BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR PROCUREMENT OF SCIENTIFIC EQUIPMENT

FOR

THE UNIVERSITIES

IN

THE PEOPLE'S REPUBLIC OF BANGLADESH

APRIL 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan has decided to conduct a Basic Design study on the Project for Procurement of Scientific Equipment for the Universities and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Bangladesh a study team headed by Dr. Tomoya Shibayama, Associate Professor, the Department of Civil Engineering in the Faculty of Engineering, Yokohama National University, from December 17, 1988 to January 3, 1989.

The team had exchanged views on the Project with the officials concerned of the Government of Bangladesh and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

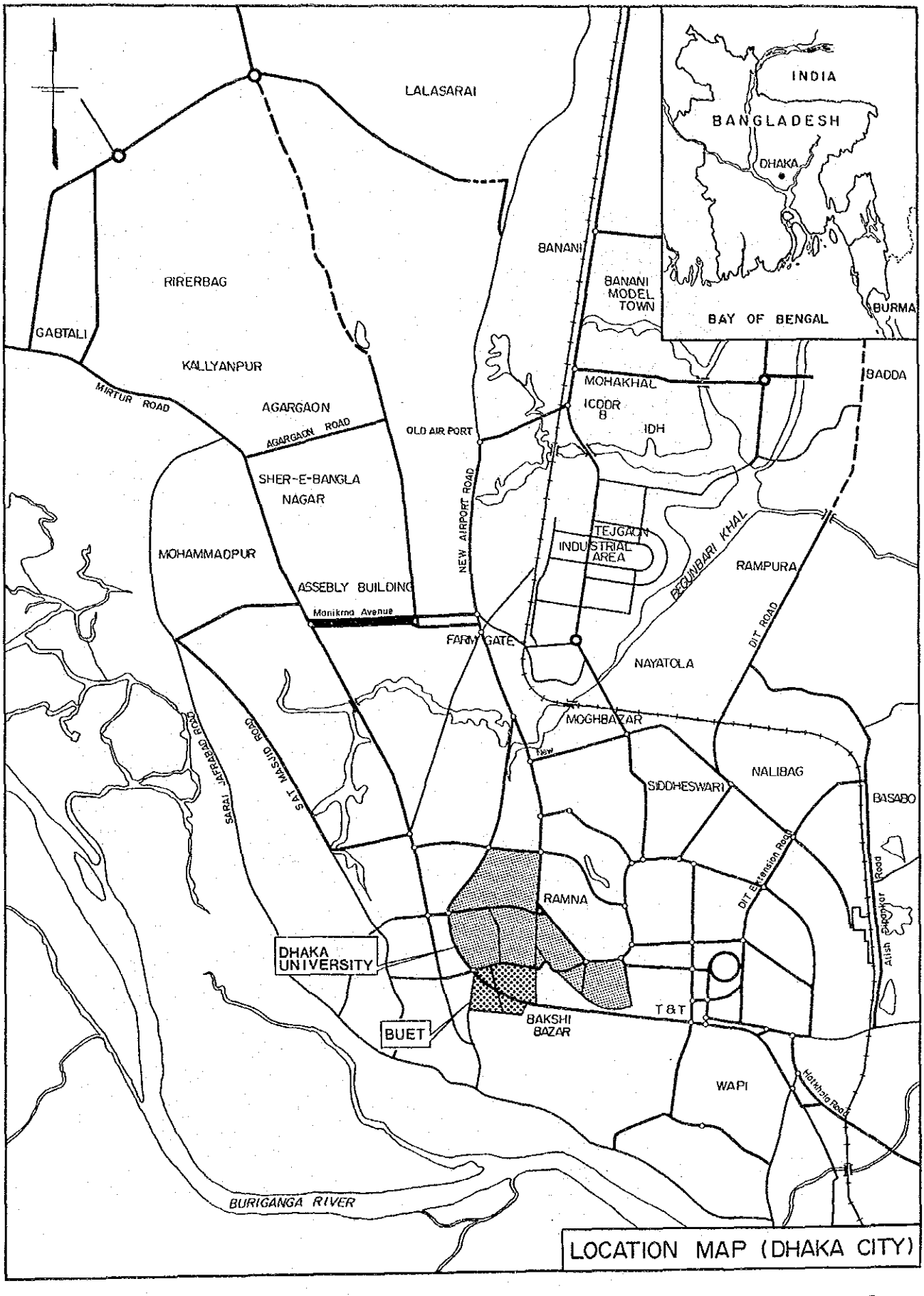
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

April 1989

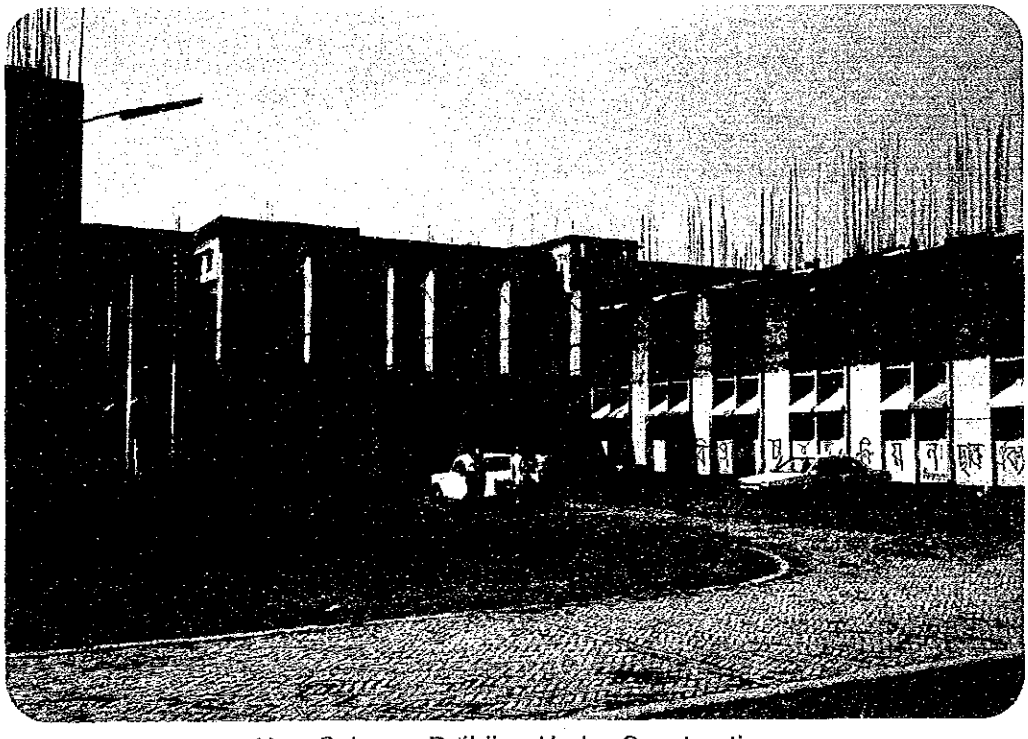
Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



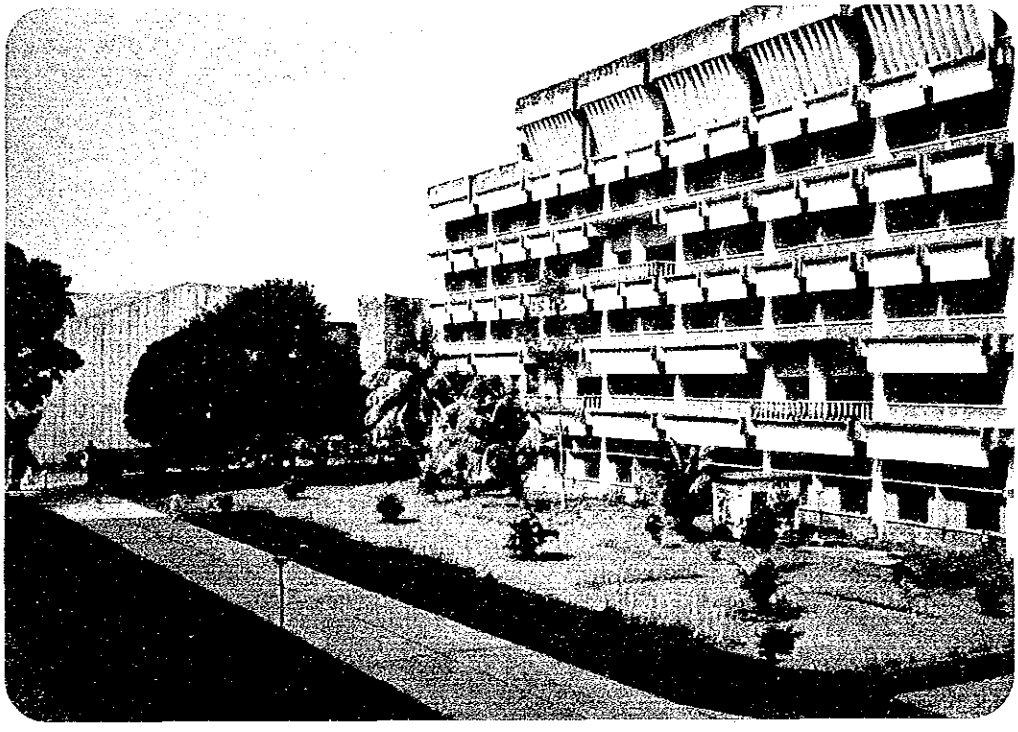
MAP OF BANGLADESH AND AROUND AREA OF THE UNIVERSITIES

The Department of Chemistry



New Science Building Under Construction

The Department of Electrical & Electronic Engineering/
The Department of Mechanical Engineering



The Department of Civil Engineering

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SUMMARY

SUMMARY

The People's Republic of Bangladesh makes great efforts to promote economic development in order to cope with population growth and increase national income. Achievement of the goal is highly depended on the development of talent by university education in the scientific and engineering fields. However, its financial conditions have caused difficulty in procuring educational equipment for universities since 1971.

Having recognized shortage and obsoleteness of educational equipment at universities and its adverse effect on educational standards, the Bangladesh Government made a plan to improve the educational equipment at science and engineering departments of universities, covering 90 departments of 16 faculties of 6 universities. Based on the plan, the government requested the Japanese Government to assist in procuring these equipment. At subsequent meetings between the two governments, the Bangladesh Government asked the Japanese Government to aid in procuring educational equipment for 3 departments of the University of Dhaka and Bangladesh University of Engineering and Technology respectively, a total of 6 departments.

By request, JICA sent a survey team responsible for basic design to Bangladesh from December 17, 1988 to January 3, 1989. The study team had meetings with Bangladesh government officials about the Project, surveyed the present educational situation about background of the need for educational equipment, organization and procedure for the Project, and equipment maintenance system in that country, and verified demarcation of undertakings in the Project and sites to install equipment. After returning to Japan, the study team analyzed and evaluated the Project to select adequate equipment, estimate costs, and develop a plan of equipment maintenance.

The original request by the Bangladesh Government was to procure 228 items of educational equipment for 3 departments (physics, chemistry, and botany) of the University of Dhaka, and 3 departments (electrical & electronic engineering, civil engineering and mechanical engineering) of Bangladesh University of Engineering and Technology. As a result of meetings between the study team and Bangladesh officials, 16 items were added to the original list and 83 items were deleted to total 161 items to be supplied.

Finally, the need for the equipment requested by each department was reviewed with reference to purposes, curriculums, and the number of faculty members and students, and 134 items were selected on the basis of the basic design study, as shown in the following table.

The Proposed Number of Equipment by Departments

University/Department	The No. of Items	Major Equipment
The University of Dhaka		
Physics	32	Oscilloscopes, Signal generator, etc
Chemistry	21	Spectrometers, Gaschromatograph, melting point appratus, etc.
Botany	30	Microscopes , Leaf area meters, etc.
(Sub-total)	(83)	
Bangladesh University of Engineering and Technology		
Electrical & Electronic Engineering	9	Microwave network analyzer, High voltage impulse generator, etc.
Civil Engineering	20	Structural testing frame, High pressure mercury porosimeter, etc.
Mechanical Engineering	22	Gas turbine and test bed, Universal testing machine, etc.
(Sub-total)	(51)	
Total	134	

The University Grants Commission will serve as a project implementation body on the Bangladesh side.

The project cost is estimated approximately at ¥3,780 thousand (Tk. 937 thousand) for the Bangladesh portion. The period of the Project will be a total of 13.5 months after the signing of Exchange of Notes by the two governments, including 2.5 months for detailed design, 0.5 month for tender procedure, 6 months for equipment design and manufacture, 0.5 month for transport, and 2 months for installation work.

Maintenance of the equipment to be supplied under the Project should be integrated with that of the existing equipment. Therefore, the equipment needs to be managed by each department with periodical inspection and maintenance as well as timely replenishment of spare parts and consumables. In addition to spare parts for one year for the new equipment, expected increases in costs for utilities, consumables, repair parts, and labor need to be included in the budget for the Universities.

The annual maintenance cost in conjunction with the Project is estimated at about Tk. 2,622,000 for the two Universities.

The Project is expected to bring various educational benefits as follows:

- To provide knowledge of latest science and technology, thereby promoting technology transfer to the country's industries.

- To upgrade research abilities of students through increased access to experiments, thereby contributing to technological progress for the industries.

In addition, as a number of graduates from these universities will teach at technical colleges and high schools, the Project is expected to produce a great indirect effect to diffuse the educational benefits throughout that country.

Moreover, the graduates from the universities will play a major role in accelerating industrialization of that country, leading to increase in value added to industrial production, thus producing a significant economic effect.

The Project is designed to enrich educational equipment at the departments of Universities both in quantity and quality . This will result in considerable upgrade of educational quality at these departments, thereby improving higher education, industries and economy of that country. Thus the Project should be highly evaluated for the future of Bangladesh.

Contents

APPENDICES

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

It is of urgent necessity for The People's Republic of Bangladesh to strengthen national economy so as to increase the national income. It is expected, therefore, for universities to educate and raise competent scientists and engineers to contribute to national economy.

Under the present difficult financial conditions in Bangladesh, the universities have had very few chance to purchase new educational equipment since 1971. Accordingly, as educational equipment in each university has become old and obsolete, the level of the nation's university education have been obliged to deteriorate significantly.

In the light of such situation, the Bangladesh Government made a plan to provide 90 departments of 16 faculties of six universities with new scientific educational equipment.

In meantime, the Bangladesh Government requested the Japanese Government to collaborate on this plan. After discussion between the two governments, the Bangladesh Government officially submitted their request to the Japanese Government for a grant aid to supply scientific educational equipment to six departments; three respectively in the University of Dhaka and Bangladesh University of Engineering and Technology.

In response to the request placed by the Bangladesh Government, the Japanese Government dispatched to Bangladesh a survey team headed by Dr. T. Shibayama, Associate Professor, the Department of Civil Engineering in the Faculty of Engineering, Yokohama National University, through Japan International Cooperation Agency (JICA) from December 17, 1988 to January 3, 1989 to conduct a local survey and discuss the matter with parties concerned in Bangladesh. The survey team eventually conducted the local survey during the period of the assignment on the present educational situation of Bangladesh, background which reflected the necessity of the educational equipment, system for the implementation of the project as well as for the maintenance of the equipment, and confirmed each country's share of the work and specific sites to install educational equipment.

Details of organization of the survey team and survey schedules are described in the Appendix-2 and 3.

Based on the preliminary study, local survey and the studies of materials and data locally collected, the background, the objective as well as the international and domestic role of the Project were clarified, the scale of the educational equipment and selection thereof were decided, operation cost in relation with this Project was estimated and the implementation plan was made.

The result of the basic design study is developed in this report based on the above-mentioned invesitagation.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2-1 The Present Situation of Bangladesh

2-1-1 Land and population

Bangladesh has a huge delta and its peripheral region at the confluent and alluvial area of three large rivers; Ganges, Jamuna and Meghna. Total area of the land is 143,998 km^2 (according to the survey in 1988). The country had a population of 87,120,000 according to the national census in 1981, which is now estimated at 110 million . Accordingly, the density of population is roughly 765 (persons) per km^2, which is one of the highest in Asia. The government has been promoting a birth control plan to restrain an increase in population, but the population of that country is still increasing at a rate of 2.2% per year.

2-1-2 Climate and natural resources

Bangladesh is located between 20° 34" and 26° 38" North Latitude and the greater part of the land is low ground. The country's climate is tropical and partly subtropical. The year is divided into two seasons, the rainy season(or summer season) and the dry season (or winter season). Rain intensively falls during the rainy season (April to October), annual precipitation was 1,837mm - 3,021mm at Dhaka in 1977 - 1986. The temperature varied from 13.2°C to 35°C and the humidity was 52% - 84% at Dhaka in 1986. The temperature and humidity are high during the summer season, while the climate is relatively pleasant during the winter season.

The country is attacked by frequent cyclones in summer which causes disastrous floods when the upper reaches of the three rivers has large precipitation at high tide. As a matter of fact, the country suffered from the most disastrous floods in 1987 and 1988 which were said to be the largest and most calamitous floods the country has ever experienced in the past 45 years and 100 years respectively. Almost all farm land in a spacious area sank under water and many houses in the city of Dhaka were inundated. Agriculture, the country's key industry and the

infrastructure including transportation and electric power suffered great damage from the floods. Such severe climatic conditions have obstructed the development of its industries.

Forest covers 16% of the land of Bangladesh. However, as trees are too hard to be used as building materials, forest resources have not been fully utilized as yet. Natural gas is only produced in a few places in that country, but there is no other significant natural resource anywhere. Electric power is supplied by thermal power stations using the natural gas as referred to above and hydroelectric power stations utilizing water of the lake Khulnaphuli. Seen from the fact that the total elecetric power consumption in 1985/86 was 2.86 billion kwh, which means less than 30 kwh/year per capita, home electricity has not yet prevailed. Natural gas is used mainly in cities as household fuel, while in rural districts, dung of cattles, hulls and straws of rice, jute stocks (which are called "traditional fuels") are mainly used as household fuel, total consumption of which exceeds that of petroleum.

2-1-3 Economic trends

(1) Gross Domestic Product (GDP)

In 1987/1988, agriculture accounted for 49% of the country's GDP as shown in the Table 2-1. Rice, which is the staple agricultural product of that country, is produced by 75% of arable land but the productivity is low. Since the total crop did not meet the national demand for food, that country was compelled to import rice until 1985/86. Even at present, the country has little surplus rice in stock.

In the segment of industry, chemical fertilizer made by natural gas, sugar, jute-based products, yarn and fabrics of cotton are produced, output of which, however, acounts for less than 10% of the country's GDP. It is highly hoped that the country develops much more industrial activities.

Table 2-1 GDP of Bangladesh

(Unit: 10 million Tk)

Item	1986/87		1986/88	
		(Growth rate: %)		(Growth rate: %)
GDP (Actual: FY Price of 1984/85)	35,722	4.44	36,777	2.95
GDP (Current)	43,260	12.26	48,220	11.14
GDP per Capita (Current), Tk	4,112	9.82	4,489	10.91
GDP by Sector (FY Price of 1984/85)		(Share: %)		(Share: %)
Agriculture	17,808	49.85	17,924	48.73
Commercial	7,881	22.06	8,275	22.50
Industry	3,462	9.69	3,599	9.78
Government	2,433	6.81	2,524	6.86
Transportation/Telecommunication	1,875	5.25	2,033	5.52
Housing	1,082	3.03	1,109	3.02
Construction	880	2.46	967	2.63
Electricity/Gas	310	0.84	346	0.94
Total	35,722	100.00	36,777	100.00

Source: 1987/1988 Annual Report of Central Bank of Bangladesh

(2) International trade

Jute and tea are major exports of Bangladesh. The country's jute accounts roughly for 75% of the world production. However, due to sharp decline of supply of jute during the two wars of Independence and Liberation, substitute synthetic textiles has prevailed throughout the world and the jute market has substantially shrinked. Tea of good quality has been produced in the area adjacent to Assam, India. At present, it is exported to England and the Middle and Near East (especially to Egypt). However, it appears to be quite difficult for Bangladesh to expand the market because the neighboring countries, India and Sri Lanka are very competitive.

In addition to those commodities, that country exports ready-made clothes mainly to the USA. However, the country's terms of trade have been rapidly aggravated since 1972/73 as shown in the Table 2-2 and not yet restored.

Table 2-2 Transition of Trade Conditions

(Trade index: 100 for 1972/1973)

FY	Import Price Index	Export Price Index	Term ofTrade
1979/80	300.2	211.3	70.4
1980/81	352.6	181.2	51.4
1981/82	368.1	155.5	42.2
1982/83	349.5	163.1	46.7
1983/84	339.3	193.2	56.9
1984/85	339.1	224.8	66.3

Note: Term of trade =export price index/ import price index

The country's 1986/1987 exports totaled 27,166 million Tk while its total imports amounted to 63,538 million Tk, thus resulting in a large trade deficit. The country's trade has been in the red since 1971 when the country was involved in the war of liberation.

As regards trade with Japan, Bangladesh imported from Japan in the amount of 8,233 million Tk and exported to Japan in the amount of 1,946 million Tk in 1986/87. Bangladesh mainly imports machinery and metal products while shipping shrimp as its main exports. Japan, ranking first as its import partner and second as its export partner following Singapore, is one of the most important trade partners of Bangladesh.

(3) Economic development plan

To recover from the economic confusion caused by the War of Liberation in 1971, Bangladesh established and implemented the first 5-year plan (1973 - 1978), 2-year plan (1979 - 1980), the second 5-year plan (1980 - 1985) and the third 5-year plan (1985 - 1990). Adversely affected by cyclones and disastrous floods, however, the country has not yet got satisfactory results.

The Table 2-3 shows the rate of economic growth attained under the three economic development projects before the third 5-year plan. In the Table 2-4 is shown the rate of increase in population according to the national census in and after 1951. As clearly seen from the two tables, the rate of economic growth does not even exceed 1% more than the rate of population increase, except for the period the first 5-year plan was in effect.

Table 2-3 The Rate of Economic Growth

	Primary 5-year plan (1973 - 1978)	2-year plan (1979 - 1980)	Secondary 5-year plan (1980 - 1985)
GDP growth rate (% /year)	6.1	3.5	3.8

Source: The Third Five-Year Plan 1985-90, Ministry of Planning

Table 2-4 The Rate of Population Increase

Year of Census	1951	1961	1974	1981
Population (1,000)	41,932	50,840	71,478	87,120
Rate of population increase (%/year)		1.95	2.66	2.87

Source: 1987 Statistic Yearbook of Bangladesh, Bangladesh Bureau of Statistics

GDP of Bangladesh in 1987/88 was 4,489 Tk per capita (equivalent roughly to US$140). It has been of great concern for the government to control the rapid increase in population in order to realize better life for the people.

2-2 Background of the Request

2-2-1 Educational system

Education in Bangladesh succeeds traditional British system. Children are enter primary schools at ages between 4 to 6 years old and receive five-year compulsory education, followed by 5 years in secondary schools, 2 years in high schools. In the science course, students are requested to study at university for 3 years to obtain the bachelor of science (B.Sc.). Finally there are three graduate degrees offered: the master of science (M.Sc.) requiring one-year more education, the doctoral degree (Ph.D.) with additional two-year education, and the M. Phil. degree.

It should be noted, however, that the number of years required to obtain the bachelor's degree varies with universities. For instance, the University of Dhaka offers a 3-year honours course and a 2-year pass course. The pass course grants the "ordinary bachelor" degree, while the honours course the "bachelor of science" degree. On the other hand, Bangladesh University of Engineering and Technology offers a 4-year programme (B.Sc. in engineering) and a 5-year programme at the department of architecture (B.Arch.). In addition, bachelor's degree is also offered to technical college graduates.

Holders of the ordinary bachelor's degree, who intend to obtain the master's degree, are required to take a 1-year preliminary course in the master's programme before entering a final course, while graduate of the honors course start from the final course. Generally speaking, bright students are more found in the honours courses than the pass courses.

Science and engineering education is offered at 34 technical colleges. In addition, there are 54 vocational schools which offer education at a junior high school level. Thus, a variety of choice for education is available.

The educational system is shown in Figure 2-1.

