| ME xxx | Technical Electives | 3 |
| | Total | 20 |
| ME 304 | Industrial Training (Not less than 6 consecutive weeks) | 0 credit |

## Fourth Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 7** | |
| ME 405 | Mechanical Engineering Laboratory III | 2 |
| ME 406 | Projects Seminar | 0 |
| ME 414 | Mechanical Design II | 3 |
| ME 425 | Automatic Control System | 3 |
| ME 433 | Refrigeration and Air Conditioning | 3 |
| ME 434 | Power Plant Engineering | 3 |
| IE 302 | Engineering Economy | 3 |
| | Total | 17 |
| | **Semester 8** | |
| ME 407 | Mechanical Engineering Project | 3 |
| ME 435 | Internal Combustion Engines | 3 |
| ME xxx | Technical Electives | 3 |
| ME xxx | Technical Electives | 3 |
| xx xxx | Free Electives | 3 |
| | Total | 15 |

COURSE PLANNING FOR CHEMICAL ENGINEERING STUDENTS

## First Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 1** | |
| LE 121 | Computer for Engineers | 2 |
| CE 102 | Introduction to Engineering | 1 |
| ME 111 | Engineering Drawing I | 2 |
| SC 124 | Chemistry for Engineers I | 4 |
| SC 133 | Physics for Engineers I | 4 |
| MA 101 | Mathematics I | 3 |
| EL xxx | English Course x | 3 |
| | Total | 19 |
| | **Semester 2** | |
| IE 121 | Material Science I | 3 |
| IE 158 | Engineering Tools & Operations | 2 |
| ME 112 | Engineering Drawing II | 2 |
| SC 134 | Physics for Engineers II | 4 |
| AE 101 | Physical Chemistry | 4 |
| MA 102 | Mathematics II | 3 |
| EL xxx | English Course x | 3 |
| | Total | 21 |

## Second Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 3** | |
| AE 201 | Mateiral and Energy Balance I | 2 |
| AE 211 | Thermodynamics I | 3 |
| LE 241 | Introduction to Electrical Engineering | 3 |
| IE 201 | Engineering Management | 3 |
| CE 202 | Engineering Mechanics I | 3 |
| MA 203 | Mathematics III | 3 |
| AE 203 | Analytical chemistry | 4 |
| | Total | 21 |
| | **Semester 4** | |
| AE 202 | Material and Energy Balance II | 2 |
| AE 212 | Chemical Engineering Thermodynamics | 3 |
| CE 221 | Mechanics of Solids I | 3 |
| ME 221 | Engineering Mechanics II | 3 |
| ME 241 | Mechanics of Fluids I | 3 |
| MA 204 | Mathematics IV | 3 |
| AE 204 | Organic Chemistry | 4 |
| | Total | 21 |

## Third Year

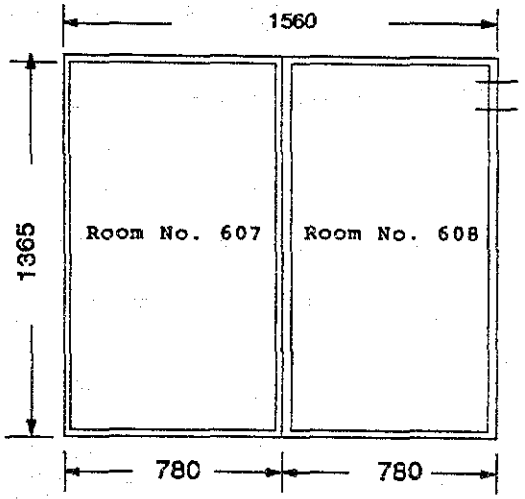
| Course Number | Title | Credits |
|---|---|---|
| | **Semester 5** | |
| AE 303 | Fundamentals of Heat Transfer | 3 |
| AE 304 | Fluid Analysis | 3 |
| AE 321 | Chemical Engineering Unit Operation Design I | 3 |
| AE 322 | Chemical Engineering Kinetics and Reactor Design | 3 |
| AE 381 | Chemical Engineering Laboratory I | 1 |
| IE 261 | Engineering Statistics | 3 |
| IE 302 | Engineering Economy | 3 |
| | Total | 19 |
| | **Semester 6** | |
| AE 305 | Fundamentals of Mass Transfer | 3 |
| AE 323 | Chemical Engineering Unit Operation Design II | 3 |
| AE 324 | Chemical Engineering Reactor Design | 3 |
| AE 382 | Chemical Engineering Laboratory II | 1 |
| AE xxx | Technical Electives | 3 |
| MA 305 | Numerical Methods | 3 |
| TU xxx | Humanities Electives | 2 |
| | Total | 18 |
| AE 391 | Industrial Training (Not less than 180 hours) | 0 credit |

