Department of Civil Engineering (including Dept. of Town Planning and Dept. of Structural Eng.)
Department of Mechanical Engineering(including Workshop)

3.3.3 Site

The College of Engineering, Pune is in Pune which is about 200 km southeast of Bombay, the capital of Maharashtra State. The city of Pune is situated on a plateau of about 600 m high above the sea level and extends toward south from the junction of River Muta and River Mura.

The College of Engineering, Pune is located in the center of Pune city. The campus is bounded by River Muta and the railway, and divided into two parts by the Highway No.4 which runs through the center of campus. The Highway No.4 is where there is much traffic and impedes traffic within the campus. Since the noise and automobile exhaust gas are causing trouble to study and research, a move of the campus to another place is being proposed.

The site area is 15 ha and the total floor area of the buildings is 23,000 m^2.

Table 3-9 Floor Area and Structure of Main Buildings

	Name of the Department	Structure	Number of Floors	Floor Area (m^2)
1.	Electronics & Telecommunication	Reinforced Concrete	G+1	4,304
2.	Metallurgy	"	G+2	2,215
3.	Electrical Engineering	"	G+1	1,009
4.	Workshop	"	B+G	1,896
5.	Instrumentation & Control	"	G+1	1,000
6.	Applied Mechanics	"	B+G	1,017
7.	Civil Engineering	"	G+1	1,797
8.	Civil Engineering, Mathematics, Geology	"	G+1	1,822
9.	Mechanical Engineering	"	B+G	1,000
10.	Library	"	G+1	4,653
11.	Main Building and Town Planning	"	G+2	2,523
	Total			23,236

(2) Space for Installation of Equipment

All Departments have extra space for accommodating new equipment either vacant or occupied with some tables and there is no problem with its availability.

Name of Department	Name of Laboratories	Floor Area (m^2)
A. Electronics & Telecommunication	1 Signal Process Lab.	64
	2 Applied Electronics Lab.	50
B. Metallurgy	1 Spector Analyser Lab.	34
	2 X-Ray Defractometer Lab.	74
	3 Material Testing Lab.	56
C. Electrical Engineering	1 Power Electronics Lab.	75
D. Instrumentation & Control	1 Biomedical Lab.	111
E. Civil Engineering	1 Environmental Lab.	39
	2 U.T.M. Lab.	43
F. Mechanical Engineering	1 Internal Combustion Engine Lab.	26
	2 Computer and Electronic Lab.	40
	3 Machine Tool Lab.	118
	4 C.I.M Lab.	108
	5 3-D Measuring Lab.	95
Total		933

(3) Infrastructure

1) Power Source

The College of Engineering, Pune receives electricity at the voltage of 11 kV and drops the voltage down to 440 V in a substation in the campus and supplies it to terminals (Fig. 3-3)

Power failures happen about three times per month for the duration of about three minutes. The laboratories which use precision electronic devices are equipped with power failure proof sources. It is necessary to take similar safety measures for some equipment to be provided by the project.

The fluctuation of the voltage exceeds +- 5 % and some existing equipment uses constant voltage power sources. Some new equipment needs similar stable power sources.

(a) power sources

1-phase 230 V +-6%, 50 Hz

3-phase 440 V +-5%, 50 Hz

(b) plugs

Since the buildings are old, many types of plugs are being used. Many of them are of old round type of three-pins, but recently installed plugs are of 5-pins type with a switch and a red lamp indicator.

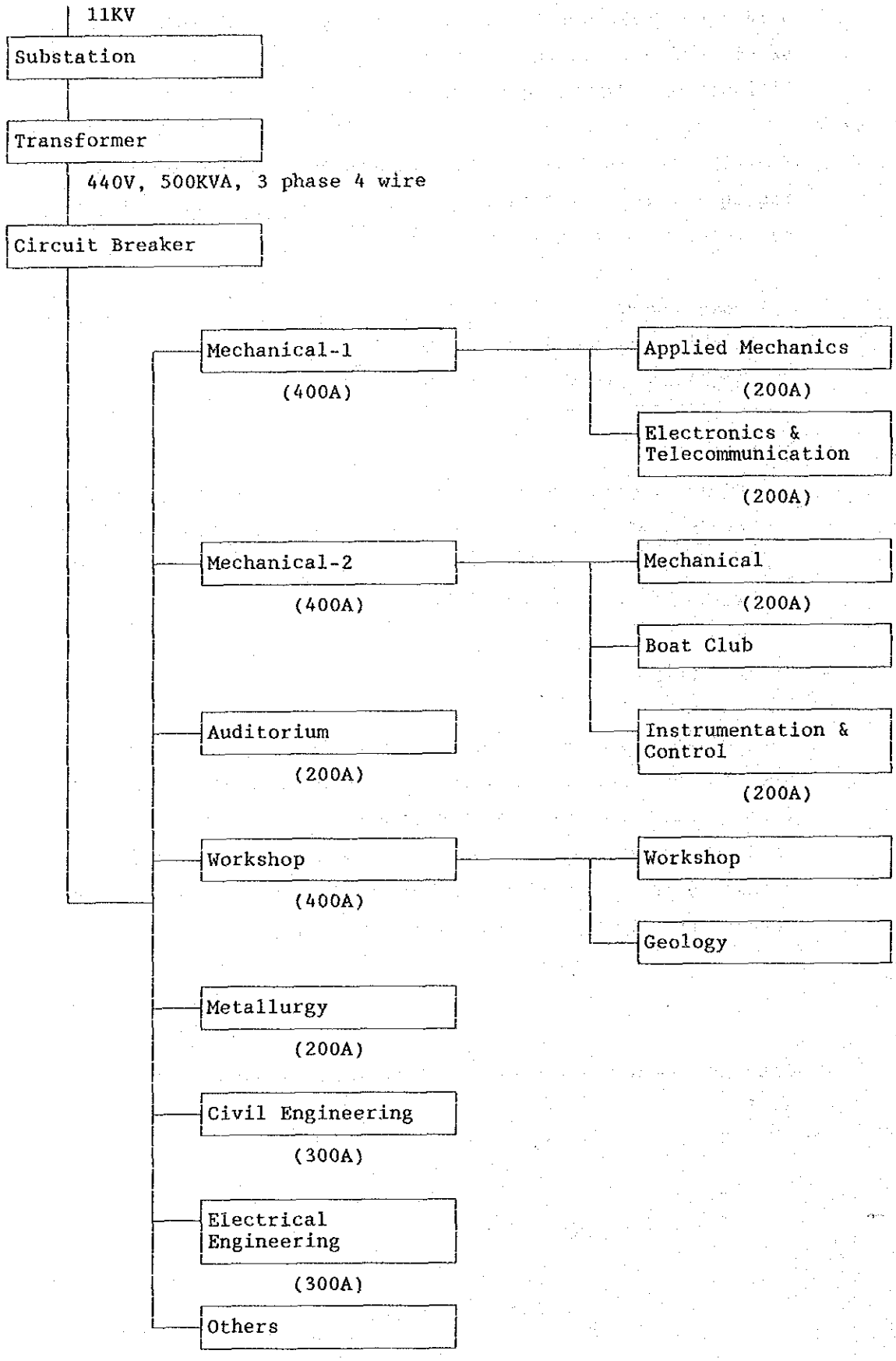
2) Water Supply

The College is supplied with city water. The water is potable, but not suitable for doing chemical analysis. The Environment Laboratory of the Department of Civil Engineering is equipped with a pure water supply apparatus using ion exchange resin. Therefore consideration must be taken for pure water supply to the Department of Civil Engineering.

3) Gas

City gas is not available. When heat is necessary, LPG is used.

Fig. 3-2 Electrical Services



(4) Climatological Statistics

Pune is situated at 600m from sea level, that is why Pune is much comfortable than Bombay. COEP shall prepare Air Conditions in response to necessity.

	Temperature (°C)		Relative Humidity (%)	Monthly Total Rainfall (%)	Note
	Daily Max.	Daily Min.			
January	30.7	12.0	74	1.9	
February	32.9	13.3	64	0.3	
March	36.1	16.8	52	3.1	Dry Season
April	37.9	20.6	50	17.6	Summer Season
May	37.2	22.6	58	34.7	
June	31.9	23.0	74	102.8	Summer Season Rainy Season
July	27.8	22.0	83	186.8	
August	27.7	21.5	85	106.4	
September	29.2	20.8	82	106.4	Rainy Season
October	31.8	19.3	79	91.9	Dry Season
November	30.8	15.0	73	37.0	
December	30.1	12.0	75	4.9	
Mean	32.0	18.2	71	714.7	

Annual Highest Temperature	Annual Lowest Temperature	Heaviest Fall in 24 Hours
43°C	1.7°C	149.1mm

3.3.4 Outline of the Equipment

The contents of the equipment requested are confirmed as described in the List of Equipment requested by the College of Engineering, Pune, for its modernization project in Appendix 3. Eight departments will receive equipment. However, the Department of Town Planning and the Department of Structural Engineering are part of the Department of Civil Engineering, and the Workshop part of the Department of Mechanical Engineering. The departments which constitute undergraduate courses are the Department of electronics & Telecommunications, the Department of Metallurgy, the Department of Electrical Engineering, the Department of Instrumentation, the Department of Civil Engineering and the Department of Mechanical Engineering. The following is a categorized list of equipment proposed to these six departments.

1. Department of Electronics and Telecommunication

	Name of Equipment	Major Uses
1 2	Field Strength Meter Standard Dipole Antenna Set	Measurement of field strength and
4 5	Modulation Analyser Radio Communication Analyser	Measurement of modulation characteristics such as linearity index, and band with etc.
3 6 7	Electronic Counter Microwave Power Meter Microwave Sources	Measurement of microwave high power and other parameters in the system
8 9 10	Spectrum Analyser Network Analyzer Scalar Network Analyser	Measurement of loss and gain in the high frequency equipment including area of microwave and characteristics of frequency
11	Optical Fiber Communi-cation Test Setup	Experiment and measurement on optical fiber communication
12	Logic Analyser	Parameter analysis of communication transmission line and measurement of frame
13	EMI Test System	Measurement of Electrical Disorder
14	Waveform Synthesizer Waveform Recorder Digital Oscilloscope	Synthesizing and Analysis of wave form in the communication technology
15	Video Signal Processing Equipment	Digital recording/processing, mixing and editing of video signal
16	Electronics Parts and Devices	Diode, Transister, Switch, Microprocessor, etc.
17	Standard Equipment	Standard Cell, Standard Resistor, Standard Capacitor, etc.

2. Department of Metallurgy

	Name of Equipment	Major Uses
18	Fatigue Testing Machine	Measurement of each composition and condition under varying loading condition
19	Hisomet Microscope	Measurement of thickness and depth of materials
20	Microhardness Tester	Measurement of surface hardness of soft material such as metal, ceramic, rubber and plastics
21	Vacuum Emission Spectrometer	Quantitative elemental analysis including identification of elements and their concentration by atomic spectroscopy
22	Auto Sonohard Ultrasonic Hardness Tester	Measurement of hardness distribution pattern for sectional area
23	X-ray Stress Analyser	Automatic measurement and calculation of stress through sectional distortion on the stom by X-ray analysis
24	Induction Remelting Unit	Preparation of metallic samples with homogeneous composition
25	Carbon Sulphur Analyzer	Measurement of Carbon and Sulphur for new materials

3. Department of Electrical Engineering

	Name of Equipment	Major Uses
26	Self Education Robotic Trainer	Basic learning on operational procedure for robotte
27	Power Line Multitrans-ducer	Change of voltage, current, frequency, phase, etc.
28	Multichannel Voltage & Current Source	Source of voltage and/or current for miscellaneous electrical experiments
29	Isolated Probe System	Instrument measurement of high voltage electrical power through isolation method
30	Digital Power Meter	Comparative measurement of electrical power for direct measurement and calculation
31	Electronic Hybrid Meter	Digital and analogue style meter for voltage and current
32	Analyzing Recorder with Colour Plotter	Analog to Digital convertor with recorder
33	Digital Multimeter	Measurement of voltage, resistance and current
34	Digital Oscilloscope	Measurement of indication of waveform
35	Digital Indicating Controller	Indicating controller for temperature, pressure, fluid level, etc.
36	Analogue Oscilloscope	General use for electrical experiment
37	Digital Memory	Visual experiment of transition state by recording and replay
38	Fast Transient Digitizer	High speed transient phenomena experiment, high speed analogue to digital cover
39	High Resolution, High Accuracy DMM	High resolution, high accuracy of Digital Multimeter
40	Digital Electrometer	Measurement of tiny current
41	Powerscope	Measurement of dynamic electricity
42	Portable Photometer	Measurement of luminous intensity
43	H.V. DC Voltmeter	Voltmeter for high voltage direct current
44	H.V. AC/DC Voltmeter	Voltmeter for high voltage
45	HVDC Transmission Line Simulator	Simulation of model for direct current transportation of power, power plant operation and power station
46	Electrical Parts and Devices	Frequency meter, DC meter, converter, etc.

