MINISTRY OF EDUCATION
TEH ISLAMIC REPUBLIC OF PAKISTAN

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF EDUCATIONAL EQUIPMENT FOR THE UNIVERSITY OF ENGINEERING AND TECHNOLOGY, LAHORE
IN
THE ISLAMIC REPUBLIC OF PAKISTAN

FEBRUARY 1998

JAPAN INTERNATIONAL COOPERATION AGENCY
UNICO INTERNATIONAL CORPORATION

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF EDUCATIONAL EQUIPMENT FOR THE UNIVERSITY OF ENGINEERING AND TECHNOLOGY, LAHORE IN THE ISLAMIC REPUBLIC OF PAKISTAN
FEBRUARY 199

MINISTRY OF EDUCATION
THE ISLAMIC REPUBLIC OF PAKISTAN

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF EDUCATIONAL EQUIPMENT FOR THE UNIVERSITY OF ENGINEERING AND TECHNOLOGY, LAHORE
IN
THE ISLAMIC REPUBLIC OF PAKISTAN

FEBRUARY 1998

JAPAN INTERNATIONAL COOPERATION AGENCY
UNICO INTERNATIONAL CORPORATION

PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan the Government of Japan decided to conduct a basic design study on the Project for Improvement of Educational Equipment for the University of Engineering and Technology, Lahore and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team from October 20 to November 13, 1997.

The team held discussions with the officials concerned of the Government of Pakistan and conducted a field study at the study area. After the team returned to Japan, further studies were made, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

February 1998

Kimio Fujita
President
Japan International Cooperation Agency

February 1998

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of Educational Equipment for the University of Engineering and Technology, Lahore in the Islamic Republic of Pakistan.

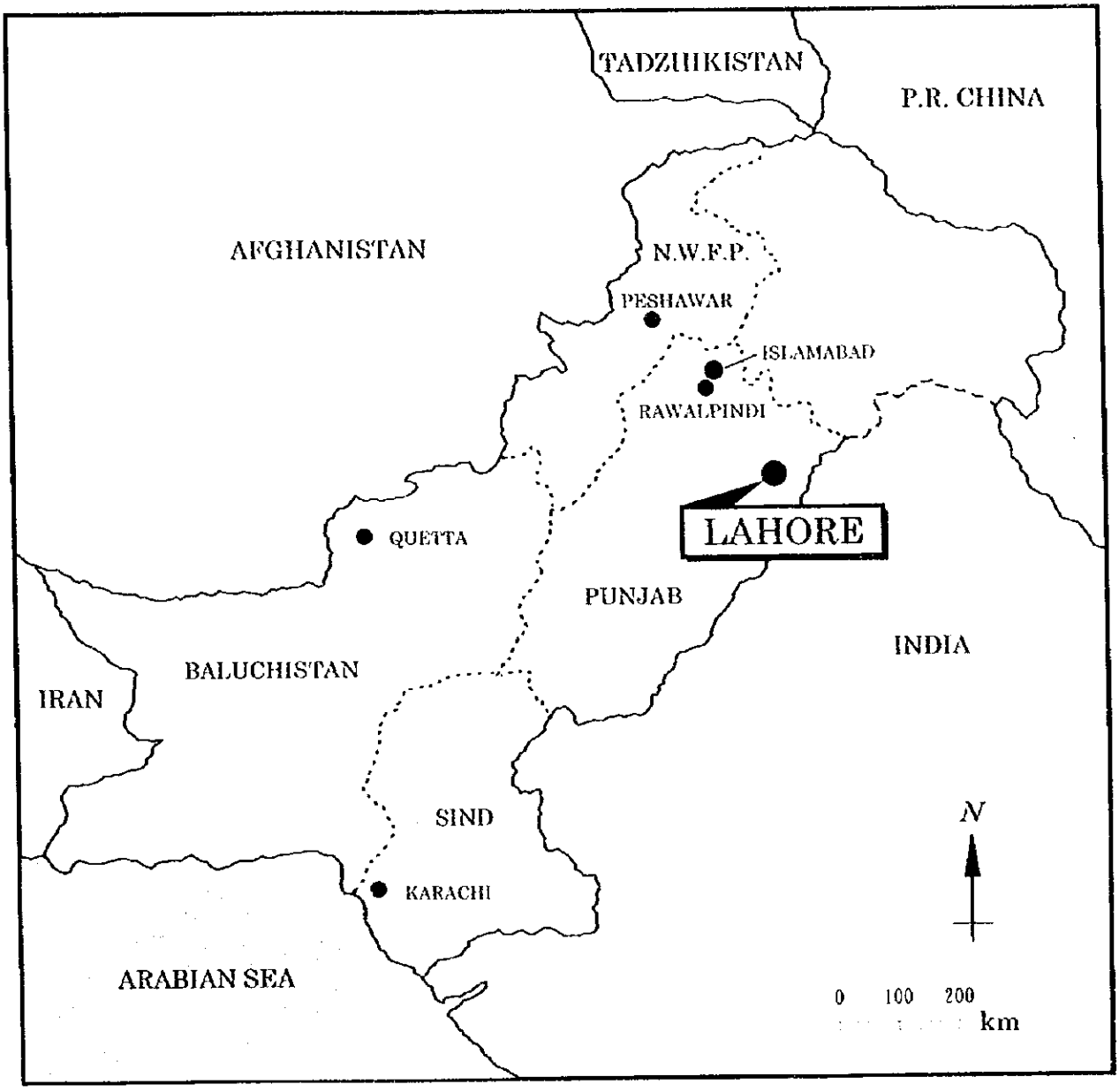
This study was conducted by UNICO International Corporation, under a contract to JICA, during the period from October 14, 1997 to February 10, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Pakistan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

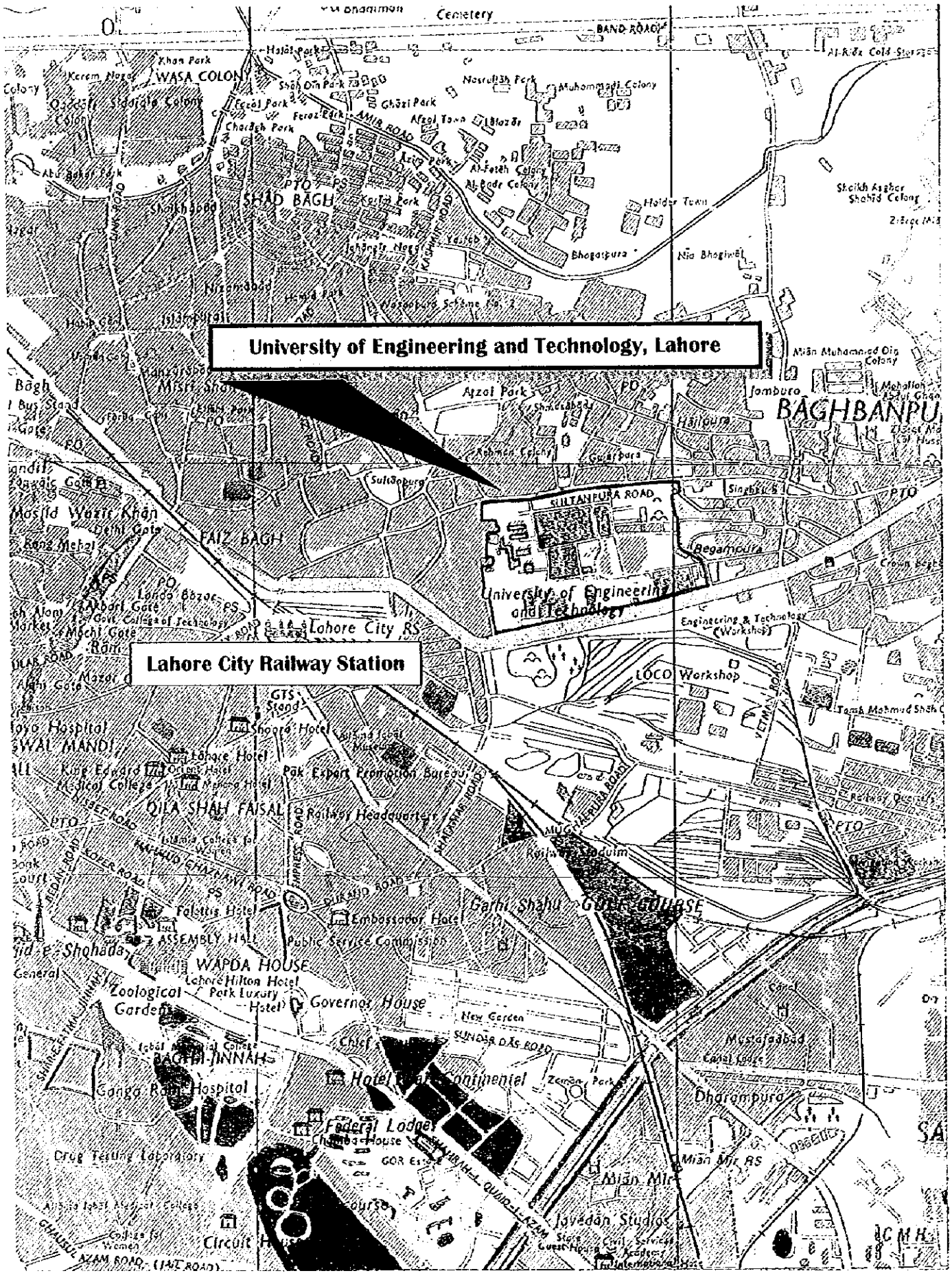
Wataru Shiga
Project Manager,
Basic design study team on the Project for Improvement of Educational Equipment for the University of Engineering and Technology, Lahore,
UNICO International Corporation

THE ISLAMIC REPUBLIC OF PAKISTAN



LOCATION MAP

(University of Engineering and Technology, Lahore)



ABBREVIATIONS

A/V	:	audiovisual
AVR	:	automatic voltage regulator
B.Sc.	:	bachelor of science
BHN	:	basic human needs
CAD	:	computer aided design
CAM	:	computer aided manufacturing
CDWP	:	Central Development Working Party
CNC	:	computer numerical control
CPU	:	central processing unit
EAD	:	Economic Affairs Division
ECNEC	:	Executive Committee of the National Economic Council
GDP	:	gross domestic product
IAP	:	Institute of Architects, Pakistan
IEER	:	Institute of Environmental Engineering and Research
JICA	:	Japan International Cooperation Agency
LAN	:	local area network
M.Phil.	:	master of philosophy
M.Sc.	:	master of science
N-W.F.P.	:	North-West Frontier Province
PCATP	:	Pakistan Council of Architects and Town Planners
PC-1	:	Planning Commission Proforma-1
Ph.D.	:	doctor of philosophy
R&D	:	research and development
RAM	:	random access memory
ROM	:	read only memory
UETL	:	University of Engineering and Technology, Lahore
UGC	:	University Grants Commission
UNDP	:	United Nations Development Program
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
UPS	:	uninterruptible power source
USAID	:	United States Agency for International Development
VTR	:	video tape recorder
WHO	:	World Health Organization

TABLE OF CONTENTS

Appendices

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

(1) Overview

The Islamic Republic of Pakistan extends between lat. 23 and 37 N and between long. 61 and 76 E. It has a land area of 796,095 square kilometres, more than twice that of Japan. It is bounded by Iran on west, Afghanistan on northwest, China on north, and India on east. High mountain ranges of the Himalayas, Karakoram and Hindu Kush occupy the northern part, and the Indus flows through the central region and reaches the Arabian Sea on south. West of the Indus is dominated by mountain areas to form barren land up to Iran and Afghanistan. On the west side is a fertile alluvial plain created by branch streams of the Indus with scattered barren desert. The country' s climate is generally dry and small precipitation, but abundant water of the Indus and well-developed irrigation channels support its economic base. Pakistan has a population of 132.7 million with its annual increase rate of 2.9% as of 1994 (UNDP Human Development Report 1997).

Since her independence in August 1947, Pakistan has been implementing several development plans based on an industrialization strategy. In the 1980s, industrialization was accelerated as the government emphasised the fostering of the private sector by inducing foreign investment, promoting export oriented industries, and developing industries using domestic resources as well as key industries. This resulted in firm growth of the economy in the early 1990s, and GDP grew at around 5% each year on average, albeit some fluctuations. At the same time, however, the growth drive had various harmful effects: inflation (an average 6.7% in the 1980s and 10% in the 1990s); persistent government budget deficits due to structural impediments, including a weak tax collection system and inflexible expenditure patterns; and a continuous deficit in the international balance of payments due to limited exportable products and a decrease in remittances by Pakistanis working overseas.

Traditionally, the Pakistan economy has been growing by primarily relying on agriculture and the processing of agricultural products. Commodities such as cotton, rice, and processed products (e.g., cotton yarn, cotton fabrics and clothing) maintain strong competitiveness in the international markets, and they represent more than 70% of the country' s exports on a value basis. Nevertheless, the agriculture-centric economy has proven to be vulnerable and susceptible to weather conditions. To achieve economic stability, the country must strengthen the industrial sector, including the manufacturing, mining, electricity and gas, and construction industries, which can supplement the agricultural sector by the share of the economy. The manufacturing sector, which has the largest share of the industrial sector, has traditionally been dominated by textile and clothing, and food processing. Recently, modern industries such as steel, fertilizer, cement, household appliances, and automobile assembly have steadily been growing. Today, the manufacturing sector accounts for approximately 18% of GDP and 13% of the total employed population and is the second important economic base next to agriculture. As the manufacturing sector is expected to play an increasingly important role in improving the country' s balance of payments by boosting exports, it needs to offer high value added products and strengthen international competitiveness. This will call for conversion of the industry from traditional agriculture-oriented with low levels of processing to a more capital intensive structure.

Alerted by the ailing economy in 1996-97, which slowed down to the GDP growth rate of 3.1% in consequence of political stability as well as unfavorable weather conditions, the Pakistan government announced the Economic Revival Programme in March 1997, which set two primary goals, macroeconomic stabilization which was essential in reconstructing the economy and the revitalization of industry, particularly the manufacturing sector. The programme contains a number of concrete measures - notably various incentives offered to expand industrial production in a variety of areas including finance, investment,

and export promotion (e.g., currency devaluation, reduction of tariff barriers, tax exemption for imported materials, and reduction of tariff rates on imported production machinery and equipment).

The Eighth Five Year Plan (1993-98) sets forth a primary objective of improving social and economic welfare of population through promotion of economic growth and population control. It establishes various tangible targets such as the annual average growth rate of GDP at 7.0%, a 50% reduction of the government deficit, and control of inflation to an annual 6%. In addition, the plan envisages the creation of employment opportunities and the correction of regional inequity in economic growth and wealth to be priority issues as continued from the past five year plans. To address the issues, the development of the industrial sector decentralized to rural regions and the increase in industrial production are strongly expected.

To accomplish the self-sufficiency of the Pakistan economy and its sustainable growth by achieving the above objectives and targets, the development of human resources is considered to be one of the most important and urgent tasks, particularly people who receive advanced education in the engineering fields and who are capable of extending leadership in various industrial subsectors.

(2) Background of the project

The University of Engineering and Technology, Lahore is situated in the city of Lahore, the provincial capital of Punjab. Its history dates back to 1921. Before the independence of Pakistan, Lahore thrived as an economic, cultural and educational center of the region. Punjab has the largest population of the country, occupying approximately 56% of the total. Lahore has some three million population in its urban area and is the second largest city next to Karachi. The city accommodates a number of industries including food processing, leather,

textile and clothing, machining, chemicals, etc. Undoubtedly, it is an administrative, economic, educational, research, and cultural center of the region. Also, the city constitutes the core of a major industrial zone in the eastern part of the province, which is comprised of major industrial cities including Faisalabad, Gujranwala, Shaikhpura, etc.

The University of Engineering and Technology, Lahore has its origin in Mughalpura Technical College established in 1921. In 1932, the college started to offer undergraduate education to award bachelor's degree in engineering. In 1961, the college was reorganized to the present form. Originally, the technical college had only electrical engineering and mechanical engineering departments, then civil engineering and mining engineering departments were added in 1940s and 1950s respectively. After 1961, chemical engineering, petroleum engineering, metallurgical engineering, architecture, and city and regional planning departments were established. The University of Engineering and Technology, Lahore is the oldest among seven universities in the field of engineering and technology in Pakistan. It is made up of six faculties, civil engineering, electrical engineering, mechanical engineering, chemical/mineral/metallurgical engineering, architecture and planning, and natural sciences/humanities/Islamic studies, under which 15 departments (7 engineering departments, 2 architecture and planning departments, 4 basic sciences departments, and 2 humanity departments) and an institute provide undergraduate and post graduate levels of engineering education for some 5,500 students (Table 1-1).