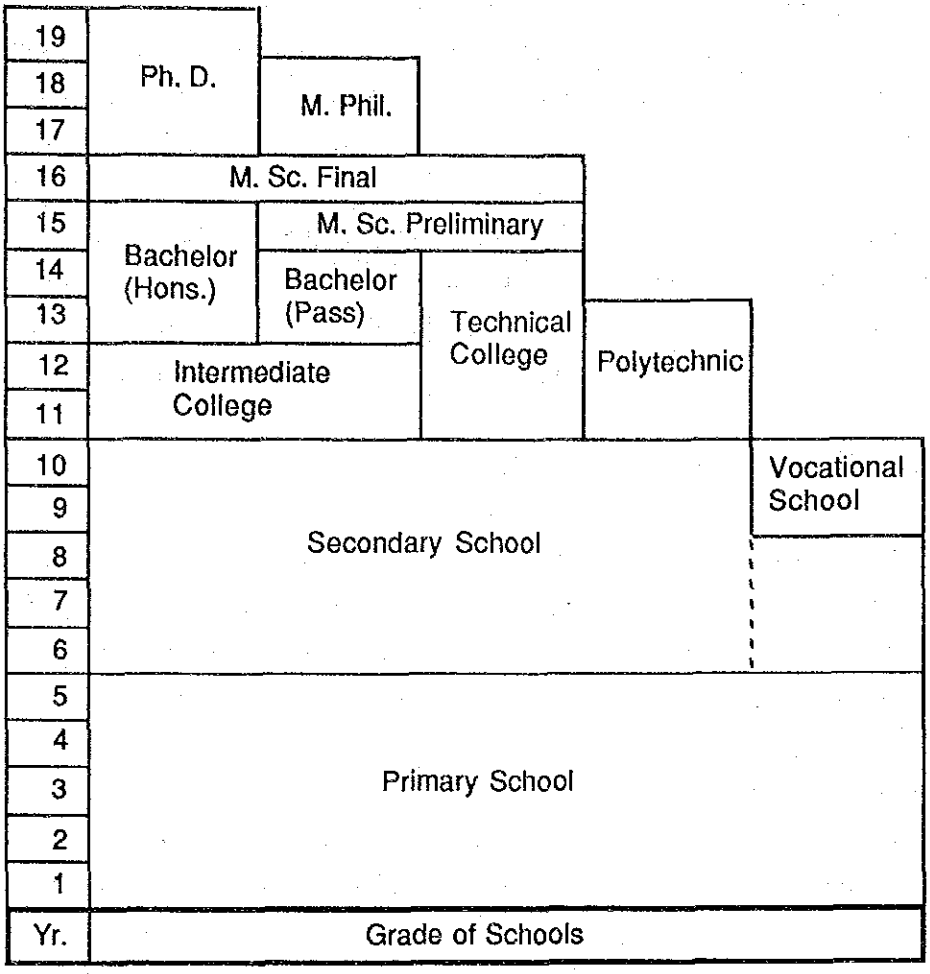


Figure 2-1 Engineering Education System in Bangladesh

2-2-2 Enrollment rate

According to the 1986 statistics, 9,115,544 students entered primary schools; 8,120,282 students in national or public primary schools and 995,272 students in private schools. The enrollment rate was estimated at 52% from the 1981 census; of 14,158,000 at 5-9 years old, 7,358,829 enrolled in primary schools, and the number of primary schools is still in shortage. The Third Five-Year Plan sets forth a target to increase primary schools to accommodate 70% of all children in the age group by 1990. On the other hand, there are 2,345,166 students enrolled in secondary schools in 1986; 142,659 in national schools and 2,202,507 in private schools. The enrollment rate based on the 1981 census was 17%; 1,979,075 out of 12,650,000 in the age group between 10 and 14 years old. It is now estimated to reach a 20% level.

In high schools and high school level colleges, 92,586 students are enrolled in 1986. Percentage of the enrollment in high school level schools in the total graduates from secondary schools was approximately 1.6%.

Finally, 1,095 students obtained the ordinary bachelor's degree(pass course), 6,743 the honors degree, and 1,476 the B.Sc. in engineering and agriculture. Assuming that there is no duplication in these figures, 9,314 students obtained the bachelor's degree.

2-2-3 Public administration system related to education

In Bangladesh, the president serves as the chancellor of all the universities; a long time tradition since the foundation of the University of Dhaka where the governor of India served as the chancellor. Thus, vice chancellors are responsible for management of universities.

The universities are granted of a wide range of autonomy and major decisions including budget allocation(to be decided under coordination among universities) are made by the University Grants Commission (UGC) which is represented by Ex-professors from the universities. The UGC advises the Ministry of Education and may directly advice the chancellor (president).

Colleges, high schools, junior high schools, and primary schools are under the direct supervision of the Ministry of Education. Most of these schools are privately operated, with subsidy being granted by the government. Recently, the government started to manage some of primary schools under responsibility of upzilas(the smallest administrative unit equivalent to county).

In addition, there are 4,218 Madrasha(Islamic schools) which provide primary to collage level education under the subsidy of the government.

Public administration system related to public education is illustrated in Figure 2-2.

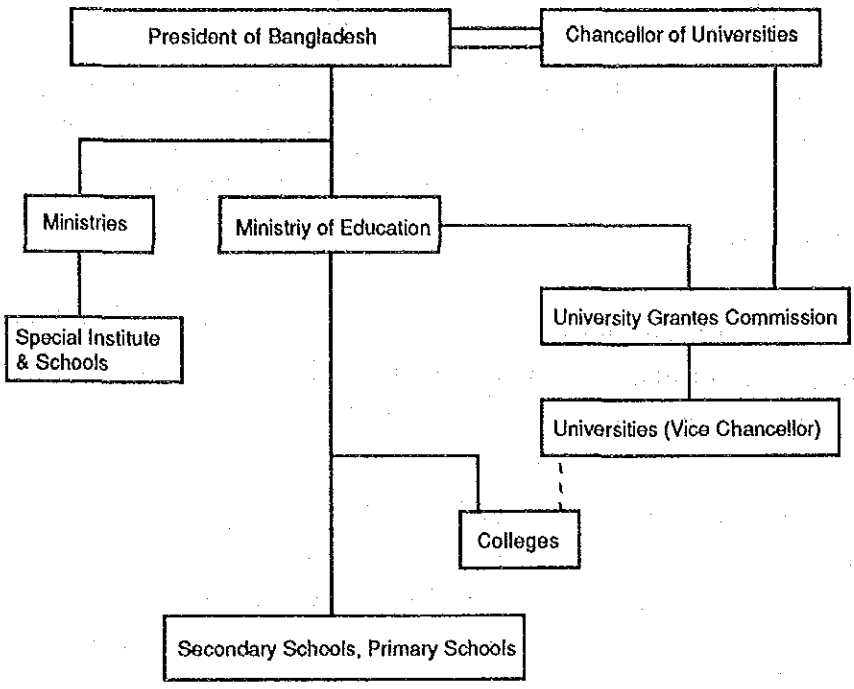


Figure 2-2 Administration System of Public Education

Schools in Bangladesh are classified as follows; 44,244 primary schools; 2,588 junior high schools(private); 7,269 secondary schools; 291 higher secondary schools(two years); 430 degree colleges; 10 military academies; 4 engineering colleges; 2 agriculture colleges; 9 medical colleges; 1 dental college; 1 nursing college; 35 homeopathic(traditional therapy) colleges; 22 law colleges; 1 music college; 2 physical education colleges; 18 polytechnic colleges; 1 college of ceramic technology; 1 commercial college; 54 vocational schools; 1 graphic art college; 1 college of leather technology; 1 college of textile technology; 10 teachers training colleges; 53 primary school teachers training colleges; 4 universities; 1 university of engineering and technology; 1 agricultural university; and 1 Islamic university.

Some of these schools are under the supervision of ministries other than the Ministry of Education. Large percentage of schools other than universities are of private school.

2-2-4 A program for the development of education

As mentioned in the section 2-1, GDP of Bangladesh is as low as US$140 per capita. That country is also suffering not only from the high rate of population increase but also from export stagnancy and repeated natural disasters.

In order to get out of such situation, the country's third 5-year plan aims at accomplishing the following eight objectives. Items (2) (3) and (4), in particular, closely relate to education.

(1) Reduction of population growth.
(2) Expansion of productive employment.
(3) Universal primary education and human resource development.
(4) Development of technological base to bring about a long-term structural change.
(5) Food self-sufficiency.
(6) Satisfaction of minimum necessities of life.
(7) Acceleration of economic growth.
(8) Promotion of self-reliance.

The country's educational budget accounted for 8.6% of its total official expenditures in 1983 and for 1.9% of GNP. These figures should be improved as compared with other developing countries.

The country's educational budget, as a fact, has remarkably been increasing every year as shown in the Table 2-5. At present, personnel expenses account for the greater part of the educational budget, which is amended on the basis of wage index to compute the rate of real increase in the budget as shown in the Table 2-6. Calculation based on this table shows that the educational budget has really increased by 1.51 times during the past eight years and that the rate of real increase in the budget is 5.32% on the annual average. This percentage significantly exceeds the rate of the economic growth as shown in the Table 2-3 of the preceding section and expressly ensures that country has its policy to put emphasis on education.

Table 2-5 Educational Budget Appropriated by the Bangladesh Government

FY	Budget for Management	Budget for Development	Total
1980/81	209.64	75.75	285.39
1981/82	234.64	73.92	308.56
1982/83	283.22	90.25	373.47
1983/84	365.17	126.46	491.63
1984/85	470.21	128.44	598.65
1985/86	487.44	163.41	650.85
1985/87	697.03	251.12	948.15
1987/88	*800.00	* 200.00	*1,000.00

* Round figures by UGC estimation
Source: Bangladesh Educational Statistics 1987, BANBEIS

Table 2-6 Educational Budget Amended on the Basis of General Wage Index

FY	(1970/71=100)	(1,000 mil Tk)	(1,000 mil Tk)
1980/81	492	285.39	285.39
1981/81	566	308.56	268.22
1982/83	598	373.47	307.27
1983/84	685	491.63	353.11
1984/85	734	598.65	401.27
1985/86	895	650.85	357.79
1986/87	1,085	948.15	429.94
1987/88	** 1,140	1,000.00	431.58

* Amended on the basis of wage index to 1980/1981 level.

** Calculated on the presumption that the general wage index would rise by 5% from 1986/1987.

The third 5-year plan aims at accomplishing the following seven objectives in education.

(1) To enrol 70% of primary age-group children in the primary schools (compulsory education)
(2) To reduce the rural-urban gap in educational facilities.
(3) To provide in-service training to primary, secondary and technical school teachers.
(4) To lay emphasis on science, technical and vocational education.
(5) To reduce illiterate adults.
(6) To reform the admission system to colleges and universities.
(7) To reduce the gap in educational opportunities between sexes.

Item (4) directly relates to the Project.

The third 5-year plan provides that universities should change the trend of stress on the liberal art education and rather lay emphasis on cultivation and training engineers and scientists who contribute to the development of the nation's economy. The Bangladesh Government requested the Japanese Government to cooperate with and help it realize the Project as a part of the third 5-year plan.

2-2-5 International role

Bangladesh depends on international funds for about half of economic development budget in the third 5-year plan. As mentioned in the section 2-2-1, the most important objective in the third 5-year plan in education is to increase enrollment to primary schools. To help that country, Asian Development Bank (ADB) accommodated the country with a loan of US$50 - 60 million at a low interest for five years. That country is also asking ADB to extend another financial cooperation to improve secondary school education.

UNICEF is providing welfare to children in that country who are not yet aged to enter primary schools.

In addition to the above, ADB has also accommodated that country with a 5-year loan of US$30 million at a low interest to educate illiterates.
In the meantime, up to today, except for personal support, no universities in that country have ever received systematic aid from abroad. Accordingly, that country hopes to receive aid from the Japanese Government in universities and colleges and regards the Project as the first step of assistance which that country could expect from Japan.

2-3 Background of the Selection of Universities and Departments

2-3-1 Background of the selection of universities

Bangladesh has 4 general universities and 3 specialized universities. 2 more universities will be opened in 1989. These universities, their enrollment and years of foundation are summarized in Table 2-7.

Table 2-7 Summary of University in Bangladesh

Name	Enrollment (1986/87)	Year of Foundation
University of Dhaka	15,985	1921
University of Rajshahi	11,405	1955
University of Chittagong	5,685	1966
Jahangirnagar University	3,000	1970
Bangladesh University of Engineering and Technology	3,350	1962
Bangladesh Agricultural University	4,215	1962
Islamic University	* 1,000	1988
Shahjalal University	* 5,000	1989
Khulna University	* 5,000	1989

*Planning figures indicated by UGC

Source: Bangladesh Educational Statistics 1987, BANEIS

All of them are national universities. Their location are shown in Figure 2-2. The establishment of the two universities will achieve reduction of local gap by appropriate distribution of universities nationwide.

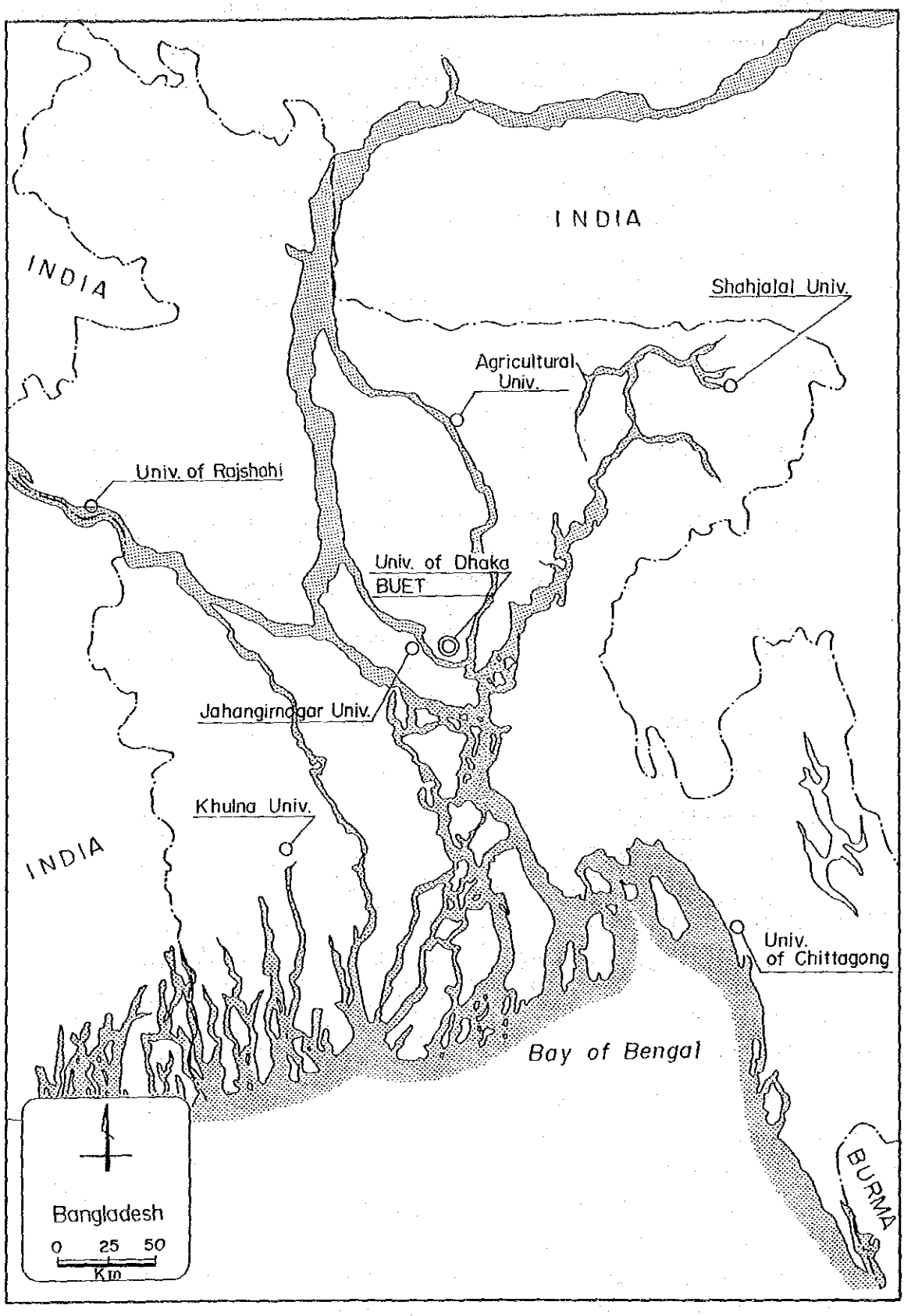


Figure 2-2 Location Map of the Universities in Bangladesh

The existing six universities have 90 departments of 16 faculties specializing in science and engineering education, and two more universities will be added to them by 1990. The Bangladesh Government is apparently desirous of aid from the Japanese Government in all the departments of the existing six universities. This time, however, the Bangladesh Government officially requested the Japanese Government to cooperate to provide three departments of a general university, namely, the University of Dhaka and three departments of a engineering university, namely, Bangladesh University of Engineering and Technology with necessary educational equipment.

The University of Dhaka founded in 1921 is the oldest and largest university in that country, while Bangladesh University of Engineering and Technology is a relatively new academic institute founded in 1971. The University of Dhaka has science departments but no engineering departments, whereas Bangladesh University of Engineering and Technology has engineering departments but no science departments. Each university is educating students based on its own independent philosophy. The professorate of the two universities is comprised of the most capable and excellent scholars in that country, which atttracts competent students throughout that country.

The following are major reasons why the said two universities have been selected under this Project:

(1) Each of them is a representative university in the fields of science and engineering in that country.
(2) The standard of teaching staff and students of the two universities is high and in consequence the most favorable outcome can be anticipated out of provision of equipment.
(3) In that the both universities are adjacent to each other in Dhaka city, local survey and implementation of the Project can be carried out efficiently. In addition, it will be easy for Government agencies to make evaluation after equipment is installed since the universities are located in the capital.

The item (3) is particularly reasoned in the light of the fact that this will be the first educational grant aid provided by the Japanese Government to the Bangladesh Government.

After the implementation of the Project, shortage of educational equipment will still continues to be a large obstacle to adequate and effective education in departments other than the said six departments in that country. The country's government, therefore, hopes that the Japanese Government expands its aid so that educational equipment will be distributed to all other departments of universities including two universities which will be founded in 1989 in order to reduce a local gap in university education.

In addition to the universities mentioned above, there are four senior technical institutes, two senior agricultural institutes, nine medical colleges, one dental school and eighteen polytechnics, all of which are contributing to higher education in the fields of science and engineering in that country. Shortage of educational equipment in these institutes are more serious than universities. The country's government hopes to receive further aid from the Japanese Government in the same manner as already proceeded to the six departments.

2-3-2 Background of the selection of departments

After the two Universities were selected as candidates for this Project, selection of departments was discussed. As a result of such discussions, three departments each in the two Universities, a total of 6 departments, were selected for the Project: the departments of physics, chemistry and botany of The University of Dhaka, and the electrical and electronic engineering, civil engineering and mechanical engineering departments of Bangladesh University of Engineering and Technology.

The following are major reasons why the said departments were selected:

1. Taking into consideration that this will be the first project of grant aid to the University education in Bangladesh, traditional departments in the fields of science and engineering education are selected in order to obtaine the firm results.

2. Departments in which teaching staff and students has sufficiently high level to get variable effect from the equipment provision, are selected.

3. Limitation to the educational field is placed to avoid difficulty arising from complicated selection of educational equipment.

Each department of physics and chemistry of The University of Dhaka was established in 1921 when the university was founded, while the department of botany was branched in 1952 out of the department of biology established in 1939. All the three departments are known as the traditional departments in scientific education for which a standard of professorate and curriculum has been well established in the university.

The electrical and electronic engineering, civil engineering and mechanical engineering departments of Bangladesh University of Engineering and Technology are departments existing for long in its former of which the university became independent in 1962 (excepting that the present department of electrical and electronic engineering was then the department of electrical engineering). These three departments are particularly traditional in the field of engineering, except electronic engineering which have made rapid progress recently. All curriculums have already been established and supported by the excellent professorate in these departments.

All the said six departments is especially popular with capable students. The competitive ratio of examinees for admission to the Universities is as high as 7-8:1, and in particular, to the department of civil engineering, it is as high as 20:1.

2-4 Outline of the Selected Universities

The outline of the selected two Universities for this Project are as follows:

2-4-1 The University of Dhaka

(1) History

The University of Dhaka was established in July of 1921 according to the University of Dhaka Law approved by the Governor of India in 1920; despite strong opposition from University of Calcutta, the governor approved the foundation of the University from the standpoint to respect Bengal's own culture and served as the chancellor. Upon foundation, the University had 3 faculties, arts, science and law, with 12 departments including physics and chemistry. The department of biology was established in 1939/40, and the department of botany was separated from the department of biology in 1952. Today, the University of Dhaka has 6 faculties and 36 departments.

(2) Faculties and departments

There are the following 6 faculties plus institutes (those which will receive the equipment under the Project are marked by circle)

	The Faculty of Arts	14 departments
	The Faculty of Social Science	5 departments
o	The Faculty of Science	8 departments
	The Faculty of Law	1 department
o	The Faculty of Biological Science	6 departments
	Institutes	7

Departments of the faculty of the science and the faculty of biological science are as follows:

The Faculty of Science

- o The Department of Physics
  The Department of Applied Physics & Electronics
- o The Department of Chemistry
  The Department of Applied Chemistry
  The Department of Mathematics
  The Department of Statics
  The Department of Geography
  The Department of Geology

The Faculty of Biological Science

- o The Department of Botany
  The Department of Zoology
  The Department of Biochemistry
  The Department of Pharmacy
  The Department of Soil Science
  The Department of Psychology

(3) Degree requirements

The faculties of science and biological science of the University of Dhaka offer the honours and pass courses which have degree requirements shown in Figure 2-4.

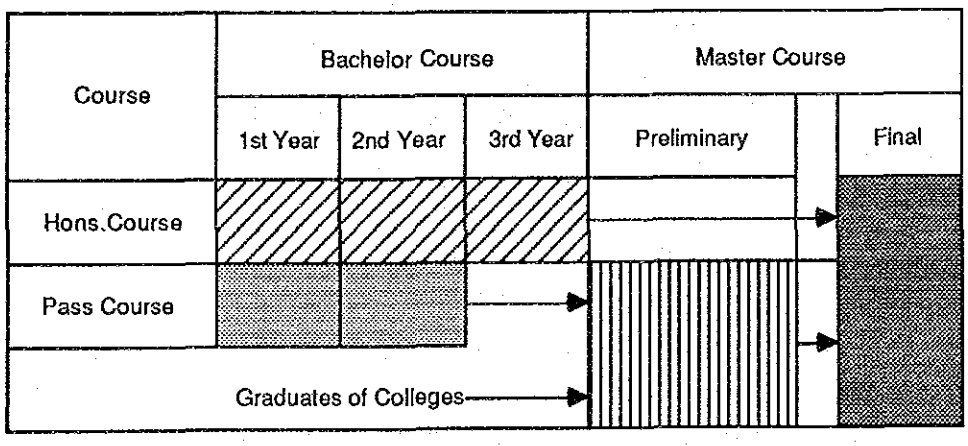


Figure 2-4 Degree Requirements at Faculties of Science and Biological Science of the University of Dhaka

As seen in the figure, graduates from the honours course are allowed to enter the final course for the master's programme, while those from the pass course are required to attend the preliminary course for one year prior to the final course. Graduates from subsidiary colleges are also required to take the preliminary course.

2-4-2 Bangladesh University of Engineering and Technology

(1) History

Bangladesh University of Engineering and Technology was established in 1876 as Dhaka Survey School. It was moved to the present site in 1948 and became Ahsanullah School of Engineering offering 3-year bachelor courses. The school was later raised to the faculty of engineering at the University of Dhaka to offer 4-year bachelor courses in the five departments of civil engineering, electrical engineering, mechanical engineering, chemical engineering, and metallurgy. In 1962, the faculty become independent from the University of Dhaka to be East Pakistan University of Technology. Finally, in 1971, it was named as Bangladesh University of Engineering and Technology upon independence of Bangladesh. Today the University consists of 5 faculties and 14 departments.