4. Department of Instrumentation and Control

	Name of Equipment	Major Uses
47	Arbitrary Waveform Generator	Simulation of physiologically signal wave in the biomedical experiment
48	Analyzing Recorder	Digital oscilloscope with memory
49	Digital Portable Calibrator	Calibration of measuring instrument
50	Data Acquisition System with Processing Unit	Development of patient management system in a Hospital
51	Digital Manometer	Digital pressure gauge
52	Single Loop Programmable Controller	Remote control industrial instrument internally equipped with microcomputer in which measurement procedure is programmed for target variables such as voltage, ampere, and electrical power, etc.
53	Smart Transmitter and Smart Field Communicator	Analysis and monitoring of industrial variables such as temperature, flow rate, pressure and liquid level, etc. in opeational condition for detector, transmitter and controller without disconnecting the wiring between a field instrument and operation panel. To be used widely in the field of miscellaneous industrial control section, and effectively used to support the regional industry in research and development.
54	Ultrasonic Analyser with Accessories	Instrumentation and bio-medical technology and process design of equipment
55	Electric Myographic Unit	Data gathering and Analysis on electric myographic
56	FFT Analyser	Experiment on Control system and bio medical technology characteristic including the communication of nervous system
57	Electronics Measurement Parts and Devices	Voltage/currents standard, standard register, frequency counter, etc.
58	Sensors	Thermistor Temperature Sensor, Absolute Humidity Sensor, Pressure Transducer, etc.

5. Department of Civil Engineering

	Name of Equipment	Major Uses
59	Computer Controlled UTM System	Material testing for tensile, compression, bending, repeated stress, strain-gauge type distortion, twisting (50kgW torque) etc.
60	Electronic Digital Theodolite	Measurement of vertical and horizontal angles
61	Automatic Level	Getting level automatically.
62	Electronic Distance Meter	Measurement of distance with reflecting signal
63	Digital Planimeter	Measurement of area of map
64	Sound Level Meter	Monitoring of traffic noise
65	Gas Monitor for CO, H_2S, SO_2 Portable	Monitoring of air pollution

6. Department of Mechanical Engineering

	Name of Equipment	
66	X-Y Plotter	Plotter for CAD
67	Digital Thermo Hygrometer	Digital type relative humidity meter with recorder
68	Computing Datalogger	Time shearing data processing with recorder
69	Fully Automatic Compressor Testing System	Performance and Workmanship testing apparatus for compressor for refrigeration
70	3-D Coordinate Measuring Machine	Three dimensional precision measurement of cubic material through x-axial, y-axial and z-axial movement of measuring rod
71	Universal Gear Tester	Measurement of tooth profile, pitch, eccentricity, distance of center

CHAPTER 4

CHAPTER 4 BASIC DESIGN

4.1 Design Policy of Equipment

Design Policy of equipment was studied and determined for the educational and research equipment in the provision of equipment as follows:

(1) Capacity and Usability of Equipment

Capacity and performance of equipment shall be verified in consideration of nature of laboratory practice and training for undergraduate student use under the objective of educational and/or research, activity development.

Equipment which will be provided and installed in the specified laboratories, should be a general and flexible one to achieve a wide range of function and applicable to duplicated laboratory studies and trainings in consideration of their wide range of educational and/or research objectives and their interrelationship of equipment uses.

(2) Duplication with Existing Equipment and/or Equipment to be Purchased by the College Itself

In the selection of equipment, duplication of equipment provision shall be avoided to the available equipment and equipment scheduled to be purchased by the budget of the Central Government, which is listed in Appendix 9.

(3) Layout Plan of Equipment

Equipment to be provided in the Project shall be installed at individual laboratory and/or training room.

There is no obstacles for installation equipment because these spaces are vacant at present and any other obstacles are not installed excluding plain tables and chairs. Therefore, layout

plan of equipment to be provided shall be designed only in consideration of weight, dimension, their uses, and utility requirement.

4.2 Design Condition

4.2.1 Climate Condition

(1) Temperature and Humidity

According to the past climatic record of PUNE city, maximum temperature was 43°C and 1.7°C for minimum temperature.

In consideration of these, design condition for monthly average and minimum temperature was supposed as follows:

Especially, specification of equipment which is very sensitive for velocity of temperature increase and/or decrease, will be carefully studied and verified.

Design temperature: Max. 45°C
Min. 1°C

Design Humidity: Max. 85%
Min. 20%

4.2.2 Building and Utility

(1) Building Requirement

There is no problems for the installation on the 2nd and/or 3rd floor of the equipment to be supplied to the dept. of electronics and telecommunication and dept. of electrical engineering because there is no heavy equipment and equipment necessary of foundations, however, several equipment to be provided to the Dept. of Metallurgy, Dept. of Civil Engineering and Dept. of Mechanical Engineering may need a foundation and should be installed on the ground floor.

(2) Electrical Power Source

Frequency of electrical power failure is about three times per month, and voltage fluctuation is reported as ± 6%.

In the existing computer apparatus at the College of Engineering PUNE, UPS and Stabilizer are installed usually in the Laboratories.

Therefore, in case of sophisticate electronics instruments, these devices are recommended to be installed and these should be supplied by the College of Engineering, PUNE.

Electrical Plugs and Socket

3 Phase, 440 V ..... Power cable will be directly connected to the distribution panel. Separate distribution panel shall be installed for the specified rating.

Single Phase, 230 V ... There are many types of plugs are used at the laboratories, among these, three-round pin type are used widely.

In this project, 5-pin type new model is recommended.

4.3 Basic Plan

Based on evaluation and verification of the equipment requested, specification of equipment was designed, in consideration of priority order of equipment selection which as agreed at the site survey meeting on 12th July, 1991 and the results of DGTD's approval for the important equipment.

However, specification of equipment, partly was changed in view of the nature of equipment requested to achieve the required target. These short specification is shown on Table 4.1 for each department.

Table 4-1 Short Specification of Equipment Proposed

(1) Department of Electronics and Telecommunication

No.	Equipment	Number	Reference
1	Field Strength Meter	1	Field Strength Meter, Frequency Converter Preselector
2	Standard Dipole Antenna	1	f: 30MHz to 1000MHz (23Freq.) Output Impedance: 50Ohms
3	Electronic Counter	3	f: 10MHz to 26GHz
4	Modulation Analyser	1	f: 150KHz to 3GHz
5	Radio Communication Analyser	3	f: 25 to 1000MHz
6	Microwave Power Meter	1	Mainframe Sensors
7	Microwave Sources	1	f: 100KHz to 4.5GHz, Out: +16 to -140dBm
8	Spectrum Analyser	1	Impedance Measurement Mainframe, Noise Field Strength Measurements
9	Network Analyser	1	f: 10Hz to 300MHz
10	Scalar Network Analyser	1	Mainframe, Synthesized Sweep Adaptor, Detectors, Directional Bridge, Power Splitter, Open/Short Connector for Calibration
11	Optical Fiber Communication Test Set Up	1	LED Light Sources, White Light Source Optical Spectrum Analyzer, Optical Wavelength Meter, Optical Fiber Bandwidth Test Set, Optical Time Domain Reflectometer Components for Optical Setup, Optical Power Multimeter, Laser Diode Light Sources
12	Logic Analyser	1	Mainframe, 300MHz Timing Module, Personality Kit
13	EMI Test System	1	EMI Test System, Active Antenna, Active Dipole Antenna, Log Periodic Antenna, Doubnle Rigid Guide Antenna, Antenna Assembly Parts
14	Waveform Synthesizer		Waveform Synthesizer, Waveform Recorder, Digital Oscilloscope
15	Video Signal Processing Equipment	1	Colour Video Camera, Portable Cassette Recorder, Editing Recorder, Editing Control Unit, Colour Video Monitor, Connecting Cable, Colour Special Effect Generator, Audio Mixer, Colour Graphic Video Printer
16	Electronics Parts and Devices		Diode, Transister, Switch, etc.
17	Standard Equipment		Standard Cell, Standard Resister, Standard Capacitor, etc.

(2) Department of Metallurgy

No.	Equipment	Number	Reference
18	Fatigue Testing Machine	1	Loading Unit, Control Unit, Hydraulic Power Supply
19	Hisomet Microscope	1	Measuring Stage 100 x 50 mm
20	Microhardness Tester	1	Load: 11-step selection, Stage size: 120x120mm
21	Vacuum Emission Spectrometer	1	Excitation Source Spectrometer Readout Unit Data Processing Unit
22	Auto Sonohard Ultrasonic Hardness Tester	1	Display Unit, AC adaptor/Charger, Mainframe, Probe, Probe Cable, Portable Case, Reference Hardness Block, Measuring Stand
23	X-Ray stress Analyzer	1	X-Ray Generator, Goniometer, Data Processing Unit
24	Induction Remelting Unit	1	Casting Weight: 750 g, Capacity: 16 KVA
25	Carbon Sulphur Analyzer	1	Sample : 1.0 g

(3) Department of Electrical Engineering

No.	Equipment	Number	Reference
26	Self Education Robotic Trainer	1	Robot Arm, Drive Unit, Personal Computer, Software
27	Power Line Multitransducer	1	3 Phase 3-wire
28	Multichannel Voltage & Current Source	1	Mainframe, DC Voltage/Current Unit
29	Isolated Probe System	4	Band Width: DC to 15MHz (-3db)
30	Digital Power Meter	1	3 Phase, 4-wire (AC)
31	Electronic Hybrid Meter	6	DC voltmeter/ammeter, AC voltmeter/ammeter
32	Analyzing Recorder with Colour Plotter	1	
33	Digital Multimeter	1	6-1/2 digits, with true RMS AC ranges
34	Digital Oscilloscope	1	f: DC - 100MHz, Sample: 100MS/s, Memory: 128kwords
35	Digital Indicating Controller	1	Sampling Period: 200ms, Accuracy: ±0.25% of F.S. ±1 digit
36	Analogue Oscilloscope	1	f: DC - 200MHz (Zin=1MΩ), DC - 300MHz (Zin=50Ω)
37	Digital Memory	1	f: DC - 10MHz
38	Fast Transient Digitizer	1	f: 80MHz, Channels: 4 Sampling: 200MS/s (4ch) 400MS/s
39	High Resolution, High Accuracy DMM	1	
40	Digital Electrometer	1	Ultra high resistance/Micro current measurement
41	Powerscope	1	Number of channel: Isolated 4, 30MHz, differential channels and one 50MHz conventional channel
42	Portable Photometer	1	Range: 0.01 - 19990 lux Display: 4 digit, Detecter: Optical Battery
43	H.V.DC Voltmeter	2	For DC voltage only: max. 30kV, High input impedance: 1000MΩ
44	H.V. AC/DC Voltmeter	2	For DC, AC (50-60Hz) voltage High input impedance: 1000MΩ
45	H.V. DC Transmission Line	1	H.V. DC Transmission Line, Power Station Simulator, Substation Simulator
46	Electrical Parts and Devices		Frequency Meter, DC Meter, Converter, etc.

(4) Department of Instrumentation & Control

No.	Equipment	Number	Reference
47	Arbitrary Waveform Generator	1	Number of channel: 2, Output impedance: 50Ω, Maximum output voltage: 2Vpp
48	Analyzing Recorder	1	Mainframe, Printer, Interface, Memory card
49	Digital Portable calibrator	5	Mainframe, RJC Sensor, Terminal Block
50	Data Acquisition System with Processing Unit	1	Mainframe, Remote scanner connection, Remote Scanner, External Alarms, External alarm interface
51	Digital Manometer	1	Pressure Range: Positive Pressure 0 to 2 Kg/cm^2 Megative Pressure 0 to -1 Kg/cm^2
52	Single Loop Programmable Controller	1	
53	Smart Transmitter & Smart Field Communicator	1	Smart Transmitter5, Field Communicator
54	Ultrasonic Analyzer with Accessories	1	Mainframe, Search Units
55	Electro Myographic Unit	1	Mainframe, Colour Display, Recorder, Stimulators
56	FFT Analyzer	1	FFT Servo Analyzer, Network Analyzer
57	Electronics Measurement Parts and Devices		Voltage/currents Standard Standard Resister, Frequency Counter
58	Sensors		Thermistor Temperature Sensor, Absolute Humidity Sensor, Pressure Transducer, etc.

(5) Department of Civil Engineering

No.	Equipment	Number	Reference
59	Computer Controlled UTM System	1	25 Ton UTM with Hydraulic wedge type grips for testing of compression bending, tension and compression low cycle fatigue test
60	Electronic Digital Theodolite	1	Magnification: 32 x Field of view: 1°30'
61	Automatic Level	1	Magnification: 32 x Field of view: 1°20'
62	Electronic Distance Meter	1	3 Reflecting Prisms
63	Digital Planimeter	1	Measuring range: 3,000 x 300 mm
64	Sound Level Meter	1	Digital Indication
65	Gas Monitor for CO, H_2S, SO_2, Portable	1	Measuring Gas: CO, H_2S, SO_2

(6) Department of Mechanical Engineering

No.	Equipment	Number	Reference
66	X-Y Plotter	1	Plotting Area: ISO A-1 787 mm x 564 mm ISO A-3 403.95 mm x 275 mm Plotting Speed: 450 mm/sec, 400 mm/sec. Resolution : 0.025 mm
67	Digital Thermo Hygrometer	1	
68	Computing Data Logger	1	Total number of input points: 80 Number of measuring point: 40/unit Scan rate: 50 ms/point
69	Fully Automatic compressor	1	Testing method : Direct method specified in JIS B-8606 Measuring Range: 600 - 10,000 kcal/hr. Coolant : Liquid Ammonia
70	3-D Coordinate Measuring Machine	1	Structure : Bridge-Bed Measuring Range: 0.0005 mm Operation : Motor-Drive and Manual Floating Switchable
71	Universal Gear Tester	1	Measuring Range: 350ϕ

4.4 Layout Plan of Equipment

The large and/or heavy equipment which requires foundations for installation is shown in Appendix-7 showing the location of the laboratories and workshops of the individual departments concerned. The experimental equipment, measuring devices and work tools for use on laboratory benches will be stored in the laboratories on the benches or on racks.