Table 1-1 Courses of Study

Department	B.Sc. Course	Seats Allocation	M.Sc. Course	Entry/ Annum	Remarks
Civil Engineering	4 years	197	2 years	30-40	Offers Ph.D.
Electrical Engineering	4 years	204	2 years	40-50	Offers Ph.D.
Mechanical Engineering	4 years	195	2 years	40-50	Offers Ph.D.
Mining Engineering	4 years	52	2 years	0-5	Offers Ph.D.
Metallurgical Engineering	4 years	48	2 years	5-10	Offers Ph.D.
Chemical Engineering	4 years	56	2 years	5-10	Offers Ph.D.
Petroleum Engineering	4 years	19	-	-	M.Sc. Course being planned
Institute of Environmental Engineering & Research	-	-	2 years	10-20	Offers Ph.D.
Architecture	5 years	44	2 years	0-10	Offers Ph.D.
City & Regional Planning	4 years	50	2 years	5-10	Offers Ph.D.
Computer Science	-	-	2 years	20	
Mathematics	-	-	2 years	5-20	Offers Ph.D.
Chemistry	-	-	2 years	10-20	Offers Ph.D.
Physics	-	-	-	-	Offers common course
Humanities & Social Sciences	-	-	-	-	Offers common course
Islamic Studies	-	-	-	-	Offers common course
Workshop	-	-	-	-	Offers common course

* Total seats allocation is 900 with 35 open seats.
Source: Undergraduate Prospectus 1997 Entry, UET L

Brief description of 16 departments and sections which are to receive equipment under the project are as follows;

① Department of Civil Engineering

This department has a long history since 1939. It admits some 200 students each year and approximately 1,000 undergraduate and post graduate students are currently enrolled. There are 46 faculty members. The department offers undergraduate and graduate courses that are classified into three fields, structural engineering, soil mechanics/basic engineering, and hydraulics/irrigation engineering. Also, it offers a doctoral programme in civil engineering. The department provides a variety of services for outside organizations, including the calibration of surveying equipment and technical consultation.

② Department of Electrical Engineering

This is the oldest department of the University of Engineering and Technology, Lahore and boasts a 75-year history since the establishment of the antecedent technical college. The department admits some 200 students and the total enrollment is well over 1,000. There are 40 faculty members. The undergraduate programme in electrical engineering is divided into two courses, electrical power and electronics/communication. The master's programme is offered in power engineering, electronics, computer engineering, and control system engineering. A doctoral programme in electrical engineering is also offered. The department provides consulting and testing services for electrical and electronics manufacturers.

③ Department of Mechanical Engineering

The department is one of the two oldest departments (with electrical engineering) established 75 years ago. It has over 1,000 students and 43 faculty members. The undergraduate course is mechanical engineering, and the master's course consists of production engineering, power engineering, and stress analysis. Also, a doctoral programme is offered. It contains the Energy Resources Centre which conducts R&D projects on diverse energy sources. The department is also active in holding open lectures on technological upgrading and new technology for engineers of private companies, and provides consulting service for outside organizations.

The above three departments constitute the core curriculum of the university by representing approximately 70% of the total number of undergraduate students as well as graduates, 45% of faculty members and other staff, and nearly 50% of the university budget.

④ Department of Mining Engineering

The department was established in 1954 to offer the country's first degree in mining engineering. Some faculty members of the mining engineering department of the N-W.F.P. University of Engineering and Technology, Peshawar, to which equipment was provided under a Japan's grant aid project, were graduated from this department. It admits 50 students annually and has about 200 students in total and 15 faculty members. The department offers undergraduate, master's and doctoral courses. Its graduate programme provides part-time courses for in-service mining engineers.

⑤ Department of Metallurgical Engineering and Materials Science

This is a relatively new department established in 1965. It admits 50 students annually and has about 200 students in total and 15 faculty members. Enrollment is gradually on the rise. Undergraduate courses are offered in both metallurgical engineering and materials science education, and the master's and doctoral courses are offered in metallurgical engineering. The department boasts an curriculum emphasizing the relationships with production fields and industries and provides advisory and testing services for companies.

⑥ Department of Chemical Engineering

The department was established in 1962 as the first chemical engineering department in the country. It admits some 60 students. In the past three years, the admittance has been growing by about 20% annually. It now has approximately 350 students and 19 faculty members. It offers undergraduate, master' s and doctoral courses in chemical engineering. The master's course is divided into several majors, including advanced chemical engineering, environmental engineering, biochemical engineering, and CAD and process engineering. The department is actively engaged in the exchange of human

resources and equipment with public and private companies. It accepts scholarship from various companies.

⑦ Department of Petroleum Engineering

This is a relatively new department established in 1969. Originally, it was under the Department of Mining Engineering and became an independent department in 1975 to reflect the importance of the petroleum and gas industries in the national economy. While the quota of admission is around 20, actual admission has reached 32 at maximum. It has about 100 students in total and 9 faculty members. It offers a degree course in petroleum engineering. The department has established close relationships with oil and gas companies inside and outside the country and accepts scholarships from various companies. It has laboratories to conduct experiments in the fields of drilling engineering, petrophysics, reservoir fluid properties and corrosion control, and a computer centre.

⑧ Institute of Environmental Engineering & Research

This was established in 1972 to address the growing need for environmental engineering as well as sanitary engineering. Originally named the Institute of Public Health Engineering and Research, the present name was adopted in 1996. It is currently offering undergraduate courses in environmental and public health engineering (services courses for students of the civil engineering department), master's courses for its own students, and a doctoral course in public health engineering. Full-time students in the master' s programme have an opportunity to receive fellowship from World Health Organization (WHO). The master's programme admits 10-20 students annually. There are 16 faculty members. The institute provides education for in-service personnel and field engineers and consulting service for companies. It has laboratories covering water quality tests, unit process, air pollution

monitoring, water pollution control, and sanitary microbiology used for sanitary engineering.

⑨ Department of Architecture

The department was established in 1962 as the first institution to offer a bachelor's degree in architecture in the country. Its five-year undergraduate programme is accredited by Pakistan Council of Architects and Town Planners (PCATP) and the Institute of Architects, Pakistan (IAP). It started master's and doctoral courses in 1990. The department admits around 45 students and has about 200 students in total, nearly half of which is female. There are 16 faculty members. It has laboratories related to building materials, building construction, structural design, surveying and levelling, environmental control within buildings, preparation and model making, and CAD and drafting.

⑩ Department of City & Regional Planning

The department was established in 1962 as the first institution to offer the engineering degree in city planning in the country. It offers undergraduate, master's and doctoral courses. Compared to the admission capacity of 50 students, actual admission is limited to 30-40. It has about 170 students and 12 faculty members. The department also provides training and consultation services for outside organizations.

⑪ Department of Computer Science

Originally established as a part of the Department of Mathematics and later become independent, the department offers service courses in computer science and numerical analysis for students in other departments, and has a master's course in computer science for its own students by admitting around 20 students annually. There are 9 faculty members. It manages its computer

laboratories and a LAN system, serving as the core of computer education in the campus. It also offers short-term courses for the public and provides access to computer facilities by outside organizations.

⑫ Department of Mathematics

This is one of the three basic science departments, including chemistry and physics. Its origin dates back to the Department of Science established as a part of the original college in 1921. It teaches mathematics to engineering students as a basic requirement course. In addition to service courses such as mathematics, statistics and applied mathematics, the department offers master's and doctor courses for its own students. Annual admission varies between 5 and 20. There are 12 faculty members. Its has the computer center which provides short-term programming courses for the public.

⑬ Department of Chemistry

The department teaches services courses for engineering students such as applied chemistry, physical chemistry, and organic chemistry, and offers master's and doctor courses for its own students. The master's programme admits 10-20 students annually. There are 12 faculty members. The department sends students to factories for practical training and orientation. It also provides testing and standardization services for outside organizations.

⑪ Department of Physics

The department teaches applied physics to the first year classes of engineering students. It does not admit physics major students, but plans to start a graduate programme in the near future. There are 9 faculty members.

⑮ Workshop

Since the establishment in 1937, the workshop has been providing practical training in the fields of machining and processing for engineering students as a package practical course. The workshop is managed by a professor and 10 instructors teach students.

⑯ Library

A three-story building accommodates 400 seats and approximately 125,000 books and 76,500 periodical publications. Reading rooms are air-conditioned. It has a seminar hall equipped with a simple broadcasting system, which is used for formal events such as workshops and presentations. There is a book bank to rent textbooks to students.

The University of Engineering and Technology, Lahore admits around 1,000 students annually to its undergraduate courses. The present enrollment including graduate students is 5,500, of which 320 are female students and 225 foreign students. Each department is led by a chairman, consisting of professors, associate professors, assistant professors, and lecturers. There are technical staff who instruct students in laboratories.

The following table shows yearly changes in number of fresh students enrolled at the University of Engineering and Technology, Lahore.

Table 1-2 Enrolment of Fresh Students

Department	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Civil Engineering	163	137	211	179	241	241	215	225	234	218
Electrical Engneering	198	181	206	221	266	266	222	255	266	266
Mechanical Engineering	193	172	180	175	256	256	215	228	247	233
Mining Engineering	27	26	37	22	52	52	62	48	42	37
Metallurgical Engineering & Materials Science	37	33	35	22	48	48	58	63	58	44
Chemical Engineering	43	42	47	44	56	56	66	76	91	95
Petroleum Engineering	13	10	16	12	19	19	29	32	24	26
Architecture	48	47	27	22	36	34	44	51	44	42
City & Regional Planning	56	53	25	24	31	32	30	18	38	34
Total	778	701	784	721	1,005	1,004	941	996	1,044	995

Source : UETL

Table 1-3 shows yearly changes in the number of graduates from the university.

Table 1-3 Number of Graduates

Department	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Civil Engineering	231	-	216	194	195	181	173	153	147	144
Electrical Engneering	-	207	247	177	447	250	209	205	171	190
Mechanical Engineering	-	196	206	362	203	201	198	187	184	159
Mining Engineering	43	-	19	26	20	28	27	26	27	15
Metallurgical Engineering & Materials Science	18	18	-	44	27	40	38	34	24	22
Chemical Engineering	53	44	-	59	45	51	43	46	35	39
Petroleum Engineering	23	13	-	20	20	15	13	11	15	8
Architecture	29	23	-	32	-	36	26	28	28	22
City & Regional Planning	23	-	31	31	32	26	32	30	22	21
Total	420	501	719	945	989	828	759	720	653	620

Source : UETL

Graduates are mainly working with manufacturers, construction companies, mining industries (mines, petroleum and gas), educational institutions including universities and technical colleges, vocational training schools, and high schools, and research and training institutes and government organisations, including the following:

Table 1-4 Organisations offering Job Opportunities

Public Organisations	Research & Training Institutions
Water and Power Development Authority (WAPDA)	Space Research Organization
Provincial Irrigation Department	Staff Training Institute
National Engineering Services of Pakistan (NESPAK)	Technical Teacher Training Centres
National Highway Authority (NHA)	Gas Technical Testing Lab.
Civil Aviation Authority (CCA)	Arid Zone Research Institute
Heavy Mechanical Complex (HMC)	National Transport Research Centre
Pakistan Steel Mills (PSM)	National Education Equipment Centre
Heavy Electrical Complex Taxila	Hydrocarbon Development Institute of Pakistan
Oil and Gas Development Corporation (OGDC)	National Institute of Electronics
Karachi Electric Supply Corporation (KESC)	National Institute of Silicon Technology
Environmental Protection Agency (EPA)	National Institute of Power, Lahore
Development Corporations (LDA, CDA, KDA, etc.)	Irrigation and Water Research Institute
National Refinery	International Water Logging & Salinity Research Institute
Pakistan Railways (PR)	Cotton Research Institute
Ministry of Industries	Pakistan Council of Scientific & Industrial Research
Ministry of Education	National Building Research Institute
Ministry of Labour and Manpower Training	National Agricultural Research Centre
Ministry of Housing and Works	Geological Survey of Pakistan
Ministry of Planning and Development	Others

Source : UETL

The University of Engineering and Technology, Lahore, in addition to its own academic practices, controls the academic programmes and examinations of the following institutions, which are affiliated to it for award of degrees.

- National College of Textile Engineering, Faisalabad
- Electrical & Mechanical Engineering College, Rawalpindi
- Government College of Technology, Lahore
- Government College of Technology, Multan
- Government College of Technology, Rasul
- Government College of Technology, Bahawalpur
- Government College of Technology, Faisalabad
- Others

Laboratories located in the department buildings, including a main building completed in 1921, are equipped with a basic set of educational equipment and materials. Nevertheless, most of them are very old and deteriorated due to aging. They include testing machines made in the U.K., which were procured by the then government of British India more than 70 years ago, and most of them were supplied more than two decades ago under the

Colombo Plan or by international organisations. Furthermore, the number of equipment has not kept up with the increases in students and faculty members, 12 times and 7 times compared to those in 1961 when the university was formally started. There is a serious shortage of necessary educational equipment. As a result, education emphasizes on lectures rather than experimental work, which is carried out in the form of demonstration using old equipment that often lacks accuracy. While the university maintains an idea of education centered on hands-on experiments and training by students, actual education is inevitably limited to the lecturing of theories and principles. The institute is unable to develop a sufficient number of human resources with practical knowledge and forward-looking mind, which are strongly demanded by a number of industries facing rapid technological advancement. Having great concern about the situation, the Pakistan government has requested the Japanese government for a grant aid project to supply educational equipment to the University of Engineering and Technology, Lahore in order to enable more practical and qualified engineering education at an advanced level. The preliminary list of equipment requested is summarised below.

LIST OF REQUESTED EQUIPMENT

Requested Equipment	Qty
CIVIL ENGINEERING DEPARTMENT	
CONCRETE LABORATORY	
Compression Testing Machine	1
Portable Core Drill Machine	1
Concrete Corrosion Mapping System	1
Others	1 lot
EARTHQUAKE ENGINEERING LABORATORY	
Signal Enhancement Seismograph	1
Vibration survey System	1
Universal Testing Machine	1
Others	1 lot
SOIL MECHANIC & FOUNDATION ENGINEERING LABORATORY	
Hydraulic Jack (300t)	1
Motorized Direct Shear Apparatus	1
Speedy Moisture Tester of Different Capacity	1
Others	1 lot
HIGHWAYS AND TRANSPORTATION LABORATORY	
Motorized Centrifugal Extractor	1
Marshall Test Apparatus	1
Asphalt Mixer	1
Others	1 lot
HYDRAULICS AND IRRIGATION LABORATORY	
Pelton Turbine	1
Francis Turbine	1
Hydraulic Bench	1
Others	1 lot
SURVEYING LABORATORY	
Electronic Total Station	1
One Second Digital Theodolite	3
Electronic Level	1
Others	1 lot
COMPUTERS AND PERIPHERALS	
Personal Computer	30
Others	1 lot
ELECTRICAL ENGINEERING DEPARTMENT	
REPLACEMENT OF OLD EQUIPMENT	
Digital Multimeter	30
Function Generator	10
Power Supply	20
Others	1 lot
TRAINERS REQUIRED FOR THE DEPARTMENT	
Sequence Control Trainer	1
Replay Trainer	1
Colour Television Trainer	1
Others	1 lot
MEASUREMENT LABORATORY	
Oscilloscope	10
Function Generator	10
Transformer	
Others	1 lot
ELECTRONICS ENGINEERING LABORATORY	
General Purpose Oscilloscope	10
Microprocessor Development System	1
Electronic Circuit Development	1
Others	1 lot
CONTROL SYSTEM LABORATORY	
DC Speed Control Training System	2
AC Servo and Synchro System	2
Air Flow, Temperature Control Training System	2
Others	1 lot
COMMUNICATION ENGINEERING LABORATORY	
Spectra Analyzer	
Sampling Oscilloscope	
Multi Function Synthesizes	2
Others	1 lot
MICROWAVE LABORATORY	
Microwave education test bench	2
Glass Vane Present attenuator	3
Double cruciform directional coupler	3
Others	1 lot