## Fourth Year

| Course Number | Title | Credits |
|---|---|---|
| | **Semester 7** | |
| AE 425 | Chemical Engineering Unit Operation Design III | 3 |
| AE 426 | Process Dynamics Control | 3 |
| AE 427 | Chemical Engineering Plant Design | 3 |
| AE 428 | Biochemical Engineering | 3 |
| AE 492 | Chemical Engineering Seminar | 1 |
| AE xxx | Technical Electives | 3 |
| TU xxx | Social Sciences Electives | 3 |
| | Total | 19 |
| | **Semester 8** | |
| AE 493 | Chemical Engineering Project | 3 |
| AE xxx | Technical Electives | 3 |
| IE 231 | Industrial Safety | 3 |
| xx xxx | Free Electives | 3 |
| | Total | 12 |

## Department of Electrical Engineering

Digital Control




2.4.1 Experimental Process Unit

2.4.2 Robotic Unit

2.4.3 General-purpose DSP Board

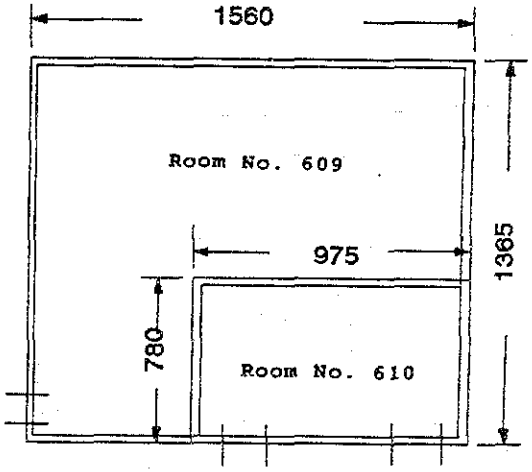
2.4.4 Accessory Boards

2.4.5 DSP Software Package

2.4.6 Arbitrary Waveform Generator

2.4.7 FFT Analyzer

Communication



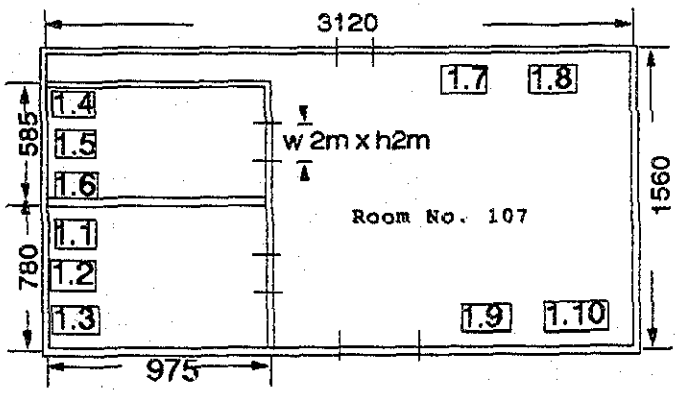

2.3.5 High Frequency Analog Design Software Package

2.3.6 EMC Measurement Systems

2.3.9 Bit Error Rate Analyzer

# Department of Electrical Engineering

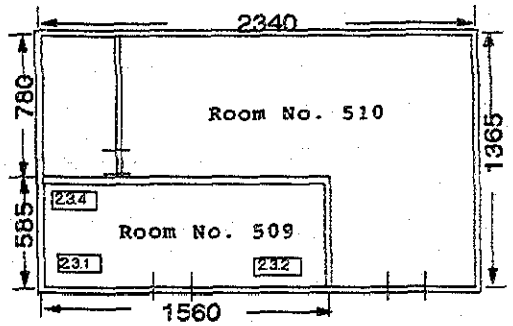
## Electromachnical




Equipment to be Installed in the Room

1. 1 Three Phase Squirrel-cage Induction Lab. Set
1. 2 Three Phase Slipring Induction Motor Lab. Set
1. 3 DC Motor Lab. Set
1. 4 DC Generator Lab. Set
1. 5 Single Phase Motor Lab. Set
1. 6 Three Phase Synchronous Motor Lab. Set
1. 7 Transformer Lab. Set
1. 8 Amplidyne Generator Lab. Set
1. 9 Power Electronic Equipment
1.10 Converter & Others