4.5 Project Implementation Plan

4.5.1 Implementation Organization

Responsibility for implementation of the Project is with the government College of Engineering PUNE concerned, under the supervision of Education and Employment Department, Technical Education of the State of Maharashtra.

Therefore, procedures involved in consultant contract, contractor contracts, bank agreements and equipment planning and facility planning are to be carried out by the Government College of Engineering PUNE and the tasks involved will be proceeded with under the responsibility guided by Education and Employment Department, Technical Education of the State of Maharashtra.

4.5.2 Implementation Plan

After the Exchange of Notes concerning the Project, the Government College of Engineering PUNE and the selected Japanese consultant will carry out discussions as necessary relating to the implementation planning, tender of bids and delivery of contracted materials, and installation works on the site in accordance with the policies drawn up in the Basic Design.

With regard to the execution plan the consultant will evaluate the following points in conjunction with the Government College of Engineering PUNE and establish appropriate implementation schedule and measures concerning these.

- the scope of work for each country and the timing for commencement of works
- the delivery to site of materials and the installation of equipment
- the designation of technical assistants in Government College of Engineering, PUNE responsible for test operations and adjustments

Further, it is necessary to establish a construction and installation plan to ensure that works are completed smoothly in the scheduled period allotted. This should afford consideration to determining the best time for the dispatch of engineers for the equipment installation and test operation, adjustment works mentioned above.

4.5.3 Scope of Works

The scope of works of Japan will include the provision of the educational equipment, its transportation and delivery to the site, installation including inside piping and wiring, test operation and adjustments after installation, together with consulting works such as the drawing up of tender guidelines and supervision of tenders. The party of India will be responsible for the preparation and execution of the following items.

(1) Supply of the electric power sources and lighting facilities needed for all equipment provided. Further, for the preparation of utilities, including water, fuels, etc.

(2) The preparation of the foundations and emplacements for the equipment which is determined on in accordance with the foundation drawing submitted by the Consultant.

(3) The installation and preparation of experiment benches, racks and lockers which are required in accordance with the layout drawings for the equipment lay out plan.

(4) Procedural work, bearing of expenses, etc.

- Bank commissions

- Submissions to and Approvable from DGTD on an import permission of the product

- Expenses accompanying the procedure for import tax for imported product, and value added tax for local product, etc.

- Expediting measures for customs clearance and for inland transportation

- Coordination of approvals required for all procedures relating to implementation of the Project under control of DGTD and CCIE

- Procedures for tax exemption from taxes and other fiscal duties of India imposed on Japanese personnel engaged in the implementation of the Project in accordance with the agreement that has been approved.

- Privileges for the entry into and the stay in India by the Japanese to conduct the work in accordance with the agreement that has been approved.

- Placement of the staff necessary for the administration and control of the Project under the precisely planned personnel placement plan

4.5.4 Works to be Undertaken by the Indian Government

Cost of the Work to be borne by the Indian Government is estimated as follows, leaving aside necessary undertakings relating to the overall project plan.

Foundation work for equipment	:	6,300	Rupee
Repair and/or modification of buildings and facilities	:	325,400	Rupee
UPS and Voltage Stabilizer	:	206,000	Rupee
Total	:	537,700	Rupee

These should include a installation and finishment of partition, replacement and installation of wire, installation of experimental table, shelf, and locker, and shall be undertaken by the Indian Government.

4.5.5 Implementation Schedule

In the implementation of the Project through a grant aid cooperation of the Japanese Government, the Project shall be executed in three stages after the signing of the Exchange Note by the two countries, comprising the preparation of the design documents, the tender and work contracts, and the erection.

Detail Design	: 3 months,
Equipment Manufacture and Transportation	: 9 months,
Total	: 12 months

(1) Detail design

The tender documents are prepared according to the basic design and are composed of the detailed design drawings, specifications, calculations, estimations of budget, etc. In the detail design stage, after deliberate discussions with the organizations concerned of India, when necessary, the work relating to the tender is conducted with the approval of the final documents. The time required is estimated to be 2 months.

(2) Tender and Evaluation

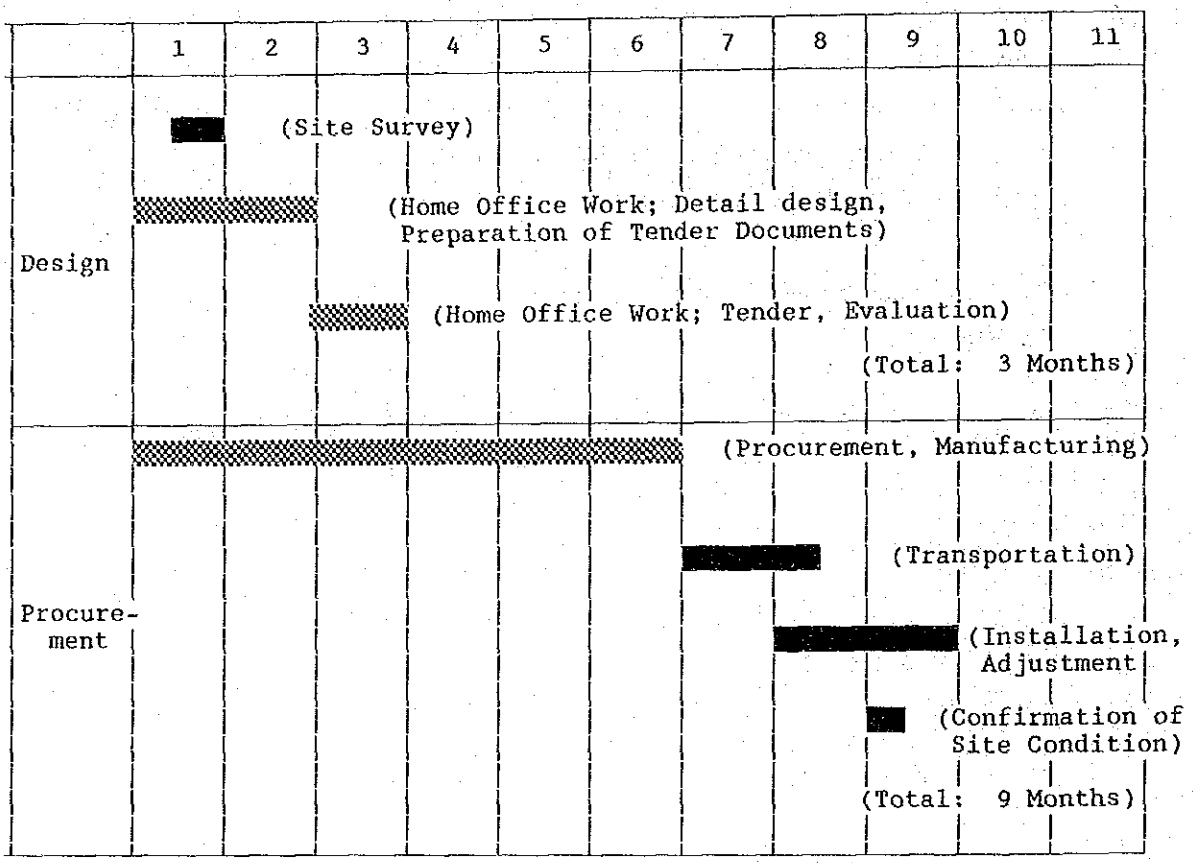
On completion of the work relating to the tender, the pre-qualification screening shall be done in Japan upon public announcement. Based on the results of the screening, the executing body shall invite the companies that participated in the tender, and conduct the bidding in the presence of the parties concerned. The bidder of the lowest price, when the contents of its bid is evaluated to be proper, shall be the successful bidder, and shall enter into a contract with the Indian Government. The period from the tender to the execution of the contract is expected to be 1 month.

(3) Delivery of Equipment

After the signing of the contract, the fabrication of the equipment shall be commenced and the time required for the work on the Project for Providing Equipment for the College of Engineering, PUNE is estimated to be approximately 12 months judging from the size and the facilities of the target departments, assuming that the procurement of the equipment is carried out satisfactorily and the preparatory work within the scope of the Indian side proceeds smoothly.

The overall schedule for the Project is conceived as indicated in Fig. 4-1.

Fig. 4-1 Overall Schedule for the Project for Providing Equipment for Government College of Engineering, PUNE



CHAPTER 5

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

This project was formulated linked to the human resources development and regional development policy of India and aims at upgrading the technical education level of the College of Engineering, Pune which is a regional technical college in India.

The Project is linked to a middle term plan, "the Schemes of Thrust Areas of Technical Education Achievements" of the Ministry of Human Resource Development and aims at expansion of equipment for undergraduate student experiments and for research by master course students in six technological departments of the College in the fields identified in the said Scheme. The improvement of equipment is expected to help the development of the economy and society of Maharashtra State where the College is located. This effect is shown in Table 5-1.

As seen from Table 5-1, the Project is to improve the equipment for student experiments and research at the College of Engineering, Pune in Maharashtra State which is the beneficiary of the Project, and is in line with the education and human resources development policies. The Schemes are also a major target to be achieved in Eighth Five Year Plan.

The implementation body of the maintenance of the Project after the Project has been completed is the Directorate General of Technical Education of the Ministry of Human Resource Development. Judging from the manpower and management ability of the Directorate, the Project will be maintained properly. The Project , as mentioned before, is expected to have a great impact on the improvement of the College and to contribute to the improvement of living conditions of people. For these reasons, it is considered to be appropriate that the Project be supported by the Grant-In-Aid system of the Japanese Government.

Table 5-1 Effect of the Project Implementation and Improvement

Present situation and Issues	Measures to be taken in this Project	Results of the Project, Improvement
1. At present the Directorate General of Technical Education, the Ministry of Human Resources Development is carrying out a programme of "Strengthening of Facilities in Crucial Areas of Technology where Weakness exists" in 10 areas of industrial production process where India's technology lags behind in that of advanced countries. But the quality and quantity of equipment for education and research is not yet satisfactory. Moreover, shortage of teachers in regional universities in advanced technology fields is a matter of concern in India. The main reasons are lack of research equipment and technical information.	1. The Project plans to improve the equipment for undergraduate student experiments and for research by master course students in following six departments ; -Dept. of Electgronics & Communications -Dept. of Metallurgy -Dept. of Electrical Eng. -Dept. of Instrumentation and Control -Dept. of Civil Eng. -Dept. of Mech. Eng.	1. Of 10 areas, seven areas: (1) computer science and technology, (2) electronics, (3) instrumentation, (4) material science, (5) maintenance technology, (6) product development/design and (7) ergonomics will be equipped better and the educational and research environment of the College will be improved. The activities of the teaching staff will be heightened. Dissemination of information will be accelerated.
2. The College under the Directorate General of Technical Education of the Ministry of Human Resources Development provides only few graduates who can work in advanced technology areas which industries need.	2. The project provides the six departments with educational and research equipment necessary for technical education that can produce graduates who can work in advanced technology areas after graduation.	2. Through the improvement of equipment 400 graduates (of which 150 masters) who can meet the requirements of industries will be produced every year and will make significant contribution to the economy and society of India
3. The technical education sector of India is expected to contribute to the national and regional development. However, the present situation of universities is not so attractive to the local industries and communities. Requests for joint research or testing service are few. These are some of the reasons why universities are behind in industrial technology and local industries lack technological development ability.	3. Beside the provision of equipment mentioned above, the project is planning to set up Telematics Center, Material Science Center, and Prototype Development and Design Center after 1992.	3. The equipment to be provided to the six departments is also used for technical support services to regional industries beside for the student experiments and research.