Requested Equipment	Qty
ELECTRICAL MACHINE LABORATORY	
Measurement Module	1
Load Benches (Eddy Current Brake and Transducer Assembly)	10
Test Machines	
Others	1 lot
POWER SYSTEM LABORATORY	
Power System simulation Software	1
Complete laboratory control and monitoring equipment	1
Power System laboratory with modules	1
Others	1 lot
HIGH VOLTAGE LABORATORY	
Iron Loss Tester	1
Steel Sheet Tester	1
Digital Micro Ohm meter	2
Others	1 lot
MECHANICAL ENGINEERING DEPARTMENT	
HEAT TRANSFER AND THERMODYNAMICS LABORATORY	
Steam Power Plant	1
Engine Test Bed	1
Modules	
Others	1 lot
FLUID MECHANICS LABORATORY	
Basic Hydraulic Bench with Attachments	1
Practical Training Package for Compressors,Pumps and Turbines	1
Impulse Turbine Demonstration Unit	1
Others	1 lot
REFRIGERATION AND AIR CONDITIONING LAB	
Mechanical Heat Pump	1
Recirculating Air Conditioning Unit	1
Humidity Measuring Bench	1
Others	1 lot
MECHANICS OF MACHINES LAB	
Static and Dynamic Balancing Apparatus	1
Whirling Shaft Apparatus	1
Angular Acceleration Apparatus	1
Others	1 lot
MATERIAL TESTING LABORATORY	
Universal Testing Machine	1
Metallurgical/Industrial Microscope	1
Charpy Impact Testing Machine	1
Others	1 lot
CNC/CAD/CAM TRAINING LABORATORY	
Instructors Workstation	1
CNC Milling Machine	1
CNC Lathe	1
Others	1 lot
COMPUTER & PERIPHERALS	
Personal Computer	10
Others	1 lot
MINING ENGINEERING DEPARTMENT	
MINE VENTILATION LABORATORY	
Air Flow Unit	1
Geiger Counter	1
Portable Dust Sampler	1
Others	1 lot
MINE SAFETY AND RESCUE LABORATORY	
Portable CO Meter	1
Portable Gas Detector	1
Escape Apparatus	1
Others	1 lot
MINE SURVEY LABORATORY	
Precision Pocket Altimeter	1
Planimeter	1
Total Station with Traverse Target System	1
Others	1 lot
MINERALOGY AND PETROLOGY LABORATORY	
Collection of Rocks	2
Moh's Hardness Test Set	10
Rock cutting and Trimming Machine	1
Others	1 lot

Requested Equipment	Q'ty
MINERAL PROCESSING LABORATORY	
Vibratory Mill, Lab. Type	1
Digital Gauss Meter	1
Laboratory Electronic Jig	1
Others	1 lot
ROCK MECHANICS LABORATORY	
Portable Sheer Box Assembly	1
Rock Specimen Preparation Machine	1
Triaxial Compression Machine	1
Others	1 lot
COMPUTER & PERIPHERALS	
Personal Computer	5
Others	1 lot
METALLURGICAL ENGINEERING & MATERIAL SCIENCE DEPARTMENT	
CAST METALS RESEARCH LABORATORY	
Furnace	1
Temperature Chart Recorder	2
Induction Melting Furnace with Vacuum	1
Others	1 lot
CORROSION ENGINEERING LABORATORY	
Corrosion Monitoring Unit	2
Coating Thickness Measurement Device	4
Corrosion Studies Kit	1
Others	1 lot
ANALYSIS LABORATORY	
Digital Electronic Balance	3
Saybolt Viscometer	1
Atomic Absorption Spectrometer	1
Others	1 lot
INSPECTION & TESTING LABORATORY	
Universal Testing Machine	1
Digital Micro Hardness Tester	1
Universal Sheet Metal & Deep Drawing Machine	1
Others	1 lot
COMPUTER & PERIPHERALS	
Personal Computer	5
Others	1 lot
HEAT TREATMENT LABORATORY	
Furnace	1
Muffle Furnace	1
Jominey End Hardenability Tester	2
Others	1 lot
CHEMICAL ENGINEERING DEPARTMENT	
FLUID FLOW & PARTICLE TECHNOLOGY LABORATORY	
Hydraulic Bench	1
Compressible Flow Bench	1
Turbulence and Velocity Meter	1
Others	1 lot
INSTRUMENTATION & CONTROL LABORATORY	
Process Module	1
Electrical Console	1
Laboratory Recorder	1
Data Logger	1
Others	1 lot
REACTION ENGINEERING & THERMODYNAMICS LABORATORY	
Continuous Stirred Tank Reactor	1
Tubular Flow Reactor	1
Stirred Tank in Series	1
Others	1 lot
HEAT & MASS TRANSFER LABORATORY	
Thermal Radiation Apparatus	1
Free & Forced Convection Heat Transfer Apparatus	1
Thermal Conductivity of Liquid & Gases	1
Others	1 lot
ANALYTICAL LABORATORY	
Photometer Analyzer for Kinetic Enzyme	1
Inverted Biological Microscope	1
Portable Digital Residual Chlorine Meter	1
Others	1 lot
COMPUTER & PERIPHERALS	
Personal Computer	5
Others	1 lot

Requested Equipment	Q'ty
PETROLEUM ENGINEERING DEPARTMENT	
Automatic Drill Press	1
Core Slabbing Saw	1
Relative Permeability Apparatus	1
Others	1 lot
INSTITUTE OF ENVIRONMENTAL ENGINEERING & RESEARCH	
Digital pH/Temperature/mV Meter	2
Turbidimeter	2
Water Quality Checker	1
Others	1 lot
ARCHITECTURE DEPARTMENT	
GRAPHICS & PRESENTATION LABORATORY	
Opaque Projector	1
Transparency Maker	1
Spray Gun	5
Others	1 lot
PHYSICAL ENVIRONMENT STUDIES LABORATORY	
Digital Luxmeter	2
Precision Integrating Sound Level Meter	2
Random Noise Generator	1
Others	1 lot
PHOTOGRAPHIC DEVELOPING & PRINTING LABORATORY	
Micro Fisch Reader Printer	1
Ammonia (white) Printing Machine	1
SLR Camera with Zoom/Close-up Lenses	1
Others	1 lot
SURVEYING LABORATORY	
Pantagraph	2
Plain Varigraph	1
Planimeter	1
Others	1 lot
COMPUTERS & PERIPHERALS	
Personal Computer	5
Others	1 lot
CITY & REGIONAL PLANNING DEPARTMENT	
DRAWING & DATA ANALYSIS LABORATORY	
Digital Planimeter	5
Drafting Machine	5
IBM PC Compatible Computer (Pentium)	5
Others	1 lot
COMPUTER SCIENCE DEPARTMENT	
Computer	20
Fileserver	1
LAN System	2
Others	1 lot
MATHEMATICS DEPARTMENT	
Compound Pendulum	2
Screw Jack	2
Inclined Plane	2
Others	1 lot
CHEMISTRY DEPARTMENT	
Water Distillation Unit	1
Flash Point Apparatus	1
Softening Point Apparatus	1
Others	1 lot
PHYSICS DEPARTMENT	
X-Y Recorder	1
Digital Storage Oscilloscope	1
Oscilloscope Dual Trace	1
Others	1 lot
WORKSHOP EQUIPMENT	
Computer	2
Comparator (Mechanical)	1
CNC Lathe Machine	1
Others	1 lot
LIBRARY	
Overhead Projector	1
Slide Projector	1
Opaque Projector	5
Others	1 lot

CHAPTER 2 CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Objective of the Project

The primary objective of this project is to help improve and upgrade engineering education in Pakistan by supplying educational equipment at the University of Engineering and Technology, Lahore, a traditional center of engineering education in the country, so as to replace old and deteriorated equipment and add new ones, thereby to raise quality of education offered by the university and to assist it in developing human resources who will be able to act as leaders in the industrial sector that constitutes the country's economic base, as well as government organizations, educational institutions, and research organizations, and who will be able to participate in invigoration of the country's economy.

2-2 Basic Concept of the Project

(1) Overall concept

The project is designed to assist the University of Engineering and Technology, Lahore which faces difficulty in providing sufficient engineering education for students due to deterioration of its educational equipment, in developing highly educated engineers who are demanded as core elements under the country's Eighth Five Year Plan and education policies, thereby contributing to the development of the country's industrial sector that constitute a major economic base. In particular, the project focuses on supply of educational equipment used by existing laboratories and related facilities of the university in an attempt to enhance its educational activities and raise technology levels. The basic principle of the project is therefore;

- The project sets the highest priority to the replacement of existing equipment that is unserviceable due to deterioration or failure.

- Next priority is placed upon the addition of equipment which is in short supply as compared to the number of students who need to use it, as well as equipment which is currently shared by two or more departments or borrowed by one department to another, and which needs to be exclusively owned by a department in consideration to the frequency of use.

- New equipment is limited to those which are required to meet educational requirements under the present curriculum and course contents, and which can be maintained with ease by existing resources at the university.

Based on the overall concept, the study team has reviewed the equipment list requested by the Pakistan government on the basis of the field survey and follow-up analysis in Japan, and has formulated the basic policy in selecting a final list.

(2) Review of the request

In 1988, the University of Engineering and Technology, Lahore made a plan to replace and upgrade old educational equipment, mainly those of electrical engineering, chemical engineering, and petroleum engineering departments, under the aids from the United States Agency for International Development (USAID) for the purpose of improving its engineering education. However, the plan was not materialized for various reasons. Having concerned about the deterioration of educational quality of the university due to outdated equipment, the Ministry of Education has requested the Japanese government to assist in improvement of necessary equipment in the form of grant-in-aid. The request to

the USAID was revised, starting in 1993, to cover all the departments of the university, and a formal request was submitted to the Japanese government in April 1994.

However, as time passed after the submission of the original request (PC-1), the situation changed significantly to force the university to revise its request for a number of reasons, including the reorganization of course offerings and curriculum designs, an increase in equipment failure, the upgrading of equipment specifications to meet technological advancement, and the changes in cost estimates due to the currency devaluation. As a result, the university submitted the revised request proposal to the study team during the field study. Then, further revisions on the equipment list were proposed by various departments as the study team entered detailed discussion with each department. These revisions incorporated opinions of faculty members who did not participate in preparation of the revised PC-1 and who identified specific equipment not included in the revised list, which required under the current curriculum. They also reflected the changes in remodeling or upgrading of the listed equipment after 1994. The revised PC-1 was approved in October 1997 by the Central Development Working Party (CDWP) under the Planning Commission. Then, it was approved in January 1998 by the Executive Committee of the National Economic Council (ECNEC).

The discussion between the study team and each department of the university focused on the study team's selection criteria set on the basis of the project's selection and the preparation of a final equipment list reflecting such criteria. Through extensive and detailed discussion, equipment which failed to meet the criteria was dropped from the list, such as equipment duplicated in the requests from different departments, equipment which requires high maintenance costs, equipment which function can be performed by existing equipment, and equipment which did not require urgently. For equipment which was requested in more than one unit, the minimum required quantity was identified by evaluating its use in details. Equipment functions were limited to minimum required ones as far as possible to ensure the ease of maintenance

including the cost. Finally, for equipment which was included in the additional requests made by the departments at the time of meeting, its need and urgency were evaluated and only those which procurement were justifiable in overall consideration were selected and added to the list.

Then, the revised list was further evaluated during the analytical phase in Japan, and equipment which was found unjustifiable was dropped from the list to decide on a final list. The selected equipment consists of educational equipment to be used by the University of Engineering and Technology, Lahore including general laboratory apparatus, analytical equipment, measuring instruments, testing equipment, computers, and other auxiliary equipment.

General description of the selected equipment according to each department is presented below.

1) Department of Civil Engineering

The undergraduate programme has approximately 250 students each year, totaling some 1,000 students in the entire department. Faculty members consist of ten professors, twelve associate professors, fourteen assistant professors, and ten lecturers, with sixty five technical and administrative staff. Most of younger faculty members have received the master' s degree from the department. The department' s educational policy emphasizes the understanding basic theories and principles in relevant fields and the development of the ability to use them in practice. Thus, the department places as much weight on laboratory work as class lecture. Graduates from the department are playing vital roles in construction and maintenance of roads, bridges, public buildings, irrigation and drainage channels, power stations, and railroads. Approximately 40% of them work with public organizations, and the remaining 60% with private companies. Equipment owned by the department is very old and deteriorated, including those installed more than 70 years ago. Many of them do not function properly due to failure or deterioration of accuracy. Equipment requested by the laboratories under the department and the results of evaluation are summarized as follows.

a) Concrete Laboratory

Equipment requested by the laboratory includes equipment and tools used to prepare specimen (portable core drilling machine, heavy duty masonry saw, thermostatic curing tank, and concrete mixer), destructive testing equipment to measure strength of materials by destruction (compression testing machine and creep test apparatus), nondestructive testing equipment and devices to examine the inside of materials by ultrasonic wave and other media without destruction (resonant frequency tester, ultrasound tester, micro cover meter, concrete corrosion mapping system, and Windsor probe system), and other material testing equipment (Vebe consistometer, cement test system and column buckling measurement apparatus). From the equipment list, the Vebe consistometer was dropped because the existing one was still serviceable, while several others including the concrete mixer and the column buckling measuring apparatus were excluded due to the low priority. All the selected equipment is used for basic education, but needs replacement due to the malfunctioning of the existing equipment which materially affects quality of education.

b) Earthquake Engineering Laboratory

The requested equipment includes equipment to evaluate strength of materials by examining propagation of shock wave (signal enhancement seismograph, seismic digital timer, response spectrum analyzer, servo accelerometer, and strong motion accelograph), basic measuring instruments (data logger and distortion meter), basic material testing equipment (universal testing machine, Rockwell hardness machine, Brinell hardness machine, fatigue testing machine and torsion meter), and a universal structural testing frame and experimental kit. Among them the spectrum analyzer, the accelograph and the data logger were dropped from the list due to the low priority based on the frequency of use, and the torsion meter in consideration to availability of existing equipment after repair.

c) Soil Mechanics & Foundation Engineering Laboratory

The laboratory requested equipment required for preparation of experiments (300-ton, 100-ton and 50-ton hydraulic jacks, automatic mechanical compactor, portable core drilling machine, tube sampler set, power auger, sample cutter, and constant temperature oven), soil testing equipment (triaxial test system, power-operated direct shear apparatus, digital direct shear apparatus, expansion index test apparatus, falling head permeameter, constant head permeameter, CBR test set, relative density set, and data acquisition system for CBR, triaxial & shear test), and equipment to examine foundation structure (seismic test apparatus). Among them, the 300-ton hydraulic jack was excluded because the 100-ton jack could serve the purpose in most cases; the seismic test apparatus and the core drilling machine can be shared with other departments; the automatic mechanical compactor, the power-operated direct shear apparatus and the Rowa-cell consolidation test set can be substituted for by existing equipment or other equipment supplied under the project.

d) Highway and Transportation Laboratory

The requested equipment includes testing equipment for road construction materials (Marshall test apparatus, penetration tester, Saybolt viscometer, Los Angels abrasion machine and aggregate impact value apparatus), equipment and materials required for test preparation (electric thermostatic water bath, Muffle furnace, fan circulated oven, core drilling machine, asphalt mixer and water de-ionizer), and testing equipment and materials for road performance evaluation (traveling beam device, Benkelman beam test apparatus and friction tester). Among them, the Los Angeles abrasion machine was dropped from the list because of availability of existing equipment, while the water bath, the Muffle furnace, the core drilling machine and the water de-ionizer can be shared with other departments.

e) Hydraulics and Irrigation Laboratory

Most of equipment requested by the laboratory is testing equipment covering basic experiments related to fluid dynamics and checking

performance of fluidic devices, including a Pelton turbine, a Francis turbine, a hydraulic bench and accessories, a fluid friction apparatus, a pipe surge and water hammer apparatus, a multipurpose testing flume, particle drag coefficients, a glass sides tilting length, an adjustable bed flow channel, a laminar flow analysis tube, and a computer-aided practical training package on fluid mechanics. Among them, the Pelton turbine was dropped as the existing turbine could still be used, while the multipurpose testing flume, the particle drag coefficients, and the computer-aided training package were dropped because their level of urgency was not very high as their functions were partially duplicated with other equipment or could be partially fulfilled by existing equipment,

f) Survey Laboratory

Standard surveying equipment was requested, including an electronic total station, theodolites, distance meters, digital theodolites, electronic levels, optical squares, and high precision equipment used by senior-year students including a gyroscopic theodolite and a GPS differential receiver. As graduates in Pakistan are expected to perform high levels of work soon after employment, practical training for surveying equipment with relatively high precision is essential. For this reason, the total station, the gyroscopic theodolite and the GPS differential receiver will be used by three groups alternately. The optical squares was dropped as they could be purchased by the department筑s budget. Two total stations with similar functions were requested, and one was dropped to avoid functional duplication.

g) Computer Laboratory

The use of computers in engineering education is being promoted by the Ministry of Education and the University Grants Commission (UGC), and the University of Engineering and Technology, Lahore plans to promote computerization in line with the policy. As part of the efforts, all the departments including civil engineering has requested a minimum set of computers and peripherals. The department requests personal computers, dot matrix printers, a plotter and a laser printer. At the department, about 60 students constitute a basic unit of laboratory work. They will be divided

into three groups, 20 each, and two students will share one personal computer, totaling 10. It is assumed that the university will purchase additional computers in the future, as required, on their own.