(2) Faculties and departments

5 faculties are listed as follows: (those marked by circle will receive the equipment under the Project)

	The Faculty of Engineering	5 departments
o	The Faculty of Electrical and Electronic Engineering	2 departments
o	The Faculty of Civil Engineering	2 departments
o	The Faculty of Mechanical Engineering	3 departments
	The Faculty of Architecture & Planning	3 departments

3 departments related to the Project are organized as follows:

The Faculty of Electrical and Electronic Engineering

- The Department of Electrical and Electronic Engineering
  The Department of Computer Engineering

The Faculty of Civil Engineering

- The Department of Civil Engineering
  The Department of Water Resources Engineering

The Faculty of Mechanical Engineering

- The Department of Mechanical Engineering
  The Department of Naval Architecture & Marine Engineering
  The Department of Industrial and Production Engineering

(3) Degree requirements

Bangladesh University of Technology and Engineering offers 4-year bachelor's programme and 1-year master's programme, providing continuous education from the undergraduate level to the master's degree, in contrast to the University of Dhaka.

CHAPTER 3 CONTENTS OF THE PROJECT

CHAPTER 3 CONTENTS OF THE PROJECT

3-1 Objective of the Project

The objective of the Project is to supply the following six departments with educational equipment necessary for the adequate performance of the education based on their curriculum: the department of physics, chemistry and botany of the University of Dhaka and the departments of electrical and electronic engineering, civil engineering and mechanical engineering of Bangladesh University of Engineering and Technology.

3-2 Basic Line regarding the Selection of Equipment

The plan of providing educational equipment in the Project is based on the above-mentioned objective of the Project, the request of the Bangladesh Government stated in the chapter 1. Equipment was selected on the following three basic lines.

1. Equipment required only for the education of undergraduate and postgraduate students and for research activities by the students.
2. Educational equipment and accessories only, excluding facilities, required and used for scientific and engineering curriculums;
3. Excluding general-purpose equipment manufactured in Bangladesh and easily available in the local market.

In addition to the above lines, it was considered that selected equipment would be used in the existing facilities of the universities without any significant difficulty, and that each department could technically maintain the equipment.

Accordingly, based on the above basic lines and further discussions, the departments, deleted a part of requested equipment out of the original requirement list.

The order of priority was decided, closely examining curriculums of each department, on the basis of the following.

1. Basic equipment required for each curriculum and equipment highly necessary for the progress of Bangladesh.
2. Equipment to substitute those too obsolete to be used.
3. Equipment educationally indispensable to cope with the progress of new technology and science.
4. High-cost equipment which cannot be procured with the current budget of the Universities.
5. Equipment to supplement and fill up shortage caused by an increase in the number of students.

3-3 Study of the Request

After studying the situation of each department including the number of the teaching staff and students, program of the curriculum and necessary equipment used for the curriculum, the results of the study are described as follows:

3-3-1 The number of the teaching staff and students

The followings show the number of the teaching staff and students of the six departments for the Project, and the detailed list is shown in the Table 3-1.

(1) The University of Dhaka

- The Department of Physics	The teaching staff:	38
	Students:	873
- The Department of Chemistry	The teaching staff:	39
	Students:	2,266
- The Department of Botany	The teaching staff:	26
	Students:	1,162

(2) Bangladesh University of Engineering and Technology

- The Department of Electrical and Electronic Engineering	The teaching staff:	37
	Students:	903

- The Department of Civil Engineering — The teaching staff: 38; Students: 1,205
- The Department of Mechanical Engineering — The teaching staff: 34; Students: 1,354

The total number of students to utilize the equipment to be supplied by the Project is 7,763.

Table 3-1 The number of Teaching Staff and Students of each Department (1)

(1) University of Dhaka

Item	Department of Physics	Department of Chemistry	Department of Botany
Teaching Staff	Professors 23 Associate Professors 13 Lecturers 2	Professors 15 Associate Professors 11 Assistant Professors 7 Lecturers 6	Professors 8 Associate Professors 7 Assistant Professors 7 Lecturers 4
Total	38	39	26
Student	Hons. Course (A) (B)* First Year 120 10 Second Year 110 10 Third Year 70 15 M.Sc. Preliminary 50 M.Sc. Final 188 Subtotal 573	Hons. Course (A) (B)* / Pass Course (A) (B)* First Year 60 0 250 0 Second Year 55 70 250 30 Third Year 51 60 M.Sc. Preliminary 30 30 M.Sc. Final 100 100 Subtotal 556 530	Hons. Course (A) (B)* (C)** / Pass Course (A) (B)* First Yeat 70 0 0 180 0 Second Year 65 50 15 180 130 Third Year 55 40 10 M.Sc. Preliminary 60 0 5 M.Sc. Final 40 62 10 Ph.D 40 Subtotal 512 490
	Subsidiary Course From / First Year / Second Year Mathematics 30 30 Statistics 30 30 Chemistry 70 70 Geology 20 200 Sub total 300	Subsidiary Course From / First Year / Second Year Physics 150 150 Applied Physics 70 70 Soil Science 200 200 Botany 50 50 Geology 70 70 Zoology 50 50 Sub total 1,180	Subsidiary Course From / First Year / Second Year Soil Science 35 35 Zoology 40 40 Biochemistry 5 5 Sub total 160
Total	873	2,266	1,162

Note: *B shows students ordered to remain by the campus dispute
**C shows repeaters

Table 3-1 The number of Teaching Staff and Students of each Department (2)

(2) Bangladesh University of Engineering and Technology

Item	Department of Electrical& Electronic		Department of Civil Engineering		Department of Mechanical Engineering	
Teaching Staff	Professors	5	Professors	12	Professors (including Vice-Chanceller)	6
	Associate Professors	3	Associate Professors	7	Associate Professors	6
	Assistant Professors	12	Assistant Professors	6	Assistant Professors	10
	Lecturers	17	Lecturers	13	Lecturers	12
Total		37		38		34
Students		(A) (B)		(A) (B)		(A) (B)
	First Year	166 147	First Year	200 0	First Yeat	133 7
	Second Year	144 0	Second Year	195 25	Second Year	132 13
	Third Year	111 0	Third Year	210 30	Third Year	133 5
	Fourth Year	145 0	Fourth Year	190 25	Fourth Year	146 10
	Master Course	188 0	Master Course	70 0	Master Course	33 10
	Doctor Course	2 0	Doctor Course	5 0	Doctor Course	2 0
	Total	903	Total	947	Total	947
				First Year / Second Year		First Yeat / Second Year / Third Year
			Electrical & Electronic Engineering	120 0	Civil Engineering	185 0 0
			Mechanical Engineering	120 0	Computer Engineering	31 0 0
			Metallurgical Engineering	8 0	Electrical & Electronic Engineering	176 144 0
			Naval Architecture and Marine Engineering	0 10	Chemical Engineering	48 46 0
			Total	258	Metallurgical Engineering	8 12 0
					Naval Architecture and Marine Engineering	15 14 0
					Architecture	0 0 53
					Total	732
Total		903		1,205		1,354

Note: *B shows students ordered to remain by the campus dispute
**C shows repeaters

3-3-2 Outline of the curriculum

The followings are the outline of the curriculum and equipment planning of the each department in this Project. Detail of curriculum is shown in the Table 3-2.

(1) The University of Dhaka

1) The department of physics

The department of physics has the longest history among other departments of the University, since its foundation. The honours course of the department has a curriculum to provide basical study on physics including mechanics in the first and second years.

Electronics, which shows rapid development in recent years, is taught in the third year.

The pass course teaches outline of physics for two years, followed by the M. Sc. preliminary course which gives advanced levels of education in atomic physics, electronics and other fields.

The M. Sc. final course offers quantum mechanics as a compulsory subject, with group theory, laser physics, semiconductor devices, and cosmic rays physics as electives.

In the field of research activities, the following works are mainly performed in the department:

- Research activities on communication system by optical fiber
- Research activities on meteorology, solar energy and wind power
- Studies for the properties of non-conductors, semi-conductors and metallic conductors and process of making solar cell
- Research for nuclear physics and quantum physics

On curriculum, approximately 30% of course hour is devoted to laboratory work.

a) Electronics, electricity and magnetism

Electronics and electricity and magnetism become more important curriculum for the dfepartment of physics, because of increasing demand for this field and high degree of interest among students; these fields have been making rapid technological progress in recent years, with increasing applications to instrumentation, communicatioins, and automatic control; some knowledge on electronics and electricity and magnetism is requested to almost everybody.

The department has mainly oscilloscopes and signal and signal generators in radio frequency band, but most of them are too obsolete to use. The Project will renew them. The department has also equipment to conduct experiments on medium and long wave radio, AC/DC circuits, and electrical temperature measurements, but they are also too obsolete to use. The Project will supply new equipment and measuring instruments for modernization and afford students better opportunities to learn the latest subjects such as properties and applications of semi-conductors, principles of radio and audio equipment, and the measuring of resistance, inductance, capacitance, dielectric loss, magnetic force, and thermoelectromotive force.

b) Atomic physics

Atomic radiation is widely used for medical and material inspection purposes and will increase importance in the future of that country. As a first step assistance, the Project will supply atomic and neuclear timer scaler.

c) Geophysics

Geological survey techniques are underdevelopment in that country, but their applications to exploration of ground water and natural gas are useful. The Project will supply the equipment to measure conductivity of earth for geological survey.

d) Waves, acoustics and optics

Optics has wide applications to measurement, analysis and communications technology. However, equipment particularly in this field was not included in the original request. The Project will supply sound level meters and X-Y recorders that will be used by postgraduate students to conduct research on acoustic impacts on human body.

e) Meteorology

Equipment related to research on solar energy is included in the Project.

f) Solid state physics, thermodynamics, polymer physics, dynamics

General-purpose measuring instruments and recorders will be supplied for these curriculums.

The existing equipment related to dynamics is of simple type for demonstration purpose, which can be manufactured at the Universities; thus, no request for procurement was made.

2) The department of chemistry

Like the depaprtment of physics, the department of chemistry was established upon foundation of the University.

The honours course is divided into physics chemistry, organic chemistry, inorganic chemistry, and environmental chemistry. Then, quantitative chemistry, chemical spectroscopy, nuclear chemistry, and analytical chemistry are added in the third year.

In the pass course, physical chemistry, organic chemistry and inorganic chemistry are studied for two years, then in the M. Sc. preliminary course, advanced-level study on these subjects as well as industrial chemistry, environmental chemistry, chemical spectroscopy, and analytical chemistry are taught.

The M. Sc. final course for the master's programme is divided into physical chemistry & inorganic chemistry major and organic chemistry major, both of which offer analytical chemistry and spectro-chemistry as compulsory subjects.

The physical chemistry & inorganic chemistry major offers mass chemistry, statistical chemistry, and chemical bonding theory as compulsory subjects, with advanced reaction rate theory, physical bio-chemistry, and inorganic bio-chemistry as electives, plus laboratory works on physical chemistry and inorganic chemistry.

The chemistry mainly consists of compulsory subjects including chromatograph technology and organic applied chemistry, and selectives such as synthetic polymer and organic synthesis, with laboratory works on organic chemistry and chromatography.

Typical research programs in each field of the department of chemistry are as follows:

- Physical chemistry:

  -Laboratory works for the theory of chemical reactions and electro-chemistry, colloidal-chemistry, etc.
  -Experiments on the adsorption and chemical changes of hydrocarbons and different types of organic compounds.

- Organic chemistry:

  -Research works for trees and fruits of local origin.
  -Research for using green jute plant to the cellulose based industries.
  -Chemical analysis of jute plant, purification and identification of different compounds collected from jute seeds and leaves.
  -Study on the structure of bitter materials of jute.
  -Study on structure and purification of cellulose and hemi-cellulose collected from straw.
  -Analysis of carbohydrate compounds collected from fruits, specially on banana and jack-fruits.

- Inorganic chemistry:

  -Research works for coordinate chemistry, bio-inorganic chemistry, analytical chemistry, inorganic solid matter, and norganic complex compound.
  -Finding for different catalyst for easy chemical reaction of nitrogen in the air.
  -Research works on producing complex compounds of saccharin, amino-acids and different vitamins.
  -Works on organic silicon compounds.
  -Works on producing silica-compounds with aluminium, strontium and sodium in different way.

In terms of curriculum, about 30% of each course load is devoted to laboratory work.

a) Chemical spectroscopy

Chemical spectroscopy is an analytical method to identify substances, their molecular and atomic state and structure by detecting absorption or radiation of electromagnetic waves at specific spectrum. For wide range of electromagnetic waves, several different types of specter photometer are developed. Chemical spectroscopy is widely used because it requires very small amount of substance for accurate analysis, so that researchers in the chemical fields are required to get acquainted with the technique. Although the department has 3 visible spectrometers and 1 IR spectrometer, these are not sufficient to carry out efficient training on chemical spectroscopy for all the students in the department.

Under the Project, UV-visible spectrometers will be introduced in addition to the existing visible spectrometers, thereby extend chemical spectroscopy in a ultraviolet range.

In addition, IR spectrometers widen measuring range to infra-red zone. Atomic absorption spectrometer is widely used in industrialized countries because of its high ability to detect heavy metal element, but very small numbers are only used in Bangladesh. In consideration of promotion of its usage, the atomic absorption spectrometer will be introduced to the department under the Project.

b) Chromatography

Gas chromatography is a method of quantitative analysis to separate a trace element in a solution by using gas as a medium. It is widely used and one of important analytical methods, so that all the students in the chemistry departments should be trained. The department has 4 units of gas chromatography at present. Procurement of gas chromatography with TCD detector under the Project will enable analysis of inorganic gas, organic compound and other elements at high level of sensitivity.

c) Analytical chemistry, physical chemistry

For curriculums of analytical chemistry and physical chemistry, general-purpose equipment used for conventional chemical analysis and measurement will be replaced, because the existing equipment has already heavily worn down. In addition to these, melting point apparatuses for physical chemistry and specific gravity balances for analytical chemistry will be supplied under the Project.

d) X-ray analysis, magnetic analysis

Since the existing equipment is relatively new, no addition is required.

e) Pretreatment equipment for chemical analysis

Chemical analysis requires pretreatment of samples, such as condensation, dilution, distillatioin, mixing, separation, and pyrolysis. However, the equipment needed for pretreatment are not sufficient qualitatively and quantitatively in the laboratories of the department. Under the Project, these pretreatment equipment will be supplemented.

f) Equipment for visual education

Overhead projectors and slide projectors are introduced for the effective teaching by visual explanations.

3) The department of botany

Courses offered by the department of laboratory of botany cover a wide range of subjects.

The honours course consists of plant taxonomy, microbiology, mycology, phycology, cytology, genetics, ecology, and plantpathology, both lecture and laboratory.

The pass course mainly teaches microbiology, phycology, genetics and ecology. The M. Sc. preliminary course offers plant bleeding and biological statistics in addition to advanced-level study on subjects studied in the pass course.

The M. Sc. final course teaches gymnosperm taxonomy, plant physiology, plant environmental science, plant ecology, and molecular genetics as compulsory subjects, with 2 courses selected from 3 groups of cell culture/genetics major, plant pathology/physiology major, and phycology/crop ecology major.

Followings are major research activities in the department of botany:

Microbiology:
-Research for microbiology of shrimp

Plant disease and fungous:
-Microflora of the leaves of crop type plants
-Determination of germs carried by seeds and influence of anti-fungous additives on seeds

Algae and limnology:
-Research on algae of paddy field of Bangladesh
-Limnological study of Bangladesh
-Collection of different types of algae and determination of their nutritive value
-Research on algae of sea-water

• Study on Moss

• Ecology: Study on environment of the forest, mangrove plant, relation of crop-type plant with saltiness, etc.

• Plant cycle: Ion exchange and plant nutrition; growth of jute at low temperature; jute seed production and production of biomass of one type of beans

• Plant genetics: Hybridization of different types of jute

• Tissue culture: Tissue culture of jute, germination of orchid seed, production of orchid from orchid leaf and root, production of hypoploid of paddy, development of new types of rice, tissue culture of woody plant, culture of potato, tissue culture of sugar-can, etc.

a) Microscope and related equipment

Microscopes are the most essential equipment for this department. Student microscopes owned by the department have passed service life and have poor resolution due to fungus fouling of lenses, together with low sensitivity because of no light source other than natural light. Under the Project, advanced student-use microscopes with anti-biofouling and built-in illuminator will be supplied in quantities to increase the opportunity of the student to use them. In addition, the Project will supply high resolution microscopes for observing micro-organisms in training of researchers for agriculture, a major industry of that country.

b) Equipment related to microbiology, cytology, tissue culture, plant breeding

Experiment in these curriculums requires various equipment, However, equipment is basically shorted and obsoleted in the department. New equipment will be supplied to improve the situation.

c) Analytical equipment and instruments

The department has one flame analyzer but lacks other analytical equipment and instruments. The Project intends to supply a variety of equipment including photosynthesis measuring system and UV-visible spectrometer to enforce the department.

d) Equipment for visual education

Overhead projectors will be supplied to conduct visual lectures.

(2) Bangladesh University of Engineering and Technology

1) The department of electrical and electronic engineering

Electrical and electronic engineering is expected to lay an important role in upgrading power supply system and telecommunications in the country.

The bachelor's programme teaches basic electricity, and other subjects related to electricity and telecommunications. Then, the master's programme offers linear analysis, quantum electronics, laser theory, and optical control system.

Major research subjects in the department are as follows:

- Power system's stability
- Comparative study of new and conventional methods of measuring synchronous machine
- Optimum load scheduling
- AC transmission system stabilization by DC link
- Determination of radio data for Bangladesh terrain at microwave frequencies
- Microwave filters
- Analysis, design and synthesis of electronic circuits
- Fabrication of solid state diodes and transistors
- Energy conversion

a) Electronics, microwave engineering

Electronics, recently undergoing rapid advanement, is receiving greater attentioin in the field of education. The existing equipment was procured in 1964, at the most advanced level at that time. Under the Project, a microwave analyzer will be added to comply with the progress of electronics.

b) High voltage engineering

Most of the existing equipment has deteriorated due to aging, except for 25 kV insulation tester. Under the Project, some of these old equipment will be replaced with latest ones.

c) Electrical circuits, electrical machinery

The existing equipment includes old instruments, transformers, inductance, motor-generator and resistors. Motor-generators listed in the existing equipment were widely used as AC/DC converter, but completely disappeared by replacement with the system using semi-conductors such as thyristors. The Project will provide the modernization of equipment, and partial renewal of measuring instruments.

2) The department of civil engineering

The department of civil engineering covers four major areas such as structural engineering, concrete technology, environmental engineering, soil engineering, and transport engineering.

The first year in the bachelor's programme teaches basic subjects of mechanics, chemistry, mathematics, and physics, followed by surveying, geology & geomorphology, structural mechanics, structural analysis, and reinforced concrete in the second and third years. Finally, students are required to take elective courses according to their majors in addition to project planning, management, and structural analysis as compulsory subjects.

The master's programme teaches bridge engineering, antiseismic structure design, industrial waste treatment, soil mechanics, and foundation analysis.

Research on civil engineering is important in construction of infrastructure, and major research items are as follows:

- Behavior of available building and road materials with emphasis on indigenous materials
- Low-cost cyclone resistant housing
- Seismic zoning of Bangladesh
- Water pollution and its control
- Traffic safety studies in urban areas

Some of these research results are adopted in the building standards of that country.

In addition, the department conducts basic research on civil engineering.

a) Structural mechanics, engineering materials

The existing equipment including universal testing machine and beam testing equipment are used to test structural element. The Project will add a structural testing frame with hydraulic loading units which is designed for test and analysis of complete structure or its model.

b) Geotechnical engineering, geotechnical mechanics

The existing equipment covers simple soil tests, but equipment under the Project, such as ROWE consolidation apparatus and consolidation permeability cells, are used to examine more detailed soil properties such as dynamic water gradient, consolidation characteristics, and permeability. High pressure mercury porosimeter and freeze drying apparatus will be supplied for the researches by postgraduate students. In particular, the porosimeter will be used in experiments not only for geotechnical engineering but also for material engineering and transportation engineering.

c) Transportation engineering

The existing equipment is mostly consisted of testing equipment for materials of asphalt pavement. New equipment is divided into those related to highway planning, such as vehicle speed recorder and traffic counter, and those related to testing of road construction materials, such as CBR Marshall tester and TRRL compactibility apparatus, and friction tester.

CBR Marshall tester is used to determine bearing capacity of roadbed and stability of asphalt pavement for the purpose of highway design. These equipment is widely used for work in which graduates are expected to engage.

d) Environmental engineering

The department has only traditional analytical equipment, while environmental engineering has changed greatly with progress of analytical methods. Under the Project, thus, postgraduate-level equipment will be supplied to meet demands at present and in the near future.

3) The department of mechanical engineering

The bachelor's programme covers a wide range of subjects from basic to advanced levels of mechanical engineering for 4 years. In addition, courses related to industrial engineering are taught at senior levels, including quality control in the third year and industrial management in the fourth year.

The master's programme offers statistics, thermodynamics, computer science, as well as production engineering, industrial management and industrial economics and other subjects.

Research activities of the department cover a wide range of fields to aim at problem solving at a national level.

Major research subjects in the department are as follows:

- Thermodynamics

- Fluid mechanics
- Heat transfer
- Applied mechanics
- Wind and solar energy
- Construction of low cost manually operated pumps
- Design and fabrication of wind turbines for lifting water for irrigation

a) Thermal engineering

As the numbers of combustion engines are less in Bangladesh, students have less opportunity to operate. Therefore, it is important to afford experience in testing engines at university. Although the department already has combustion engines for operation and performance measurement by students, many of them are obsolete. Thus, the Project will include partial renewal of the existing equipment.

Gas turbines of smaller output are not commercially viable so that those similar to industrial type are not available for educational purpose. Under the Project, a small gas turbine with test bed for educational demonstration will be supplied. However, power turbine and gas generator will be supplied with system useful for teaching practical technology.

b) Fluid mechanics, aerodynamics

Bangladesh has mostly flat terrain, and mountain areas in the east where hydropower station is operating. Pumps are widely used in agriculture. The existing equipment includes a small wind tunnel which is used in combinatioin with 2 channel anemometer and U-tube pressure gauge to test blades and nozzles. Under the Project, model positioning instruments, pressure gauge and recordfer for the wind tunnel test, demonstration apparatus for flow measuring methods and water hammer demonstration apparatus will be supplied.

c) Mechanics of material, material engineering

The department has only a fatigue tester and hardness tester, but apparently lacks other basic material testing machine. Under the Project,

therefore, the universal testing machine for tensile and compression tests and the impact testing machine for testing brittleness of materials will be introduced.

d) Automobile engineering

This is a relatively new field and the department has no equipment specific for automobile engineering. The fuel injection test bed and the instrument for measuring vibration felt by human body in the car will be supplied under the Project.

e) Applied mechanics

The department has only old type demonstration equipment, strain gage, and critical speed demonstrator which are not so practical today. Under the Project, a dynamic balancing machine which is small but the same one as used in modern workshop and a frequency analyzer used to analyze causes of vibration will be supplied.

f) Control engineering

The department has no equipment available for control engineering because of a relatively new field. Under the Project, pneumatic and hydraulic servo mechanism demonstrators will be supplied.