APPENDIX

Appendix-1 MEMBERS OF THE STUDY TEAM

1.1 Basic Design Survey Team (April 4, 1991 - April 24, 1991)

Prof. Masataka ARIYAMA	Team Leader Professor Department of Computer Science and Information Mathematics Faculty of Engineering The University of Electro-Communications
Prof. Hitoshi YASUNAGA	Electronics Engineering Education Professor Department of Electronics Engineering The University of Electro-Communications
Mr. Yuki ARATSU	Project Coordinator Staff, Second Basic Design Study Div. Grant Aid Study and Design Department Japan International Cooperation Agency
Mr. Akira YUKAWA	Expert, Educational and Research Equipment UNICO International Corporation
Mr. Teruo KOBARI	Expert, Electronics Engineering UNICO International Corporation
Mr. Takashi BABA	Expert, Industrial Engineering UNICO International Corporation
Mr. Jun IKEDA	Expert/Layout Plan, Cost Estimation UNICO International Corporation

1.2 Draft Report Explanation Team (July 8, 1991 - July 17, 1991)

Prof. Masataka ARIYAMA	Team Leader Professor Department of Computer Science and Information Mathematics Faculty of Engineering The University of Electro-Communications
Prof. Hitoshi YASUNAGA	Electronics Engineering Education Professor Department of Electronics Engineering The University of Electro-Communications
Mr. Nobuhide SAWAMURA	Project Coordinator Staff, Consultant Contract Division Procurement Department Japan International Cooperation Agency
Mr. Akira YUKAWA	Expert, Educational and Research Equipment UNICO International Corporation
Mr. Teruo KOBARI	Expert, Electronics Engineering UNICO International Corporation

APPENDIX-2 Survey Schedule

2.1 Basic Design Survey Team (April 4, 1991 - April 24, 1991) 1/2

DATE	ROUTE	PLACES OF VISITING	DETAILS OF SURVEY
April 4 (Thu.)	TYO-Delhi(AI-307) Prof. Masataka Ariyama Prof. Hitoshi Yasunaga JICA Mr. Yuki Aratsu Consl't Mr. Akira Yukawa Consl't Mr. Teruo Kobari Consl't Mr. Takashi Baba Consl't Mr. Jun Ikeda		- Travelling -
April 5 (Fri)	Delhi	JICA Embassy of Japan Ministry of Finance Ministry of Human Resource Development (Agency of Technical Education)	Discussion on Policy and Contents of Study Discussion on Schedule
April 6 (Sat.)	Delhi-Bombay(IC-167) Pune		- Travelling -
April 7 (Sun.)	Pune	Automobile Factory	Review of Related Organization
April 8 (Mon.)	Pune	Government College of Engineering, Pune	Study of Outline of the College (Survey of Each Department)
April 9 (Tue.)	Pune	- ditto -	Brief Meeting of JICA Grant Aid System Presentation of Inception Report Brief Meeting for Questionnaire Study of Curriculum
April 10 (Wed.)	Pune	- ditto -	Interim Report Discussion on Next Week's Schedule Discussion on Minutes of Meeting
April 11 (Thu.)	Pune-Delhi(IC-450) Prof. Ariyama Prof. Yasunaga JICA Mr. Aratsu Consl't Mr. Yukawa		- Travelling -
	Pune Consl't Mr. Kobari Consl't Mr. Baba Consl't Mr. Ikeda	C-DAC	Survey of Related Institute
April 12 (Fri.)	Delhi Prof. Masataka Ariyama Prof. Hitoshi Yasunaga JICA Mr. Yuki Aratsu Consl't Mr. Akira Yukawa Pune Consl't Mr. Teruo Kobari Consl't Mr. Takashi Baba Consl't Mr. June Ikeda	JICA Embassy of Japan Ministry of Finance Ministry of Human Resource Development Government College of Engineering, Pune	Reporting Presentation of JICA Grant Scheme Discussion on Equipment List
April 13 (Sat.)	Delhi-BKK(IC-316) Prof. Masataka Ariyama Prof. Hitoshi Yasunaga JICA Mr. Yuki Aratsu Delhi-Pune(IC-499) Consl't Mr. Akira Yukawa Pune Consl't Mr. Teruo Kobari Consl't Mr. Takashi Baba Consl't Mr. June Ikeda	- ditto -	Collection of Information Study of Laboratory

DATE	ROUTE	VISITING PLACES	DETAILS OF SURVEY
April 14 (Sun.)	Pune	- ditto -	Team Meeting
April 15 (Mon.)	- ditto -	- ditto -	Study of Requested Equipment (Instrumentation and Control, Metallurgy, Workshop, Town Planning)
April 16 (Tue.)	- ditto -	- ditto -	Study of Requested Equipment Study of Layout Plan
April 17 (Wed.)	- ditto - Pune - Bombay	- ditto -	Study of Requested Equipment - Travelling -
April 18 (Thu.)	Bombay Bombay - Pune	Agency of Technical Education of Maharashtra State Directorate General of Technical Development Indian Institute of Technology (Bombay)	Study of Related Institute Collection of Information - Travelling -
April 19 (Fri.)	Pune	Government College of Engineering, Pune	Discussion and Confirmation of Equipment List
April 20 (Sat.)	Pune Pune - Delhi	- ditto -	Discussion on Memorandum Discussion on Building Modification Survey of Library, Sub-Station - Travelling -
April 21 (Sun.)	Delhi	- ditto -	Team Meeting Collection of Information
April 22 (Mon.)	- ditto -	JICA Embassy of Japan Delhi Institute of Technology HCL Limited	Reporting Survey of Relatioed Institute
April 23 (Tue.)	Delhi Delhi - BKK(AF-180) BKK(JL-718) -		Collection of Information - Travelling -
April 24 (Wed.)	- TYO(JL-718)		- Travelling -

2.2 Draft Report Explanation Team (July 8, 1991 - July 17, 1991)

DATE	ROUTE	VISITING PLACES	DETAILS OF SURVEY
July 8 (Mon.)	TYO(JL 717) - BKK(AF175) - DELHI Prof. Masataka Ariyama Prof. Hitoshi Yasunaga JICA Nobuhide Sawamura Consl't Mr. Akira Yukawa Consl't Mr. Teruo Kobari		- Travelling -
July 9 (Tue.)	Delhi Delhi(IC 449) - Pune	JICA Embassy of Japan Ministry of Finance Ministry of Human Resource Development (Agency of Technical Education)	Discussion on the Report - Travelling -
July 10 (Wed.)	Pune Pune - Bombay Prof. Masataka Ariyama Prof. Hitoshi Yasunaga JICA Nobuhide Sawamura	Government College of Engineering, Pune	Explanation on the Draft Report and Discussion on the Selected Equipment - Travelling -
July 11 (Thu.)	Bombay Pune Bombay - Pune	IIT's Bombay Government College of Engineering, Pune	Survey of IIT's Bombay Discussion on the Equipment - Travelling -
July 12 (Fri.)	Pune	Government College of Engineering, Pune	Discussion on Minutes of Meeting and the Equipment
July 13 (Sat.)	Pune Pune(IC 450) - Delhi	- ditto -	Discussion on the Specification of the Equipment - Travelling -
July 14 (Sun.)	Delhi		Team Meeting
July 15 (Mon.)	Delhi	JICA Embassy of Japan Ministry of Fiance Ministry of Human Resource Development	Reporting
July 16 (Tue.)	Delhi Delhi(AI 302) -	JICA	Reporting - Travelling -
July 17 (Wed.)	- TYO		- Travelling -

Appendix-3 Minutes of Discussion

3.1 Basic Design Survey (April 4, 1991 - April 24, 1991)

MINUTES OF DISCUSSIONS ON THE PROJECT FOR PROVIDING EQUIPMENT FOR THE GOVERNMENT COLLEGE OF ENGINEERING PUNE IN INDIA

In response to the request of the Government of India, the Government of Japan decided to conduct a basic design study on the project for providing equipment for the Government College of Engineering PUNE (hereinafter referred to as COEP) and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA"). JICA sent to India the basic design study team for 21 days from 4th April to 24th April, 1991.

The team had a series of discussions and exchanged views with the authorities concerned of the Government of India.

As a result of the study and discussions, both parties agreed to recommend to their respective Government that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Pune, 11th April, 1991

Mr. Masataka Ariyama
Team Leader
JICA Study Team

Dr.K.R.Satyanarayan
Principal
College of Engineeing,Pune

ATTACHMENT

1. The objective of the Project is to enhance the quality of engineering education and research activity of the COEP through the supply of necessary equipment.

2. Major equipment requested by Indian authorities concerned are listed in Annex 1.

3. Equipment to be provided by the Japanese Aid shall be allocated to the Phase I which is a first phase of the COEP's upgrading program of the educational and research.

4. The sites of the Project are located at College of Engineering, Pune of Maharashtra as shown in Annex II.

5. Principal of COEP is responsible for the administration and execution of the Project.

6. The Indian authorities concerned have understood Japan's Grant Aid System explained by the Study Team.

7. The Indian authorities concerned will take necessary measures listed in Annex III, on condition that the grant aid by the Government of Japan is extended to the Project.

Annex I REQUESTED EQUIPMENT

a. Equipment for Material Engineering

b. Equipment for Electronics and Communication Engineering

c. Equipment for Computer Engineering

d. Equipment for Instrumentation and Control

e. Equipment for Mechanical Engineering

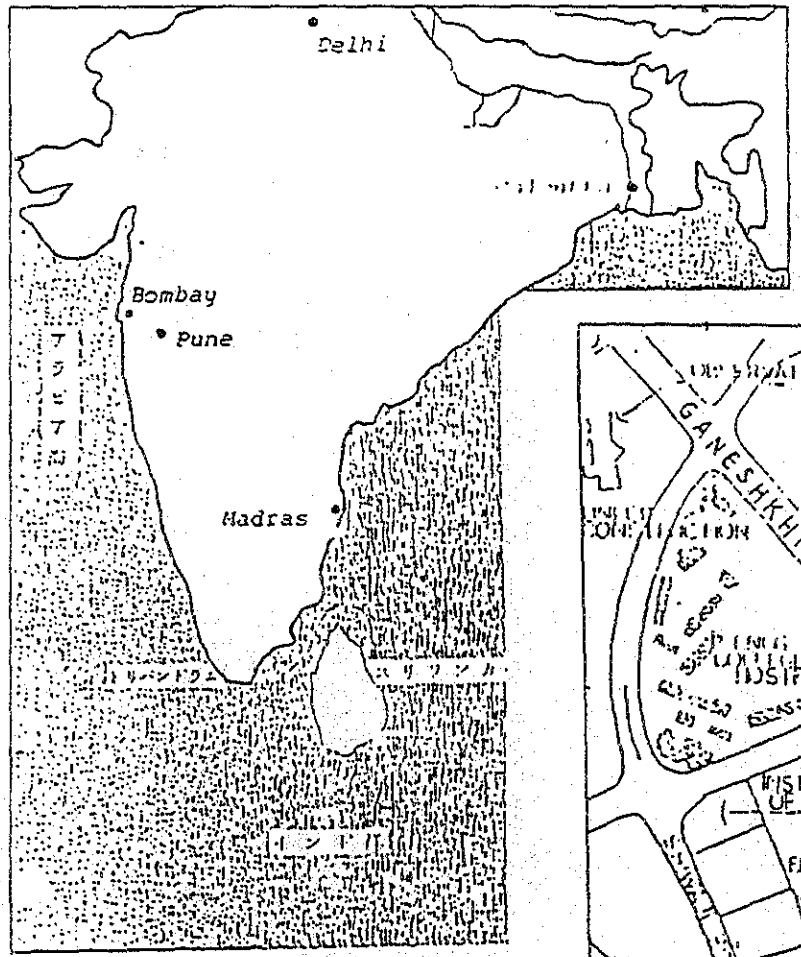
f. Equipment for Civil and Engineering and Applied Mechanics

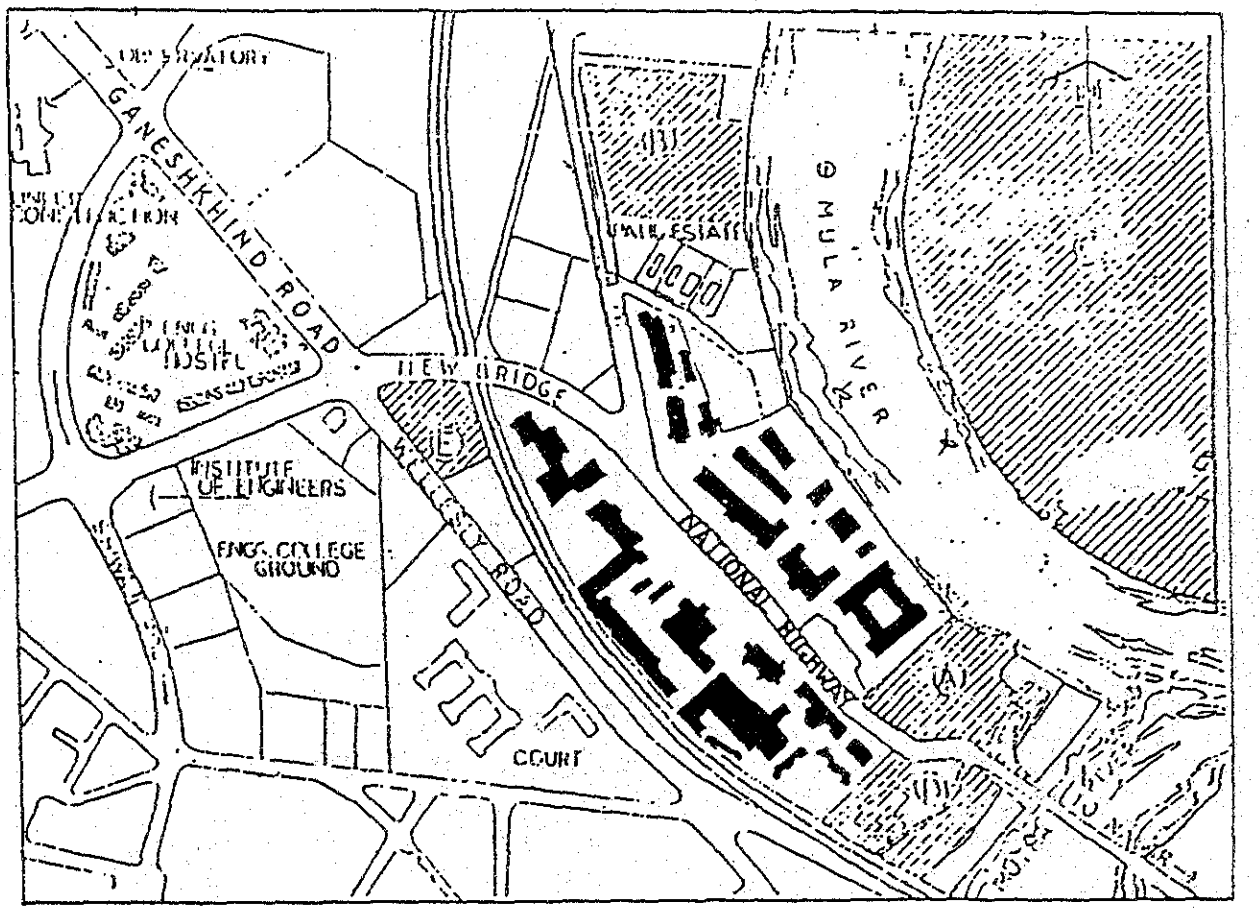
g. Equipment for Electrical Engineering

h. Equipment for Workshop Engineering

Annex II

The sites of the project





Annex III

Following arrangements are requested to be taken by the Government of the India, on condition that the grant aid by the government of Japan is extended to the Project.