2) Department of Electrical Engineering

The undergraduate programme enrolled by over 1,000 students in total, some 260 each year. Faculty members are ten professors, ten associate professors, twelve assistant professors, eight lecturers, and sixty five support staff including technical staff. For laboratory work, around 70 students form a basic unit, which is further divided into smaller groups according to the number of equipment available. Most of laboratory equipment and measuring instruments were furnished more than two decades ago and are severely deteriorated due to aging. In particular, most equipment purchased from Eastern Europe under the barter trade is not serviceable due to the lack of spare parts or the inability to repair as a manufacturer cannot be found. As a result, there is an apparent shortage of laboratory equipment and measuring instruments throughout the department. The department is currently constructing a new building which will accommodate four laboratories.

a) Equipment for basic education and trainers

Laboratory equipment used in Electronics Laboratory 1 is requested, mainly consisting of those used for experiments in basic electronics and electrical measurement related to electronics. At present, there are 17 benches (used by 6 students each), on which function generators, power supplies, and oscilloscopes are placed all the time. Thirteen function generators, 12 power supplies an 8 oscilloscopes are in use. Although trainers used for experiments related to industrial electronics will be installed in the laboratory for space availability, they will be relocated to the new building. Ten function generators and 10 oscilloscopes will be supplied to replace those which are unserviceable, physically or due to poor accuracy, plus several units used for spare use as required. For other equipment, it was assumed that the same work would be conducted simultaneously on two tables, thus providing two units. In addition to the above three, the list includes measuring instruments such as logic analyzers, megaohmmeters,

wheat-stone bridges, and frequency meters, and sequential controllers and colour television trainers. Among them, equipment which was requested in duplication or could be purchased by the department was dropped, including multi-meters, current testers, voltmeters, power meters, decade capacitors, voltage regulators, thermometers and hygrometers. Also dropped was equipment less frequently used, such as Gaus meters and WOW & flutter meters, and special equipment with a low urgency level, including vacuum air circuit breaker trainers and circuit trainers.

b) Measurement Laboratory

The laboratory mainly performs experiments related to electrical measurement. There are 8 tables (used by 8-9 students each), As the same experiment is conducted at the same time, equipment will be basically supplied 8 units, subject to adjustment according to the number of existing equipment available. Note that function generators, power supplies and oscilloscopes are provided 10 units each, including 2 units for additional requirements in consideration to the fact that they are used frequently and additional units are required in some experiments. In addition, essential equipment for laboratory education on electrical measurement will be supplied, including LCR bridges, electronic galvanometers, power factor meters, standard resistors, variable capacitors, and transformers. On the other hand, some types of transformers, ammeters, power meters and power factor meters were dropped from the list due to low priority, and so were AC/DC voltmeter/ammeter calibration systems and troubleshooting testers because they were not suitable for university education.

c) Electronics Engineering Laboratory

At the laboratory, experiments on basic and applied electronics for junior and senior year students are mainly performed. Equipment and measuring instruments mainly related to circuit theory were requested. The laboratory has 10 tables (7 students each), each of which is provided with a function generator, a power supply and an oscilloscope. They are very old and accuracy levels are very low, and need to be replaced to maintain an adequate level of laboratory work. The number of equipment was

determined by assuming that it would be used on a rotational basis. The basic unit of supply is one or two. Analog and digital trainers are increased to 10 units each because they are important in learning circuit theory and all the students need to use the same type of equipment. Other equipment includes laboratory equipment, such as operation amplifier trainers, logic circuit trainers, AD/DA conversion equipment, SCR circuit trainers and power supply circuit equipment, and measuring instruments including a logic analyzer, a sweep generator, digital storage oscilloscopes, and distortion meters. On the other hand, advanced equipment used at factory such as computer-aided circuit design system, a computer-based CAD system for printed circuit board design, and production equipment was dropped from the list, while equipment requested in duplication, such as function generators and logic analyzers, was reduced.

d) Control System Laboratory

The laboratory is used by junior and senior year students to conduct experiments related to feedback control and other control theories. There is no table. In the room, 2-4 controllers are placed and 10 students form one group to conduct the same experiment. A majority of equipment does not work due to aging. The basic unit of supply was set at one or two by assuming that each equipment would be used on a rotational basis. For instance, basic controllers control devices such as DC speed control systems, AC servo systems and flow/temperature control training systems will be supplied in two units each in consideration to a relative high frequency of use. On the other hand, equipment covering applied technology, such as a digital servo system, a magnetic levitation system, a twin rotor mimo system, and a hydraulic servo system, will be supplied in one unit. Finally, a liquid level/temperature control system dropped in the final list as its functions can mostly be performed by the flow/temperature control training system.

e) Communication Engineering Laboratory

The laboratory conducts experiments on communication system theory and telecommunications for senior year students, covering a wide range of experiments including high harmonic circuits, radio propagation, optical fiber

communication, and telephone line. The laboratory has 10 tables (10 students each). The basic unit of supply was set at two by assuming that two groups conduct the same experiment simultaneously, subject to adjustment (reduced to one unit) according to availability of existing equipment. The selected equipment includes pulse circuit experimental equipment, audio test sets, analog/digital communication trainers, antenna system demonstrators, digital telephony trainers, and fiber optics training systems, as well as measuring instruments including oscilloscopes, power supplies, high harmonics generators and spectrum analyzers. On the other hand, equipment which was requested in duplication, such as spectrum analyzers, LCR meters and sampling oscilloscopes, and those requested by other laboratories and which can be shared with them, such as colour television trainers, were dropped from the list. Also, equipment used for advanced research purposes, such as computer-aided audio or image recognition software, was also excluded.

f) Microwave Laboratory

The laboratory conducts experiments on microwave theory for senior year students and has 3 tables (20-25 students each). Basically, laboratory work is carried out on a demonstration basis. The equipment requested was 3 sets consisting of 40 items including transmitters for microwave test, measuring instruments, an transmission components such as waveguide. They were sorted out and arranged into comprehensive experimental sets for university education including manuals in consideration to the ease of experiment and maintenance. The selected training equipment consists of two microwave training systems to learn basic theory and one micro-strip training system to cover applied theories.

g) Electrical Machine Laboratory

At the laboratory, experiments on electrical-mechanical engineering and general machinery theory are conducted for students in all the years. The laboratory has equipment that was installed when the institute was opened. Although very old, some equipment is still in use. Nevertheless, their performance and appearance are very different from those used by today's

industry, and replacement of all the equipment seems to be necessary. The laboratory maintains 10 tables (7 students each), and thus load benches and connection bases are required in same quantities. The basic unit of supply for other equipment is set at one. The selected equipment includes motors and generators (10 types), an advance electrical machine 4Q drive system and auxiliary units required to learn the latest industry-standard technologies. Equipment including eddy current brakes and speed indicators, which functional requirements are met by existing equipment, and those with low priority, such as drive control systems, measuring data analysis software and interface, were not included in the final list.

h) Power System Laboratory

This is a laboratory used for experiments on power systems and the learning of design techniques for students in all the years. As the power sector is important infrastructure in the country and Lahore City has a head office of Water and Power Development Authority (WAPDA) which employs a large number of graduates from the electrical engineering department, nearly 60% of students in junior and senior years are majoring in the power system course. Also, experiments on power systems are compulsory for freshmen and sophomore year students, the laboratory is frequently used and plays the most important role among other laboratories. However, laboratory equipment is limited to those produced by students as projects, and they are severely deteriorated. Although circuits and devices are made in unit and their combinations can be varied to configure different systems, they are not sophisticated enough for full experimental purposes Power systems, together with high voltage system in the next section, involve a high risk of accident and equipment used for laboratory work must have sufficient safety features. For this reason, high priority should be given to replacement of equipment at this laboratory. While the request equipment is relatively expensive on account of systematized training units, they are expected to be used by more than 1,000 students in the department alone and thus have a very high educational effect. The basic unit of supply is set at one as these equipment is mainly used on a demonstration basis. The selected equipment includes a power system simulation unit used to learn computerized power system design techniques, laboratory control and monitoring equipment

which includes complete simulation of monitoring work in power systems, and module power receiving and distribution units that configure a power system.

i) High Voltage Laboratory

The laboratory is one of the most important facilities of the department, including the power system laboratory. Existing equipment was installed in the 1960s and is considerably deteriorated. As they use high voltage, entire replacement is required to secure safety. The unit of supply is set at one each as a number of equipment constitutes a single system, except for frequently used measuring instruments which will be supplied in two units if required. The selected equipment includes impulse voltage generating equipment, a micro-ohm meter, a insulation tester, a surge scope, a tensile tester for wires and cables, a null detector for EHV Schering bridge, and a digital oscilloscope with recorder. Equipment with a low level of urgency, including a transformer tester, a high voltage AC/DC generator, a surge tester, and a surge current generator, was dropped from the final list. Note that the laboratory is already provided with shields against high voltage, which should cover the entire room containing high voltage testing equipment.

j) Computer Laboratory

The original request was limited to 10 computers to meet minimum requirements. Then, during the field survey, the department requested replacement of 70 computers which have become obsolete. However, while the request meets the need for the effective use of computers in university education, personal computers are subject to frequent model changes every three to six months, and they are considered as equipment with short depreciation. For this reason, it is assumed that the use of latest computers will be limited to a minimum required level, while programming and other work will be carried out by using existing models. Under the assumption that students will be organized into a small group consisting of 20 students, where two students will share one computer, 10 computers will be supplied. Note that the institute is expected to procure additional computers on their

own. Finally, peripherals with a low level of urgency, which can be procured in the future, such as printers, plotters, copiers, film development sets, and drafters, were dropped from the list.

3) Department of Mechanical Engineering

The department offers undergraduate and graduate courses (master' s and doctoral). The undergraduate programme consists of around 250 students in each year, totaling over 1,000 students, more or less the same size as the civil engineering and electrical engineering departments. The department has 6 laboratories. 10 professors, 10 associate professors, 14 assistant professors, and 9 lecturers conduct educational and research activities in a wide range of fields. 53 technical and administrative staffs provide assistance and maintain equipment. As seen in the civil engineering department, many faculty members have obtained master' s degree from the department. As mechanical engineering is essential in most industries and production facilities, nearly 100% of graduates find jobs. They work with a wide range of industries, including steel plants, automobile assembly plants and automotive parts suppliers, railways, textile mills, machine tool manufacturers, cement mills, sugar mills, and food processing plants. At public organizations, they are assuming important roles in policy making and equipment maintenance in various fields including irrigation and drainage, electricity, and transportation.

a) Heat Transfer and Thermodynamics Laboratory

The requested equipment includes testing equipment to check performance of steam generators, generator turbines, engines and burners (steam power plant, engine test bed, modules, combustion laboratory unit, fuel gas analyzer, photovoltaic trainer, two-shaft gas turbine unit, and boiler unit), equipment and materials used for electric heat tests (concentric tube heat exchanger, bench top cooling tower, thermal conductive of liquid & gas apparatus, boiling heat transfer unit, turbulent flow heat exchanger, fluid bed heat transfer system, and DC/AC heat exchanger), and basic measuring systems (temperature measurement unit, etc.). While all the equipment is essential in obtaining knowledge required for the efficient use of electrical, mechanical and heat energies, the training modules, the combustion

laboratory unit, the two-shaft gas turbine unit and the fluid bed heat transfer system are considered to have duplication in some functions with other equipment, which can be used to serve the intended purpose, thus they were dropped from the final list.

b) Fluid Mechanics Laboratory

The request equipment includes experimental units used to understand basic fluid mechanic theories (basic hydraulic bench, educational wind tunnel, and practical training package for fluid mechanics), and equipment used to check performance of hydraulic equipment (practical training package for compression pumps and turbines, impulse turbine demonstration unit, and reaction turbine demonstration unit). Among them, the impulse turbine demonstration unit, the reaction turbine demonstration unit, the compressor test rig, the multi pump test rig, and the practical training package of fluid mechanics were dropped from the list.

c) Refrigeration an Air-conditioning Laboratory

The request equipment is a mechanical heat pump, a re-circulating air-conditioning unit, and a humidity measuring bench, all of which are currently in use but are aged to require replacement. All the them are basic equipment in this field and indispensable in tests which require a combination of these equipment with other existing equipment. It was decided to supply one unit each of these equipment.

d) Mechanics of Machines Laboratory

The requested equipment includes a static and dynamic balancing apparatus, a whirling shaft apparatus, a angular acceleration apparatus, and a torsional vibration apparatus, as well as a transmitted light polariscope which checks stress distribution by photo-elasticity. Among them, the light polariscope is considered to be serviceable for undergraduate-level experiments and has been excluded in the final selection process.

e) Material Testing Laboratory

The requested equipment includes a universal testing machine to perform tensile, compression and being tests of metallic materials, a metallurgical microscope to observe the texture of metallic materials, a Charpy impact testing machine to measure resistance of metal to impact, a micro hardness tester, a Rockwell hardness tester, and a Brinell hardness tester. While all of them are basic equipment required to examine physical properties of materials, the micro hardness tester, the Rockwell hardness tester, and the Brinell hardness tester can be shared with the Mechanics of Machines Laboratory which now has all of them, thus have been dropped from the final list.

f) CNC/CAD/CAM Laboratory

The requested equipment is essentially a practical training set for computer-aided automation of machining operation by a milling machine and a lathe by using a CNC machine tool, consisting of a instructor' s workstation, student workstations, a CNC milling machine, a CNC lathe, software, a dot matrix printer, and a 6 pen plotter. While CNC machine tools are increasingly used in the country, existing models owned by the laboratory are obsolete and are no longer sufficient to teach automation technology required for production equipment and machine tools. As they are essential from the country' s national objective to strengthen linkage between industry and academia, one set will be supplied for the use by a group of 10 students. The dot matrix printer, however, is not necessarily included in the system and can be purchased by the laboratory' s budget, and thus it has been dropped from the list.

g) Computer Laboratory

The requested equipment consist of personal computers, dot matrix printers, a color plotter and a laser printer. At present, 60-70 students form a group as the basic unit of laboratory work. Assuming that they will be further divided into smaller groups consisting of 20 students each, where two students will share one computer, 10 PCs will be supplied to the department.

Note that additional requirements should be met by the university's own efforts.

4) Department of Mining Engineering

The department has undergraduate, master' s and doctoral programmes. There are around 50 students in each year of the undergraduate programme, totaling 200 students. In addition, the department offers service courses in other departments as follows:

- Civil Engineering Department: Industrial geology
- Petroleum Engineering Department: Surveying, applied geology, tectonic geology and stratigraphy
- Metallurgical Engineering Department: Ore preparation

The department has 6 laboratories. Faculty members consist of nine professors, one associate professor, four assistant professors, and one lecturer, with twenty eight technical and administrative staff. Pakistan is said to have abundant, largely untapped mineral resources. Limestone deposits are extensively found, and gems, gypsum, silica sand and coal are commercially mined to some extent. In the North-West Frontier province and the Balochistan province, exploration activities are underway. Previously, a development study on mineral exploration in some areas of Balochistan has been conducted under the assistance of JICA. Graduates are working in a variety of industries including cement and gem companies, in addition to public mining corporations, contributing greatly to the development of the mining sector.

a) Mine Ventilation Laboratory

The equipment requested by the laboratory includes equipment to learn air flow and ventilation inside the mines (an air flow unit, a mine ventilation educator and a layering of roof gases apparatus, instrument to measure air flow rate and pressure in the mines (a hot wire anemometer, a digital micro manometer and a aneroid barometer), analytical instruments for chemical composition of air (a portable dust sampler, a total sulfur estimation apparatus, an oxygen meter, and a carbon monoxide detector). These

equipment is basic educational aids to understand mine ventilation techniques by analyzing the air and measuring the flow in the mines. Among them the air flow unit was dropped as existing equipment with similar functions could be used for the purpose, while an existing portable dust sampler will be repaired.

b) Mine Safety and Rescue Laboratory

The requested equipment includes detectors and measuring instruments of detrimental gases (a carbon monoxide detector and a multi toxic gas monitor), emergency evacuation equipment (an escape apparatus, a self-rescuer respirator and an oxygen breathing apparatus), and a set of equipment to estimate the ground conditions by causing an artificial earthquake and recording vibration waveforms (a small seismograph, a velocity of detonation recorder, a sequential blasting machine and an electric blasting machine). These equipment is essential in learning how to examine and secure safety in the mines by evaluating the air and ground conditions. However, the small seismograph, the velocity of detonation recorder and the sequential blasting machine have been removed from the candidate list as they can be shared with other departments.

c) Mine Survey Laboratory

The requested equipment includes a total station, a digital theodolite, optical theodolites, range finders, an auto reduction EDM alidade, and a digital level. Among them, the total station has been selected in consideration to its wide use. On the other hand, the auto reduction EDM alidade has been dropped as its functions can be achieved by a combination of other equipment.

d) Mineralogy and Petrology Laboratory

The requested equipment includes rock and mineral collections, specimen boxes, a rock cutting and trimming machine used to prepare rock and mineral specimen, and a resistivity meter to determine a mineral type from resistivity. While all of them are useful for basic education, specimen boxes

have been removed from the list as they should be purchased under the department budget.

e) Mineralogy and Petrology Laboratory

The requested equipment consists of ore dressing equipment and chemical analyzers, including a plate electrostatic separator, a screen plate electrostatic separator, a wet magnetic separator, an air classifier, a laboratory cyclone, a gravity table, a multigravity separator, an inductivity coupled plasma emission spectrometer, and a XRF chemical analysis equipment. Among them, the laboratory cyclone was dropped from the final list as existing equipment serves the purpose. The inductivity coupled plasma emission spectrometer and the XRF chemical analysis equipment, although useful equipment for analysis of elements contained in rocks, were also dropped on account of difficulty in operation and maintenance.

f) Rock Mechanics Laboratory

The requested equipment consists of a portable seer box assembly, a rock specimen preparation machine, data loggers, and a triaxial compression machine. Rock mechanics are an important area of study to rationalize the mine development, mining and ore dressing. These equipment is essential in learning the entire process of analyzing physical properties of rocks, including the cutting and shaping of rock specimen, compression testing, and recording of test data by data logger.

g) Computer Laboratory

The department requested personal computers, a dot matrix printer, a plotter, a laser printer, a digitizer, a data projector, and overhead projectors. 5 personal computers are considered to be minimum requirements under the assumption that students in each year will be divided into small groups, consisting of 10 students each, where two students will share a computer. Note that additional requirements in the future will be met by the university's own efforts.