Table 3-2 Curricums of Each Department

1. The University of Dhaka

(1) Department of Physics

A. Hons. Course

1st Year (2 Classes)		2nd Year (2 Classes)		3rd Year (1 Class)		M.Sc. (Preliminary) (1 Class)		M.Sc. (Final) (3 Classes)	
Course Name	**Units**	**Course Name**	**Units**	**Course Name**	**Units**	**Course Name**	**Units**	**Course Name**	**Units**
Mechanics	(1)	Heat, Thermodynamics & Kinetic theory of Radiation	(1)	Classical Mechanics & Special theory of relativity	(1)	Classical Mechanics, Relativity and Mathematical Physics	(1)	Quantum Mechanics (Compulsory)	(1)
Properties of Matter and Methods of Experimental Phys.	(1)	Waves, Acoustics & Optics	(1)	Solid State Physics & Statistical Mechanics	(1)	Electricity ; Classical Electrodynamics	(1)	**Group 1 (any two)**	
Electricity & Magnetism	(1)	Methods of Mathematical Phys.	(1)	Electrodynamics	(1)	Quantum Mechanics	(1)	Nuclear Physics	(1)
Physics Laboratory	(2)	Physics Laboratory	(2)	Electric Circuits & Electronics	(1/2+1/2)	Atomic Physic, Statistical Mechanics and Physics of Solids and Materials	(1)	Solid State Physics	(1)
Physics Viva	(1/2)	Physics Viva	(1/2)	Atomic & Moleccular Physics	(1/2)	Electronics	(1/2)	Electronics	(1)
				Nuclear Physics	(1/2)	Nuclear Physics	(1/2)	**Group 2 (any two)**	
				Quantum Mechanics	(1)	Practical	(2)	Advanced Nuclear Physics	(1)
				Physical Laboratory	(2)	Viva Voce	(1)	Advanced solid state physics	(1)
				Physics Viva	(1)			Group theoy	(1)
								Modern field theories	(1)
								Bio Physics and Reactor physics Crystallography and Polymer physics	(1)
								Laser Physics and Physics of semiconductor Devices	(1)
								Computor Science and microprocessors	(1)
								Atmospheric Physics and Meteorology	(1/2)
								Geophysics (1/2 unit) or Cosmic Ray Physics (1/2 unit)	(1/2)
								Practical	(2)
								Viva voce	(1)

B. Pass Course

Course Name	Units	Course Name	Units
Mechanics, Oscillation, Waves & Sound	(1/2)	Electricity and Magnetism, Electronics	(1/2)
Properties of matter, Heat, Thermodynamics and Kinetic Theory of Gases	(1/2)	Optics, Modern Physics, Nuclear Physics	(1/2)
Physics Lab.	(1/2)	Physics Lab.	(1/2)

Note: Figures in parentheses show the number of units. One unit consists of two classes per week throughout the year.

(2) Department of Chemistry

Hons. Course

A. Theory Course

	1st Year (2 Classes)	Unit	2nd Year (2 Classes)	Unit	3rd Year (2 Classes)	Unit
Physical Chemistry	General Physical Chemistry	(1)	Thermodynamics & Statistical thermodynamics	(1/2)	Chemical Kinetics, Surface chemistry, Phase equilibria, etc.	(1)
			Electrochemistry	(1/2)		
Organic Chemistry	General Organic Chemistry	(1)	Organic reaction mechanism	(1/2)	Natural product Chem.	(1/2)
			Stereochemistry	(1/2)	Carbohydrates & polymers	(1/2)
Inorganic Chemistry	Principles of Inorganic Chemistry		Chemistry of Representative Element(I)	(1/2)	Advanced Inorg. Chem.I	(1/2)
			Chemistry of Representative Element(II)	(1/2)	Advanced Inorg. Chem. II	(1/2)
Industrial and Environmental Chemistry			Industrial & Envir. Chem.(I)	(1/2)	Industrial & Envir. Chem. II	(1/2)
					Industrial & Envir. Chem. III	(1/2)
					Industrial & Envir. Chem. IV	(1/2)
Quantum C. & Spectroscopy					Quantum mechanics and chemical spectroscopy	(1/2)
Nuclear & Analytical Chemistry					Nuclear & Analytical Chem.	(1/2)

B. Laboratory Course

Physical Chemistry			Physical Chemistry	(1/2)	Physical Chemistry	(1/2)
Organic Chemistry	Organic Chemistry	(1/2)			Organic Chemistry	(1)
Inorganic Chemistry	Qualitative Inorg. Analysis	(1/2)	Qualitative Inorganic Analysis & Analytical Techniques	(1)	Advanced Inorganic synthesis and Characterisation	(1/2)
Industrial & Enivironmental Chemistry	Synthetic Inorg. Chemistry. & Elementary Crystal Chemistry	(1)			Industrial & Environmental Chemistry	(1/2)

Pass Course	• Physical Chemistry	(0.6)	• Inorganic Practical • Organic Practical •Physical Practical	(1)	
	• Organic Chemistry				
	• Inorganic Chemistry	(0.6)			

Note: Figures in parentheses show the number of units. One unit of two classes per week throughout the year.

M. Sc. (Preliminary)

(2 Classes)

	Unit
Physical Chem. I	(1/2)
Physical Chem. II	(1/2)
General & Concenputual Org. Chem.	(1/2)
Reaction Mechanism, Stereochemistry & special Topics	(1/2)
Inorganic Chem. I	(1/2)
Inorganic Chem. II	(1/2)
Industrial & Environmental Chem. I	(1/2)
Industrial & Environmental Chem. II	(1/2)
Quantum mechanics and Chemical spectroscopy	(1/2)
N & A Chemistry	(1/2)
Physical Chem.	(1/2)
Organic Chem.	(1/2)
Chemistry	(1/2)
Ind. & Env. Chem.	(1/2)
Viva Voce	(1)

M. Sc. (Final)

For students Specializing in Physical & Inorganic Chemistry

(4 Classes)

Theory

Main Course	Unit	Optional Course	Unit
Analytical Chemistry	(1/2)	Advanced Chemical Kinetics	(1/2)
Chemical Spectroscopy	(1/2)	Physical Chemistry of High Polymers	(1/2)
Quantum Chemistry and Statistical Mechanics	(1)	Advanced Electro- and Solar Photochemistry	(1/2)
Chemical Crystallography and Solid Sta'e Chemistry	(1)	Bio-physical Chemistry (Physical Chemistry with Applications in Biological Systems)	(1/2)
Coordination Chemistry and Reaction Mechanism	(1/2)	Inorganic Polymers	(1/2)
Advanced concepts of Atomic Structure and Chemical bounding	(1/2)	Electron Deficient Compounds	(1/2)
		Advanced Nuclear Chemistry and Actinids	(1/2)
		Nonaqueous Solvents	(1/2)
		Bio-Inorgani Chemistry	(1/2)
		Organometallic Chemistry	(1/2)

Laboratory Course	Unit
Physical Chemistry Advanced Laboratory Course I	(1)
Inorganic Chemistry Advanced Laboratory Course I	(1)

For Students Specializing in Organic Chemistry

Theory

Main Course	Unit	Optional Course	Unit
Analytical Chemistry	(1/2)	Synthetic Polymers	(1/2)
Chemical Spectroscopy	(1/2)	Cehmistry of Carbohydrates	(1/2)
Advanced Organic Reaction Mechanism	(1)	Organometallic Chemistry	(1/2)
		Organic Synthesis	(1/2)
Chromatographic Techniques (The Examination of this course will be along with the course 501H)		Chemistry of Natural Products	(1/2)
		Organic Chemistry with application in Agriculture	(1/2)
Advanced Stereochemistry	(1/2)	Advanced Chemistry of Heterocyclic Compounds	(1/2)
Organo applied Chemistry	(1/2)		

Laboratory Course	Unit
Physico-organic Chemistry	(1/2)
Organo applied Chemistry	(1/2)
Organic Quantitative Analysis	(1/2)
Chromatographic Methods of Analysis	(1/2)

Viva Voce (1)

Note: Figures in parentheses show the number of units. One unit consists of two classes per week throughout the year.

(3) Department of Botany

A. Hons. Course	1st Year (2 Classes)	Unit	2nd Year (2 Classes)	Unit	3rd Year (2 Classes)	Unit
Theory	• Plant Dicersity	(1/2)	• Microbiology II	(1/2)	• Cytology and Cytogenetics	(1/2)
	• Plant Anatomy and Embryology of Agiosperms	(1/2)	• Mycology II	(1/2)	• Evolution	(1/2)
	• Microbiology I	(1/2)	• Fundamental Genetics	(1/2)	• Plant Physiology	(1/2)
	• Phycology I	(1/2)	• Plant Physiology	(1/2)	• Physiological Ecology Autecology	(1/2)
	• Higher Cryptogams Bryophyta and Pteridophyta	(1/2)	• Ecology (General Ecology)	(1/2)	• Plant Breeding	(1/2)
	• Gymnosperm, Angiosperms and Economic Botany	(1/2)	• Biometry	(1/2)	• Moleccular Genetics	(1/2)
					• Contemporary systematics	(1/2)
					• Higher Cryptogams II.	(1/2)
					• Phycology II.	(1/2)
					• Limnology and Hydrobiology	(1/2)
					• Plant Pathology I.	(1/2)
					• Plant Pathology II.	(1/2)
Practical	• Plant Diversilty, Plant Anatomy and Embryology of Angiosperms	(1/2)	• Microbiology II, Mycology II	(1/2)	• Cytology and Cytogenetics, Evolution Plant Breeding, Molecular Genetics	(1/2)
	• Microbiology I, Mycology I	(1/2)	• Fundamental Genetics	(1/2)	• Plant Pathology I, Plant Pathology II	(1/2)
	• Phycology, Higher Cryptogams Bryophyta and Pteridophyta	(1/2)	• Plant Physidogy, Ecology	(1/2)	• Contemporary systematics, Higher Cryptogams II	(1/2)
	• Grymnosperms, Angiosperms and Economic Botany	(1/2)	• Cytology, Biometry	(1/2)	• Phycology II, Limnology and Hydrobiology	(1/2)
					• Plant Physiology, Physiological Ecology, Autecology	(1/2)
Viva voce	(1/2)		(1/2)		(1)	

B. Pass Course				
Theory	• Microbiology, Mycology & Plant Pathology, Economic Botany & Embryology	(1/2)	• Genetics, Cytology and Cytogenetics, Evolution	(1/2)
	• Phycology, Limnology and Lichenes, Higher cryptogams and Gymnosperms, Morphology and Anatomy	(1/2)	• Ecology, Plant Physiology, Taxonomy of Angiosperms	(1/2)
Practical	• Practical	(1/2)	• Practical	(1/2)

Note: Figures in parentheses show the number of units. One unit consists of two classes per throughout the year.

M. Sc. Preliminary

(1 Class)

Theory	Course No.	Unit
Phycology Hydrobiology and Limnology	501	(1/2)
Mycology Plant Pathology	502	(1/2)
Microbiology Higher Cryptogams	503	(1/2)
Anayomy Embryology Economic Botany	502	(1/2)
Plant Physiology Plant Biochemistry	505	(1/2)
Cytology Cytogenetics and Evaluation	506	(1/2)
Genetics Plant Breeding	507	(1/2)
Ecology Biometry	508	(1/2)
Taxonomy Gymnosperms	509	(1/2)
Practice		
(501+502)		(1)
(503+504)		(1)
(505+506+507)		(1)
(508+509)		(1)
Viva Voce		(1)

M. Sc. Final

(3 classes)

Course title	Unit
A. Core course (compulsory for all student)	
Angiosperm Systematics	(1/2)
Plant Physiology	(1/2)
Plant Ecology and Physiological Ecology	(1/2)
Molecular Genetics	(1/2)
B. Selective course (To choose any two courses from any one of thefollwing three groups)	
Group I :	
Morphogenesis and tissue culture	(1)
Cytogenetics	(1)
Plant Breeding and Biometry	(1)
Tropies in Genetics	(1)
Group II :	
Principles of Plant Pathology	(1)
Seed Pathology and Diseases of Crop plants	(1)
Plant Nutrition	(1)
Plant Physiology	(1)
Microbiology	(1)
Group III :	
Phycology	(1)
Hydrobiology and Limnology	(1)
Biological Oceanography	(1)
Crop Ecology	(1)
Environmental Biology	(1)
Higher Cryptogams	(1)
Plant Systematics	(1)
C. Practical or Thesis	(2)
D. Viva Voce	(1)

Note: Figures in parentheses show the number of units. One unit consists of two classes per week throughout the year.

2. Bangladesh University of Engineering and Technology

(1) Department of Electrical & Electronic Engineering

Undergraduate

1st Year	Marks
Civil Engineering Drawing	50
Servey Practical	50
Chemistry	200
Chemistry Sessional	100
Computer Techniques	150
Computer Techniques Sessional	50
Basic Electrical Engineering	200
Basic Electrical Engineering Sessional	50
English and Economics	150
Mathematics	
Paper I	150
Paper II	150
Basic Mechanical Engineering	150
Basic Mechanical Engineering Sessional	50
Mechanical Engineering Drawing	50
Physics	200
Physics Sessional	100
Foundry Shop	50
Metal and Welding shop	50
Machine Shop	50

2nd Year	Marks
Mechanics of Materials	150
Mechanics of Materials Sessional	50
Electrical Design and Drafting	50
Electrical Circuits I	250
Electrical Circuits I Sessional	50
Electrical Machines I	250
Electrical Machines I Sessional	50
Electronics I	250
Electronics I Sessional	50
Accountancy and Industrial Management	
Accountancy	100
Industrial Management	150
Mathematics	
Paper I	150
Paper II	150
Thermodynamics and Fluid Mechanics	250
Fuel Testing and Fluid Machanics Sessional	50

3rd Year	Marks
Digital Techniques	200
Digital Techniques Sessional	50
Electronics Shop Sessional	50
Electronics II	300
Electronics II Sessional	100
Electrical Circuits II	300
Electrical Machnies II	300
Electrical Machines II Sessional	100
Measurements and Instrumentation	200
Measurements and Instrumentation Sessional	50
Electromagnetic Fields and waves	200
Transmission and Distribution of Electric power	300
Electrical Design Sessional	50
Mathematics	200

4th Year	Marks
Microprocessors & Digital Computer*	200
Mircoprocessor Digial Electronics	50
Project and Thesis	200
Control Systems	200
Control Systems Sessional	50
Power Systems Analysis	200
Power System Analysis Sessional	50
Power Stations	200
Integrated Circuits and IndustrialElectronics	300
Integrated Circuits and Industrial Electronics Sessional	50
Telecommunication Engineering	200
Telecommunication Engineering Sessional	50
Science of Materials	200
Switchgear and Protection	200
Switchgear and Protection Sessional	50
Microwave Engineering*	200
Microwave Engineering Sessional	50
Electronics III*	200
Electronics III Sessional	50
High Voltage Engineering*	200
High Voltage Engineering Sessional	50
Electrical Circuits III*	200
Electrical Circuits III Sessional	50

* Indicates optional courses.

Postgraduate

	Credit hours
Thesis	18
Project	6
Seminar	0
Compulsory Subjects	
Engineering Analysis	3
Energy Conversion Process	3
Optional Subjects	
Linear System Analysis	3
Network Synthesis I	3
Network Synthesis II	3
Non-Linear Circuits	3
Advanced Topics in Network Theory	3
Statistical Communications Theory	3
Information Theory	3
Telephone Traffic Theory	3
Advanceed Electronics	3
Quantum Electronics	3
Solid State Davices	3
Active Circuit Design	3
Electric and Magnetic Properties of Material	3
Electronics of Solids	3
Laser Theory	3
Applied EM Theory	3
Microwave Theory and Techniques	3
Microwave Tubes and Circuits	3
Antennas and Propagation	3
Non-linear Conrol	3
Sampled-data Control	3
Modern Control Theory	3
Optional Control Systems	3
Statistical Models for Enginnering Stystems	3
Generalized Machine Theory	3
Special Machines	3
Power Semiconductors and Modulators	3
Advanced Machin Desing	3
Optimization of power System Operation	3
Computer-aided Power System Design	3
Protective Relays	3
Power System Stability	3
Transcients in Power Systems	3

Note: Figures show unit points. 100 points mean one unit with 2 classes/week through the year. Figures in parentheses in the master's course show the number of classes per week.

(2) Department of Civil Engineering

Undergraduate

1st Year	Marks
Civil Engineering Drawing	100
Engineering Mechanics	200
Chemistry	200
Chemistry Sessional	50
Basic Electrical Engineering	200
Electrical Enginnering Sessional	50
English and Economics	150
Mathematics	
Paper I	150
Paper II	150
Mechanical Engineering Drawing	50
Physics	200
Physics Sessional	50
Machine shop	50
Welding shop	25
Carpentry shop	25

2nd Year	Marks
Details of Construction and Estimating	100
Surveying	250
Practical Surveying (Tree weeks field work)	100
Engineering Materials	250
Computer Programming and Numerical	150
Methods in Civil Engineering	
Computer Programming Sessional	50
Geology and Geomorphotology	150
Mechanics of Materials	250
Structural Mechanics and Materials	50
Sessional	
Concrete Sessional	50
Accounts and Sociology	150
Mathematics	250
Fluid Mechanics	250
Fluid Mechanics Sessional	50

3rd Year	Marks
Structural Analysis and Design I	300
Structural Analysis and Design I	
Sessional	50
Reinforced Concrete	300
Reinforced Concrete Sessional	50
Environmental Ebgineering I	300
Environmental Engg. Sessional	50
Geotechnical Engineering I	300
Geotechnical Engg. Sessional	50
Transportation Engineering I	300
Transportation Engg. I Sessional	50
Mathematics	300
Open Channe Flow and Hydraulic	
Machinery	300
Open Channel Flow Sessional	50
Hydrology	200

4th Year	Marks
Compulsory Subjects	
Project and Thesis	200
Project Planing and Management	200
Structural Analysis and Design II	300
Strutural Analysis and Design Sessional	50
Water Resources Engineering I	300
Hydraulic Machinery Sessional	50
Optional Subject	
Any two groups out of Group A, Group, Group (Cor E), and Group D	
Group A	
Water Resources Engineering II	300
Water Resources Engineering III	200
Water Resources Engineering Sessinal	50
Group B	
Structural Analysis and Design III	300
Structural Analysis and Design IV	200
Structural Analysis and Design Sessional	50
Group C	
Environmental Engineering II	300
Environmental Engineering III	200
Environmental Engineering Sessional	50
Group D	
Geotechnical Engineering II	300
Geotechnical Engineering III	200
Geotechnical Engineering Sessional	50
Group E	
Transportation Engineering II	300
Transportation Engineering III	200
Transportation Engineering Sessional	50

Postgraduate

	Credit hours
Thesis	18
Project	6
Theory of Elasticity	3
Theory of Plates	3
Plastic Design of Structures	3
Elastic Stability of Structures	3
Analysis and Design of Shells	3
Finite Element Methods I	3
Computer Methods in Civil Engineering	3
Advanced Design of Concretes Structures	3
Analysis and Design of Tall Building	3
Bridge Engineering	3
Finite Element Methods II	3
Structural Dynamics Seisimic Design of Structures	3
Advanced Concretes Technology	3
Theory of Water Treatment	3
Theory of Sewage Treatment	3
Biology of Sewage and polluted Waters	3
Environmental Sanitation	3
Industrial Water and Waste Treatment	5
Municipal and Rural Sanitation	3
Water Pollution and its Control	3
Water Supply Engineering Design	3
Sewage and Drainage Engineering Design	3
Soil Mechanics I	3
Soil Mechanics II	3
Foundation Analysis Methods	3
Earth Pressure and Retaining Structures	3
Earth Dams and Stability of Slopes	3
Rock Mechanics	3
Soil Dynamics	3
Advanced Engineering Geology	3
Transpotation Engineering	3
Geometric Design of Highways	3
Highway Materials	3
Advanced Surveying	3
Structural Design of Pavements	3
Traffic Engineering	3
Railway Engineering	3
Waterways	3
Planning and Design of Airports	3
Transportation Planning	3

Note: Figures show unit points. 100 points mean one unit with 2 classes/week through the year. Figures in parentheses in the master's course show the number of classes per week.

(3) Department of Mechanical Engineering

Undergraduate

1st Year	Marks
Surveying	50
Civil Engineering Drawing	50
Chemistry	200
Chemistry Sessional	50
Basic Electrical Engineering	200
Basic Electrical Engineering Sessional	50
English and Economics	150
Mathematics	300
Paper I	
Paper II	
Thermal Engineering	200
Thermal Engineering Sessional	50
Basic Mechanical Engineering Drawing	50
Physics	200
Physics Sessional	50
Foudry shop	50
Welding shop	50
Machine shop	50

2nd Year	Marks
Chemistry of Non-metallic Engineering Materilas	150
Electrical Technology	250
Production Processes	150
Vector Calculus, Matrices, Laplace's Transferms, Differential equations	250
Basic Thermodynamics	250
Basic Thermodynamics Sessional	50
Engineering Mechanics	250
Mechanics of Solids	250
Mechanics of Solids Sessional	50
Mechanical Engineering Drawing	50
Metallic Materials	150
Metallic Materials Sessional	50

3rd Year	Marks
Industrial law, Sociology and Accounts	300
Production Processes	200
Production Prosesses Sessional	50
Measurement and Quality Control	300
Measurements and Quality Control Sessional	50
Fourier series, Partial Differential Equations and Harmonic Analysis, Numerical Analysis and Complex Variables	300
Computer Programming	50
Heat and Mass Tranfer	300
Heat Transfer Sessional	50
Mechanics of Machinery	300
Mechanics of Machinery Sessional	50
Fluid Mechanics	300
Fluid Mechanics Sessional	50
Machine Design	300
Machine Design Sessional	50

4th Year	Marks
Industrial Management	300
Machine Tools	300
Machine Tools Sessional	50
Production Planning and Control	300
Project and Thesis	300
Applied Thermodynamics	300
Applied Thermodynamics Sessional	50
Fluid Mechanics and Machinery	300
Fluid Mechanics and Machinery Sessional	50
Optinal Subjects (Any Two)	
Aerodynamics	200
Automobile Engineering	200
Control Engineering	200
Plastics Process Technology	200
Operations Research	200
Refrigeration and Airconditioning	200

Postgraduate

	Credit hours
Thesis	18
Project	
Problem	6
Classical Thermodynamics	3
Statistical Thermodynamics	3
Solar Energy	3
Survey of Fluid Mechanics	3
Mechanics of Inviscid Incompressible Fluid	3
Mechanics of Viscous Fluid	3
Mechanics of Inviscid Compressible flow	3
Advanced Heat Transfer	3
Advanced Conduction and Radiation Heat Transfer	3
Advanced Convection Heat Transfer	3
Design of Heat Transfer Equipments	3
Heat Transfer Seminar	3
Thermal Environmental Engineering	3
Advanced Dynamic	3
Mechanical Vibrations	3
Applied Elasticity	3
Theory of Plates and Shells	3
Elastic Stability of Structures	3
Experimental Stress Analysis	3
Finite Element Methods	3
Advanced Numerical Analysis	3
Computer and Programming	3
Mechanical Behaviour of Engineering Materials	3
Structure and Properties of Enginerring Materials	3
Theory of Plasticity	3
Dislocation Theory	3
Principles of Enginerring Production I	3
Principles of Enginerring Production II	3
Industrial Enginerring Analysis	3
Industrial Management Planning	3
Linear Programming	3
Econometric Methods	3

Note: Figures show unit points. 100 points mean one unit with 2 classes/week through the year. Figures in parentheses in the master's course show the number of classes per week.

3-3-3 Scale of equipment

The scale of equipment was decided with the aim of providing equipment at least required to maintain adequate level of university education.

The Table 3-3 shows the major existing equipment and new equipment to be supplied, classified by major curriculums.

Quantity of each equipment was decided, in principle, on the basis of the number of students of a class using the equipment concerned. However, when experiments are conducted by divided groups in a class, on the basis of the number of students belonging to a group, when the same kind of lectures are given in several classes at the same time, on the basis of the number of classes, quantity of each equipment is modified.

Concretely, quantity of equipment was decided in consideration of differences in the form of lectures as follows:

1) On the occasion a lecture is given to one class by one instructor using one unit of equipment: One unit of equipment is required.

2) On the occasion a lecture is given to one class by one instructor lending one unit each to every student present: As many equipment as the number of students present in the class are required.

3) On the occasion a lecture is given to a class divided into several groups by one instructor lending one unit to each group: As many equipment as the number resulted from the number of students in the class, divided by the number of students in one group, are required (fractions are raised to a unit).

4) On the occasion every students in a class conducts the same kinds of experiments by rotation under the supervision of instructors dividing the class into several groups and lending one unit of

different type of equipment to each group: One Unit of equipment is required.