1. To ensure prompt unloading, tax exemption, customs clearance at ports of disembarkation in India, and prompt internal transportation therein of equipment purchased under the grant.

2. To exempt Japanese nationals engaged in the Project from customs duties, internal tax, and other fiscal levies which may be imposed in India with respect to the supply of equipment and the services under the verified contracts.

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

4. To bear all the expenses other than those to be borne by the Grant, necessary for the execution of the Project.

5. To maintain and use properly and effectively the equipment purchased under the Grant.

3.2 Draft Report Explanation (July 8, 1991 - July 17, 1991)

MINUTES OF DISCUSSION

ON

THE PROJECT FOR PROVIDING THE EQUIPMENT FOR

THE GOVERNMENT COLLEGE OF ENGINEERING, PUNE.

In response to the request of the Government of India for providing the equipment for the Government College of Engineering, Pune, the Government of Japan decided to conduct a basic design study and entrusted the study to the Japan International Cooperation Agency. Japan International Cooperation Agency sent to India the basic design study team headed by Professor Masataka Ariyama from 4th April to 24th April 1991.

As a result of the study, Japan International Cooperation Agency prepared a Draft Final Report and dispatched a team to explain and discuss the Report from 8th to 17th July 1991.

The team and the Indian authorities concerned had a series of discussions on the Report and both parties have agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Pune, 12th July 1991

Masataka Ariyama

Prof. Masataka Ariyama,
Team Leader,
JICA Study Team.

Dr K. R. Satyanarayan,
Principal,
College of Engineering, PUNE

1. The Indian side principally agreed to the basic design proposed in the Draft Final Report.

2. The Indian side understood the Japanese Grant Aid System and confirmed that the necessary arrangement would be taken by the Indian side which was manifested in the minutes of discussions on the Project for Providing the Equipment for the Government College of Engineering, Pune (hereinafter referred to as the Project) signed on 11th April 1991, on condition that the Grant Aid by the Government of Japan would be extended to the Government College of Engineering, Pune.

3. Indian side basically accepted the equipment allocation to the target Departments, but requested the team a further consideration of provision of equipment which was deleted in the proposal for the Department of Metallurgy, Department of Civil Engineering, and Department of Mechanical Engineering.

4. In connection with the above, it was agreed that a change of specification and / or deletion of some equipment proposed should be elaborated to meet the requirement of the College.

5. Indian side confirmed that there is no change in the upgrading plan of the College including procurement of necessary equipment by the College itself, modification, expansion and construction of building needed to realize the Project.

6. In case the total budget is not enough to provide each target department with all equipment requested and approved, selection of equipment, together with priority of order was decided and accepted in consideration of the specific laboratories to be strengthened.

7. Indian side suggested that the final scrutiny of specifications of equipment and approval will be done in Japan by representatives of this College in view of the nature of equipment.

APPENDIX-4 List of Persons Interviewed

1. Ministry of Human Resource Development

• Joint Educational Advisor (Technical)	Prof. S. K. Shrivastava
• Joint Educational Advisor (Technical)	Mr. I. B. Sangal
• Assistant Educational Adviser	Mr. R. N. Panda
• Section Officer	Mr. C. P. Aggavwal

2. Department of Economic Affairs, Ministry of Finance

• Joint Secretary	Mr. D. Subbarao
• Director	Mr. Anupam Kulshrestha
• Under Secretary	Mrs. Sunita Chhibba

3. Maharashtra State

• Principal Secretary	Mr. S. R. Kakodkar
• Director of Technical Education	B. B. Chopane
• Additional Industrial Advisor Directorate General of Technical Development (Regional Office)	Mr. V. Seshadri
• Engineering Staff	Mr. R. K. Agarwal
• Deputy Director of Technical Education	Mr. P. K. Patil

4. Government College of Engineering, Pune

• Principal	Prof. K. R. Satyanarayan
• Head, Department of Electronics and Telecommunication	Prof. K. S. Jog
• Prof. of Electronics	Prof. V. K. Kokate
• Head, Department of Metallurgy	Prof. D. Chaudhary

• Head, Department of Electrical Engineering	Prof. D. J. Doke
• Prof. Department of Workshop	Prof. P. P. Chikte
• Head, Department of Instrumentation and Control	Prof. B. S. Patil
• Assistant Prof. Department of Instrumentation and Control	Prof. C. P. Gadgil
• Head, Department of Applied Mechanics	Prof. S. N. Deshpande
• Prof. Department of Applied Mechanics	Prof. S. B. Bonde
Prof. Department of Civil Engineering	Prof. P. N. Vipat
• Assistant Prof. Department of Civil Engineering	Prof. P. P. Vitkar
• Prof. Department of Town Planning	Prof. G. K. Kanhere
• Head, Department of Mechanical Engineering	Prof. B. M. Domkundwar
• Prof. Department of Mechanical Engineering	Prof. H. N. Sawant

5. Other Related Organizations and Institutions

5.1 Indian Institute of Technology, Bombay

• Director	Prof. B. Nag
• Deputy Director	Prof. Kudchedkar
• Head, Department of Mechanical Engineering	Prof. C. Amar Nath

5.2 Government College of Engineering, Delhi

• Head, Department of Production, and Industrial Engineering	Prof. Rajnish Prakash
• Head, Department of Education	Prof. M. Paldas

5.3 Center for Development of Advanced Computing

• Director	Prof. S. N. Bhavsar
• Senior Staff	Prof. Ashok Joshi
HCL Limited, Country Sales Manager	Mr. Dilip Bhargava

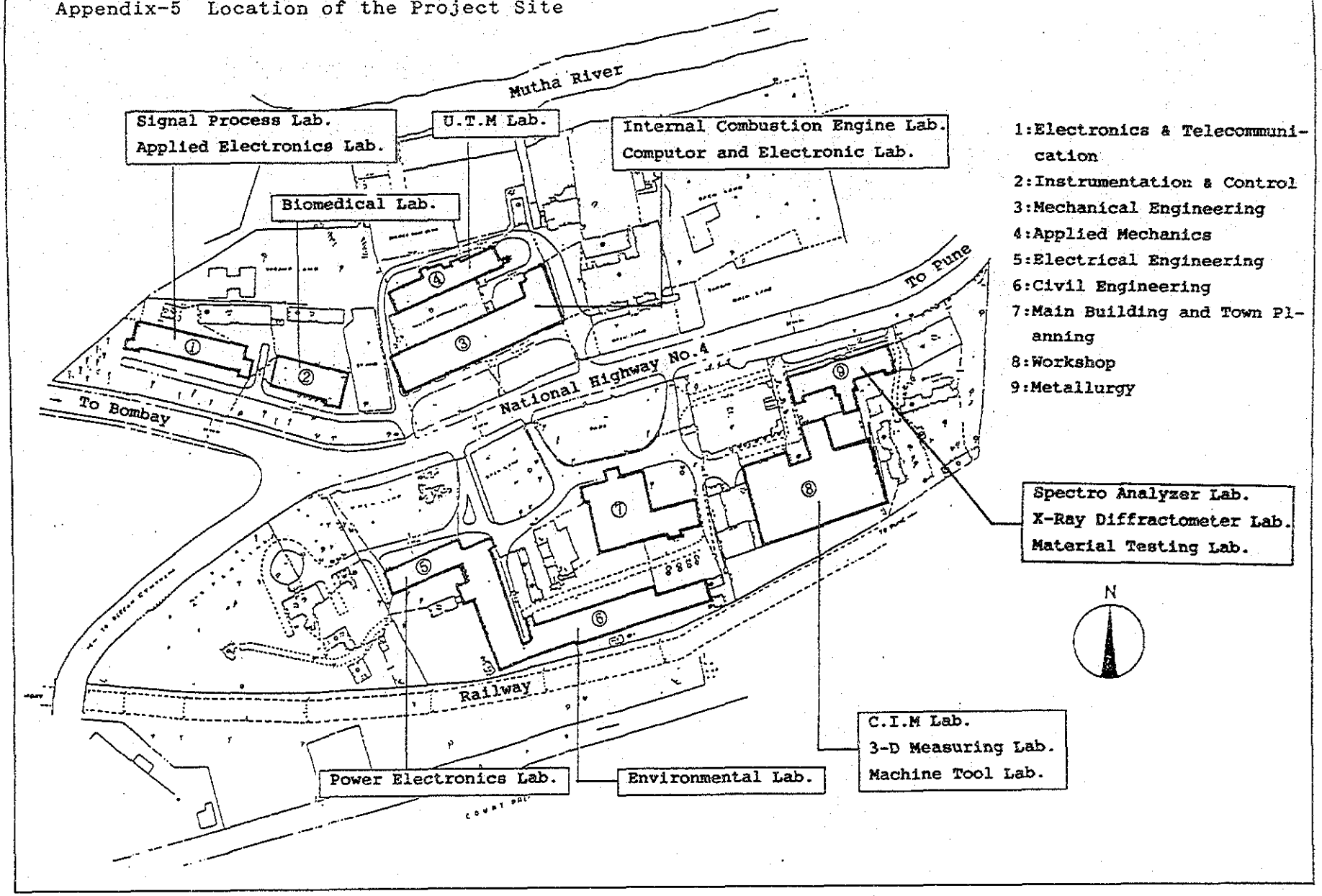
6. Embassy of Japan First Secretary

• First Secretary	Katsutoshi Hama

7. JICA India Office

• President of JICA India Office	Toshio Hida
• Deputy President Representative	Toshifumi Sakai
• Staff of JICA	Sanae Toyoda

Appendix-5 Location of the Project Site



Appendix-6 List of Equipment Proposed to COEP

1. Department of Electronics & Telecommunication

1	Field Strength meter
2	Standard Dipole Antenna Set
3	Electronic Counter
4	Modulation Analyser
5	Radio Communication Analyser
6	Microwave Power Meter
7	Microwave Sources
8	Spectrum Analyser
9	Network Analyser
10	Scalar Network Analyser
11	Optical fibre Communication Test Set Up
12	Logic Analyser
13	EMI Test System
14	Waveform Synthesizer
15	Video Signal Processing Equipment
16	Electronics Parts and Devices
17	Standard Equipment

2. Department of Metallurgy

18	Fatigue Testing Machine
19	Hisomet Microscope
20	Microhardness Tester
21	Vacuum Emission Spectrometer
22	Auto Sonohard Ultrasonic Hardness Tester
23	X-ray Stress Analyser
24	Induction Remelting Unit
25	Carbon Sulphur Analyzer

3. Department of Electrical Engineering

26 Self Education Robotic Trainer

27 Power Line Multitransducer

28 Multichannel Voltage & Current Source

29 Isolated Probe System

30 Digital Power Meter

31 Electronic Hybrid Meter

32 Analyzing Recorder with Colour Plotter

33 Digital Multimeter

34 Digital Oscilloscope

35 Digital Indicating Controller

36 Analogue Oscilloscope

37 Digital Memory

38 Fast Transient Digitizer

39 High Resolution, High Accuracy DMM

40 Digital Electrometer

41 Powerscope

42 Portable Photometer

43 H. V. DC Voltmeter

44 H. V. AC/DC Voltmeter

45 HVDC Transmission Line Simulator

46 Electrical Parts and Devices

4. Department of Instrumentation & Control

47 Arbitrary Waveform Generator

48 Analyzing Recorder

49 Digital Portable Calibrator

50 Data Acquisition System with Processing Unit

51 Digital Manometer

52 Single Loop Programmable Controller

53 Smart Transmitter & Smart Field Communicator

54 Ultrasonic Analyser with Accessories

55 Electro Myographic Unit

56 FFT Analyzer

57 Electronics Measurement Parts and Devices

58 Sensors

5. Department of Civil Engineering

59 Computer Controlled UTM System

60 Electronic Digital Theodolite

61 Automatic Level

62 Electronic Distance Meter

63 Digital Planimeter

64 Sound Level Meter

65 Gas Monitor for CO, H_2S, SO_2 Portable

6. Department of Mechanical Engineering

66 X-Y Plotter

67 Digital Thermo Hygrometer

68 Computing Data Logger

69 Fully Automatic Compressor Testing System

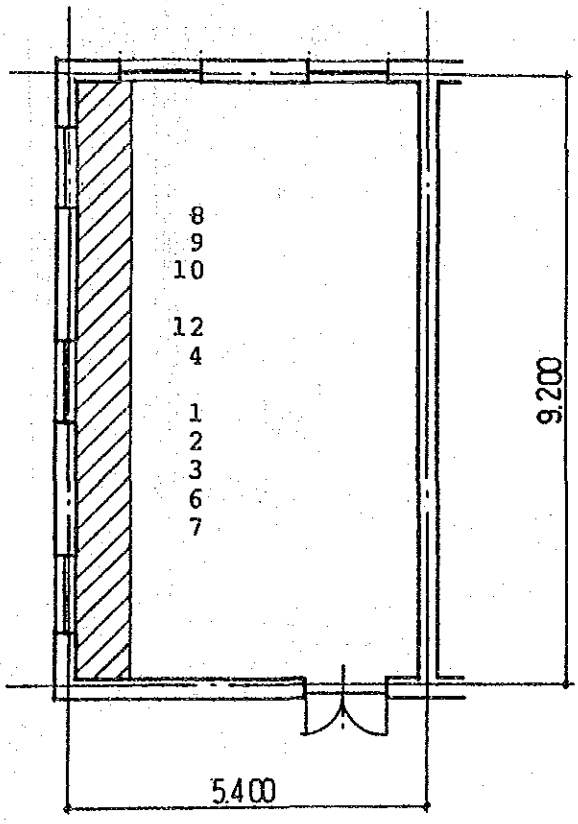
70 3-D Coordinate Measuring Machine

71 Universal Gear Tester

Appendix-7 Layout Plan of Equipment

(1) Electronics & Telecommunication

1:Applied Electronics Lab.