5) Department of Metallurgical Engineering and Materials Science

The department offers undergraduate, master' s and doctoral courses. The undergraduate programme is enrolled by around 50 students in each year, totaling 200. The department has 5 laboratories and faculty members are five professors, four associate professors, four assistant professors, and two lecturers, with twenty one technical and administrative staff. 80% of graduates go to private companies and 20% to public organizations. They work in a wide range of industries, including steel mills, foundries, smelting plants, pipe, tractor and automobile manufacturers.

a) Cast Metal Laboratory

The requested equipment consists of basic equipment to learn foundry technology, including a furnace, a smelter, a Rockwell hardness tester, an air permeameter, sand mills, and universal sand strength machines. Among the smelter has been dropped as it can be replaced with an electrical furnace, and the Rockwell hardness tester has been removed from the list as the existing one is still serviceable.

b) Corrosion Engineering Laboratory

The requested equipment consists of corrosion monitoring units to record the corrosion process over a long period of time, coating thickness measurement devices to measure the thickness of metal layer, and a corrosion studies kit. Among them, the monitoring units have been dropped from the list as they are not suitable for the use at the undergraduate level.

c) Analysis Laboratory

The requested equipment mainly consists of analytical instruments to examine chemical composition of metals, including an atomic absorption spectrometer, an optical emission spectrometer, and a carbon-sulfur apparatus. Among them, the atomic absorption spectrometer - although useful equipment to accurately analyze elements in the metal - is not

included in the final list due to difficulty in operation and maintenance and the possibility to use the one to be supplied to other department.

d) Inspection & Testing Laboratory

The laboratory has requested basic equipment used to analyze metal strength, hardness and internal structure, including a universal sheet metal & deep drawing machine, a micro hardness tester, a Rockwell hardness tester, a Brinell hardness tester, a Charpy impact tester, a metallurgical microscope, a creep test apparatus, a transmitted light microscope to examine stress distribution, a profile projector, and a universal testing machine. The deep drawing machine (which examines drawing limits for plate materials) and the creep test apparatus (which examines strength of materials under constant temperature and load) have been dropped from the list because of low priority. The universal testing machine, the metallurgical microscope and the profile projector were also dropped as those supplied to other departments can be shared.

e) Heat Treatment Laboratory

The requested equipment is basic heat treatment equipment to provide desirable properties for metal, including a furnace, a Muffle furnace, Jomney end hardenability testers, pyrometers, and a thermal analyzer to estimate phase change by measuring volume expansion of a material during a temperature rise. Among them, the study team excluded the Jomney end hardenability testers have been dropped as the existing ones can be used, and the thermal analyzer as a similar test can be done by other measurement methods.

f) Computer Laboratory

The department requested personal computers, a dot matrix printer, a plotter, and a laser printer. These items of equipment have been dropped off from the list due to the reasons that existing computers were servicing very well and that the department placed priority on the teaching equipment rather than the computers and peripherals.

6) Department of Chemical Engineering

The department has undergraduate and graduate (master and Ph.D.) programmes. The enrollment in the undergraduate programme has rapidly increase in recent years. 90 students are studying in each year, totaling 400. Faculty members are five professors, five associate professors, seven assistant professors, and two lecturers, who are supported by twenty three technical and administrative staff. The department mainly teaches the refining process in the chemical industry, instrumentation and analysis. The requested equipment mainly consists of laboratory equipment. Equipment currently in use was installed in the 1960s and a majority of them are unserviceable due to the lack of spare parts or other reasons, and the remaining equipment also malfunctions occasionally. In the equipment selection process, the request list was reviewed on the basis of urgency and importance according to the present curriculum, and as a result, the list was reduced into nearly a half. While some equipment requires a relatively large space for installation, all the laboratories have sufficient space for accommodating them.

a) Fluid Flow & Particle Technology Laboratory

The laboratory mainly conducts basic experiments to learn mobility of fluids and particles, their classification, and preparation of materials for experiments, which are carried out in the form of demonstration or by groups of students on a rotational basis. Thus the basic unit of supply was set at one. Equipment was selected according to the importance of respective experiments and the current state of existing equipment, including a hydraulic bench, a compressible flow bench, a fixed and fluidized bed apparatus, a multipump tester, a crushing machine to produce particles, a sieve shaker, and a microscope. A fluid friction apparatus, manometers, flow meters, and crushing machines have been dropped from the selection list because of duplication or because other equipment can serve the purpose.

b) Instrumentation and Control Laboratory

The laboratory mainly performs experiments related to methodology of parameter setting and control in the refining process. Laboratory work is done on a rotational basis and the basic unit of supply is set at one. The selected equipment includes various control accessories related to level, temperature, pressure, pH, flow rate, and remote, and training units for a whole range of process control. The thermocouple and the precision pressure gauge calibrator were dropped due to a low level of urgency.

c) Reaction Engineering & Thermodynamics Laboratory

The laboratory primarily conducts basic experiments to learn chemical reaction theories. The basic unit of supply was set at one. The selected equipment includes continuous stirred tank, tubular flow, stirred tank in series, and batch reactors, and experiment sets to learn thermal dynamics including the Joul-Thomson effect and the Boyle-Charles Law. Note that the Joul-Thomson effect is an important principle of thermal dynamics, so that the equipment is very important and frequently used. Thus, 3 units will be supplied to allow the use by small groups.

d) Heat & Mass Transfer Laboratory

The laboratory primarily performs experiments related to heat exchange and mass conversion theory and requests all apparatuses. The basic unit of supply was adjusted to one as the experiments are basically carried out on a demonstration basis or on a rotational basis and these equipment is relatively costly. The selected equipment includes a thermal radiation apparatus, a cross flow heat exchanger, a cooling tower, a liquid extraction unit, a distillation apparatus, separation equipment, an ion exchange unit, a gas absorption column, a tray dryer, and a drum dryer. Note that the thermal conductivity of liquid & gases apparatus, the solid/liquid extraction unit, and the universal evaporator and distillation unit, the laminar/viscous flow heat transfer unit, and the vacuum refrigerator/dryer were dropped in the selection process due to low priority.

e) Analytical Laboratory

At the laboratory, analysis of substances refined through the process equipment is taught and practiced. The requested equipment includes high performance analytical equipment, including an atomic absorption spectrometer, a X-ray diffractometer, a X-ray fluorescence spectrometer, a gas chromatograph, and a high speed fluid chromatograph, and they have been excluded from the selected equipment due to the need for advanced operating skills and high maintenance cost. Later, a strong request was made by the department for the atomic absorption spectrometer. As the laboratory has operated the one which is current unserviceable, and as the equipment has also been requested by the IEER, the Petroleum Engineering Department, and the Metallurgical Engineering Department, and after discussion, it has been confirmed that the equipment can be shared by the four departments, the study team decided that one unit will be supplied to the laboratory. At the same time, a UV visible spectrometer and a Fourier transform infra-red spectrometer have been dropped from the list as they have similar analytical capabilities as the atomic absorption spectrometer. Also, ion exchange resin, a beta scintillation counter, a paramagnetic analyzer, and an automatic elemental analyzer, and an oil in water analyzer were removed due to a low level of urgency or a low frequency of use. The selected equipment includes an inverted biological microscope, a differential thermal analyzer, a gas calorimeter, and a photometer analyzer.

f) Computer Laboratory

The department has requested personal computers, a dot matrix printer, a plotter, and a laser printer. Under the assumption that students in each will be divided into small groups consisting of 10 students each, where two students will share a computer, 5 personal computers will be supplied to meet minimum requirements, plus a laser printer for shared use. Other peripherals including the dot matrix printer and the plotter have been dropped from the final list partly due to a low level of urgency and as they can be purchased by the department under its own budget in the future.

7) Department of Petroleum Engineering

At present, the department offers an undergraduate programme only and plans to establish the master' s programme. The current enrollment is around 30 students in each year, totaling 120. Faculty members are one professor, three associate professors, two assistance professors, and three lecturers, who are supported by technical and administrative staff for laboratory work. The department was founded relatively recently and did not receive equipment by assistance of foreign governments or international organizations. Thus, it does not have its own equipment except for testing equipment donated by some companies in the relevant sector. At present, the department conducts basic laboratory work by using equipment borrowed from the chemical engineering and mining engineering departments. The small number of graduates mostly work with the Oil and Gas Development Corporation. As the department is specialized in the area of petroleum and gas, it is essential for better results of education to use specialized equipment where possible. Note that all the equipment requested by the department will be newly acquired due to the above reason. While the primary objective of the project is to replace deteriorated equipment or supplement equipment in short supply, production of petroleum and natural gas is directly and profoundly related to the national economy, and as the country' s energy industry plans to step up development of these energy sources - natural gas is already produced and supplied on a commercial basis - supply of equipment requested by the department should be given of high priority. Nevertheless, the request contained costly equipment and commercial models that were unsuitable for university education, and an adjustment was made to drop them from the list. In particular, the study team believes that drilling equipment such as an automatic drill press, a relative permeability apparatus, a micro permeameter, a core flooding system, a core resistivity meter, and a miscibility apparatus, and similar field equipment should be learned through external training and field practice offered by the outside organisations. Thus, equipment was selected placing priority on analytical equipment to be used in the department's laboratories.

The selected equipment includes a water-cooled fluid content still, a core resistivity meter, a viscosity meter, an interfacial tensiometer, testing equipment for sulfur in petroleum, and a mud consistometer. An atomic

absorption spectrometer has been removed from the list as it will be supplied to the Chemical Engineering Department for shared use. Also, a gas chromatograph will be supplied to the department for shared use with the IEER and the Chemical Engineering Department.

8) Institute of Environmental Engineering and Research

The IEER does not offer an undergraduate programme. Originally founded as the public health engineering laboratory of the civil engineering department, it conducts undergraduate courses on environmental and public health engineering to undergraduate students of the civil engineering department. The IEER has five laboratories, water quality testing, unit process, air pollution monitoring, water pollution control, and sanitary microbiology.

As laboratory work is conducted for two groups, the basic unit of supply was set at two. The selected equipment includes miniature current flow meters, portable water and hygiene testing systems, smoke testers, sulfur estimation apparatuses, CO_2/CO analyzers, coagulation testers, and oil-in-water analyzers.. Again, the atomic absorption spectrometer will be shared with the Chemical Engineering Department, and the gas chromatograph will be shared with the Petroleum Engineering Department. On the other hand, analytical equipment such as an infra red gas analyzer, an ion exchange apparatus, an ozone analyzer, and a bomb calorimeter has been dropped from the list because it is frequently used and can be borrowed from other departments.

9) Department of Architecture

The department offers a five-year undergraduate programmes as well as master' s and doctoral programmes. The enrollment is around 45 in each year, totaling approximately 200. Note that nearly a half of students are female. The faculty consists of three professors, five associate professors, and three assistant professors, with sixteen technical and administrative staff to assist laboratory and research work. The department has a number of laboratories which are eligible for the project, including graphics presentation, natural

environment, photographic development and printing, surveying, and computer.

The department emphasizes artistic design aspects of architecture rather than engineering. In fact, it requests mainly drafting and audiovisual equipment, except for several measuring instruments. Laboratory work is conducted for five groups, and the basic unit of supply has been determined accordingly. The selected equipment includes ammonia printing machines (A1-sized), photo copying machines (A1-sized), drafting machines, and a distomat

10) Department of City & Regional Planning

The department offers undergraduate and graduate (master' s and Ph.D.) programmes. While the enrollment capacity is 50 in each year, the actual number has been decreasing since 1990 to a present level of 35. The total enrollment in the undergraduate programme is less than 150. Faculty members are five professors, two associate professors, three assistant professors, and two lecturers, with sixteen technical and administrative staff to support laboratory and research work.

The request by the department primarily consists of drafting equipment and audiovisual equipment and tools. An offset printing machine was changed to a copier after discussion. The selected equipment includes CO_2/CO gas analyzers, copiers, drafting equipment and tools, several audiovisual equipment and tools. An exhaust gas analyzer was dropped from the list due to the low frequency of use.

11) Department of Computer Science

The department has only a master' s programme, and there are no undergraduate students enrolled in the department. Instead, it offers computer science, numerical analysis and other related courses to all the engineering students. Faculty members are three professors, two associate professors, three assistant professors, and one lecturer, who are assisted by seven technical and administrative staff. To meet growing demand for computer education by an increasing number of students year after year, the

department is adding two laboratory rooms. New rooms are secured on the second floor of the present building, and no construction work and facilities will be required. The department is currently operating two laboratory rooms. One room accommodates 25 computers equipped with Intel' s 80386 which cannot run recent applications. Another room houses a mainframe and 25 terminals, but they are not in use because the maintenance contract with the supplier has been expired due to the lack of funds. It intends to resume their operation and use them in the four computer training rooms. Each room will accommodate 30-60 students, depending upon the department they belong, and they are divided into groups according to the number of equipment.

The request specifies 25 computers per room, but the final list plans 20 sets by assuming that two student will share one computer. Networking of the computers was also requested to effectively utilize expensive applications. The study team believes that the request is justifiable, and network management techniques will be essential in future computer operation and the provision of the network environment will provide such opportunity. As a result, it was decided to configure the network environment without excess burdens on maintenance. The selected equipment includes 40 computers for 2 laboratory rooms, 2 servers (one in each room), 2 network systems, and printers. As the platform is the IBM-compatible machines, computers in one room will be run by Windows95, and those in another room will use WindowsNT or UNIX to serve as workstations.

12) Department of Mathematics

The department teaches applied mathematics and industrial mathematics to freshmen of the civil engineering, mining engineering, chemical engineering, and architecture departments. While it does not have a undergraduate programme, it has less than ten graduate students (both master' s and Ph.D.). Faculty members are four professors, associate professors, assistant professors, and two lecturers, with eight technical and administrative staff. The department has one laboratory, applied mathematics, to teach basic mechanics.

The equipment requested by the department is used in the laboratory, mainly consisting of Fletcher's trolleys required to measure acceleration, other

mechanics models, and basic measuring instruments such as stop watches an vernier calipers. Among them, stop watches (which can be purchased by the department budget) and several equipment for which existing equipment is available have been dropped from the list.

13) Department of Chemistry

The department teaches applied chemistry to freshmen of the electrical engineering, mining engineering, metallurgical engineering and materials science departments, and freshmen and sophomore year students of the chemical engineering department. While it does not have a undergraduate programme, it offers the master's and doctoral programmes, and nearly 20 students are studying in the master's programme. Faculty members are five professors, four associate professors, two assistant professors, and one lecturer, with thirteen technical and administrative staff. It has five laboratories, physical chemistry, organic chemistry, inorganic/analytical chemistry, geochemistry, and biochemistry. At present, an emphasis is placed on education and research activities in the fields of biochemistry and electrochemistry.

The requested equipment will be used for undergraduate education, including a flash point apparatus, a Saybolt viscometer, a bomb calorimeter, a UV visible spectrometer, a furnace and other basic chemical laboratory equipment and tools. Among them, the flash point apparatus and the softening point apparatus have been dropped due to availability of existing equipment to serve the same purpose. The Saybolt viscometer and the bomb calorimeter were excluded as they are expected to lose priority when the syllabus is revised in the future.

14) Department of Physics

The department teaches applied physics to all undergraduate students. It does not have its own undergraduate students, and it plans to open a graduate programme soon. The faculty consists of two professors, three associate professors, two assistant professors, and two lecturers, with seven technical and administrative staff to assist laboratory and research work. As the

department's education is limited to applied physics in the field of electricity, the number of requested equipment is very small. At present, there is the shortage of measuring instruments, and many are borrowed from the electrical engineering department. Experimental sets are hand-made and serve the purpose of basic experiment. An ionization current measurement gage has been dropped from the list due to the low frequency of use. The selected equipment mainly consists of measuring instruments such as a X-Y recorder, a lock-in amplifier, a spectrometer, digital multimeters, magnetic field measurement apparatuses, and electric field and potential measurement apparatuses, and power supply units used for various experiments.