5) Pertaining to the above item 1) to 4), on the occasion lectures are simultaneously given to more than one class using the same equipment: As many equipment as derivable from multiplying the quantity specified in each case under item 1) to4) by the number of the classes concurrently having the same kind of lecture. As regards the number of the simultaneously-lectured classes, necessity of giving the lecture in certain classes at the same time has confirmed, through the study of time schedule of the curriculum.

As practically each department controls equipment independently, no equipment should be lent to other departments as a rule.

Table 3-3 List of Existing and New Equipment

1. University of Dhaka

(1) Department of Physics

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Electronics	* Radio receiver (transistor)	1	Unknown		
	* Determination of wave lengths	1	1960		
	* Oscilloscope	7	1965-78	Oscilloscope	24
	* Oscilloscope	5	1985-86		
	* Dual trace oscilloscope	3	1978	Quad trace oscilloscope	2
	* Signal generator	5	1965-76	Signal generator	
	* Signal generator	6	1978-86		
	Micro computers	2	1988		
				Microcomputer trainer	2
				Transistor circuit trainer	2
				Logic circuit experimental equipment	2
				Electronic circuit experimental trainer	2
				Logic tester	2
				Semiconductor element experimental equipment	2
				AM modulation & demodulation circuit	1
				Synthesized function generator	2
				Precision digital meter	2
				Frequency counter	2
Electricity & Magnetism	* D.C. circuit	1	Unknown		
	* Thermocouple	1	Unknown		
	* Magnet set	1	Unknown		

Note: Mark * indicates the equipment beyond its life time

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Electricity & Magnetism	* Galvanometer	3	1950	Galvanometer	12
	* Platinum resistance	1	1950		
	Potentiometer	1	1980	Potentiometer	2
	Volt meter	4	1986		
	Ammeter	2	1986		
				DC bridge (Wheat-stone)	6
				Dielectric loss measuring set	1
				Magnetometer	2
				LCR meter	2
				Thermoelectromotive force measuring unit	1
				Compact digital multimeter	10
Atomic Physics	* Geiger-Muller tube	1	1978		
	* Scaler	1	1978		
	Timer scaler	2	1985	Atomic & nuclear timer scaler	5
Geophysics				Measuring equipment for conductivity of earth	
Wave, Acoustics & Optics	* Spectrometer	1	1960		
	* Prism spectrometer	1	1960		
	* Micheleson's Interferometer	1	1960		
	Polarimeter	1	1970		
				Sound level meter	1
				X-Y recorder	1
Meteorology				Pyranometer	2
				Digital hygrometer	2
Solid State Physics				Static DC power supply unit	3
				Balance	2
Thermo-dynamics				Digital thermometer	6
Mechanics	* Compound pendulum	1	Unknown		
	* Spring constant	1	Unknown		
	* Young's modulus	1	Unknown		
	* Surface tension	1	Unknown		
Polymer Physics				X-Y recorder	1

Note: Mark * indicates the equipment beyond its life time

(2) Department of Chemistry

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Chemical Spectroscopy	Visible spectrophotometer	2	1980/81		
	Visible spectrophotometer	1	1987	UV-visible recording spectrometer	5
	IR spectrophotometer (auto)	1	1977	Double beam IR spectrometer	2
				Atomic absorption spectrophotometer	1
Chromato-graphy	Gas chromatograph	1	1980	Gas chromatograph with TCD detector	1
	Gas chromatograph	1	1986		
	Capillary gas chromatograph	1	1986		
Analytical Chemistry, Physical Chemistry	* Refractometer	1	1957	Refractometer	2
	* Polarimeter	1	1960	Polarimeter	1
	Analytical balance	7	1975-82		
	* Electric balance	1	1970	Digital balance	8
	Electric balance	2	1982-87		
	pH meter	3	1984-85	pH meter	12
	Colorimeter	1	1983		
				Conductivity meter	6
				Melting point apparatus	12
				Specific gravity balance	4
X-Ray Analysis	* X-ray generator with camera	1	1968		
	X-ray generator	1	1988		
Magnetic Analysis	NMR spectrometer	1	1985		
Pre-treatment Equipment for Chemical Analysis	Oven	4	1975-85	Oven	10
	Oil bath	1	1975		
	Centrifuge	6	1980-85	Centrifuge	12
	Rotavapor	4	1980-85	Rotavapor	4
	Muffle furnace	1	1980		
	Water bath	5	1982-87	Water bath	18
	Water distillation plant	1	1987	Water still	6

Note: Mark * indicates the equipment beyond its life time

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Pre-treatment Equipment for Chemical Analysis	Furnace	1	1988	Furnace	2
				Heating mantle	24
				Hot plate stirrer	10
Equipment for Lecture				Over head projector	2
				Slide projector	2

(3) Department of Botany

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Microbiology, Cytology, Mycology, etc. (Microscope & related equipment)	Advanced student microscope	150	Unknown	Advanced Student micro-scope	100
	* Compound microscope (Phase contrast)	1	1950	Advanced research micro-scope	1
	Microscope (Phase contrast)	1	1987		
	* Disecting microscope	2	1963/65	Research microscope	4
	Disecting microscope	1	1988		
	* Microtome	1	1940	Freezing microstome	1
				Camera lucida (mirror type)	100
				Fluorescent attachment set for research microscope	
Microbiology, Cytology, Tissue Culture, Plant Breeding	* Oven	1	1968		
	* Electronic balance	2	1970	Digital balance	6
	Electronic balance	3	1978-88		
	* pH meter	2	1970	pH meter	10
	pH meter	4	1980-88		
	* Table top centrifuge	1	1970		
	Centrifuge	2	1986-88	Centrifuge	10
	Freezer	2	1970		
	Freezer	5	1980-88		
	Incubator	4	1975-81		5

Note: Mark * indicates the equipment beyond its life time

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Microbiology, Cytology, Tissue Culture, Plant Breeding	Autoclave	5	1980-88	Autoclave	2
	Homogenizer	1	1980		
	Test tube washer	1	1980	Glassware washer	4
	Distillation plant	2	1983-86	Water still	3
	Drying oven	1	1986	Precise electric drying oven	2
				Hot air sterilizer and dryer	4
	Furnace	1	1988		
	Water bath	1	1988	Water bath	4
	O_2 meter	1	1988		
	Chloride meter	1	1988		
				Gyrator shaker	4
				Recording thermohygraph	3
				Colony counter	2
				Vacuum desiccator	1
				Ultrasonic pipette washer	2
Other Analyticsl & Measuring Equipment	Flame analyser	1	1980	Flame analyser	2
				Leaf area meter	3
				Thin layer chromatography set	2
				Spectrophotometer	6
				UV spectrophotometer	2
				Universal profile projector	1
				Refractometer	8
				Portable lux meter	5
Equipment for Lecture				Over head projector	5

Note: Mark * Indicates the equipment beyond its life time

2. Bangladesh University of Engineering and Technology

(1) Department of Electrical & Electronic Engineering

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Electrical Engineering, Microwave Engineering	* Amplifier	3	1964		
	* Unit Oscillator	7	1964		
	* Low pass filter	5	1964		
	* Klystron	3	1964		
	* Signal generator	4	1964		
	* Travelling wave amp.	1	1964		
	* D.C. Micro Ammeter	1	1964		
	* Frequency meter	1	1964		
	* Microwave power meter	1	1964		
				Microwave network analyser	1
				Storage oscilloscope	1
High Voltage Engineering	* 25kV Insulation test	1	Unknown		
				High voltage test set with corona measuring equipment	1
				High voltage impulse generator	1
Electrical Circuits, Electrical Machines	* Wattmeter	30	1950-74		
	* A.C. AAmmeter	26	1950		
	A.C. meter	1	1978		
	* A. C. Voltmeter	14	1950-78		
	* A.C./D.C Ammeter	49	1950		
	* A.C./D.C. Voltmeter	23	1950		
	* D.C. Ammeter	7	1950		
	D.C. Ammeter	2	1974		
	* D.C. Voltmeter	5	1950		
	* Galvanometer	3	1950		
	* 3ø Motor (winding)	1	1950		
	* 3ø Induction motor	1	1950		
	*1ø Varriac	2	1950		
	*1ø Varriac	1	1974		
	*1ø Transformer	1	1950		
	*1ø Transformer	3	1978		
	*3ø Varriac	1	1960		

Note: Mark * indicates the equipment beyond its life time

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Electrical Circuits, Electrical Machines	* 3ø Varriac	1	1974		
	* 3ø Transformer	1	1950		
	* M-G set	6	1950		
	* Electric machine set	2	1950		
	* Inductor	9	1950		
	* Rheostat	58	1950		
	• Dacade box	6	1950		
	• D.C Bridge	2	1950		
	* Crip on Ammeter	4	1955		
	Magger	3	1974		
	* Oscilloscope	2	1974		
	* Tachometer	7	1978	Pocket tachometer	3
				Portable wattmeter	8
				Portable P.F. meter	8
				AC synchro-indicator	3
				Portable frequency meter	8

Note: Mark * indicates the equipment beyond its life time

(2) Department of Civil Engineering

Category	Major Existing Equipment		Planned Equipment	
	Item	Q'ty	Item	Q'ty
Structural Mechanics, Engineering Materials	Universal testing machine	2		
	Impact testing machine	1		
	Rockwell hardness tester	2		
	Demec strain gage 5mm, 200mm	8		
	Beam testing machine	1		
	Flow tester for cement mortar	5		
	Prestressing platform	1		
	Slump cone for cement mortar	5		
	Cement briquette mold and cube mold	8		
	Cement mixer fitted with mortar	1		
	Pundit ultrasonic concrete tester	1		
	Concrete core drill	1		
	250 ton compression testing machine	1		
			Structural testing frame	1
			Data logger	1
Geotechnical Engineering, Soil Mechanics	CBR apparatus	1		
	Tri-axial appratus	1		
	Constant pressure appratus	1		
	Mortorized direct shear appratus	1		
	Mechanical compactor	1		
	Cone penetrometer	1		
	Liquid limit device	6		
			Rowe consolidation appratus	1
			Sieve set	1
			Consolidation permeability cells	1
			Freeze-drying apparatus	1
			High pressure mercury porosimeter	1
			Data recorder	1
			Bearing plate with bearing sets	1

Category	Major Existing Equipment		Planned Equipment	
	Item	Q'ty	Item	Q'ty
Traffic Engineering	Asphalt oven	1		
	Brass Saybolt viscosity tube	4		
	Bituminous swell plate	3		
	Ductility testing machine	1		
	Penetrometer	2		
	Softening point apparatus	2		
	Auto compactor for bituminous mix	1		
			CBR-Marshall tester	1
			Vehicle speed recorder	1
			Electro-optical distance meter	2
			Digital thermometer	1
			Traffic counter	1
			Compactibility appratus	1
			Friction tester	1
Environ-mental Engineering	Aquatester	7		
	Microscope	3	Polarizing microscope	1
	Centrifuge	2		
	Distillation unit	1		
	BOD meter	1		
	Spectrophotometer	1		
	Bacteria INCULATOR	1		
	Turbidimeter	1		
	COD reactor	1		
	Isotemperature, incubator	1		
	U-V sterilizer	1		
			Atomic absorption spectro-photometer	1
			Air pollution analysis kit	1
			Total carbon analyser	1

(3) Department of Mechanical Engineering

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Thermal Engineering	* Automobil engine	1	Unknown	Petrol engine and test bed	1
	* Oil engine	1	Unknown		
	* Diesel engine	1	Unknown		
	* Beckman thermometer	1	1948		
	* Boiler	1	1948		
	Boiler	1	1983		
	* Compressor	1	1950		
	* Saybolt viscosimeter	1	Unknown		
	* Muffle furnace	1	Unknown		
	* Emerson calorimeter	1	Unknown		
	* Elec. stop watch	1	Unknown		
	* Gas analyser	1	Unknown		
	* Tachometer	1	Unknown		
	Digital tachometer	1	1983		
	Water brake	1	1978		
	Sound level meter	1	1985	Sound level meter	2
	Stroboscope	1	1988		
				Gasturbine and test bed	1
				Fuel injection test bed	1
				Refrigeration test bench	1
				Dynameter	1
				Bomb calorimeter	1
				Electronic balance	1
				Digital multimeter	2
Fluid Mechanics, Aero-dynamics	* Pelton wheel	1	1949		
	* Francis turbine	1	1949		
	* Centrifugal pump	1	1949		
	* Small wind tunnel	1	1965		
	* Nozzle test	1	1965		
	* 2 channel anemometer	1	1968		
	* U tube manometer	1	1968		

Note: Mark * indicates the equipment beyond its life time

Category	Major Existing Equipment			Planned Equipment	
	Item	Q'ty	Year Installed	Item	Q'ty
Fluid Mechanics, Aero-dynamics				Digital monometer	1
				Flow measurement apparatus	1
				Water hammer demonstration apparatus	1
				X-Y-Z co-ordinate measuring device	1
				Two pen type chart recorder	1
				Dual trace memory oscilloscope	1
Strength of Material, Material	* Column testing	1	Unknown		
	* Impact testing	1	Unknown		
	* Beam testing	1	Unknown		
	* Rockwel hardness tester	1	1896		
	Fatigue testing machine	1	1983		
				Universal testing machine	1
				Impact testing machine	1
Automobil Engineering				Fuel injection test bed	1
				Instrument for measuring vibration	1
Applied Mechanics	* Centrifugal force test	1	Unknown		
	* Gyroscope	1	Unknown		
	* Balancing test	1	Unknown	Dynamic balancing machine	
	Straingauge indicator	1	1981		
	Gauge tester	1	1981		
	Dial gauge stand	3	1982		
	Critical speed test	1	1982		
				Frequency analyser	1
Control Engineering				Pneumatic control training equipment	1
				Hydraulic control training equipment	1

Note: Mark * indicates the equipment beyond its life time

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Basic Lines of Design

In the basic design of the equipment provided by this Project, the following basic lines are laid in consideration of the substance of the Third Five Year Plan described in the section 2-2-4.

1. Equipment is to be of adequate grade in order that the university education may contribute to the economic development in Bangladesh.

2. Equipment is to be adapted to new technology.

3. Equipment can be operated by students under the guidance of teachers.

4. Spare parts and consumables for equipment can be obtained.

5. Equipment can withstand a tropical climate.

4-2 Design Conditions

4-2-1 Design conditions

Design conditions for the equipment shall be as follows:

1)	Ambient temperatures:	Maximum 40°C Minimum 8°C Mean 27°C
2)	Ambient humidity:	Daily mean humidity 86% at 31°C
3)	Altitude:	+6 - +16m
4)	Electric sources:	AC 400V ±10% 3ø (for motor) AC 230V ±10% 1ø (for general purpose) The existing electric distribution in the campus is of 3 phases, 4 lines. No DC line is available.

5) Water source: Soft water (pH 6.1 - 7.0), with maximum temperature of 30°C, is supplied from head tanks about 10m high.

6) Fuel gas: Natural gas of 9,220 Kcal/Nm^3 (low calorific value)
Supply pressure 1.0 kgf/cm^2 G

7) Compressed air source: None

4-2-2 Ambient temperatures and humidity

The ambient temperatures are given on the basis of temperatures recorded in Dhaka, with some allowances.

Table 4-1 shows maximum and minimum temperatures recorded in 1982 - 1986 in Dhaka. The maximum temperatures are recorded during March to June, and temperature becomes lower after June due to cloudy weather in the rainy season.

The minimum temperatures are recorded during December to January, when fog sets in frequently.

Those equipment which requires ambient temperature below 40°C shall be installed in air-conditioned rooms.

Table 4-1 Maximum and Minimum Temperature in Dhaka (1982 - 1986)

(Unit: °C)

Year	Maximum Temperature	Minimum Temperature
1982	38.2	8.3
1983	37.2	9.1
1984	37.6	9.6
1985	37.8	11.2
1986	39.5	10.6

Source: 1987 Statistic Yearbook of Bangladesh, Bangladesh Bureau of Statistics

Seasonal variation of humidity in Dhaka is shown in Figure 4-1. Humidity is generally high during the rainy season from April to October. The maximum humidity is recorded during the peak of rainy season from July to September. Generally, the maximum humidity does not coincide with the maximum temperature. The hot and humid season (temperature of 30°C - 31°C, and humidity of 80 - 85%) continues for about three months.

Therefore, electric parts should be produced with tropical specifications. Also, microscope lenses and other products susceptible to fungus growth should be provided with containers for dry storage.

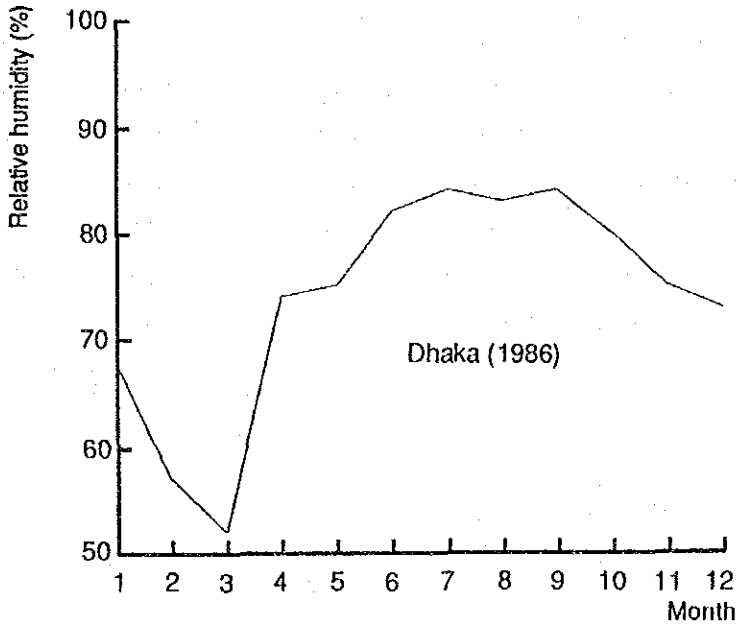


Figure 4-1 Variation of Average Humidity

4-2-3 Electric power source

The Universities receive electricity at 11kV and 6.6kV, with fluctuation allowance of ±10% by the Bangladesh Electrical Power Authority.

Distribution lines are of 3 phases and 4 lines, from which three-phase 400V and single-phase 230V can be supplied. Most of laboratories of the two campuses are equipped with outlets for single-phase 230V, which fits BS 15A-3P plugs.

Voltage flactuation in the range of ±10% at the socket terminal shall be expected as the same as at the substation. In practice, however, the flactuation exceeds the above range from time to time. The major cause of voltage flactuation is a voltage drop at transmission lines due to variation of electricity demand, so that a large voltage drop occurs at the peak demand, and voltage rises at transient to restoration after power outage. Ordinally, however, voltage flactuation does not occur abruptly. At the 230V outlet in Bangladesh University of Engineering and Technology, a measurement shows stable voltage at 223V. Since the electronic control voltage stabilizer is liable to be damaged by voltage flactuation exceeding ±10%, the Universities are using tap change type transformers.

Thus, the equipment which does not withstand voltage flactuation of ±10% shall be equipped with a transformer having a tap changer and voltmeter. Furthermore, the equipment very sensitive to the voltage flactuation shall be equipped with the electronic voltage stabilizer in seriese to the tap change transformer. Also, when the European standard voltage of 220V, the U.S. standard voltage of 110V, or the Japanese standard voltage of 100V is applied, the equipment shall be supplied with a transformer suitable for each voltage and capable of voltage control in the range of more than ±10%.

Plugs for 230V and 220V supply shall be of BS 15A-3P type, and those for 110V and 100V shall be of JIS 15A 125V-2P type, which should fit the socket attached to the transformer.

Operation voltages for the equipment, other than 230V, shall be clearly indicated. In addition, batteries or portable DC power source, if necessary, shall be supplied.

4-2-4 Water supply

The two Universities have deep tube wells from which tap water is pumped up. Deep wells in Dhaka City generally produce soft water, with 6.1 - 7.0 pH. Those at the Universities have similar good quality. At the University of Dhaka, water is pumped up to head tanks installed 10m above the ground, and at Bangladesh University of Engineering and Technology, water tanks

are installed on a roof of 5-story school building for the same purpose. Water temperature ranges from 25°C in the winter to 30°C in the summer.

4-2-5 Fuel gas

As city gas, natural gas is supplied by a gas field located about 58 miles northeast of Dhaka City, via 14-inch pipeline. Constituents and calorific value of the natural gas supplied to Dhaka City are summarized in Table 4.2. The gas is supplied to the city area at 1.0 kgf/cm^{2}G.

Table 4-2 Constituents and Calorific Value of Natural Gas

Composition	(mol %)
Methane	96.8
Ethane	1.82
Propane	0.43
Other hydrocarbons	0.67
Nitrogen	0.35
Carbon dioxide	Trace
Sulphur content	None
Low calorific value	9,220 (Kcal/Nm^3)

Source: 1987 Statistic Yearbook of Bangladesh, Bangladesh Bureau of Statistics

4-2-6 Compressed air source and others

As no common compressed air source is available, adequate compressor shall be provided to pneumatic equipment, if necessary. Medium gas for gas chromatographs shall be suplied by gas cylinders.

4-3 Equipment Plan

As a result of deliberations on requested educational equipment to be provided to each department, the number of selected equipment finally totaled 134 items.

Table 4-3 The Number of Selected Equipment

University and Department	The Number of Items
The University of Dhaka	
Department of physics	32
Department of chemistry	21
Department of botany	30
(Sub-total)	(83)
Bangladesh University of Engineering and Technology	
Department of electrical and electronic engineering	9
Department of civil engineering	20
Department of mechanical engineering	22
(Sub-total)	(51)
Total	134

List of selected equipment, as shown in the Table 4-4, contains, by department, description of equipment, quantity, basis for assessment of the quantity (the number of students of study groups using such equipment), basic specifications and major curriculums for which such equipment will be used.

The Followings are general outline of major equipment classified by categories of each department's curriculum.

4-3-1 The University of Dhaka

(1) The department of physics

The greater part of equipment to be supplied to the department of physics under the Project relates to electronics and electromagnetic.

1) Electronics

Electronics is a field of science whose applications are rapidly progressing and expanding. This factor accelerates obsolescence of the existing equipment and also causes high necessity of supply of new equipment listed below.

- To study applied circuits of semiconductors and the theory of computer:
  - Microcomputer trainer
  - Logic circuit experimental equipment
  - Electronic circuit experimental equipment

- Measuring instrument of logic circuits:
  - Logic tester

- Characteristics and application of semiconductors:
  - Transistor circuit trainer
  - Semiconductor element experimental equipment

- Characteristics of electronic circuits:
  - Oscilloscope
  - Signal generator
  - AM modulation & demodulation circuit
  - Synthesized function generator

- General measuring instrument:
  - Precision digital meter
  - Frequency counter

2) Electricity & Magnetism

The study of electricity and magnetism is most fundamental in physics. New equipment are required to replace obsoleted equipment.

- Basic measuring instrumentation (current, voltage and resistance):
  Galvanometer
  DC bridge (Whetstone)
  Potentiometer

- Characteristics of insulators:
  Dielectric loss measuring set

- Magnetism:
  Gaussmeter

- Measuring of AC circuit element:
  LCR meter

- Characteristics of thermoelectronic instrument:
  Thermoelectromotive force measuring unit

3) Others

- General measuring instrument:
  Digital thermometer
  Sound level meter
  Balance
  X-Y recorder, X-Y recorder with chart drive unit

- Atomic & nuclear physics, Measuring of radioactivity:
  Atomic & nuclear timer scaler

- Geological survey: To apply an electric current into ground to measure its electric conductance so as to survey geological structure.
  Measuring equipment for conductivity of earth

- Solar energy: To measure solar energy reached on the surface of the earth.

  Pryanometer

- To make small size transformers to be used for experimental apparatus:

  Transformer winding (hand) machine

- Power supply for experiments:

  Static DC power supply unit

(2) The department of chemistry

In the field of chemistry, it is essential to analyze molecular structure and characteristics of substances made by chemical synthesis. Instrument to be used for this particular field account for the greater part of educational equipment selected under the Project.