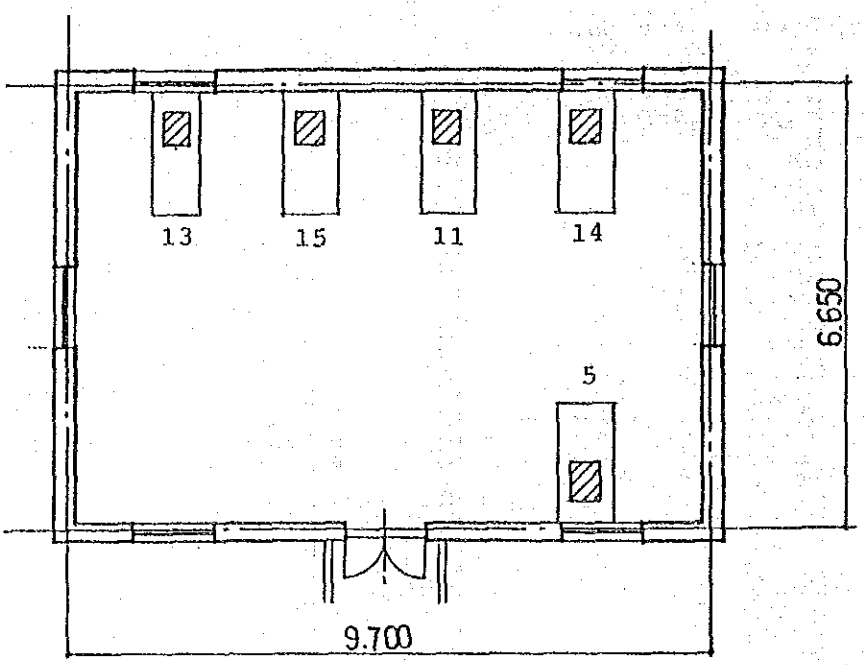


8 Spectrum Analyzer
9 Network Analyzer
10 Scalar Network Analyzer

12 Logic Analyzer
4 Modulation Analyzer

1 Field Strength Meter
2 Standard Dipole Antenna
3 Electronic Counter
6 Microwave Power Meter
7 Microwave Sources

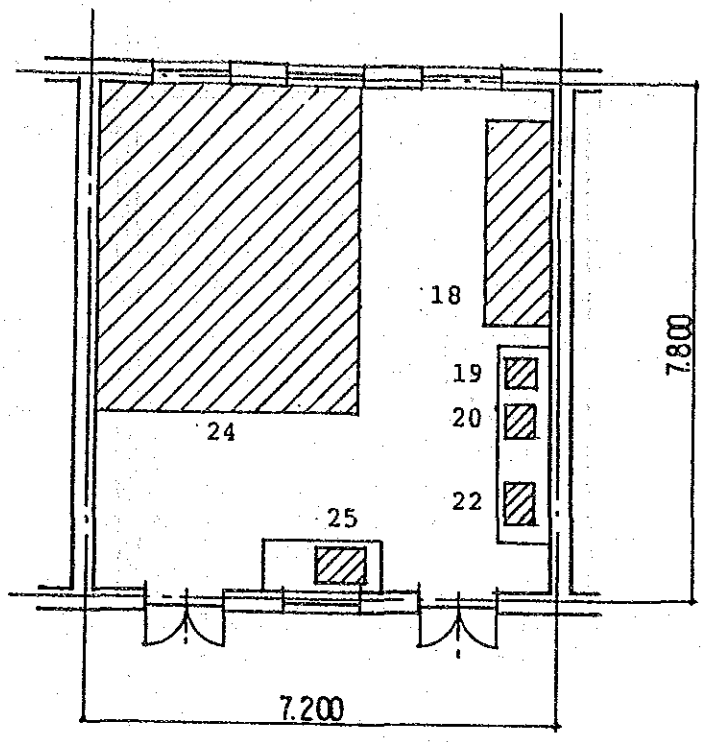
2:Signal Process Lab.



15 Video Signal Processing Equipment
13 EMI Test System
5 Radio Communication Analyzer
11 Optical Fibre Communication Test Set Up
14 Waveform Synthesizer

(2) Metallurgy

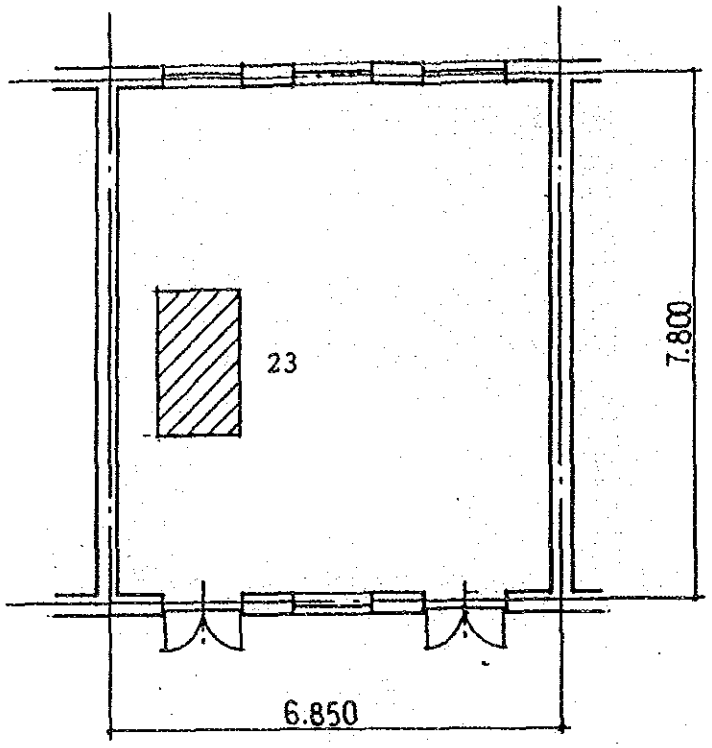
1:Material Testing Lab.



18 Fatigue Testing Machine
19 Hisomet Microscope
24 Inductgion Remelting Unit

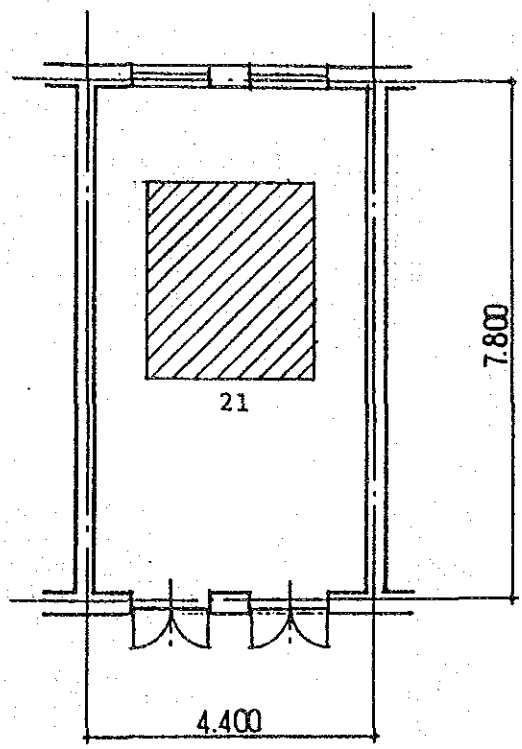
20 Microhardness Tester
22 Auto Sonohard Ultrasonic
Hardness Tester
25 Carbon Sulphur Analyzer

2:X-Ray Diffractometer Lab.



23 X-Ray Stress Analyzer

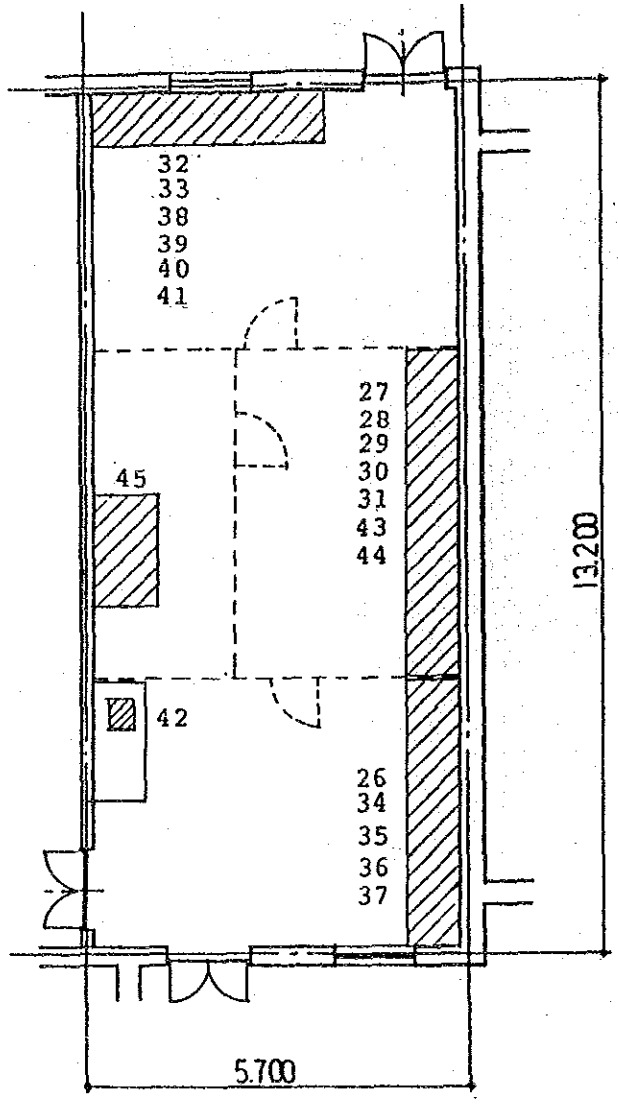
3:Spectro Analyzer Lab.



21 Vacuum Emission Spectrometer

(3) Electrical Engineering

1:Power Electronics Lab.

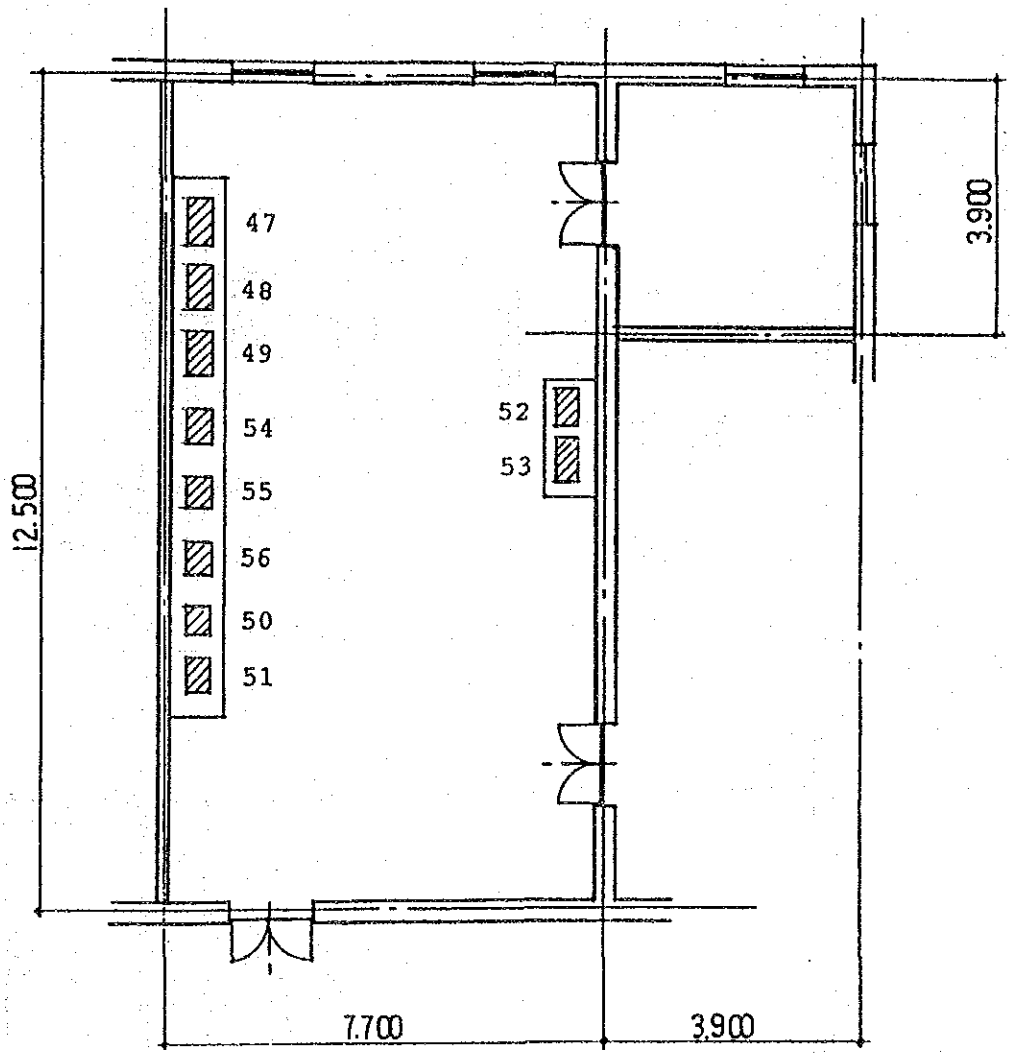


27 Power Line Multitransducer
28 Multichannel Voltage & Current Source
29 Isolated Probe System
30 Digital Power Meter
31 Electronic Hybrid Meter
43 H.V. DC Voltmeter
44 H.V. DC Voltmeter
45 H.V. AC/DC Voltmeter