15) Workshop

The workshop belongs to the Mechanical Engineering Department and is supervised by the chairman of the department. The workshop is a place for learning handwork and machining techniques by freshmen of the departments of electrical engineering, chemical engineering, metallurgical engineering and materials science, mining engineering, as well as the mechanical engineering. The workshop class is taught by a faculty member of the mechanical engineering department and instructors assigned to the wokshop.

The requested equipment includes computers, woodworking machines and tools, machining tools and machinery, electrical check and measurement devices, engine and other models, specifically a CNC lathe, a CNC milling machine, a TIG welder, a MIG welder, a die casting machine, a shear machine, an insulation oil tester, a Wankel engine model, and a gasoline engine model. The CNC lathe and milling machine have been dropped from the list as they can be shared with those owned by the mechanical engineering department. The die casting machine has been removed due to difficulty in operation and other factors making it unsuitable for the freshmen workshop.

16) Library

The original request specified equipment and tools for the library (used by students and faculty members) and the lecture hall in the building. However, equipment and tools requested were a generation old and have been largely

revised by reducing common audiovisual equipment, typewriters and microfiches (not frequently used) and by replacing an offset printing machines with copiers. Audiovisual equipment for the lecture hall was revised to develop them into a basic system. The selected equipment includes a video projector planned for image presentation, copiers, and several audiovisual equipment and tools.

2-3 Basic Design

2-3-1 Design Concept

(1) Basic design criteria

Based on the discussions during the field study, the request by the Pakistan government was evaluated. Then, basic design criteria (selection criteria) was set as follows.

1) Equipment with high priority

① Replacement of equipment which is currently in use and has become technologically obsolete, which function or precision level has deteriorated due to aging, or which has become unserviceable due to damage
② Addition of equipment which quantity is less than required for lecture or laboratory work
③ New acquisition of equipment which is not available although it is urgently required under the present curriculum

2) Equipment with low priority

① Highly advanced equipment which is used only for research purposes
② Equipment which installation or use is difficult due to insufficient infrastructure

③ Costly equipment which is infrequently used
④ Equipment which spare parts or consumable stores are difficult to obtain due to financial or geographical constraints

Based on the above criteria, performance levels required for the selected equipment and specifications were established as follows:

① Adequate performance levels for university engineering education
② Equipment generally used at the campus
③ Equipment which requires minimum practicable costs for operation and maintenance
④ Equipment which conforms to local laws, regulations and standards
⑤ Equipment for which after-sales support by a local agent is available
⑥ Specifications not limited to a specific manufacturer
⑦ Equipment which does not cause environmental pollution or which is provided with adequate pollution control

(2) Major considerations

In designing the equipment procurement plan, the following considerations were given on the basis of conditions of the project site and infrastructure related thereto.

1) To provide uninterrupted power supply (UPS) units with a sufficient capacity for equipment which is relatively costly, has a memory mechanism, and is operated or used for a relatively long period of time.

2) To provide automatic voltage regulators (AVRs) with a sufficient capacity for powered equipment which is easily damaged by voltage fluctuation (±10%) and cannot be repaired shortly within the country.

3) To include minimum quantity of spare parts to those items of equipment that require supply of spare parts.

4) To include necessary consumable to meet requirements during the commissioning of the equipment.

(3) Major considerations to procurement sources

Actual procurement sources will be determined in consideration to the effective use of equipment, the ease of maintenance. Basically, the following sourcing methods will be adopted.

1) Equipment requiring periodical maintenance and frequent replacement of consumable stores, such as printers and copiers, and equipment which is desirable to be procured locally for the convenient of upgrading (including software) such as personal computers: Local products or those most widely used, regardless of their country of origin, will be procured through local agents.

2) Basic measuring instruments, analytical equipment, and experiment kits, and similar laboratory equipment: Those which are specialized in educational purpose, which come with sufficient manuals, and which need to consider the ease of use or measuring standards will be procured from third countries other than Pakistan and Japan.

2-3-2 Basic Design

(1) Project site

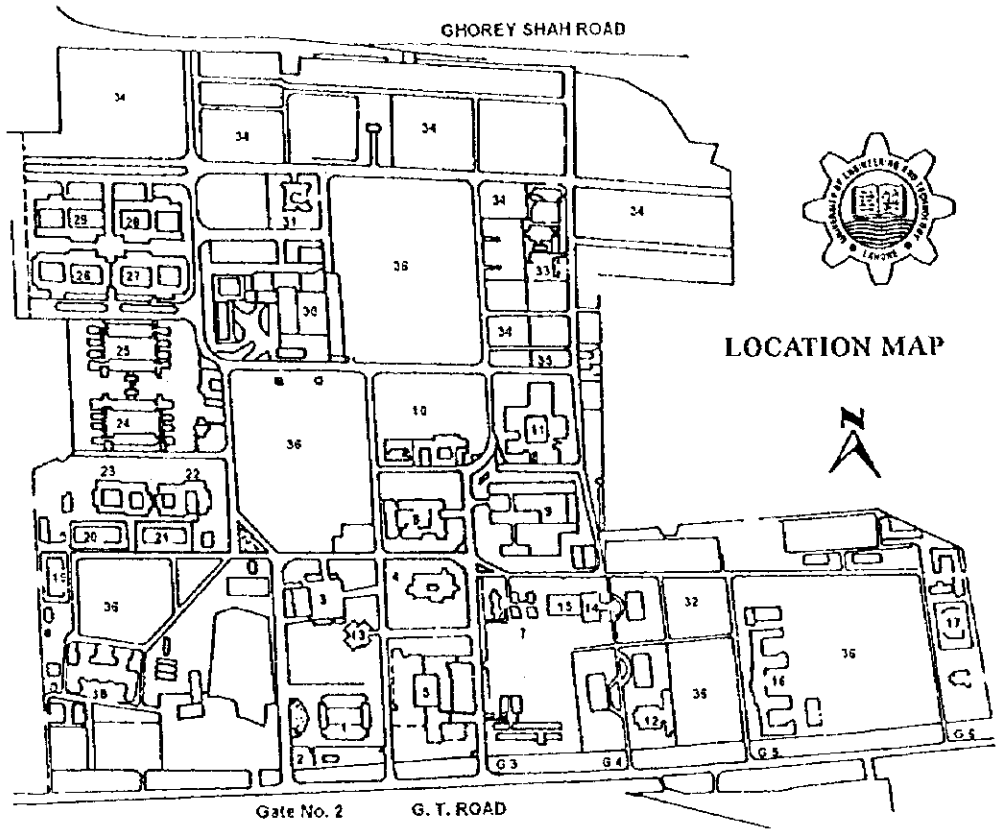
The project site is located within the campus of the University of Engineering and Technology, Lahore, which is situated in the central part of Lahore, the provincial capital of Punjab and the second largest city in Pakistan. On the east side of the Lahore Station, the campus has land area of 75ha and accommodates around 30 buildings including departments, administrative office, and dormitories. Each department occupies its own building(s) or quarter(s)

which are mainly two stories, including ample space for laboratory use. Thus, there is a sufficient space for installing all the equipment to be supplied under the project. Also, required utilities services including electricity, water and gas are accessible to all the laboratories to allow smooth equipment operation. Also, there is an ample space for transportation and temporary storage of equipment during the installation work. Laboratory rooms where equipment will be installed are securely locked except for class hours, and laboratory attendants are assigned to the proper management of room keys and equipment. Movable equipment is placed in stores annexed to laboratories while not in use, while large equipment (both desktop and floor types) is kept at a designated location within each laboratory. Finally, computers and other equipment which is easily removed are fixed to tables, and department names are inscribed on a clearly visible location such as the front side of a display unit. Equipment maintenance and security appear to be sufficient to keep equipment safely and in good condition. Thus, the university's department buildings are acceptable as the project site.

Fig.2-1 shows a general layout of the campus.

(2) Equipment selection and planning

The equipment will be used by some 300 faculty members and nearly 5,500 students. It will be managed and maintained by around 400 technical staff and laboratory assistants of each department. Laboratory work is conducted by grouping 50-70 students (for large departments) or 20 (other departments) into a class according to the department or course, which is further divided into small groups in accordance with the number of available equipment. As the university has policy to provide hands-on experiments for students in laboratory work, it intends to secure the number of equipment comparable to student population, except for costly equipment. For this reason, the number of equipment was determined to ensure that as many as students possible will be able to use it for a required period of time while giving consideration to the availability of existing equipment at the campus.



1	Administration Block	13	Islamic Studies Dept.
2	Bank	14	Mathematics Dept.
3	Mosque	15	Computer Science Dept.
4	Library	16	Main Block
5	Electrical Eng'g Dept.	17-29	Halls
6	IEER	30	Sport Complex
7	Lecture Theatre	31	Health Clinic
8	Architecture & CRP Depts.	32	A-Hall
9	Civil Eng'g Dept.	33	Girls Hostel
10	Chemical/Metallurgical Eng'g Dept.	34	Staff Residences
11	Mining/Petroleum Eng'g Dept.	35	Guest House
12	Mechanical Eng'g Dept.	36	Play Grounds

Fig. 2-1 Map of UETL Campus

Table 2-1 lists major equipment and its general description. A complete equipment list is contained in Appendix 6 and layout plans of laboratories in Appendix 7.

Table 2-1 Outline of Major Equipment

NO.	DESCRIPTION	Application/specification	Q'ty
	CIVIL ENGINEERING DEPARTMENT		
	CONCRETE LABORATORY		
CCT-01	Compression Testing Machine	Used to test compressive strength of concrete. 100 tons or more	1
CCT-02	Portable Core Drill Machine	Used to cut out concrete specimen out in the field for compressive testing. Powered by small engine.	1
CCT-03	Heavy Duty Masonry Saw	Used to cut out stone specimen for testing.	1
CCT-04	Resonant Frequency Tester	Non-destructive testing equipment to examine strength of concrete by measuring resonance frequency	1
CCT-05	Pundit Ultrasound Tester	Non-destructive testing equipment to examine porosity or crack in concrete	1
CCT-06	Micro Cover Meter	Used to measure concrete thickness covering reinforcement.	1
CCT-07	Concrete Corrosion Mapping System	Used to map the extent of concrete corrosion.	1
CCT-08	Windsor Prob System	Used to estimate internal conditions of a material on the basis of propagation of shock wave.	1
CCT-12	Automatic Cement Test System	Used to keep concrete specimen at specific temperature.	1
CCT-18	Creep Test Apparatus	Used to apply load to concrete over long hours and at specific temperature to measure creap.	1
CCT-19	Concrete Permeability Apparatus	Used to examine permeability (important physical property) of concrete accurately.	1
CCT-21	Thermostatic Curing Tank	Used to keep concrete specimen at specific temperature.	1
	EARTHQUAKE ENGINEERING LABORATORY		
CEE-01	Signal Enhancement Seismograph	Equipment to examine characteristics of a structure by applying impulse input, recording response, and analyzing changes in acceleration. Consisting of an accelerometer and a device to amplify and record waveform representing acceleration.	1
CEE-02	Seismic Digital Timer		1
CEE-04	Servo Accelerometer		1
CEE-07	Universal Testing Machine	Used to conduct compression, tensile, bending tests on concrete and reinforcement materials. Approx. 50t	1
CEE-12	Rockwell Hardness Machine	Used to measure hardness of a material by pressing diamond cone/steel ball onto surface of specimen and measuring depth of dent made.	1
CEE-14	Fatigue Testing Machines	Used to examine fatigue characteristics of a material by applying load to specimen repeatedly until destruction.	1
CCE-16	Universal Structural Testing Frame and Experimental kit	Used to learn mechanical characteristics of various structural models.	1
	SOIL MECHANICS & FOUNDATION ENGINEERING LABORATORY		
CSF-13	Modified Mechanical Compactor	Used to perform mechanical compaction of soil for testing.	1
CSF-14	Load Cells	A set of equipment to measure load accurately. Approx. 5kg - 100t.	1
CSF-17	Specimen Cutting Machine	Used to cut out specimen from pavement material for	1
CSF-24	Teraxial Test System	Used to perform triaxial compression test that is an important means to examine soil strength. Accompanying an analyzer.	1
CSF-26	Digital Direct Shear Apparatus	Used to perform box shear test to measure soil strength by examining permeability under varying water pressure conditions. Digital type.	1
CSF-28	Expansion Index Test Apparatus	Used to measure expansion coefficient of soil.	1
CSF-32	Falling Head Permeameter	Used to estimate water flow in soil by measuring permeability coefficient under the condition that water head lowers with permeation.	1
CSF-50	Relative Density Set	Used to measure relative density that is an important physical property of soil.	1
	HIGHWAY AND TRANSPORTATION LABORATORY		
CHT-03	Asphalt Mixer	Used to mix asphalt.	1

NO.	DESCRIPTION	Application/specification	Q'ty
CHT-08	Traveling Beam Device	Used to measure bearing capacity of ground by applying pressure to a rectangular plate and determining depth of ground settlement.	1
CHT-30	Friction Tester	Used to measure sliding resistance that is an important criteria to evaluate road surface.	1
	HYDRAULICS & IRRIGATION LABORATORY		
CHI-02	Francis Turbine	Used to test Francis turbine that is widely used for hydro-electric generation.	1
CHI-06	Fluid Friction Apparatus	Used to measure friction resistance of water flowing through a pipe in a multi-faceted way.	1
CHI-07	Pipe Surge & Water Hammer Apparatus	Used to learn water hammering phenomenon caused by self-excited vibration of pressure in a pipe and propagation of water's pressure wave.	1
CHI-10	Multipump Test Rig	Used to conduct performance test on pumps, including discharge, water head and axial power.	1
CHI-17	Glass Sides Tilting Flume 10m Length	A water channel (Approx. 10m long) to conduct a variety of experiment, capable of varying slope and having glass walls to allow observation from outside.	1
CHI-18	Adjustable Bed Flow Channel	A water channel capable of varying water flow (Approx. 1m long)	1
CHI-19	Laminar Flow Analysis Table	Used to learn flow through a pipe, particularly laminar	1
	SURVEYING LABORATORY		
CSV-01	Electronic Total Station	An integrated surveying system including measurement of distance. Linearity - Approx. 2mm; angle - Approx. 0.5 seconds	1
CSV-03	Electronic Distance Meter	Used to measure distance between two points. Measurement range of 900mm.	1
CSV-11	Gyroscopic Theodelite	A self-adjustable theodolite using gyro. Angle - Approx. 1 second	1
CSV-19	Highway Design Software	Used to practical training on road design.	1
CSV-20	GPS Differential Receiver	Used for accurate measurement of position. Two-frequency type; accuracy - Approx. 5mm	1
	ELECTRICAL ENGINEERING DEPARTMENT		
	REPLACEMENT OF OLD EQUIPMENT		
EER-06	Logic Analyzer	Used to analyze operating principles of a logic circuit by converting digital signals into waveform. Channel - 16; frequency range - Approx. 100MHz	1
	TRAINERS REQUIRED FOR THE DEPARTMENT		
EIN-06	Colour Television Traner	Used to learn operating principles of television by using TV circuits that are divided into panels. PAL system.	1
	ELECTRONICS ENGINEERING LABORATORY		
EEN-15	Logic Circuit Equipment	Used to learn operating principles of logic circuits and basics of logic circuit design by configuring a logic circuit. Logic circuit: 3 types	2
EEN-20	Logic Analyzer	Used to analyze operating principles of a logic circuit by converting digital signals into waveform. Channel - 16; frequency range - Approx. 100MHz	1
EEN-23	Frequency Response Tracer	Used to learn characteristics and operating principles of a servo system by measuring and analyzing frequency characteristics, delay and power spectrum of a servo system. Channel - 2; frequency range - Approx. 10Hz - 100KHz	1
	CONTROL SYSTEM LABORATORY		
ECS-01	DC Speed Control Training System	Used to learn speed control of DC motors. No. of servo motors used for training; more than 5 types including hybrid.	2
ECS-02	AC Servo and Synchro System	Used to learn speed control of AC motors. Training items: up to 15 including motor speed control.	2