1) Chemical spectroscopy

Whenever a level of energy of electron, atom or molecule varies, specific spectrum of light is absorbed or radiated. Making use of this particular phenomena, the spectroscopic analyzer checks absorption of the spectrum by transmission through a substance or the structure of the substance and substance itself. Today, as the spectrometer is widely used to conduct chemical analysis, it is vitally important for researchers to learn and master skills to operate the equipment. The Project aims at giving opportunities to all students to learn and master skills to operate the equipment.

UV-visible recording sepectrometer
Double beam IR spectrometer
Atomic absorption spectrophotometer

2) Analytical chemistry / Physical chemistry

- To dissolve a substance into gas and observe differentials in heat conductivity so as to measure constituent of the substance:
  Gas chromatograph with TCD detector

- General measuring instrument used for physical chemistry as well as chemical analysis:
  Polarimeter
  Refractometer
  Melting point apparatus
  pH meter
  Conductivity meter
  Specific gravity balance
  Digital balance

- Equipment to perform heating, separation, agitaion and concentration required for chemical analysis:
  Furnace
  Oven
  Centrifuge
  Heating mantle
  Hot plate stirrer
  Rotavapor
  Waterbath
  Water still

3) Others

- Equipment to be used in lecturerooms:
  O.H. projector
  Slide projector

(3) The department of botany

Curriculums in the department of botany are subdivided into several courses. Many requested equipment are those to be used commonly in more than one curriculums and are classified roughly into categories of

microscopes and related instrument, equipment required for plant bleeding and cultivating, and other analytical and measuring instrument.

1) Microbiology / Cytology / Mycology

As the microscope is the most basic instrument for botanical researchers, it is vitally important for students to learn and master skills to operate the microscope. In veiw of frequency of its concurrent use in many curriculums, a large number of microscopes is necessary.

- Mircoscopes for student use:
  Advanced student microscope

- Microscopes for postgraduate students with high resolving and magnifying power:
  Advanced research microscope
  Research microscope

- Apparatus for microscopes:
  Camera lucida (mirror type)
  Freezing microtome
  Fluorescent attachment set for research microscope

2) Tissue culture / Plant bleeding

- Equipment in preparation for tissue culture and plant bleeding:
  Autoclave
  Water still
  Digital balance
  pH meter
  Precise electric drying oven
  Hot air sterilizer and dryer
  Centrifuge
  Gyratory shaker

- Equipment for tissue culture and plant bleeding:
  Incubator
  Water bath

Recording thermohygraph

- Equipment for evaluation and analysis after tissue culture and plant bleeding:
  Colony counter
  Ultrasonic pipette washer
  Glassware washer

3) Other analytical and measuring equipment

- Plant bleeding: Measuring of photosyntheis:
  Leaf area meter and photosynthesis meter

- Plant physiology and ecology: Analysis of chemical components.
  Flame analyser
  Thin layer chromatography set
  Spectrophotometer
  UV spectrophotometer

- Phycology and plant taxonomy: Equipment to show to many students parts of plants through enlarged projection.
  Universal profile projector

- Plant physiology: Measuring of saccharinity.
  Refractometer

- Ecology: Measuring of the sunshine.
  Portable lux meter

- Equipment to be used in lecturerooms:
  O.H. projector

4-3-2 Bangladesh University of Engineering and Technology

(1) The department of electrical and electronic engineering

Equipment to be provided are roughly classified into categories of electronics and microwave engineering, high-voltage engineering and

electrical circuit and electric machine.

1) Electronics and microwave engineering

- As telecommunication, an application of microwave has rapidly been prevailing recently, the curriculums play an important role in providing students with opportunities to learn and comprehend the new technology. From this point of view, instrument to measure characteristics of microwave apparatus are planned to be supplied:
  Microwave network analyzer

- Instrument, including oscilloscopes, widely used in the field of electronics to measure high-speed phenomena with memory:
  Storage oscilloscope

2) High-voltage engineering

- Instrument for students to study phenomena arising in connection with high-voltage transmission line:
  High voltage test set with corona measuring equipment
  High voltage impulse generaor

3) Electrical circuits and electrical machines

- General instrument required to measure AC circuits, electric motorts and generators:
  Portable wattmeter
  Portable P.F. meter
  A.C. Synchro-indicator
  Portable frequency meter
  Pocket tachometer

(2) The department of civil engineering

Equipment to be provided for the department of civil engineering consists of various relatively large testing machine for structural mechanics, various types of test equipment for geotechnology and

material measuring instrument for traffic engineering and environmental engineering.

1) Structural mechanics / Engineering materials

- Instrument to measure stress and strain of materials by application of loads onto relatively large-size structural models or concrete slabs. This type of equipment has a high educational effect in that students learn practical knowledge and develop their ability of analyzing stress and strain in a complicated structure:

  Structural testing frame with jacks
  Data logger

The structural testing frame requires the equipment to transport and set up the test model of which maximum weight is approximately estimated at 5 tons. It is impossible to equip an over-head crane for it because the ceiling height of the laboratory where the testing frame is installed is too low to equip it. Therefore, two chain blocks with 3 ton capacity will be supplied instead of the over-head crane.

2) Geotechnical engineering / Soil mechanics

- Equipment to make geological test and material test to measure consolidation, porosity, water permeability and ratio of clearance:
  Rowe consolidation apparatus
  Sieve set
  Consolidation permeability cells
  Freeze-drying apparatus
  CBR-MARSHALL tester
  High pressure mercury porosimeter
  Data recorder
  Bearing plate with bearing sets

The large-sized specimen size of 254 mm diameter by 300 mm is used for the Rowe consolidation apparatus in England, but smaller-sized one is able to achieve more accurate test along with the development of the

measurement technology. Therefore, the specimen size of 60 mm diameter by 20 mm will be adopted.

3) Transportation engineering

- To measure speed of vehicles and traffic frequency:
  Vehicle speed recorder
  Traffic counter

- To check and test material of roads:
  Digital thermometer
  Compactibility appratus
  Friction tester

4) Environmental engineering

- Environmental conservation is one of the largest social terget in developed countries. In Bangladesh whose population density is considerably high, the environmental protection is expected to be one of the key issues in the future.
  Equipment to analyze air and water pollution is used mainly by post-graduate students so as to develop their analytical ability as specialists:
  Atomic absorption spectrophotometer
  Air pollution analysis kit
  Polarizing microscope
  Total carbon analyser

(3) The department of mechanical engineering

Equipment for the department of mechanical engineering includes gas turbines, gasoline engines, freezers, control system, flow measuring instrument, water hammer and many other instruments for demonstration and training purpose, which certainly offer good opportunities to students, who have seldom occasion to see actual operation of these machines and equipment. Though the size of them is considerably small, these equipment play an important role in education. The equipment to be supplied include some measuring instrument commonly used for engineering purpose.

1) Thermal engineering

• In Bangladesh gas turbines utilizing natural gas are widely used for power generation. As diesel and gasoline engines are expected to be increasingly used for agriculture and automobiles in the near future, these engines are important educational subjects for students. The refrigerator is also like that:

Gas turbine and test bed
Refrigeration test bench
Dynanometer
Petrol engine and test bed

Although gas turbine unit of 45 horse power level, of which function is similar to the industrial use, had been produced for the educational purpose, it is not producted now because of the decreased demand. The 6 - 7 kilowatt gas turbine unit which is available for the demonstration for students will be adopted for this Project.

In consideration of the recent trend of use of dynamometer, the small and high speed type is applicable. The dynamometer the speed range of 1,500 r.p.m. at 100 PS will be adopted based on the consideration of the circumstances of Bangladesh in addition to the above trend.

• Measuring instrument in the field of thermal engineering:
Calorific value of fuel.
Bomb calorimeter
Electronic balance
General-use measuring instrument.
Digital multimeter
Sound level meter

2) Fluid mechanics / Aerodynamics

• Educational equipment for demonstration and training:
Flow measurement apparatus
Water hammer demonstration apparatus

- Measuring instrument to determine position of the model in the wind tunnel:
  X-Y-Z coordinate measuring device

- General-use measuring instrument:
  Two pen chart type recorder
  Dual trace memory oscilloscope
  Digital manometer

Air compressor for wind-tunnel test will not be included in this Project because the existing compressor, which is rather old, can be repaired for the future use. The cabitation apparatus can not independently have an sufficient effect on educational purpose, and it should be provided as a part of overall design for the fluid mechanics testing equipment. Therefore, these equipment will not be included in this Project.

3) Mechanics of material

- Primary and basic equipment to test strength of materials:
  Universal testing machine
  Impact testing machine

4) Automobile engineering

- System to show the function of fuel injection valve of diesel engine:
  Fuel injection test bed

- Instrument to measure vibration of the body of the automobile:
  Instrument for measuring vibration

5) Control engineering

- Control equipment with servo mechanism for demonstration and training:
  Pneumatic control training equipment
  Hydraulic control training equipment

Considering that the compositions of the control equipment i.e. the pneumatic control and the hydraulic control are quite different and that the control engineering is the important technology in Bangladesh, both equipment will be included in this Project.

6) Applied mechanics

- To study dynamic balance of a rotating element:
  Dynamic balancing machine
  Frequency analyser

Frequency of the analyser ranges from 25 Hz to 20,000 Hz. Other simple measuring method is adopted for the lower range than 25 Hz.

Table 4-4 List of Equipment

1. University of Dhaka

(1) Department of Physics

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
1	Microcomputer trainer	2	48/24	Electronics	Main Unit: CPU, RAM, display & keyboard, Imput/Output board, Assembly for A/D & D/A converter, Unit for study of DC servo motor
2	Logic circuit experimental equipment	2	48/24	Electronics	Diode transistor logic, Transistor logic, Semi-conductor logic, Decorder & encorder
3	Electronic circuit experimental equipment	2	48/24	Electronics	L.F. voltage amplifier circuit, L.F. power amplifier circuit, Single and double tuning amplifier circuit
4	Transistor circuit trainer	2	48/24	Electronics	Electronic system of various transistor circuit
5	Dielectric loss measuring set	1	48/48	Electricity & Magnetism	Dielectric loss measurement set
6	Semiconductor element experimental equipment	2	48/24	Solid state physics	Diode transistor static characteristic measurement circuit, Thyristor static characteristic measurement circuit
7	Oscilloscope	24	2 x 48/4	Electronics	20MHz, 2-channel oscilloscope
8	Signal generator	24	2 x 48/4	Electronics	10Hz ~ 1MHz
9	Oscilloscope quad trace	2	24/12	Electronics	100MHz
10	AM modulation & demodulation circuit	1	24/24	Electronics	Oscillator and modulator, AM receiver circuit
11	Galvanometer	12	48/4	Electricity & Magnetism	Range: $\pm 250\mu V \pm \begin{matrix}20\% \\ 10\%,\end{matrix}$ Electronic type
12	DC bridge (Wheatstone)	6	48/8	Electricity & Magnetism	Range: 0.1 ~ 111.11MΩ

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
13	LCR meter	2	48 + 24	Electricity & Magnetism	Range: L; 0.1μH ~ 199.9H. C; 0.1pF ~ 199μF. R; 0.01Ω ~ 19.99MΩ
14	Precision digital meter	2	48 + 24	Electronics	Range: DC voltage; ±100mV~ ±1,000V, Resistance; 100Ω~100MΩ, AC Voltage; 1V~500V
15	Digital thermometer	6	2 x 48/1	Thermodynamics	Range: -100° ~ 1,760°C, thermocouple: K&R
16	Compact digital multimeter	10	5 x 48/2	Electricity & Magnetism, Electronics	Range: ±DCV; 220mV ~ 1,000V. ACV ; 200mV ~ 1,000V. ±DCA; 20μA ~ 200mA. Ohm ; 20Ω ~ 20MΩ
17	Frequency counter	2	48 + 24	Electronics	Digital display, Range: 10Hz-80MHz
18	Sound level meter	1	24/24	Waves, Acoustics & Optics	Range: 30 ~ 130dB/40 ~ 130dB Frequency range: 31.5 to 8,000 Hz
19	Logic tester	2	48 + 24	Electronics	Number of measuring point: 1-16
20	Magnetometer	2	24/12	Electricity & Magnetism	Range: 20G-20KG, Frequency range: DC to 500Hz
21	Balance	2	2 x 48/48	Solid state physics	Capacity: 120g, Readability: 0.1mg
22	Atomic and nuclear timer scaler	5	2 x 48/2 + 24/24	Nuclear physics	Timer, Scaler, Ratemeter and Frequency meter
23	Measuring equipment for conductivity of earch	1	48/48	Geophysics	Transmitter: 400Vp-p, 200mA, Receiver: 1M Imput, -0.6 ~ 0.6V & -6 ~ 6V, Digital display

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
24	X-Y recorder	1	48/48	Wave, Acoustics & Optics	One-pen (16 ranges), Automatic null-balancing
25	X-Y recorder with chart drive unit	1	24/24	Polymer physics	180mm recorder, 1-,2-,or3-pen continuous writing, 6-, 12-, 18-or 24-point dot printing
26	Thermoelectromotive force measuring unit	1	48/48	Electricity & Magnetism	Potentiometer, DC power supply, Thermocouples: K & T type
27	Potentiometer	2	48/24	Solid static physics	Range: 0 ~ 1.6V/0 ~ 160mV, Voltage divider: 3 ~ 300V
28	Static DC power supply unit	1	48/12	Solid state physics	Output: 0 ~ 35V/0 ~ 10A
		2	24/24		Output: 0 ~ 32V/0.2 ~ 2A
29	Digital hygrometer	2	24/12	Meteorology	Display: 3-digit, Range: Temperature; -30 ~ 60°C, Dew point; -45 ~ 50°C, Relative humidity; Approx. 15 ~ 99.9%
30	Synthesized function generator	2	2 x 24/24	Electronics	Frequency range: 0.01Hz ~ 1MHz, Output waveforms: Sine-, square-, triangular-and sawtooth-wave
31	Transformer winding (hand) machine	1	48/48	Practice for repair	Winding width: 110mm max., Winding diameter: 150mm max.
32	Pyranometer	2	48/24	Meteorology	Sunshine duration measurement

(2) Department of Chemistry

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
1	UV-visible recording spectrometer (1)	3	3 x 50/25	Chemical spectroscopy	Wavelength range: 200 ~ 1, 100nm, with color printer/plotter
	UV-visible recording spectrometer (2)	2			Wavelength range: 200 ~ 1,000nm
2	Double beam IR spectrometer (1)	1	2 x 50/50	Chemical spectroscopy	Wavenumber range: 4,000 ~ 400cm^{-1}, with data processor
	Double beam IR spectrometer (2)	1			Wavenumber range: 4,000 ~ 650cm^{-1}, with recorder
3	Polarimeter	1	1 x 50/50	Physical chemistry	International sugar scale: +130°S ~ -130°S
4	Refractometer	2	2 x 50/50	Analytical chemistry, Organic chemistry, etc.	Refractive index range: 1.3000 ~ 1.7000, Solid scale: 0 ~ 85%
5	Furnace	2	2 x 50/50	Analytical chemistry, Inorganic chemistry, etc.	Muffle type, Temp. range: 250 ~ 1,150°C, Internal capacity: 15 lit.
6	Oven	10	5 x 50/25	Analytical chemistry, Organic chemistry, Inorganic chemistry, etc.	Temp. range: 40 to 260°C, Internal capacity 81 lit.

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
7	Centrifuge	12	6 x 50/25	Analytical chemistry, Organic chemistry, etc.	Max. speed: 4,000 rpm, Capacity x number: 15ml x 8
8	Melting point appratus	12	6 x 50/25	Analytical chemistry Inorganic chemistry, Physical chemistry, etc.	Temp. range: 0 ~ 140°C/130 ~ 270°C/ 260 ~ 400°C
9	Heating mantle	24	6 x 50/25	Analytical chemistry, Inorganic chemistry, Physical chemistry, etc.	Max. temp.: 450°C, Capacity: 50ml/100ml/250ml/ 500ml/1,000ml/2,000ml
10	Hot plate stirrer	10	2 x 50/10	Analytical chemistry, Inorganic chemistry, Physical chemistry, etc.	Capacity: for 50 ~ 3,000ml
11	Rotavapor	4	2 x 50/25	Analytical chemistry, etc.	Capacity: up to 1,000ml, with water bath
12	Waterbath	6	4 x 50/10	Analytical chemistry, etc.	Temp. range: Room temp. +5 ~ 100°C Capacity: 9 lit.
		6			Temp. range: Room temp. +5 ~ 80°C Capacity: 20 lit.
		6			Circulator, Temp. range: Room temp. +5 ~ 200°C
13	pH meter	3	6 x 50/25	Analytical chemistry, Inorganic chemistry, etc.	Indication: Analog & digital, Min. graduation: 0.1pH/5mV/1°C, Manual calibration
		9			Indication: Analog & digital, Min. graduation: 0.01pH/1mV/0.5°C, Auto-calibration

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
14	Conductivity meter	6	3 x 50/25	Analytical chemistry, Inorganic chemistry, etc.	Indication: Analog, Range: 0 ~ 2μS/cm ~ 0 ~ 200mS/cm, Temp. compensation: Manual
15	Specific gravity balance	4	2 x 50/25	Physical chemistry	Type: for determing bulk density
16	Water still	6	6 x 50/50	Analytical chemistry, Organic chemistry, Inorganic chemistry, etc.	Water collecting method: Still, Collect volume: 1.8 l/h
17	Digital balance	4	4 x 50/25	Analytical chemistry, Organic chemistry, Inorganic chemistry, etc.	Capacity: 210g, Readability: 0.1mg
		4	4 x 50/25		Capacity: 300g, Readability: 0.01g
18	O.H. projector	2	2 x 50/50	Inorganic chemistry, Nuclear chemistry, Environmental chemistry	Table type overhead projector
19	Slide projector	2	2 x 50/50	Organic chemistry, Environmental chemistry, Industrial chemistry, etc.	For 35mm mount slide, Auto-Focusing & remote control
20	Gas chromatograph with TCD detector	1	1 x 50/50	Analytical chemistry, Organic chemistry, etc.	With TCD and FID ditector, Data processor
21	Atomic absorption spectrophotometer	1	1 x 50/50	Analytical chemistry	Wavelength range: 190 ~ 900nm

(3) Department of Botany

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
1	Advanced student microscope	100	8 x 50/4	Plant physiology, Phycology, Microbidogy, etc.	Anti-mould type with built in illuminator, Eyepiece lens: 5X, 10X, 15X, Objectives: Archromat 10X, 40X, 100X
2	Autoclave	2	2 x 40/20	Tissue culture Plant breeding, Plant pathology, etc.	Pressure: 1.2kg/cm^2, Temperature: 95 ~ 121°C Capacity: 46 lit.
3	Water still	1	3 x 50/50	Tissue culture, Plant breeding, Plant Physicology, etc.	Water collecting method: Ion ex. still, Collect volume: 1.8 lit./h
		2			Water collecting method: Still, Collect volume: 1.8 lit./h
4	Camera lucida (mirror type)	10	2 x 20/4	Phycology, Plant anatomy, etc.	Abbe's camera lucida mirror type
5	Digital balance	2	3 x 40/20	Tissue culture, Plant physicology, Plant pathology, etc.	Capacity: 210g, Readability: 0.1mg
		4			Capacity: 300g, Readability: 0.01g
6	Incubator	5	5 x 20/20	Tissue culture, Plant breeding, Plant pathology, etc.	Temp. range: -10 ~ 50°C, Inside capacity: 300 lit.
7	Leaf area meter	3	2 x 40/20	Plant physiology, Plant bleeding	Leaf area meter: Labo. type Photosynthesis system: Portable type

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
8	Water bath	4	2 x 40/20	Plant pathology, Microbiology, Mycology, etc.	Temp. range: Room temp. +5 ~ 80°C, Capacity: 17 lit.
9	Advanced reserarch microscope	1	20/20	Cytology, Microbiology, Molecular biology, etc.	Eyepiece lens: Ultra-widefielded, Diascopic differential interference contrast equipment, Photomicrographic attachment
10	Flame analyser	2	2 x 50/50	Plant physiology, Ecology	Measurement: Li, Na, K, Ca
11	Research microscope	4	4 x 20/4	Microbiology, Mycology, Plant anatomy, etc.	Trinocular eyepiece tube, Achromatic condenser, Photomicrographic attachment
12	Freezing microtome	1	2 x 50/50	Cytology, Microbiology, Plant anatomy, etc.	Thickness of section: 5 ~ 40µm, Objective stage: 30x30mm
13	pH meter	4	5 x 40/20		Indication: Analog & digital, Min. graduation: 0,01pH/1mV/0.5°C, Auto-calibration
		4		Tissue culture, Genetics, Microbiology, etc.	Indication: Analog, Min. Graduation: o.1pH/5mV/ 1°C, Manual calibration
		2			Indication: Digital, Rod-shaped type
14	Universal profile projector	1	50/50	Phycology, Plant texonomy Plant anatomy, etc.	Projection Lens: 10X, 20X, 50X, Screen dia.: 250mm

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
15	Colony counter	2	40/20	Microbiology, Mycology, Plant pathology	Display: 3 digits, digital indication
16	Precise electric drying oven	2	2 x 50/50	Plant bleeding, Plant texonomy, etc.	Temp. range: 40 ~ 210°C, Inside capacity: 300 l
17	Refractometer	4	40/5	Plant physiology	Digital type, Range: Brix 0 ~ 32%
		4			Automatic temp. compensating type, Range: Brix 0 ~ 32%
18	Thin layer chromatography set	2	40/20	Tissue culture, Plant physiclogy	Typical standard set for laboratory
19	Vacuum desiccator	1	50/50	Microbiology. Plant embryology	Inside dimension: 400x300x400(H)mm
20	Recording thermohygraph	3	3 x 40/40	Plant physiology, Ecology, Plant breeding	Two pen type
21	Portable lux meter	5	40/8	Limnology, Hydrobiology, Econogy, etc.	Range: 0-200/2,000/20,000 lx
22	Centrifuge	10	5 x 40/20	Plant breeding, Molecular biology, Phycology, etc.	Max. speed: 5,000rpm, Glass tube capacity: Max. 100ml
23	Hot air sterilizer and dryer	4	2 x 40/20	Tissue culture, Plant physiology, Plant pathology, etc.	Temp. range: 40 ~ 260°C, capacity: 72 1

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
24	Spectrophotometer	6	3 x 40/20	Plant pathology, Cytology, Plant pathology, etc.	Wavelength range and width: 340 ~ 900nm & 10nm
25	Ultrasonic pipette washer	2	2 x 40/40	Tissue culture, Cytology, Plant physiology, Microbiology, etc.	Capacity: 500 x 136ømm
26	UV spectrophotometer	2	2 x 40/40	Plant phyology, Cytology, Plant pathology, etc.	Wavelength range: 200-1,000nm
27	Glassware washer	4	2 x 40/40	Tissue culture, Cytology, Plant pathology, Microbiology, etc.	A small type motor-driven washer
28	Flourescent attachment set for research microscope	1	20/20	Microbiology, Mycology, Plant aratomy, etc.	Fluorescence attachment for "Olympus BH2-RFL-2"
29	O.H. projector	5	5 x 50/50	Limnology,, Higher criptogan, etc.	Table type overhead projector
30	Gyratory shaker	4	2 x 40/20	Tissue culture, Cytology, Plant physiology etc.	Speed: 15 ~ 100 oscillations/ min., Carrier: Test tube rack