32 Analyzing Recorder with Color Plotter
33 Digital Multimeter
38 Fast Transient Digitizer
39 High Resolution, High Accuracy DMM
40 Digital Electrometer
41 Powerscope
26 Self Education Robotic Trainer
34 Digital Oscilloscope
35 Digital Indicating Controller
36 Analogue Oscilloscope
37 Digital Memory
42 Portable Photometer

(4) Instrumentation & Control

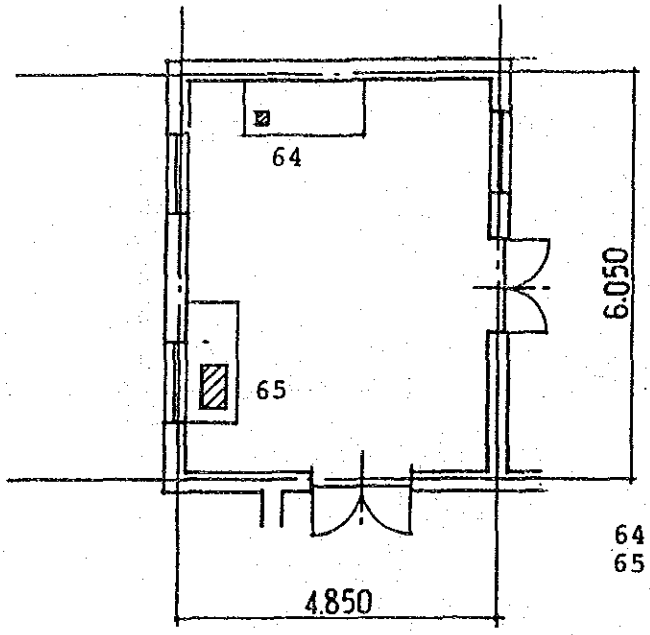
1:Biomedical Lab.



47 Arbitrary Waveform Generator
48 Analyzing Recorder
49 Digital Portable Calibrator
54 Ultrasonic Analyzer with Accessories
55 Electro Myographic Unit
56 FFT Analyzer
52 Single Loop Programmable Controller
53 Smart Transmitter & Smart Field Communicator
50 Data Aquisition System with Processing Unit
51 Digital Manometer

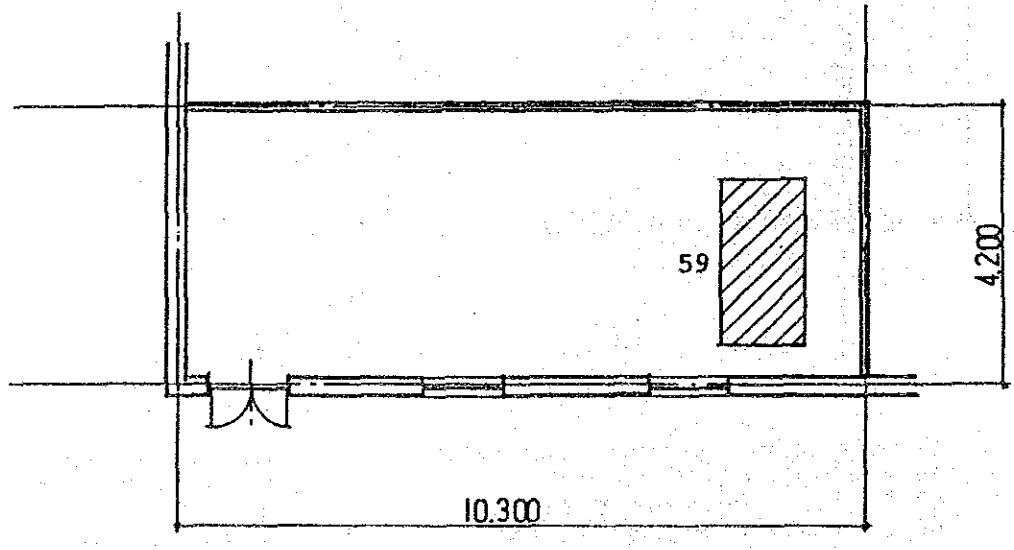
(5) Civil Engineering

1:Environmental Lab.



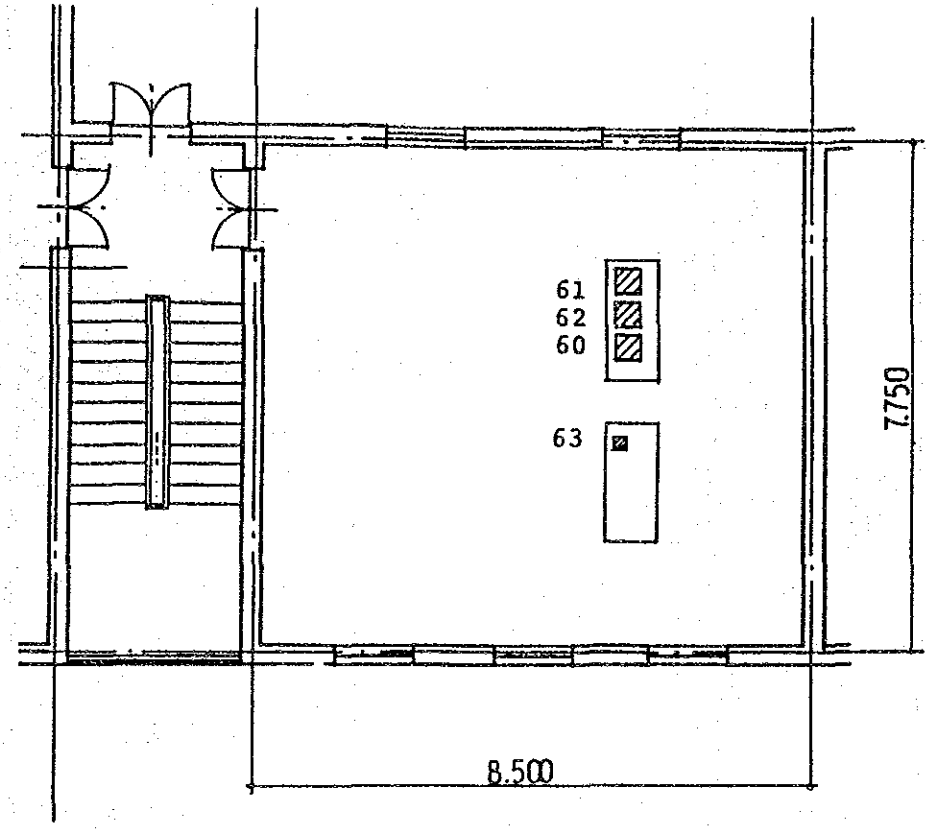
64 Sound Level Meter
65 Gas Monitor for CO, H_2S, SO_2 Portable

2:U.T.M Lab.



59 Computer Controlled UTM System

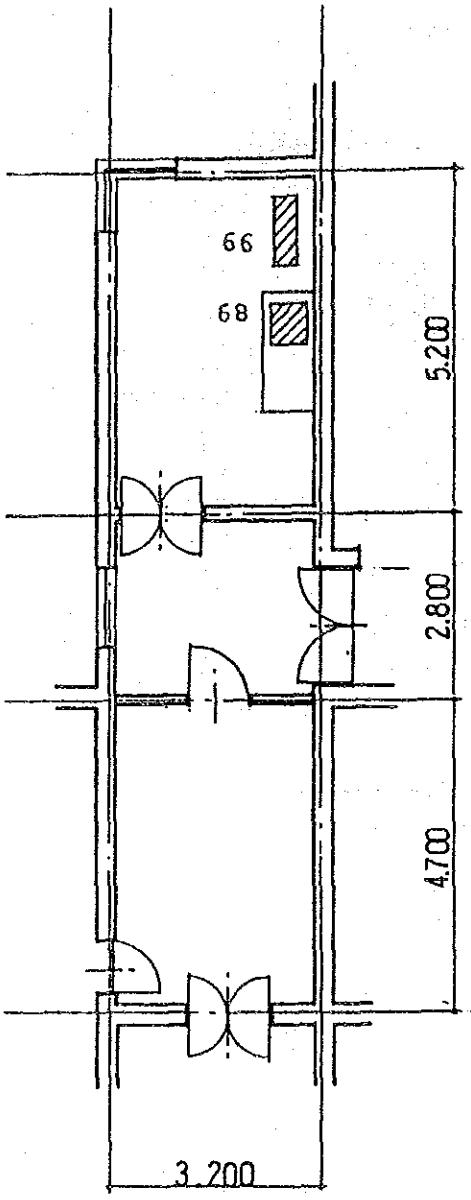
3.Survey Lab.



61 Automatic Level
62 Electronic Distance Meter
60 Electronic Digital Theodolite
63 Digital Planimeter

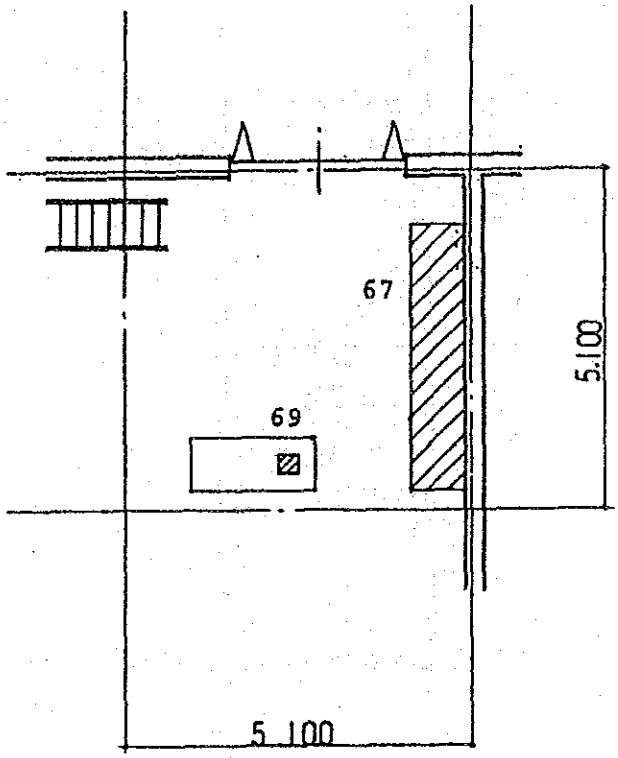
(6)-1 Mechanical Engineering

1:Computor and Electronic Lab.



66 X-Y Plotter
68 Computing Data Logger

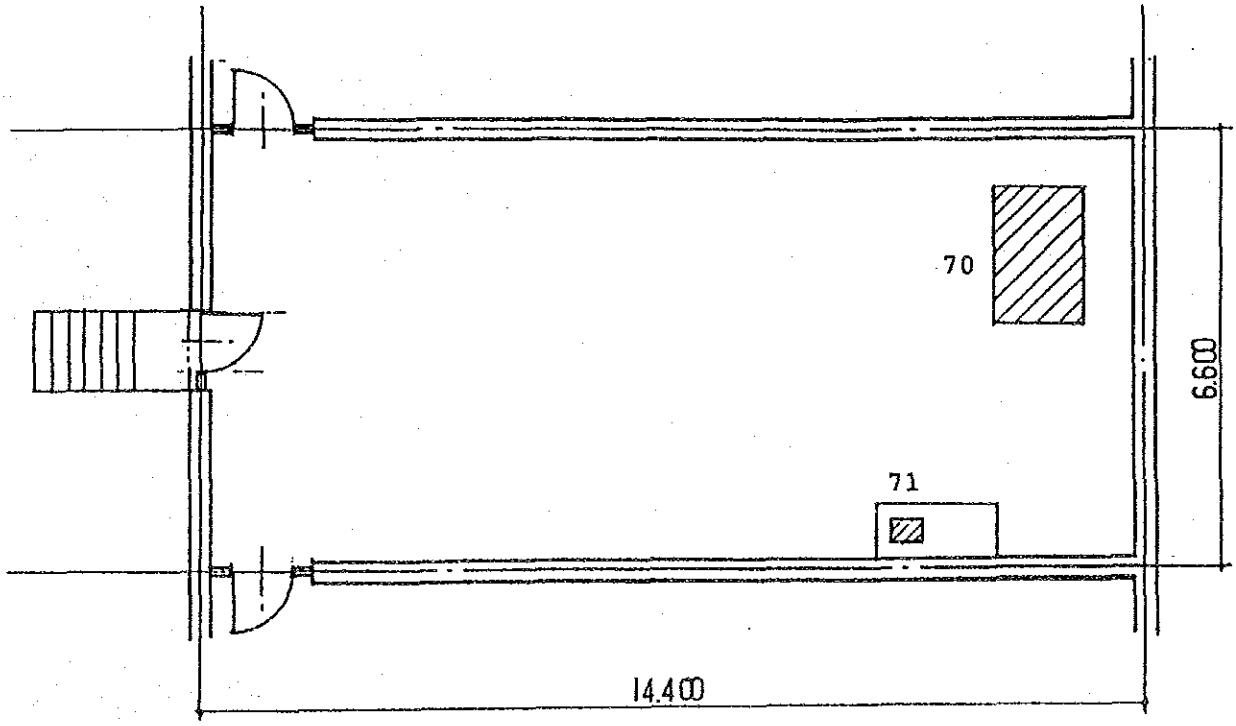
2:Internal Combustion Engine Lab.