NO.	DESCRIPTION	Application/specification	Q'ty
ECS-03	Air Flow, Temperature Control Training System	Used to learn a temperature control mechanism by adjusting air flow. Blower - 5 litter/second; temperature range - Approx. 20℃ - 70℃	2
ECS-09	Magnetic Levitation System	Used to experiment magnetic levitation theory for linear motors. Setting range - Approx. 20mm.	1
ECS-10	Digital Pendulum Control System	Used to learn automatic control of pendulum motion in various aspects including cycle and speed.	1
ECS-11	Twin Rotor Mimo System	Scaled model of a non-linear, unstable dynamic MIMD system. With main rotor and tail rotor.	1
ECS-13	Pneumatic control Teaching Mechanism	Used to learn control of a drive mechanism by air pressure. Range of control air pressure: Approx. 20-400psi	1
ECS-14	Hydraulic Servo System	Used to learn a drive mechanism by water pressure. Rotary piston motor speed: 1500rpm; flow gauge - Approx. 0.115	1
	COMMUNICATION ENGINEERING LABORATORY		
ECN-01	Spectrum Analyzer	Used to measure energy density included in a unit frequency bandwidth	
	a)Type A	Frequency bandwidth: Approx. 10 kHz - 2 GHz	1
	b)Type B	Frequency bandwidth: Approx. 2GHz/CD coupled input type	1
	c)Type C	Frequency bandwidth: SHF range (Approx. 30GHz)	1
ECN-19	VHF Signal Generator	FM/AM modulation wave signal generator for experimenting a high harmonic circuit. AM: Approx. 450KHz-2MHz; FM: Approx. 8MHz - 110MHz	2
ECN-20	Pulse Generator	A generator of various waveform signals used for input to an experiment using a circuit. Approx. 50MHz; waveform - sine, sawtooth, triangle	2
ECN-35	Computer Aided Analogue and Digital Communication trainer	Used to conduct experiments on communication technology including modulation, demodulation and detection of analog and digital signals. Modulation: AM/FM/DDP/PCM High speed access: Approx. 100M sample/sec	2
ECN-37	Antenna System Demonstrator	Used to learn propagation of radio wave and analyze directivity and efficiency by emitting simulated radio wave from antenna. Frequency band: Approx. 150MHz; output - Approx. 0.5W	2
ECN-38	Antenna Modeling System	Sample models for various types of antennas: More than three types	1
	MICROWAVE LABORATORY		
EMR-01	Microwave Education Test Bench	Used to learn Gunn oscillation that is the basis of microwave and basic characteristics of microwave. Action: 3-port circulation	2
EMR-40	Wide Micro-storip Training System with Software	Used to learn applied microwave technologies such as antenna, wave guide and transducer.	1
	ELECTRICAL MACHINE LABORATORY		
EML-14	Advance Electrical Machine 4Q Drive System, Micropocessor Based Measuring System	Used to learn a scan drive system, a drive system to obtain maximum output efficiency by monitoring and automatic controlling motors and generators on the basis of their characteristics.	1
EML-15	AC Motor Drive with Built-in Vector Visualizer Frequency Converter	A motor used as a drive source for the above system. Motor output: Approx. 1KW	1
EML-20	Inverter Bridge	Used to learn operating principles of AC converter action. Type: 6-pulse, rectification bridge	1
	POWER SYSTEM LABORATORY		
EPS-01	Power System simulation Software, network planning and network optimization and alongwith PC based network for at least 20 students	Used to practice optimum design of high voltage power transmission, receiving and transformation systems through simulation. Hardware platform: DOS5 simulation software: power source, transmission, operation control,	1

NO.	DESCRIPTION	Application/specification	Q'ty
EPS-02	Complete laboratory control and monitoring equipment and software package for the following power station simulation.	Used to practice optimum design of monitoring systems of power station facilities including turbines and power distribution facilities through simulation. Measurement items: 8; Simulation items: Approx. 60	1
EPS-03	Power System laboratory or equivalent with following modules		
	(1)Power Plant Module with High Voltage Busbars and Outgoing Lines	Simulated practice unit for the handling of high pressure output from the turbine. Voltage for pressure rise: 1200V; Capacity of four-pole cycle generator: Approx. 1KVA	1
	(2)Transmission Lines Module	Simulated practice unit for high voltage transmission lines. HV double link voltage: Approx. 130KV; MVP link voltage: Approx. 40KV	1
	(3)Receiving Substation Module with High Voltage Side and Medium Voltage Feeders	Simulated practice unit for power receiving and transformation facilities. No. of input lines: 2 (HV bus bar, with transformer); No. of output lines: 2	1
	(4)Load Module	Load device for the above simulated practices. Load: Inductance motor Approx. 0.5KV	1
	HIGH VOLTAGE LABORATORY		
HV-03	Digital Micro Ohm Meter	A resistance meter to measure cable's resistance. Minimum resolution: Approx. 1 $\mu\Omega$	2
HV-04	Automatic Schering Bridge	Used to test high voltage characteristics by measuring capacitance and loss angle. Range of voltage measurement: Approx. 300V-1KV	1
HV-06	Instrument Transformer Test Set	Used to examine performance of transformers by measuring phase angle and proportion differential. Test voltage: 2V-240V	1
HV-12	Impulse Voltage Generator Equipment	A surge voltage generator to learn characteristics of high voltage. Maximum output voltage: Approx. 300KV	1
HV-15	Surge Scope	High voltage oscilloscope to monitor the above impact voltage. Frequency range: AC5KHz - 10MHz; trigger speed: Approx. 100 μ s/100mm	1
HV-18	Tensile Tester Table Top 200kg	Used to test tensile strength of cables, etc.	1
HV-21	Profile Projector	Used to observe a metal surface (cable) damaged by impact voltage. X-Y range: Approx. 50x50mm	1
HV-26	Null Detector for EHV Schering Bridge	Used to detect changes in zero potential by using transformer phase circuits and variable ratio error. Frequency range: 55±8Hz	1
HV-33	Digital Oscilloscope with Printer	Used to digitize and monitor potential variation and record the changes. Frequency range: DC~200MHz	1
	MECHANICAL ENGINEERING DEPARTMENT		
	HEAT TRANSFER AND THERMODYNAMICS LABORATORY		
MHT-01	Steam Power Plant	A practice unit to learn performance of steam boilers, turbines, generators and similar equipment. Power generation capacity: Approx. 1-2KW	1
MHT-02	Engine Test Bed	A practice unit to measure engine power under various conditions.	1
MHT-05	Emission Analyzer	Used to analyze contents of combustion gas, such as oxygen and CO_2	1
MHT-06	Photovoltaic Trainer	Used to learn performance of photovoltaic generation	1
MHT-08	Temperature Measurement Unit	A measuring device to allow comparison and evaluation of various sensors.	1
MHT-09	Concentric Tube Heat Exchanger	Used to measure heat exchange performance of double pipe structure.	1
MHT-10	Bench Top Demo Cooling Tower with Columns	Used to measure performance of a cooling tower to cool high temperature fluids.	1
MHT-12	Boiling Heat Transfer Unit	An experimental unit to measure coefficient of heat transfer under boiling condition.	1
MHT-13	Turbulent Flow Heat Exchange, Water to water	An experimental unit to measure heat exchange performance between water and water in turbulent condition.	1

NO.	DESCRIPTION	Application/specification	Q'ty
MHT-18	Cross Flow Heat Exchanger	An experimental unit to measure performance of the series/parallel type heat exchanger.	1
	FLUID MECHANICS LABORATORY		
MFM-01	Basic Hydraulic Bench with Attachments	An experimental unit to learn basic fluid mechanics theory.	1
MFM-02	Practical Training Package For Compressor,Pump and Turbine	An experimental unit to measure performance of basic hydraulic equipment such as pumps, turbines and fans.	1
MFM-06	Compressible Flow Bench	An experimental unit on air flow produced by air compressor.	1
MFM-07	Educational Wind Tunnel	A wind tunnel capable of adjusting wind velocity to measure fluid resistance of various models such as vanes.	1
MFM-11	Nozzle Performance Study System	A device to learn injection characteristics of nozzles of various shapes.	1
	REFRIGERATION AND AIR CONDITIONING LABORATORY		
MRA-01	Mechanical Heat Pump	Used to learn characteristics of a mechanical heat pump, mainly thermal efficiency.	1
MRA-02	Recirculating Air Conditioning Unit	Used to learn characteristics, operation and maintenance of air-conditioners.	1
	MECHANICS OF MACHINES LABORATORY		
MML-01	Static and Dynamic Balancing Machine	A device to learn the meaning of a heavy balance in the machine's rotating part and the balancing method.	1
MML-02	Whirling of Shaft Apparatus	A device to understand critical revolution.	1
MML-05	Torsional Vibration Apparatus	Used to learn torsional vibration when torque is applied to the shaft.	1
MML-06	Vibration Apparatus	A device to learn characteristics of free and forced	1
	MATERIAL TESTING LABORATORY		
MMT-01	Universal Testing Machine	Used to conduct tensile, compression and bending tests of machine elements. Around 30 tons.	1
MMT-02	Metallurgical/Industrial Microscope	Used to observe metal texture.	1
MMT-03	Chary Impact Testing Mechine	Used to determine strength of machine elements against	1
	CNC/CAD/CAM LABORATORY		
MCD-01	Instructors Workstation	A set of equipment to learn programmed operation of NC machine tools (widely used in the country) by observing actual programming and movement. Consisting of computers and small machine tools.	1
MCD-03	CNC Milling Machine		1
MCD-04	CNC Lathe		1
MCD-05	Software		1
	MINING ENGINEERING DEPARTMENT		
	MINE VENTILATION LABORATORY		
MMV-05	Total Sulfur Estimation Apparatus for Coal	Used to analyze the amount of sulfur contained in coal.	1
MMV-17	Mine Ventilation Educator	A device to perform simulated ventilation using various	1
MMV-18	Layering of Roof Gases Apparatus	An experimental unit to learn gas flowing through the upper part of a mine.	1
	MINE SURVEY LABORATORY		
MMS-04	Total Station with Traverss Target System	An integrated surveying system including measurement of distance. Linearity - Approx. 2mm; angle - Approx. 0.5 seconds	1
MMS-11	Auto Reduction EDM Alidade with Plane Table	A surveying device to determine the shape and size of a topographic feature.	1
	MINERALOGY AND PETROLOGY LABORATORY		
MPM-05	Rock Cutting and Trimming Machine	A machine used to cut out and shape rock specimen.	1
MPM-06	Resistivity Meter	Used to estimate ground components by measuring specific electric resistance for exploration.	1
	MINERAL PROCESSING LABORATORY		
MMP-05	Lab. Model plate electrostatic Separator	An experimental unit to classify ores on an electrostatic charged flat plate.	1
MMP-06	Lab. Model Screen Plate Electrostatics Separator	An experimental unit to separate ores by combining sieves and electrostatic.	1
MMP-16	Air Classifier	An experimental unit to separate ores by combining a blower and rotary blade.	1
MMP-24	Multigravity Separatory Lab. Unit	An experimental unit to classify washed ores dynamically through multi-stages.	1

NO.	DESCRIPTION	Application/specification	Q'ty
MMP-26	XRF Chemicla Analysis Equipment for Minerals and Rocks	Used to analyze various elements contained in ore. Portable type	1
	ROCK MECHANIC LABORATORY		
MRM-01	Portable Sheer Box Assembly	Portable cutter to crush rock into small pieces.	1
MRM-02	Rock Specimen Preparation Machine	Used to cut out rock samples by saw action.	1
MRM-03	Data Logger	A recording probe used for static measurement of rock's distortion and stress	2
MRM-04	Triaxial Compression Machine	A testing device to determine basic mechanical properties of rock.	1
	METALLURGICAL ENGINEERING & MATERIAL SCIENCES DEPARTMENT		
	CAST METALS RESEARCH LABORATORY		
LCR-10	Sand Mill	Used to crush sand mass or mix sand.	2
LCR-11	Universal Sand Strength Machine	Used to measure tensile force, withstanding pressure and shear force of molding sand specimen.	2
	CORROSION ENGINEERING		
LCE-03	Corrosion Studies Kit	A kit to learn characteristics of various types of corrosion.	1
	ANALYSIS LABORATORY		
LAL-04	Optical Emmerssion Spectrometer	Used to totally analyze elements contained in metal.	1
LAL-05	O.S Determination Apparatus	Used to analyze carbon and sulfur which strongly affect strength of steel.	1
	INSPECTION & TESTING LABORATORY		
LIT-03	Digital Micro Hardness Tester	Used to measure hardness of metallic materials in a wide range.	1
LIT-05	Digital Rockwell Hardness Tester	Used to determine hardness of metal from the depth of a dent made by a diamond probe. Digital type.	1
LIT-07	Charpy Impact Tester	Used to destroy a specimen by the pendulum's kinetic energy and measure strength of a metallic material against shock.	1
	HEAT TREATMENT LABORATORY		
LHT-01	Furnace	Used to heat metal for heat treatment. Maximum temperature - Approx. 1,300 ℃	1
	CHEMICAL ENGINEERING DEPARTMENT		
	FLUID FLOW & PARTICLE TECHNOLOGY LABORATORY		
CFP-01	Hydraulic Bench	A practice unit on hydraulics by using an open channel and measuring flow rate, water level and pressure gage calibration. Maximum flow rate: Approx. 1.3-1.5 liter/sec	1
CFP-02	Compressible Flow Bench	An experimental unit on fluid technology, such as friction loss, by flowing compressed water through a pipe. No. of manometers - vertical 2, inclined 2	1
CFP-04	Fixed and Fluidized Bed Apparatus	Used to facilitate the study of flow through both fixed and fluidized bed of solid particle. Water flow range: Approx. 0.2 - 2 liters/min. Air flow range: 2 - 25 liter/min.	1
CFP-12	Multi Pump Test Rig	Used to learn operating principles of various types of pumps and test performance. Type of pump used: Type 4; Range of torque measurement: Approx. 0-1Nm	1
CFP-13	Centrifugal Compressor Demo Unit	Used to learn measurement of pressure, propulsion force, etc. by using characteristics of centrifugal force. Maximum pressure: Approx. 0.7kpa; Flow rate: Approx. 0.1m3/sec	1
CFP-23	Jaw Crusher	Used to crush a solid matter by compression. Crushing size: Approx. 8mm	1
CFP-26	Roll Crusher	Used to crush a solid matter by roller. Crushing size: Approx. 8mm.	1
CFP-27	Standard Sieve Set with Shaker	Used to classify particles by size through a vibration device. Particle size: Approx. 0.1-5.5mm	2
CFP-29	Microscope	A polarization microscope to observe particles. Objective lens: x4 - x100; Eye lens: x10	1
CFP-33	Centrifugal Fan Demo Unit	Used to practice ventilation and fluid transportation by blower control. Maximum pressure: Approx. 0.7kpa; flow rate: Approx. 0.1m3/sec	1
	INSTRUMENTATION & CONTROL LABORATORY		

NO.	DESCRIPTION	Application/specification	Q'ty
CIC-02	Electrical Console	A basic control panel for various controllers. Voltmeter range: Approx. 0-1V; Ampere range: Approx. 0-20mA	1
CIC-09	pH Control Accessory	Used to practice control of acid/alkaline injection and pH. Process tank capacity: 2 litre; Range of flow rate measurement: Approx. 20-300ml/min	1
CIC-10	Remote Set Point Control Accessory	Used to learn methodology on secondary control of an objective which cannot be directly controlled.	1
CIC-13	Process Control Trainer	Used to practice control the entire process which combines the above control operations.	1
	REACTION ENGINEERING & THERMODYNAMICS LABORATORY		
CRT-01	Continuous Stirred Tank Reactor	Used to learn continuous mixing and chemical reaction caused by heat, catalyst and radiation. Capacity: Approx. 1.5 liter	1
CRT-02	Tubular Flow Reactor	Used to conduct chemical reaction experiments in a piped structure. Capacity: Approx. 1.4 liter	1
CRT-03	Stirred Tank in Series	Used to conduct chemical reaction experiments by mixing. Capacity: Approx. 5 liter x 2 tanks	1
CRT-04	Batch Reactor	Used to conduct experiments related to quantitative reaction. Capacity: Approx. 0.4 liter	1
	HEAT & MASS TRANSFER LABORATORY		
CHT-01	Thermal Radiation Apparatus	Used to conduct experiments related to radiation heat on a heating plate and absorbed heat energy. Radiation source: Approx. 400W: heat source: Approx. 40W	1
CHT-02	Free & Forced Convection Heat Transfer Apparatus	Used to conduct experiments on heat energy transfer due to convection. Range of temperature measurement: Approx. 0-150℃; Duct: vertical type.	1
CHT-05	Cross Flow Heat Exchanger	Used to conduct experiments on heat exchange through interaction. Array of heat exchange through cross flow: 5 rows or more; Output: RS232C	1
CHT-06	Cooling Tower	Used for basic training on cooling control in the industrial process. Heat source: Approx. 1.5KW; Fan capacity: Approx. 0.05kps^{-1} Thermocouple: Type K	1
CHT-07	Mass Transfer and Diffusion Coefficient Apparatus (Liquid & Gases)	Used to conduct experiments on mass transfer and diffusion of gas and liquid. Bath capacity: Approx. 4 liters; heat source: Approx. 500W; range of temperature control: Approx. 0-60℃.	1
CHT-08	Liquid Extraction Unit	Used to learn methodology on extraction of specific samples dissolved in a liquid specimen. Extraction batch size: Approx. 1.2m, diameter; Approx. 50mm, pump capacity: Approx. 250ml/min.	1
CHT-10	Fluidised Bed Drier	Used to learn the drying of fluid settled in a lower year. Temperature range: Approx. 20-200℃.	1
CHT-12	Distillation Apparatus Packed Column, Computer Interfaced,	Used to conduct experiments and training of the distillation process by boiling point control, control of cooling temperature, etc.	1
CHT-14	Batch Fractionation Pilot Plant	Used to conduct experiments on distillation of volatile mixture with different boiling points. Distillation tower: Approx. 50mm diameter; Duration of heating one faction: 1-2 hours	1
CHT-15	Boiling Heat Transfer Unit	Used to conduct heat exchange experiments using boiling heat. Glass cylinder diameter: Approx. 50-75mm; length; Approx. 300mm; thermocouple; type K	1
CHT-19	Concentric Tube Heat Exchanger	Used to conduct experiments on distillation requiring high resolution. Heat exchange area: Approx. 006m^2; liquid tank capacity: Aporox. 40 liters	1
CHT-23	Gas Absorption Column	Used to learn characteristics and methodology related to fluid mechanics and absorption control and treatment.	1
CHT-24	Tray Drier	Used to practice the drying process including dry ratio on a fixed plate, energy balance, air flow efficiency, etc.	1