2. Bangladesh University of Engineering and Technology

(1) Department of Electrical and Electronic Engineering

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
1	Microwave network analyser	1	4/4	Microwave engineering	Network analyser, S-parameter test set, Sweep oscillator, Graphic Printer, Measurement range: 50MHz~20GHz
2	High voltage test set with corona measuring equipment	1	10/10	High voltage engineering	Testing Transformer, Voltage controler, Discharge detector, Measurement range: 100 KV, 10 KVA
3	Storage oscilloscope	1	8/8	Electronics	Digital type, Camera attachment
4	High voltage impulse generator	1	10/10	High voltage engineering	Generator: 50 KVAC and 75 KV DC, Inpulse: 100 KV, Waveform recorder
5	Portable wattmeter	8	8/1	Electrical circuits	Current transformer, Single phase, Frequency range: DC 25 to 500 Hz, Current range: 5/25, 5/50, 5/100
6	Portable P.F. meter	8	8/1	Electrical circuts	200V, 50 Hz, Single phase and 400 V, 50 Hz, Three phase, Current transformer
7	A.C. Synchro-indicator	3	8/3	Electrical circuits	400V, 50 Hz, Three phase, Current transformer
8	Portable frequency meter	8	8/1	Electrical machines	Frequency range: 45 to 65 Hz Power supply: 400 V, 50Hz, Three phase
9	Pocket tachometer	3	8/3	Electrical machines	0.1 V/1,000 rpm to 2.0 V/20,000 rpm Touchless use

(2) Department of Civil Engineering

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
1	Structural testing frame with jacks	1	5/5	Structural mechanics, Mechanics of material	Loading unit: 50 ton jack x 4 sets,Loading frame: 10 m x 3.5 m x 3 m, Data logger: 100 channel, 7 inch Display
2	Data logger	1	5/5	Structural mechanics, Mechanics of material	Included in structural testing frame
3	Rowe consolidation apparatus	1	2/2	Geotechnical engineering	Specimen size: ø 60 mm x 20 mm, Automatic pressure generator: max. 12.8 kgf/cm^2
4	Sieve set	1	25/25	Soil mechanics	Mesh size: ASTM basis
5	Consolidation permeability cells	1	25/25	Soil mechanics	Specimen size: ø 200 mm, Loading cap: 7 ton, Inside flask;: 30, 40, 50, 60 mm, Height: 1,000 mm
6	Freeze-drying apparatus	1	4/4	Engineering materials, Geotechnical engineering	Refrigerator: 600 W, Temp. -50 °C, Ice holding 4 lit.bath, Drying chamber 20 mmø
7	CBR-Marshal tester	1	5/5	Geotechnical engineering	Capacity 5,000 kgf, Test for CBR-Marshal test
8	Vehicle speed recorder	1	5/5	Transportation engineering	Measurement of vehicle speed between two points.
9	Electro-optical distance meter	2	6/3	Surveying	Range: w/mini prism, 150 m, w/1 prism 800 m, w/3 prism 1,200 m

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
10	Digital thermometer	1	5/5	Transportation engineering	Range: -100 °C to 1.370 °C
11	Traffic counter	1	5/5	Transportation engineering	Hand tally counter, 5 key
12	High pressure mercury porosimeter	1	4/4	Engineering materials	Pressure range: (KPa) 100~200,000, (bar) 1~2,000, output: X-Y Recorder
13	Data logger	1	4/4	Engineering materials	Included in mercury porosimeter
14	Bearing plate with bearing sets	1	25/25	Geothechnical engineering	Loading capacity: 50 ton
15	Compactibility apparatus	1	5/5	Transportation engineering	Determination of bulk density and optimum moisture contents of graded aggregate,. Test comlies with BS 5835, Part 1: 1980
16	Friction tester	1	5/5	Transportation engineering	Siglar type skid resistance test or equivalent
17	Atomic absorption spectrophotometer	1	25	Environmental engineering	Wavelength range: 190~900 mm Hollow chathode lamps: 15 Nos.
18	Air pollution analysis kit	1	6/12+20	Environmental engineering	Aspirating pump with detector tube for SO_2 , NO, NO_2 , CO
19	Polarizing microscope	1	6/12+20	Environmental engineering	Polarizing microscope with photomicro-graphic attachment and TV set
20	Total carbon analyser	1	6/12+20	Environmental engineering	Measuring range: 0-10 mgC/lit.to 0~2,000 mgC/lit., Output: recorder

(3) Department of Mechanical Engineering

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
1	Gasturbine and test bed	1	6/6	Thermal engineering	Working fuel: Kerosene, Speed range: 50,000 to 90,000 rpm, Pressure ratio 1.73:1, Turbine speed range: 4,000 to 40,000 rpm. Power turbine out put: 6 to 7 kW at 40,000 rpm.
2	Universal testing machine	1	6/6	Mechanics of materials	Capacity:100 ton, Test for tensile test, compression transverse & cold bend test
3	Fuel injection test bed	1	6/6	Automobil engineering	Fuel injection nozzle, Pressure gage, Fuel injection cylinder, Pulsation absorber (0 to 35 Kg/cm^2 , Tachometer (0 to 1,500 rpm)
4	Dynamic balancing machine	1	6/6	Applied mechanics	Rotor weight: 0.1 to 10 Kgs, Swing diameter: max 400 mm, Journal diameter: 5 to 20 mm
5	Dynamometer	1	6/6	Thermal engineering	Max brake horse power: 100 PS at 1,500 rpm
6	Impact testing machine	1	6/6	Mechanics of materials	Test for izod and Charpy type, Testing method: ASTM
7	Bomb calorimeter	1	6/6	Thermal engineering	Calory range: 1,000 to 7,500 Temparature: 15 °C to 35 °C
8	Pneumatic control training equipment	1	4/4	Control engineering	Air compressor: 0.4 KW, 7 Kgf/cm^2 Regulator, Air cylinderr: (double action) ø40 x 150 mm, pressure gage: 10 kg/cm^2

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
9	Hydraulic control training equipment	1	4/4	Control engineering	Test for displacement VS pressure, displacement VS velocity etc., Hydraulic oil pump: 10 Kgf/cm ^{2} , 13.7 l/min, Hydraulic oil cylinder ø60 x 120 mm
10	Flow measurement apparatus	1	10/10	Fluid mechanics	Pneumatic regulator: (In) 0 to 7 Kg/cm ^{2} , (Out) 0.2 to 7 Kg/cm ^{2} , Venturi meter, Rotameter, Orifice meter
11	X-Y-Z co- ordinate measuring device	1	4/4	Aerodynamics	Range: X-600 mm, Y-500 mm, Z-250 mm, Digital Output
12	Frequency analyser	1	6/6	Applied mechanics	1/3 octave analysis Range: 25 Hz to 20,000 Hz
13	Two pen chart type recorder	1	6/6	Fluid mechanics	Two-pen chart type, Input range: multi-range
14	Digital multimeter	2	6/6,10/10	Thermal engineering, Fluid mechanics	DCV: 250 mV to 1,000 V, ACV: 250 mV to 750 V, DC/AC currency: 200 mA to 10 A
15	Dual trace memory oscilloscope	1	6/6	Fluid mechanics	CRT display: 150 mm square, 2 channel Band width: DC-35 MHz, Resolution: 8 bits
16	Refrigeration test bed	1	6/6	Thermal engineering	Refrigeration cap., 3,000 kcal/h, Compressor: 50.8 mm x 63.5 x 2 cylinder, Thermometer: -30 °C to 70 °C, 0 to 70 °C, -20 °C to 50 °C
17	Electronic balance	1	6/6	Thermal engineering	Max capacity: 100 g, standard device: 0.1mg

Series No.	Equipment Item	Q'ty	Student No. One Class/ One Group	Curriculum	Description
18	Sound level meter	2	6/6, 10/10	Thermal engineering, Fluid mechanics	Range: 30 to 130 dB, Frequency range: 30 to 8,000 Hz
19	Instrument for measuring vibration	1	4/4	Automobil engineering	Accelaration measurement, Range: 0 to 56, Frequency range 0 to 100 Hz
20	Petrol engine and test bed	1	6/6	Thermal engineering	Gasoline engine: 4 cycle, water cooled, 30 bhp Pressure gage: 10, 20 kg/cm ^{2}
21	Digital manometer	1	10/10	Fluid mechanics	Pump and motor: 40 M Head, 3.7 KW x 220 V, Tank: ø216.3 x 15,000 mm
22	Water hummer demonstration apparatus	1	6/6	Fluid mechanics	Water and mercurry manometer Range: 1,000 mm

Note: The above column of "No. of students in one class / No. of students in one group" shows grounds for calculating quantity of each equipment.

4-4 Layout of Equipment and Utilities

4-4-1 Layout of equipment

The University of Dhaka and Bangladesh University of Engineering and Technology as illustrated in Figures 4-2 and 4-3, have a total site of about 1,036,000 m^2 and 283,000 m^2 respectively and dormitories for teachers and students.

Laboratories of the Universities, where the equipment is to be installed, have sufficient space and utilities for installation of the equipment. Some laboratories are equipped with window type air-conditioning units. Of the proposed equipment, the structural testing frame with jacks and the universal testing machine etc., require the reinforced foundation, while others can be placed on floor or desk without reinforcement in principle. Equipment layout plan is shown in Figure 4-4 which results from the study of locations and floor areas of the laboratories utilities and requirement of each equipment for space and utilities.

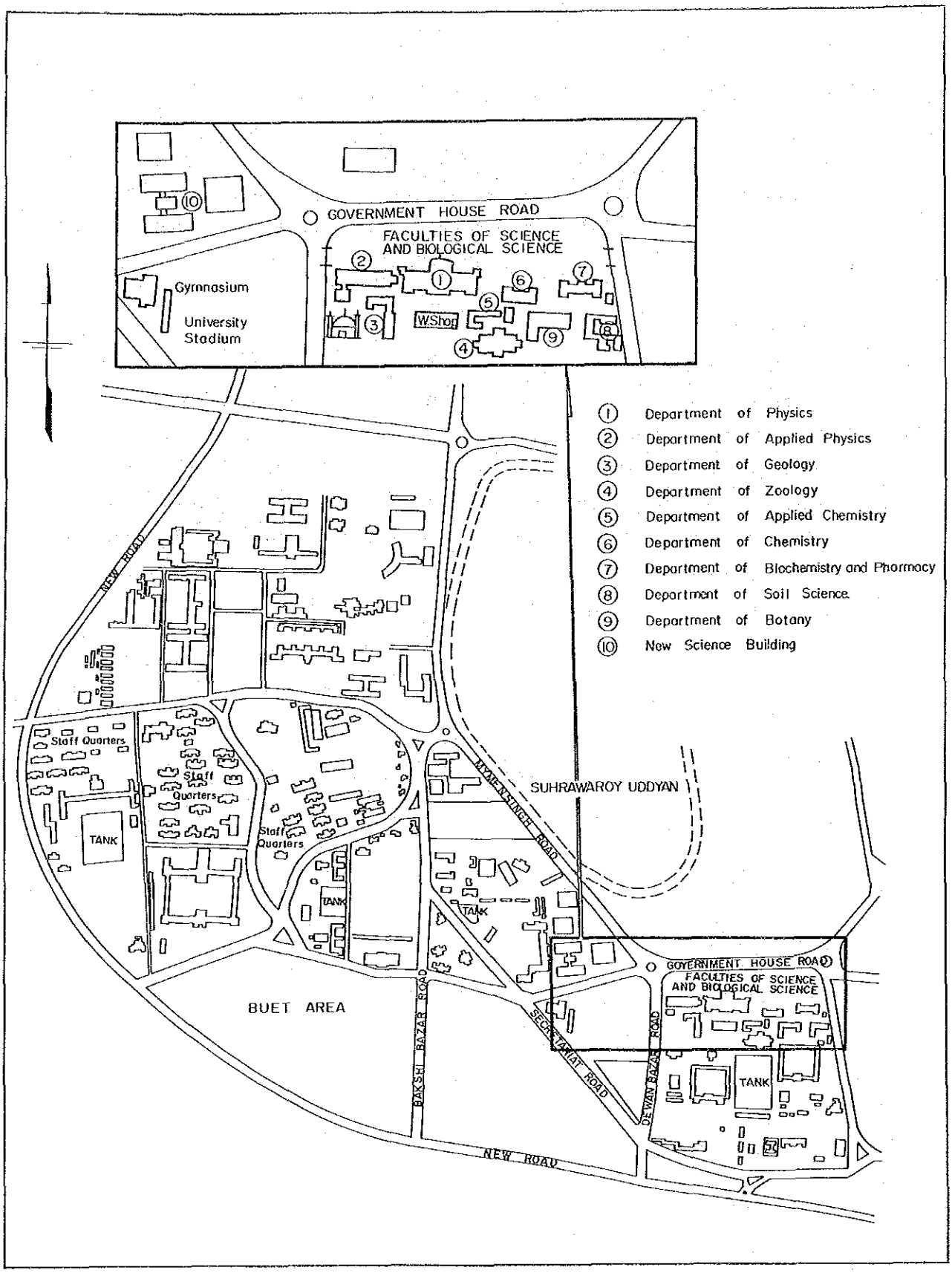


Figure 4-2 Campus Map of The University of Dhaka

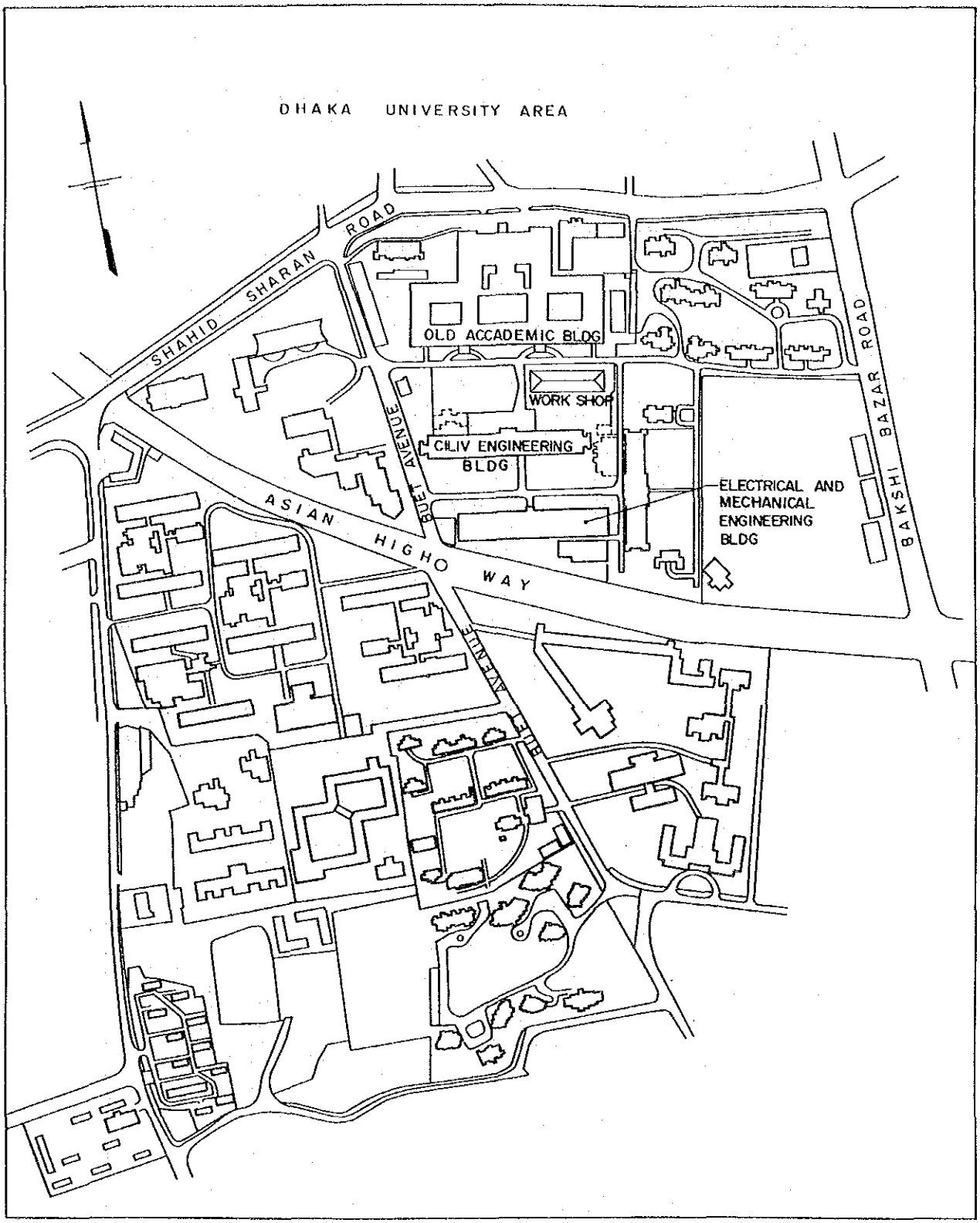
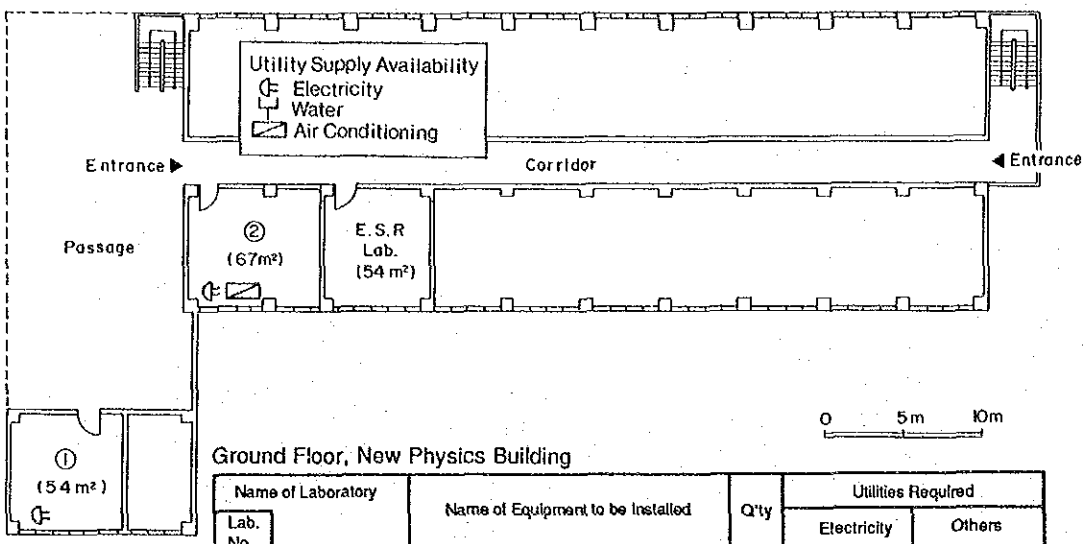
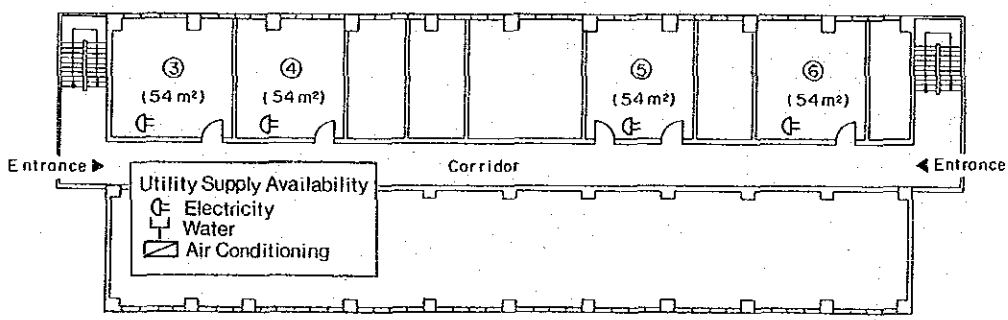


Figure 4-3 Campus Map of Bangladesh University of Engineering and Technology



Ground Floor, New Physics Building

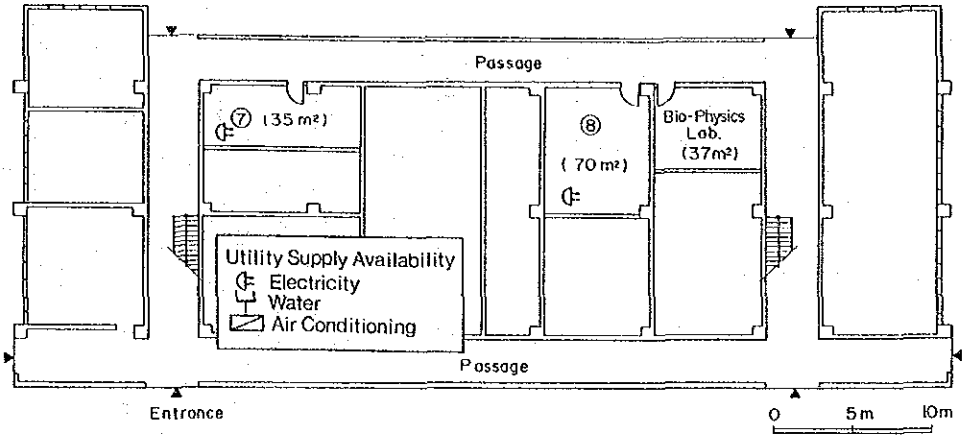
Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				Electricity	Others
①	2nd Year B. Sc., Subsidiary Lab.	Galvanometer	4	–	–
		DC bridge (Wheatstone)	2	–	–
②	Polymer Physics Lab.	Dielectric loss measuring set	1	Yes	Yes
		X-Y recorder with chart drive unit	1	Yes	–
		Digital thermometer	1	–	–



First Floor, New Physics Building

Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				Electricity	Others
③	Electronics Lab. - I	Oslilloscope	3	Yes	–
		Signal generator	3	Yes	–
		Oslilloscope quad trace	2	Yes	–
④	Electronics Lab. - II	Oslilloscope	4	Yes	–
		Signal generator	4	Yes	–
		AM modulation & demodulation circuit	1	Yes	–
		Precision digital meter	2	Yes	–
⑤	Solid State Physics Lab.	Potentiometer	2	–	–
		DC power supply unit	3	Yes	–
		Digital hygrometer	2	–	–
		Magnetometerr	2	Yes	–
⑥	Nuclear Physics Lab.	Atomic & nuclear timer scaler	2	Yes	–

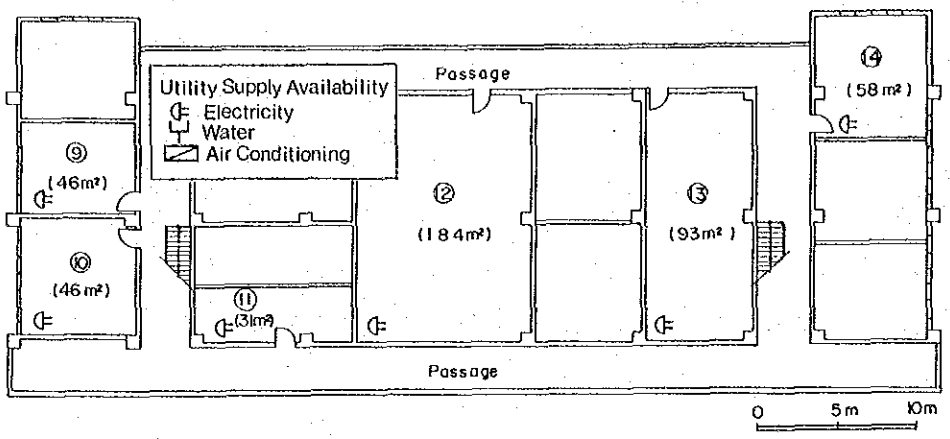
Figure 4-4 Equipment Layout Plan (1) (The University of Dhaka, Dept. of Physics)



Ground Floor, Curzon Hall

Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				• Electricity	Others
⑦	M. Sc. Preliminary Lab.	Oscilloscope	5	Yes	–
		Signal generator	5	Yes	–
		Atomic & nuclear timer scaler	1	Yes	–
⑧	Bio-Medical Physics Lab.	X-Y recorder	1	Yes	–
		Synthesized function generator	1	Yes	–
		Sound level meter	1	–	–