## Signal Processing




Equipment to be Installed in the Room

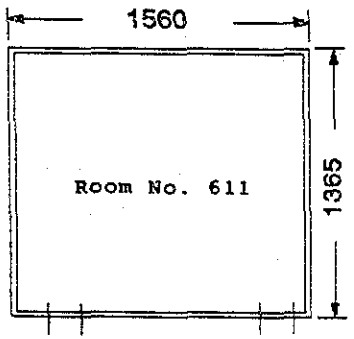
2.3.1 Signal Generator

2.3.2 RF Vector Network Analyzer

2.3.4 Frequency Counter

## Department of Electrical Engineering

PCB Fabrication Production Testing




Equipment to be Installed in the Room

2.2.1 IC Design Software Package

2.2.2 Circuit Schmatic Simulation Software Package

2.2.3 PCB Layout System Equipments for PCB Fabrication

2.2.4 Prototype PCBs Production System

2.2.5 Soldering Station

2.2.6 Plotter

2.2.7 Supporting Materials Equipments for Circuit Board Testing

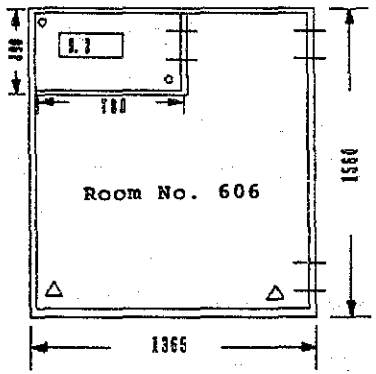
2.2.8 Digital Storage Oscilloscope

2.2.9 Function Generator

2.2.10 Logic Analyzer

2.2.11 Data Generator

CAD/CAM



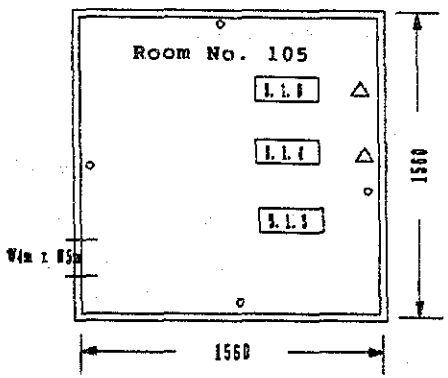

Equipment to be Installed in the Room

3.2 CAD/CAM System

△ 1-Ph inlet

○ 3-ph inlet

CNC



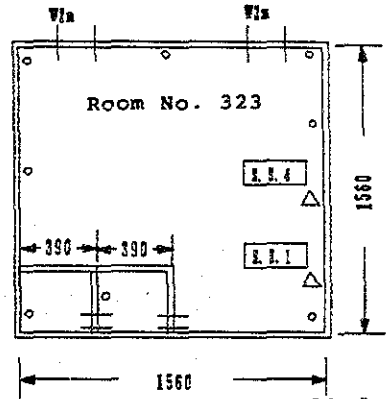

Equipment to be Installed in the Room

3.1.3 CNC Turning Center

3.1.4 CNC-BDM-Wire Cutting

3.1.8 CNC Vertical Machining Center