NO.	DESCRIPTION	Application/specification	Q'ty
CHE-25	Drum Drier	Used to practice the above drying practice in a rotating drum. Dry drum capacity: Approx. 0.2m^3; drum diameter: Approx. 300mm; drum length: Approx. 200mm.	1
	ANALYTICAL LABORATORY		
CAL-01	Photometer Analyzer for Kinetic Enzyme	Used to measure reflectance factor and penetration rate of light projected on a test object and conduct characteristic test. Wavelength of light source: Approx. 200-1000mm; resolution: Approx. 0.1mm	1
CAL-02	Inverted Biological Microscope	A microscope for an opaque object. Objective lens: x10; eye lens: x4 - x40	1
CAL-24	Differential Thermal Analyzer	Used to measure the heat of samples and base material for differential thermal analysis. Scanning speed: Approx. 480°/sec	1
CAL-27	Gas Calorimeter	Used to measure the calorific valve of combustion gas. Inlet pressure: Approx. 200mmH_2O	1
CAL-47	Atomic Absorption Spectrometer	Used for determination of propertries of sample materials by atomic absorption spectroscopy. Wavelength range: Approx. 200-1000 μ m	1
	PETROLEUM ENGINEERING DEPARTMENT		
PED-03	Soxhlet Extraction Apparatus	An experimental unit to practice the basic petroleum refining process through extraction of soluble substances into alcohol/ether.	1
PED-10	Fluid Content Stills, Water Cooled Type	Used to practice cooling distillation of volatile fine particles. No. of racks: Approx. 15	1
PED-14	Universal Porometer	Used to measure porosity of rock by measuring absorption rate of compressed gas. Sample tank capacity: Approx. 40cm^3	1
PED-40	Automatic Flash Point Tester	Used to measure ignition point of volatile matter. Testing method: balancing by using a sealed cup; heating: gas; range of measurement: 0℃ - 100℃	1
PED-41	Automatic Kinematic Viscosity Measuring System	Used to measure resistance to powered rotation and conduct viscosity test on samples. Range of measurement: Max. 100,000 μ m2/sec. Range of temperature control for constant temperature bath: Max. 100℃	1
PED-47	Density / Sp. Gr. Meter	Used to measure gravity variation with geological differences, and practice mineral exploration.	1
PED-53	Rotary Viscometer		1
PED-59	Interfacial Tensiometer	Used to measure boundary tension between two layers (gas/liquid, gas/solid, etc.). Pressure: Approx. 5,000psig	1
PED-68	Test for Sulfur in Petroleum	Used to measure sulfur content in an object. Lamp type; sample capacity; 10mm; pump capacity; Approx. 1,800	1
PED-69	Cloud and Pour Point Apparatus	Used to detect cloud and pour points of occurrence and disappearance of a condensate by alternate cooling and heating. Range of temperature adjustment: Approx. -20℃ - +40℃	1
PED-72	Thermostat Oven	An oven capable of adjustment temperature to heat a test object. Range of temperature adjustment: 50℃ - 250℃	1
PED-86	Dean Stark Apparatus	Used to separate water and oil contents by using Dean's law and Stark effect. No. of racks: 15; flask capacity; 200-250ml	1
PED-90	Gas Chromatograph	Used to examine molecular structure of an organic compound of a test object on the basis of carbon ion content determined from combustion. Combustion temperature: Approx. 40℃; detection method: PCD	1
PED-91	Mud Consistometer	Used to measure sludge and water contents in crude oil. Rotating speed; Approx. 150rpm; operating pressure; Approx. 25000psi	1
	INSTITUTE OF ENVIRONMENTAL ENGG. & RESEARCH (IEER)		

NO.	DESCRIPTION	Application/specification	Q'ty
IEER-27	Portable Dust Sampler	Used to collect and classify trace substances contained in the air and practice air pollution monitoring. Particle size collected: 1.0-7.0mm; No. of stages: 4	1
IEER-35	Sulpher Estimation Apparatus	Used to measure and analyze sulfur oxides in the air and practice air pollution monitoring. Heating temperature: Approx. 1,300℃	1
IEER-36	CO_2/CO Portable Analyzer	Used to measure and analyze CO_2/CO in the air and practice air pollution monitoring. Approx. range of measurement: CO_2/max20%; CO/max25%	1
IEER-41	Flocculation Test Unit	Used to conduct experiments on floc sedimentation by coagulation and practice water quality preservation and purification. Mixing speed: max. 150rpm	1
IEER-63	Oil-in Water Analysis	Used to measure oil content in water and practice water quality test. Non-dispersive infrared absorption system; range of measurement: max. 200mg/l	1
IEER-64	Furnace	An electric furnace for heat treatment of a test object. Operating temperature: Approx. 1,500℃	1
	ARCHITECTURE DEPARTMENT		
	GRAPHICS & PRESENTATION LABORATORY		
APP-02	Ammonia(white) Printing Machine	Ammonia printing machine for design drawings Copy size: A1	1
APP-03	Photo Copying Machine (Large Size)	Photo copying machine for design drawings Copy size: A1	1
	SURVEYING & LEVELING LABORATORY		
ASL-06	Distomat	Infrared reflective range finer for surveying practice. Range of measurement: Approx. 20km; Time required for measurement: 10 sec. or less	1
	CITY & REGIONAL PLANNING DEPARTMENT		
RPD-14	Fluid Gas Analyzer	Used to measure and analyze CO_2/CO in the air and practice air pollution monitoring. Approx. range of measurement: CO_2/max20%; CO/max25%	1
	COMPUTER SCIENCE DEPARTMENT		
CSD-02	Fileserver	Server for 20 computers in Computer Lab A: CPU; Pentium 166MHz or more, Memory 64MB, OS; Windows95	1
CSD-03	Fileserver	Server for 20 computers in Computer Lab A: CPU; Pentium 166MHz or more, Memory 64MB, OS; Windows NT	1
	MATHMATICS DEPARTMENT		
	APPLIED MECHANICS LABORATORY		
BAM-14	Fletcher's Trolley	A truck used to learn acceleration theory in basic mechanics	2
	CHEMISTRY LABORATORY		
BCH-11	Kjeldahl Nitrogen Apparatus Analyzer Digest /Automatic	Used to measure nitrogen content in an organic matter.	1
BCH-12	Centrifuge Basket Type	Used to centrifugal separate specimen for chemical experiment. Approx. 30000rpm.	1
BCH-15	Gas Chromatograph	Used for analysis in organic and inorganic chemistries. Capillary type.	1
BCH-16	Potentiostat	Used for electrochemical experiment.	1
BCH-19	UV-Visible Spectrophotometer	Used for quantitative and qualitative analyses of specimen. Wavelength: Approx. 200-1100mm	1
	WORKSHOP EQUIPMENT		
WSE-39	FIAT 131 Turbo Supercharged Diesel Engine	A diesel engine model of turbo supercharging type, used to learn engine construction.	1

2-4 Implementation System

2-4-1 Organisation

(1) Principal government authority

The budget and personnel management of universities and colleges are controlled by the University Grants Commission (UGC) under the Ministry of Education, which is thus responsible for allocating the federal budget to universities. Fig.2-2 shows the organisation of the Ministry of Education.

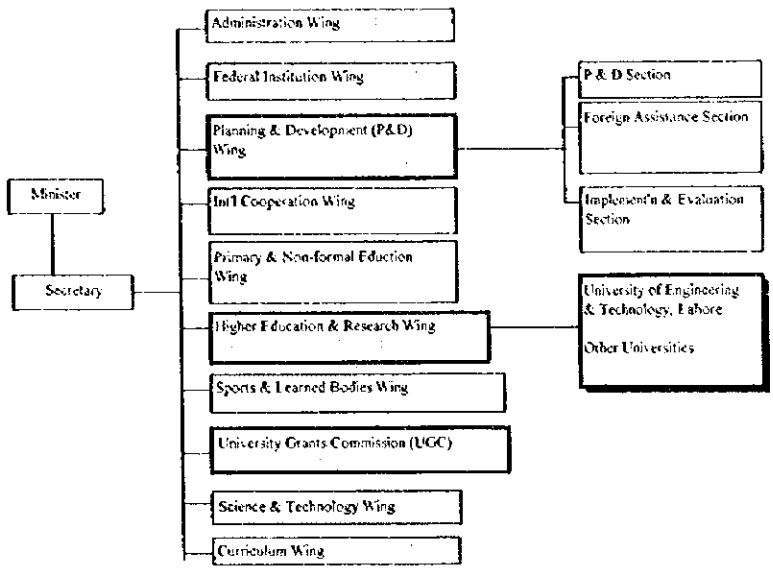


Fig.2-2 Organisation Chart of the Ministry of Education

(2) Implementation body

The implementation body of the project will be the University of Engineering and Technology, Lahore which will manage and maintain the equipment to be supplied. The university is led by President (the Governor of Punjab) and Vice President (the Education Minister of Punjab), who are the ex-officio members. Vice Chancellor is primarily responsible for overall management, assisted by Pro Vice Chancellor. Day-to-day management of the

university is carried out by 324 employees (77 officials including registers, inspectors and accountants, and 247 clerical and other staff, see Fig.2-3).

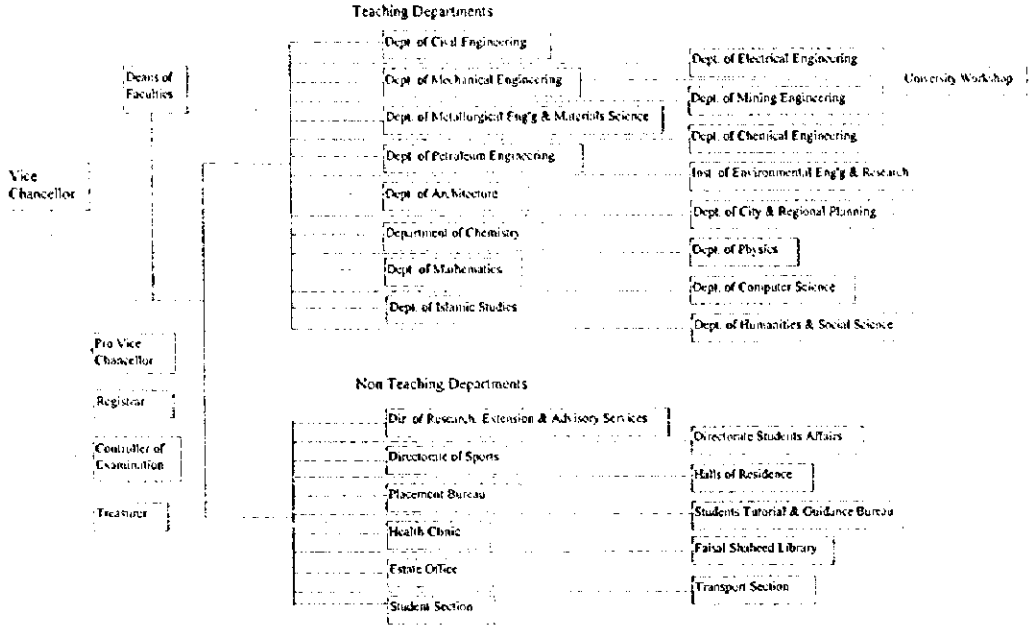


Fig.2-3 Organisation Chart of the UETL

2-4-2 Budget

The university's annual budget and its breakdown in recent years as well as forecast are shown below.

Table 2-2

Year	Personnel Expenses	Procurement of Equipment	Repair & Maintenance of Equipment	Utilities - Power, Water, Gas, etc.	Others	Total
1993-94	83,366	1,797	3,692	15,210	23,891	127,956
1994-95	87,489	5,922	4,248	16,154	30,035	143,848
1995-96	100,072	6,990	5,969	22,084	32,018	167,133
1996-97	100,146	5,291	5,267	27,538	27,698	165,940
1997-98	110,160	5,821	5,794	30,291	30,405	182,471
1998-99	121,176	6,402	7,648	39,984	33,445	208,655
1999-2000	133,293	7,042	8,412	43,982	36,789	229,518
2000-2001	146,622	7,746	9,253	48,380	40,467	252,468

Table 2-3

Year	Subsidy from Federal Gov.	Subsidy from Provincial Gov.	Own Income-Tuition Fee	Own Income-Research Contracts	Others *	Total
1993-94	132,824	0	1,919	0	40,984	175,727
1994-95	103,135	0	2,450	0	53,323	158,908
1995-96	115,869	0	2,084	2,000	62,536	182,489
1996-97	119,711	0	2,807	450	61,989	184,957
1997-98	128,250	0	2,529	0	68,965	199,744
1998-99	137,401	0	2,782	0	75,861	216,044
1999-2000	147,210	0	3,060	0	76,619	226,889
2000-2001	157,726	0	3,366	0	84,280	245,372

* Self Finance and other user charges received from the students and fees other than the tuition fee.

As seen above, the maintenance budget (equipment repair and replacement) accounts for around 3% of the total operating budget, with some yearly fluctuation, and has been on the rise year after year.

Note that Tables 3-2 and 3-3 contain the figures after 1998-99 which were estimated by the university. The budget estimates after 1999-2000 in Table 3-2 exceed the estimated revenues in Table 3-3 because the estimated expenses shown in Table 3-2 are based on the assumption that labor costs will increase due to an increase in number of faculty members. A budget deficit is carried over to the subsequent year, while a surplus is reserved and incorporated into the subsequent year's budget. The accumulated deficit is set off by a subsidy from the Ministry of Education by matching fund.

2-4-3 Present Staffing and Levels

The University of Engineering and Technology, Lahore has 296 faculty members (excluding those who are staying overseas). Of total, professors account for 27.7%, associate professors 24.3%, assistant professors 30.7%, and lecturers 17.2%. As for a breakdown by degree, Ph.D. holders represent 28.7%, master degree (M.Sc., M.Phil., etc.) 35.5%, and others 35.8%, showing relatively high educational levels. In addition, laboratory assistants and administrative staff

amount to 406 persons in terms of full strength. Table 3-4 shows a breakdown of faculty members and staff by department.

Table 2-4 List of Academic and Lab. Staff

Department	Prof.	Assoc. Prof.	Assist. Prof.	Lecturer	Total	Ph.D.	M.Sc./ M.Phil.	Others	Lab. Staff
Civil Engineering	10	12	14	10	46	7	20	19	65
Electrical Engineering	10	10	12	8	40	14	21	5	65
Mechanical Engineering	10	10	14	9	43	10	11	22	53
Mining Engineering	9	1	4	1	15	7	6	2	28
Metallurgical Engineering & Materials Science	5	4	4	2	15	9	4	2	21
Chemical Engineering	5	5	7	2	19	10	4	5	23
Petroleum Engineering	1	3	2	3	9	0	4	5	12
Institute of Environmental Engineering & Research	6	4	4	2	16	3	5	8	23
Architecture	3	5	8		16	8	3	5	16
City & Regional Planning	5	2	3	2	12	3	2	7	16
Chemistry	5	4	2	1	12	4	2	6	13
Physics	2	3	2	2	9	4	2	3	7
Mathematics	4	2	4	2	12	3	9	0	8
Computer Science	3	2	3	1	9	3	3	3	7
Humanities & Social Science		2	2	1	5	0	3	2	3
Islamic Studies	1	1	4		6	0	6	0	11
University Workshop				5	5	0	0	5	35
Pool Post	3	2	2		7	0	0	7	
Total	82	72	91	51	296	85	105	106	406

More than 60% of faculty members have studied in various countries including the U.S. and the U.K. to obtain higher degrees. They have experience in using a variety of laboratory equipment that are widely in the countries, and have written research papers and dissertations by applying rational and scientific methodology . As they request equipment they have used in overseas universities, they presumably know latest equipment using advanced electronics. At the same time, technical staff manage to operate testing equipment installed 70 years ago and laboratory equipment purchased more than 20 years ago, they have high levels of equipment maintenance capabilities. For these reasons, there is little risk of having difficulty in operating the equipment to be supplied.