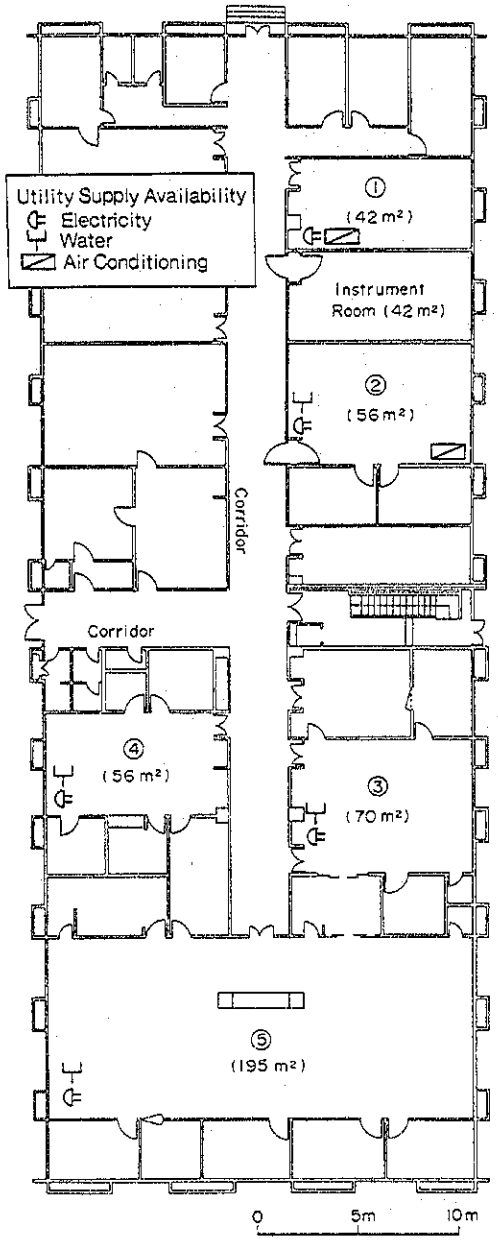
Figure 4-4 Equipment Layout Plan (2) (The University of Dhaka, Dept. of Physics)



First Floor, Curzon Hall

Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				Electricity	Others
⑨	3rd Year Hons. Lab. - I	Electronic circuit experimental equipment	2	Yes	--
		Transistor circuit trainer	2	Yes	--
		Semiconductor element experimental equipment	2	Yes	--
		Oscilloscope	8	Yes	--
		Signal generator	8	Yes	--
		LCR meter	2	Yes	--
		Logic tester	1	Yes	--
		Atomic & nuclear timer scaler	2	Yes	--
⑩	3rd Year Hons. Lab. - II	Microcomputer Trainer	2	Yes	--
		Logic circuit experimental equipment	2	Yes	--
		Compact digital multimeter	2	Yes	--
		Frequency counter	1	Yes	--
		Logic tester	1	Yes	--
⑪	Geophysics Lab.	Measuring equipment for conductivity of earth	1	--	--
⑫	2nd Year Hons. Lab.	Oscilloscope	4	Yes	--
		Signal generator	4	Yes	--
		Thermoelectromotive force measuring unit	1	Yes	--
		Galvanometer	4	--	--
		DC bridge (Wheatstone)	2	Yes	--
		Digital thermometer	2	--	--
		Compact digital multimeter	4	Yes	--
		Balance	2	Yes	--
⑬	1st Year Hons. Lab.	Galvanometer	4	Yes	--
		DC bridge (Wheatstone)	2	Yes	--
		Digital thermometer	3	--	--
		Compact digital multimeter	2	Yes	--
		Transformer winding (hand) machine	1	--	--
⑭	Laser Physics Lab.	Pyranometer	1	Yes	--

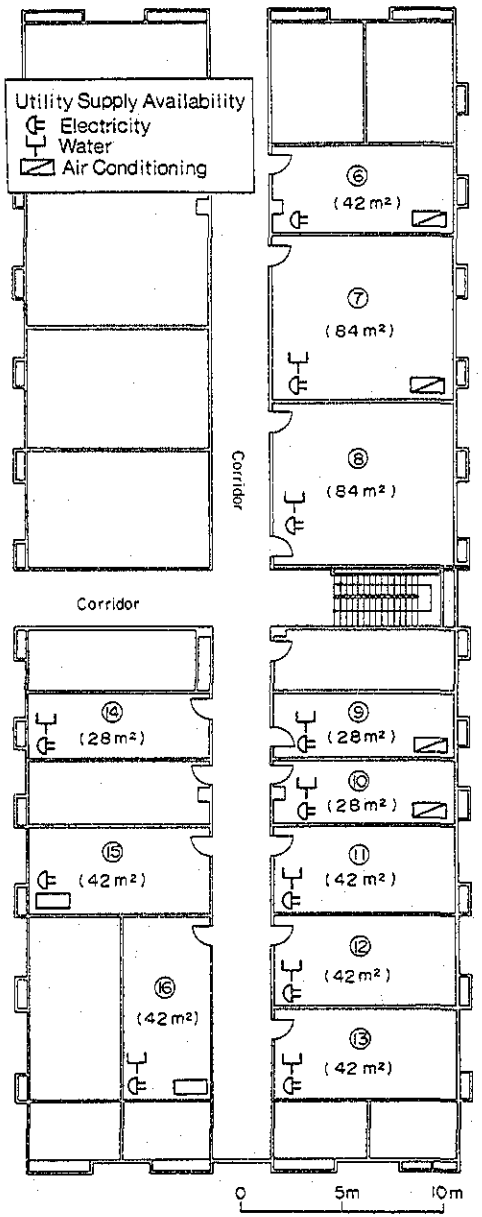
Figure 4-4 Equipment Layout Plan (3) (The University of Dhaka, Dept. of Physics)



Ground Floor, New Science Faculty Building

Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required: Electricity	Water	Air Cond.	Others
①	Research Lab.	UV-visible recording spectrometer	1	Yes	–	Yes	–
		Atomic absorption spectrophotometer	1	Yes	–	Yes	N_2O, $N_2C_2H_2$, Ar
②	X-Ray Room	Double beam IR spectrometer	1	Yes	–	Yes	–
		Digital balance	1	Yes	–	–	–
③	General Preparation	Oven	2	Yes	–	–	–
		Centrifuge	2	Yes	–	–	–
		Water still	1	Yes	Yes	–	–
		Digital balance	1	Yes	–	–	–
		O.H. projector	1	Yes	–	–	–
		Slide projector	1	Yes	–	–	–
④	Inorganic Lab.	Oven	1	Yes	–	–	–
		Water still	1	Yes	Yes	–	–
		Digital balance	1	Yes	–	–	–
⑤	Advanced Inorganic Lab.	Furnace	2	Yes	–	–	–
		Oven	4	Yes	–	–	–
		Centrifuge	10	Yes	–	–	–
		Melting point apparatus	12	Yes	–	–	–
		Heating mantle	24	Yes	–	–	–
		Hot plate stirrer	10	Yes	–	–	–
		Water still	2	Yes	Yes	–	–
		Digital balance	2	Yes	–	–	–

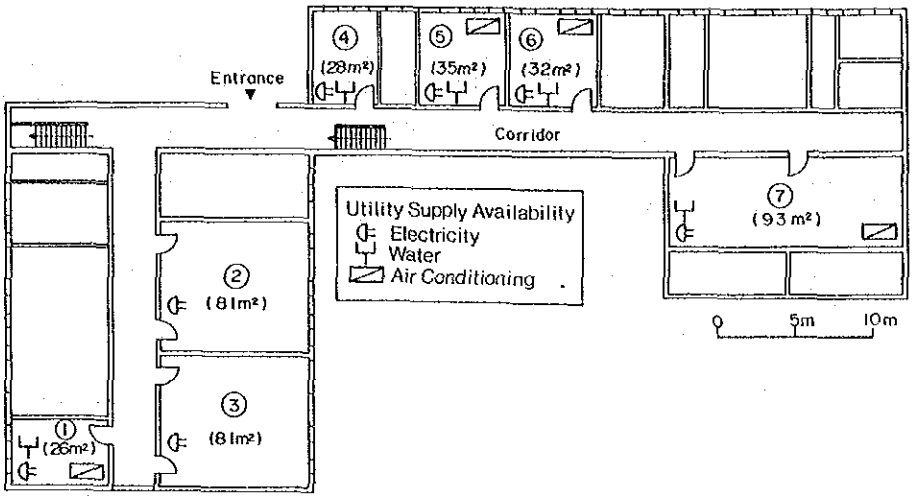
Figure 4-4 Equipment Layout Plan (4) (The University of Dhaka, Dept. of Chemistry)



First Floor, New Science Faculty Building

Name of Laboratory		Name of Equipment to be Installed	Q'ty	Utilities Required			
Lab. No.				Electricity	Water	Air Cond.	Others
⑥	Organic Research Lab.-I	Double beam IR spectrometer	1	Yes	–	Yes	–
⑦	Organic Research Lab.-II	Rotavapor	2	Yes	–	–	–
		Water bath	9	Yes	Yes	–	–
⑧	Organic ResearchLab.-III	Rotavapor	2	Yes	–	–	–
		Water bath	9	Yes	Yes	–	–
		O.H. projector	1	Yes	–	–	–
		Slide projector	1	Yes	–	–	–
⑨	Student Lab. for Instrumental Work	UV-visible recording spectrometer	1	Yes	–	Yes	–
		pH meter	12	Yes	–	–	–
		Conductivity meter	6	Yes	–	–	–
⑩	Electrochemistry Research Lab.	Water still	1	Yes	Yes	–	–
⑪	Catalysis Research Lab.	Oven	1	Yes	–	–	–
		Digital balance	1	Yes	–	–	–
⑫	Gas Kinetics Research Lab.	Digital balance	1	Yes	–	–	–
⑬	Lab. for Wet Chemical Analysis	Oven	1	Yes	–	–	–
		Water still	1	Yes	Yes	–	–
⑭	Photochemistry Lab.	Polarimeter	1	Yes	–	–	–
		Refractometer	2	Yes	–	–	–
		Oven	1	Yes	–	–	–
⑮	Instrument Room-II	UV-visible recording spectrometer	1	Yes	–	Yes	–
⑯	Instrument Room-III	Gas chromatograph with TCD detector	1	Yes	–	–	N_2, H_2 He
		Digital balance	1	Yes	–	–	–

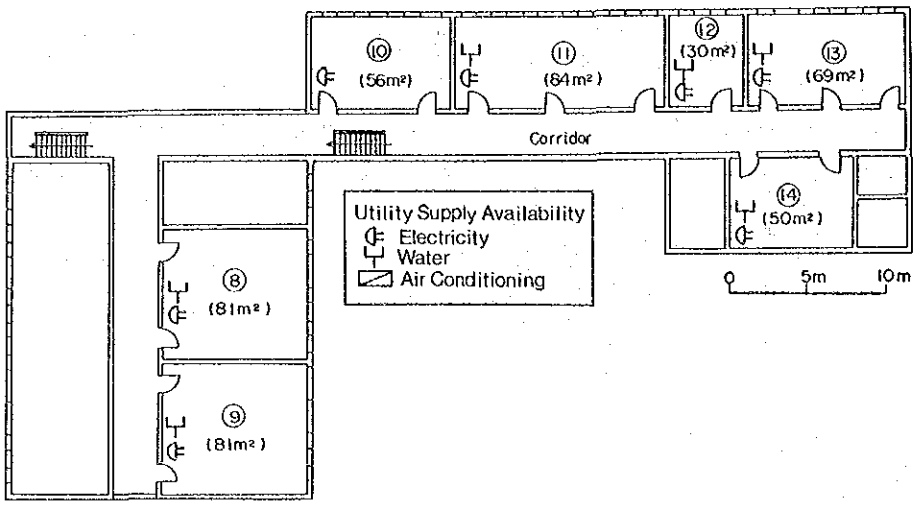
Figure 4-4 Equipment Layout Plan (5) (The University of Dhaka, Dept. of Chemistry)



Ground Floor, Department of Botany

Name of Laboratory		Name of Equipment to be Installed	Q'ty	Utilities Required		
Lab. No.				Electricity	Water	Others
①	Plant Tissue Culture Lab.	Incubator	1	Yes	--	--
		Research microscope	1	Yes	--	--
		Portable lux meter	1	--	--	--
		Centrifuge	2	Yes	--	--
		Gyratory shaker	1	Yes	--	--
		Hot air sterilizer and dryer	2	Yes	--	--
		Ultrasonic pippette washer	1	Yes	Yes	--
		Glassware washer	1	Yes	Yes	--
②	Lecture Room	Advanced student microscope	15	Yes	--	--
		O.H. projector	1	Yes	--	--
③	Lecture Room	Advanced student microscope	15	Yes	--	--
		O.H. projector	1	Yes	--	--
④	Genetics Lab.	Centrifuge	2	Yes	--	--
⑤	Plant Breeding Lab.	Centrifuge	2	Yes	--	--
		Gyratory shaker	1	Yes	--	--
		Fluorescent attachment set for research microscope	1	Yes	--	--
⑥	Cytogenetics Lab.	Incubator	1	Yes	--	--
		Water bath	1	Yes	Yes	--
		Centrifuge	2	Yes	--	--
⑦	Plant Physiology Lab.	Water still	1	Yes	Yes	--
		Digital balance	2	Yes	--	--
		Leaf area meter	3	yes	--	--
		Flame analyser	1	Yes	--	LPG
		Precise electric drying oven	1	Yes	--	--
		Refractometer	2	--	--	--
		Thin layer chromatography set	1	Yes	--	--
		Recording thermohygraph	2	Yes	--	--
		Centrifuge	1	Yes	--	--
		Spectrophotometer	2	Yes	--	--
		UV spectrophotometer	1	Yes	--	--
		Glassware washer	1	Yes	Yes	--

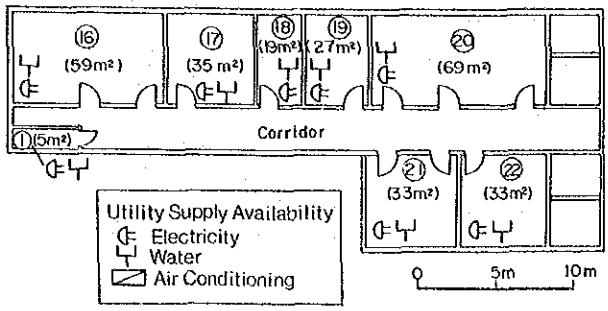
Figure 4-4 Equipment Layout Plan (6) (The University of Dhaka, Dept. of Botany)



First Floor, New Science Faculty Building

Name of Laboratory		Name of Equipment to be Installed	Q'ty	Utilities Required		
Lab. No.				Electricity	Water	Others
⑧	Practical Lab.-I	Advanced student microscope	11	Yes	--	--
		Water still	1	Yes	Yes	--
		O.H. projector	1	Yes	--	--
		Camera lucida (mirror type)	2	--	--	--
		Water bath	2	Yes	Yes	--
		pH meter (portable type)	2	--	--	--
⑨	Practical Lab.-II	Advanced student microscope	11	Yes	--	--
		O.H. projector	1	Yes	--	--
		Camera lucida (mirror type)	2	--	--	--
		Water bath	2	Yes	Yes	--
		pH meter	2	Yes	--	--
⑩	Lecture Room	Advanced student microscope	15	Yes	--	--
⑪	Practical Lab.-III	Advanced student microscope	11	Yes	--	--
		O.H. projector	1	Yes	--	--
		Camera lucida (mirror type)	2	--	--	--
		Water bath	2	Yes	Yes	--
		pH meter	2	Yes	--	--
⑫	Ecology Lab.	Digital balance	2	Yes	--	--
		Flame analyser	1	Yes	--	LPG
		Refractometer	2	--	--	--
		Recording thermohygraph	1	Yes	--	--
		Portable lux meter	1	--	--	--
⑬	Practical Lab.-IV	Advanced student microscope	20	Yes	--	--
		Water still	1	Yes	Yes	--
		Camera lucida (mirror type)	2	--	--	--
		Water bath	1	Yes	Yes	--
		pH meter	2	Yes	--	--
⑭	Phycology, Limnology & Hydrobiology Lab.	Research microscope	1	Yes	--	--
		Refractometer	2	--	--	--
		Thin layer chromatography set	1	Yes	--	--
		Portable lux meter	2	--	--	--
		Gyratory shaker	1	Yes	--	--
		Hot air sterilizer and dryer	2	Yes	--	--
		Spectrophotometer	2	Yes	--	--
		UV spectrophotometer	1	Yes	--	--

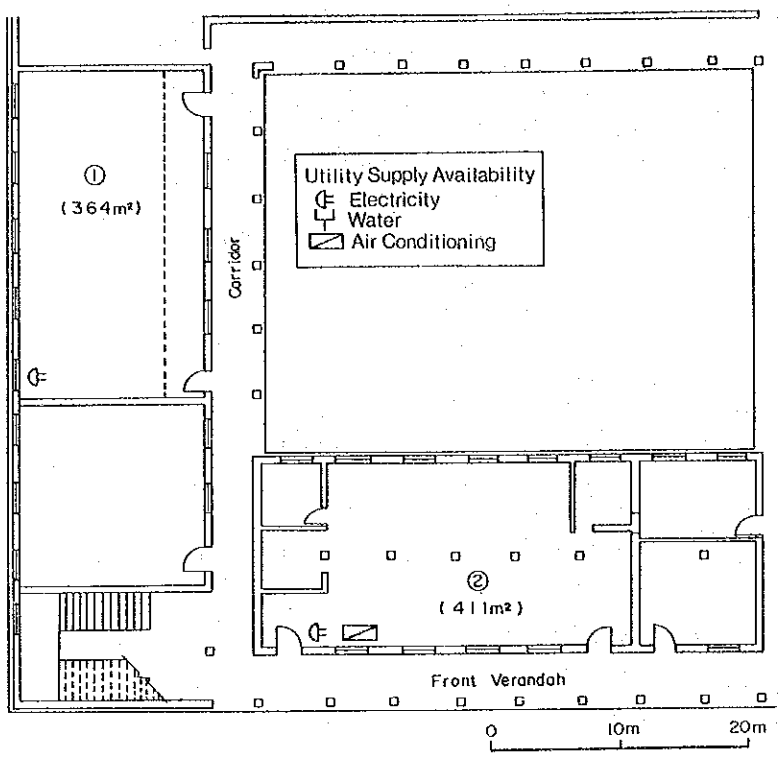
Figure 4-4 Equipment Layout Plan (7) (The University of Dhaka, Dept. of Botany)



Second Floor, Department of Botany

Name of Laboratory		Name of Equipment to be Installed	Q'ty	Utilities Required		
Lab. No.				Elect-ricity	Water	Others
⑮	Autoclave Room	Autoclave	2	Yes	--	--
⑯	Practical Lab.-V	Advanced student microscope	11	Yes	--	--
		Water still	1	Yes	Yes	--
		Camera lucida (mirror type)	2	--	--	--
		Water bath	1	Yes	Yes	--
		pH meter	2	Yes	--	--
⑰	Mycology & Plant Pathology Lab.	Incubator	1	Yes	--	--
		Research microscope	1	Yes	--	--
		Freezing microtome	1	Yes	--	--
		Colony counter	1	Yes	--	--
⑱	Seed Pathology Lab.	Incubator	1	Yes	--	--
		Glassware washer	1	Yes	Yes	--
⑲	Microbiology Lab.	Digital balance	1	Yes	--	--
		Incubator	2	Yes	--	--
		Advanced research microscope	1	Yes	--	--
		Colony counter	1	Yes	--	--
		Vacuum desiccator	1	Yes	--	--
		Centrifuge	1	Yes	--	--
		Gyratory shaker	1	Yes	--	--
		Spectrophotometer	1	Yes	--	--
		Ultrasonic pipette washer	1	Yes	--	--
		Glassware washer	1	Yes	Yes	--
			1	Yes	Yes	--
⑳	Herbarium	Precise electric drying oven	1	Yes	--	--
㉑	Physiological Ecology Lab.	Refractometer	2	--	--	--
		Portable lux meter	1	--	--	--
		Spectrophotometer	1	Yes	--	--
㉒	Higher Cryptogams Lab.	Reasearch microscope	1	Yes	--	--
		Universal profile projector	1	Yes	--	--

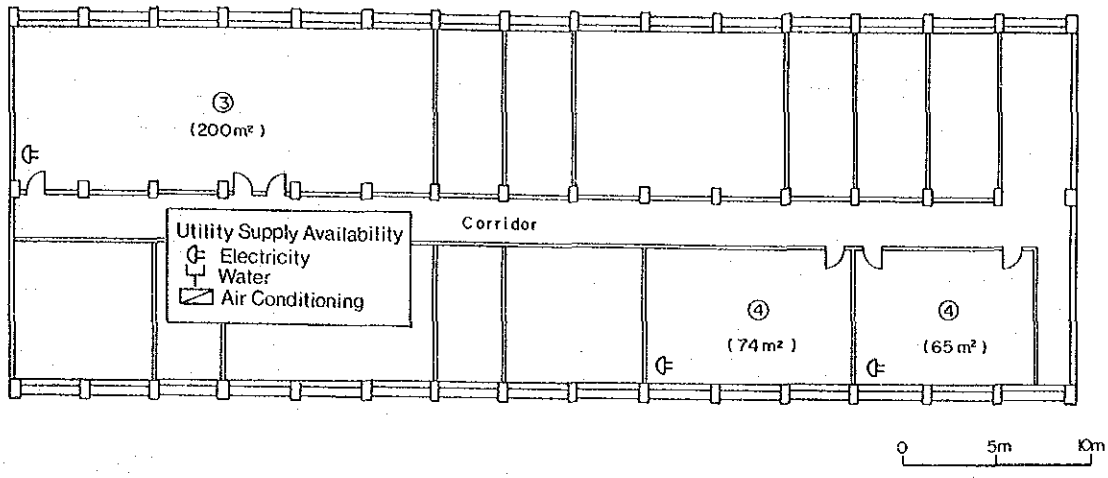
Figure 4-4 Equipment Layout Plan (8) (The University of Dhaka, Dept. of Botany)



Old Academic Building

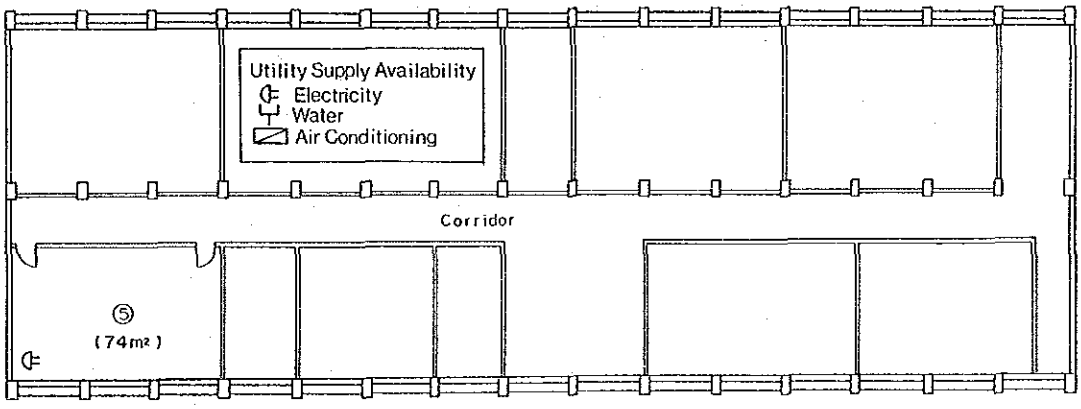
Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				Electricity	Others
①	High Voltage Lab.	High voltage test set with corona measuring equipment	1	Yes	–
		High voltage impulse generator	1	Yes	–
②	Electronics Lab.	Storage oscilloscope	1	Yes	–

Figure 4-4 Equipment Layout Plan (9) (Bangladesh University of Engineering and Technology, Dept. of Electrical & Electronic Engineering)



Ground Floor, EME Building

Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				Electricity	Others
③	Machine Lab.	A.C. synchro-indicator	3	Yes	--
		Portable frequency meter	8	--	--
④	Circuit Lab.	Pocket tachometer	3	--	--
		Portable wattmeter	8	--	--
		Portable P.F. meter	8	--	--



Third Floor, EME Building

Lab. No.	Name of Laboratory	Name of Equipment to be Installed	Q'ty	Utilities Required	
				Electricity	Others
⑤	Microwave Lab.	Microwave network analyser	1	Yes	--

Figure 4-4 Equipment Layout Plan (10) (Bangladesh University of Engineering and Technology, Dept. of Electrical & Electronic Engineering)