Precision Measuring



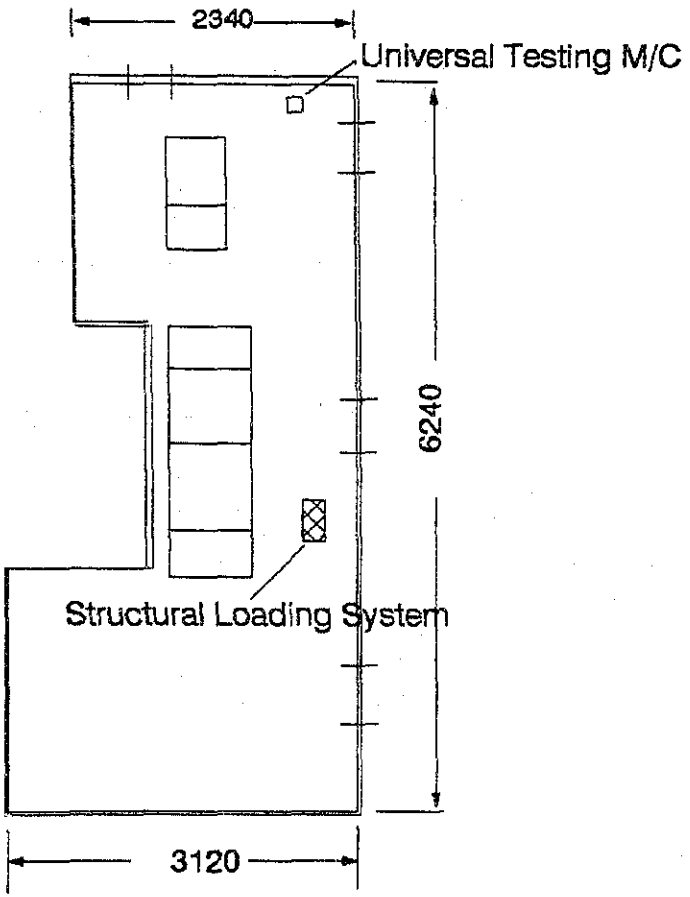

Equipment to be Installed in the Room

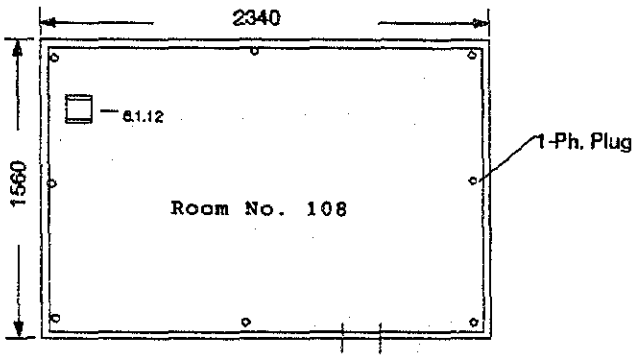
3.3.1 Measurement Data Processing Unit

3.3.4 Roundness Tester

Department of Civil Engineering

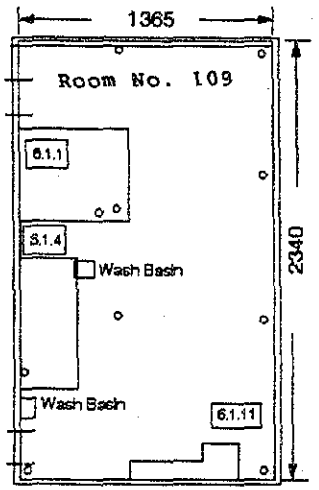
Ground Floor of Workshop Bldg.






Equipment to be Installed in the Room

6.1.12 Ball Mill Set



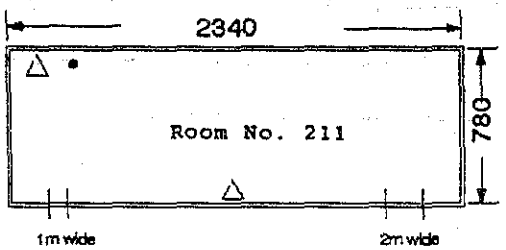

Equipment to be Installed in the Room

6.1.1 Liquid-Liquid Extraction System

6.1.4 Continuous Plate Distillation Unit

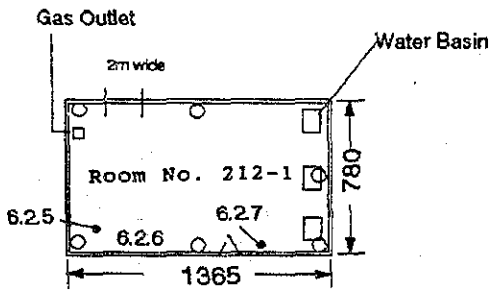
6.1.11 Drum Dryer

# Department of Chemecal Engineering




Equipment to be Installed in the Room

6.1.10 Stirres Set



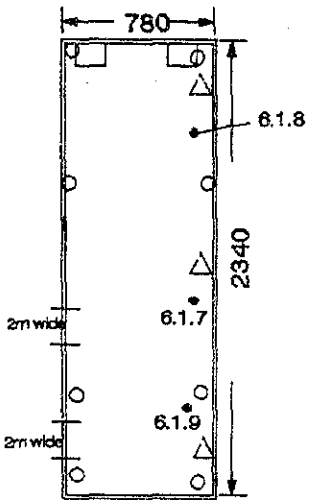

Equipment to be Installed in the Room

6.2.5 UV-Visible Spectrophotometer

6.2.6 FTIR

6.2.7 Gas Chromatograph

Room No. 212




Equipment to be Installed in the Room

6.1.7 Stirred Liquid Phase Reaction Unit

6.1.8 Fluidized-bed Reactor

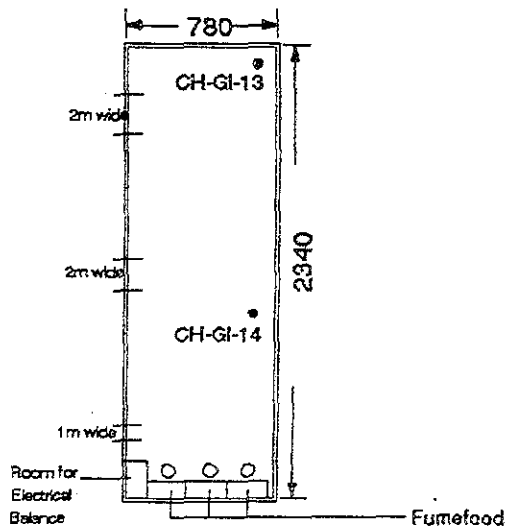
6.1.9 Fixed-bed Reactor

Remarks:

○ :1-ph inlet

△ :3-ph inlet

Room No. 325

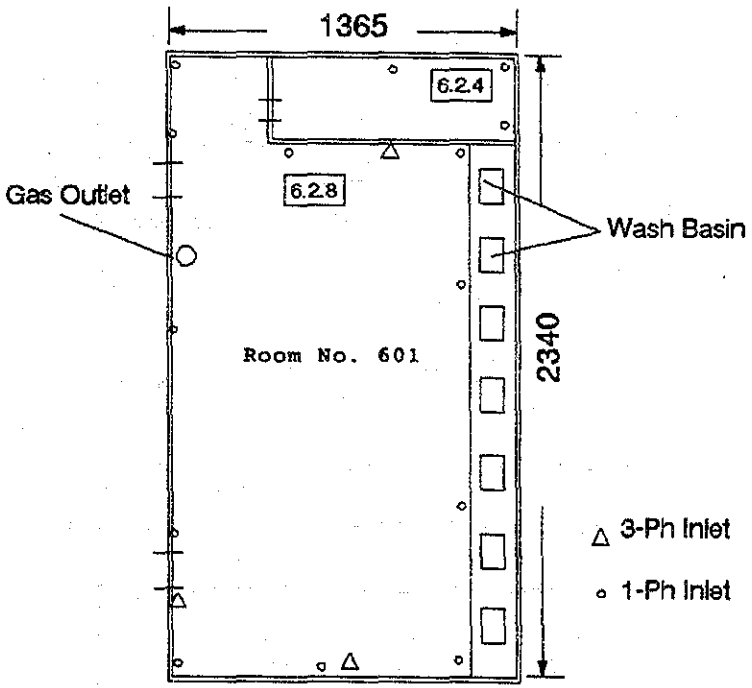



Equipment to be Installed in the Room

6.1.14 Glassware for Organic Chemistry Lab.

6.1.13 Glassware for Analytical Chemistry Lab.

Department of Chemical Engineering

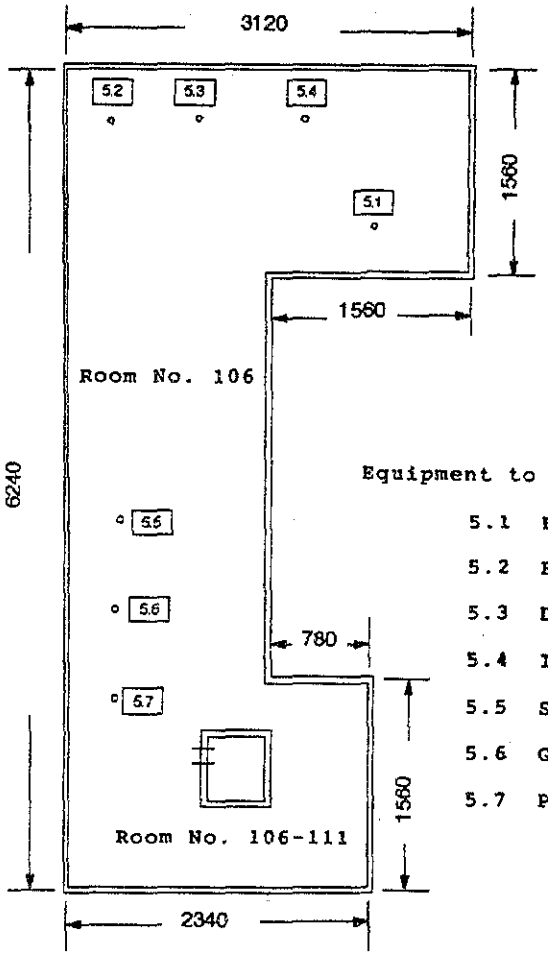



Equipment to be Installed in the Room

6.2.4 Scaning Electron Microscope

6.2.8 Thermal Analysis Instrument

# Department of Mechanical Engineering




Equipment to be Installed in the Room

5.1 Eddy Current Dynamometer

5.2 Exhaust Gas Analyzer

5.3 Diesel Engine Fuel Pump Test Bed

5.4 Internal Combustion Engine Test Bed

5.5 Steam Power Plant Test Set

5.6 Gas Turbine Plant Test Set

5.7 Pneumatic and Hydraulic Control System