67 Digital Thermo Hygrometer
69 Fully Automatic Compressor

(6)-2 Mechanical Engineering(Workshop)

1:Measuring Lab.



70 3-D Coordinate Measuring Machine
71 Universal Gear Tester

Appendix-8 List of Present Curriculums

Syllabus for Bachelor of Engineering

(Electronics & Telecommunication)

		Lecture	Practical (Hours/Week)	Draught
Syllabus for First Year				
First Semester	1. Engineering Mathematics-I	4	2	–
	2. Applied Science-I	4	2	–
	3. Elements of Mechanical Engineering	4	2	–
	4. Elements of Electrical Engineering	4	2	–
	5. Computer Fundamentals	2	2	–
	6. Workshop Practice	–	4	–
	Total	18	12	–
Second Semester	1. Workshop Practice	–	2	–
	2. Engineering Mathematics-II	4	–	–
	3. Applied Science-II	4	2	–
	4. Engineering Mechanics	4	2	–
	5. Elements of Civil Engineering	4	2	–
	6. Engineering Graphics	2	–	4
	Total	18	8	4
Syllabus for Second Year				
First Semester	1. Engineering Mathematics-III	5	–	–
	2. Workshop Processes	1	2	–
	3. Electron Devices & Circuits I	5	–	–
	4. Network & Lines	5	–	–
	5. Computational Methods	5	2	–
	6. Electronics & Communication Engineering Practice-I	–	4	–
	Total	21	8	–
Second Semester	1. Electron Devices & Circuits-II	5	–	–
	2. Electronic Instrumentation	4	–	–
	3. Electrical Circuits & Machines	4	2	–
	4. Components & Devices Technology	4	–	–
	5. Digital Electronics	5	2	–
	6. Electronics and Communications Engineering Practice-II	–	4	–
	Total	22	8	–
Syllabus for Third Year				
First Semester	1. Network Analysis & Synthesis	5	–	–
	2. Feedback Control Systems	4	2	–
	3. Signal Conditioning & Data Conversion	4	–	–
	4. Microprocessor Techniques	4	2	–
	5. Electronics Design-I	2	4	–
	6. Electronics & Communications Engineering Practice-III	–	4	–
	Total	19	12	–
Second Semester	1. Industrial Management	4	–	–
	2. Electromagnetic Engineering	4	–	–
	3. Communication Systems-I	4	–	–
	4. Electronic Design-I	2	2	–
	5. Power Electronics	4	–	–
	6. Microprocessor Interfacing & Peripherals	4	2	–
	7. Computer Aided Manufacturing	–	2	–
	8. Electronics and Communication Engineering Practice-IV	–	4	–
	Total	22	10	–
Syllabus for Final Year				
First Semester	1. Elective-I	4	2	–
	2. Communication Systems-II	4	–	–
	3. Radiation & Microwave Techniques	4	–	–
	4. Computer Systems	4	–	–
	5. Digital Signal Processing	4	–	–
	6. Electronic Design-II	2	2	–
	7. Electronics & Communication Engineering Practice-V	–	4	–
	8. Project Work	–	2	–
	Total	22	10	–
Second Semester	1. Elective-II	4	2	–
	2. Telematics	4	–	–
	3. Consumer Electronics	4	–	–
	4. Electronic Measurement	4	–	–
	5. Electronics & Communication Engineering Practice-VI	–	4	–
	6. Project Work	–	4	–
	Total	16	10	–
Elective I	1. Advanced Power Electronics			
	2. Microprocessor Based System Design			
	3. Television Engineering			
Elective II	1. Fibre Optic Communication			
	2. Microwave and Radar Engineering			
	3. System Programming			

Syllabus for Bachelor of Engineering

(Metallurgy)

		Lecture	Practical (Hours/Week)	Draught
Syllabus for First Year				
First Semester	1. Engineering Mathematics-I	4	2	–
	2. Applied Science-I	4	2	–
	3. Elements of Mechanical Engineering	4	2	–
	4. Elements of Electrical Engineering	4	2	–
	5. Computer Fundamentals	2	2	–
	6. Workshop Practice	–	4	–
	Total	18	12	–
Second Semester	1. Workshop Practice	–	2	–
	2. Engineering Mathematics-II	4	–	–
	3. Applied Science-II	4	2	–
	4. Engineering Mechanics	4	2	–
	5. Elements of Civil Engineering	4	2	–
	6. Engineering Graphics	2	–	4
	Total	18	8	4
Syllabus for Second Year				
First Semester	1. Mechanical Engineering-I	4	2	–
	2. Engineering Mathematics-III	5	–	–
	3. Electronic Principles	4	2	–
	4. Elements of Metallurgy	4	–	–
	5. Material Testing	2	–	–
	6. Metallurgy Laboratory Practice-I	1	6	–
	Total	20	10	–
Second Semester	1. Electricals Machines & Energy Utilisation	4	2	–
	2. Mechanical Engineering-II	4	2	–
	3. Material Testing	2	–	–
	4. Metallurgical Manufacturing Processes-I	4	–	–
	5. Physical Metallurgy	4	2	–
	6. Metallurgy Laboratory Practice-II	–	6	–
	Total	18	12	–
Syllabus for Third Year				
First Semester	1. Introduction to Machine Tools Metrology, Jigs & Fixtures	2	2	–
	2. Mechanical Engineering-III	4	2	–
	3. Metallurgical Thermodynamics	5	–	–
	4. Engineering Materials Technology	4	–	–
	5. Unit Operations in Metallurgy	4	–	–
	6. Metallurgy Laboratory Practice-III	1	6	–
	Total	20	10	–
Second Semester	1. Introduction to Machine Tools Metrology, Jigs and Fixtures	2	2	–
	2. Microprocessor Applications	4	2	–
	3. Experimental Techniques in Metallurgy	4	–	–
	4. Computer Applications in Metallurgy	4	4	–
	5. Technical Control and Management	4	–	–
	6. Metallurgy Laboratory Practice-IV	1	4	–
	Total	19	12	–
Syllabus for Final Year				
First Semester	1. Elective-I	4	2	–
	2. Principles of Metal Casting	4	–	–
	3. Ferrous Metallurgy	4	–	–
	4. Furnace Technology	2	–	–
	5. Structural Metallurgy	4	–	–
	6. Metallurgical Drawing and Design	1	–	2
	7. Metallurgy Laboratory Practice-V	1	6	–
	8. Project Work	–	2	–
	Total	20	10	2
Second Semester	1. Elective-II	4	–	–
	2. Furnace Technology	2	–	–
	3. Selections of Materials and Failure Analysis	4	2	–
	4. Metallurgical Manufacturing Processes-II	4	–	–
	5. Metallurgical Drawing and Design	–	–	4
	6. Metallurgy Laboratory Practice-VI	1	4	–
	7. Project Work	–	6	–
	Total	15	12	4
Elective I	1. Heat Treatment Technology			
	2. Corrosion and Corrosion Control			
	3. Energy Resources & Applications			
	4. Processes of Ore Formation			
Elective II	1. Modern Materials Technology			
	2. Powder Technology			
	3. Composite Materials			
	4. Metallurgy and Science of Welding			

Syllabus for Bachelor of Engineering

(Electrical Engineering)

		Lecture	Practical (Hours/Week)	Draught
Syllabus for First Year				
First Semester	1. Engineering Mathematics-I	4	2	–
	2. Applied Science-I	4	2	–
	3. Elements of Mechanical Engineering	4	2	–
	4. Elements of Electrical Engineering	4	2	–
	5. Computer Fundamentals	2	2	–
	6. Workshop Practice	–	4	–
	Total	18	12	–
Second Semester	1. Workshop Practice	–	2	–
	2. Engineering Mathematics-II	4	–	–
	3. Applied Science-II	4	2	–
	4. Engineering Mechanics	4	2	–
	5. Elements of Civil Engineering	4	2	–
	6. Engineering Graphics	2	–	4
	Total	18	8	4
Syllabus for Second Year				
First Semester	1. Engineering Mathematics-III	5	–	–
	2. Applied Thermodynamics (Electrical)	4	2	–
	3. A. C. Circuits & Transformers	5	2	–
	4. Electrical Engineering Materials	4	2	–
	5. Workshop Technology & Manufacturing Processes	2	4	–
	Total	20	10	–
Second Semester	1. Fluid Mechanics & Machinery	4	2	–
	2. Applied Electronics-I	4	2	–
	3. Mechanical Design of Machine Elements	4	2	–
	4. Electrical Measurements & Measuring Instruments	5	2	–
	5. Electrical Machines-I	5	2	–
	Total	22	10	–
Syllabus for Third Year				
First Semester	1. Applied Electronics-II	4	2	–
	2. Electrical Machines-II	5	2	–
	3. Power Systems-I	5	–	–
	4. Advanced Measurement Techniques (Instrumentation)	4	2	–
	5. Electrical Installation & Estimation	2	–	4
	Total	20	6	4
Second Semester	1. Microprocessor Fundamentals and Applications	4	2	–
	2. Power Systems-II	5	2	–
	3. Digital Computational Techniques	4	–	–
	4. Network Analysis	4	2	–
	5. Principles of Electrical Machine Design	4	–	2
	6. Computer Programming	1	2	–
	Total	22	8	2
Syllabus for Final Year				
First Semester	1. Elective-I	4	–	–
	2. Industrial Organization & Management	4	–	–
	3. Industrial Drives & Control (Power Electronics)	4	2	–
	4. Control Systems-I	4	2	–
	5. Design of Electrical Machines	4	–	4
	6. Seminar (Internal Assessment Only)	–	1	–
	7. Project Work	–	2	–
	Total	20	7	4
Second Semester	1. Elective-II	5	2	–
	2. Switchgear and Protection	5	2	–
	3. Electrical Utilization	4	–	–
	4. Electrical Machines-III	5	2	–
	5. Project Work	–	4	–
	Total	19	10	–
Elective I	1. Energy Audit & Conservation			
	2. Electromagnetic Fields			
	3. Illumination Engineering			
	4. Entrepreneurship Development			
	5. Electro Mechanical Energy Conversion			
	6. Modern Power System Practice			
	7. Robotics and Automation			
Elective II	1. Control Systems II			
	2. H. V. Engineering			
	3. Advanced Electrical Drives & Control			
	4. Special Purpose Electrical Machines			
	5. Control System Devices			
	6. Advanced Microprocessor Techniques			

Syllabus for Bachelor of Engineering

(Instrumentation and Control)

		Lecture	Practical (Hours/Week)	Draught
Syllabus for First Year				
First Semester	1. Engineering Mathematics-I	4	2	-
	2. Applied Science-I	4	2	-
	3. Elements of Mechanical Engineering	4	2	-
	4. Elements of Electrical Engineering	4	2	-
	5. Computer Fundamentals	2	2	-
	6. Workshop Practice	-	4	-
	Total	18	12	-
Second Semester	1. Workshop Practice	-	2	-
	2. Engineering Mathematics-II	4	-	-
	3. Applied Science-II	4	2	-
	4. Engineering Mechanics	4	2	-
	5. Elements of Civil Engineering	4	2	-
	6. Engineering Graphics	2	-	4
	Total	18	8	4
Syllabus for Second Year				
First Semester	1. Industrial Instrumentation	5	2	-
	2. Electronic Devices and Circuits	5	4	-
	3. Materials & Processes	4	2	-
	4. Workshop Technology & Fabrication Techniques	4	2	-
	5. Programming Practice I	-	2	-
	Total	18	12	-
Second Semester	1. Transducers & Signal Conditioners	4	2	-
	2. Digital Techniques	4	4	-
	3. Engg. Mathematics III	5	-	-
	4. Electrical Circuits and Machines	4	2	-
	5. Thermal and Fluid Power Engineering	4	2	-
	Total	21	10	-
Syllabus for Third Year				
First Semester	1. Microprocessor Techniques	5	4	-
	2. Linear Techniques	5	4	-
	3. Automatic Control Systems	4	-	-
	4. Control System Components	4	2	-
	5. Programming Practice II	-	2	-
	Total	18	12	-
Second Semester	1. Computer Techniques	4	2	-
	2. Analytical Instrumentation	4	2	
	3. Modern Control Theory	4	4	-
	4. Power Electronics	4	2	-
	5. Engineering Economics & Resource Management	4	-	-
	Total	20	10	-
Syllabus for Final Year				
First Semester	1. Unit Operations	4	-	-
	2. Process Equipment Design	4	2	-
	3. Electronic Instrumentation	4	-	-
	4. Instrumentation and System Design	4	-	-
	5. Elective I	4	2	-
	6. Practice of EI-ISD	-	2	-
	7. Project Design	-	2	-
	8. Seminar	-	2	-
	Total	20	10	
Second Semester	1. Process Instrumentation	4	2	-
	2. Project Planning Estimation & Assessment	4	2	-
	3. Process Modelling & Optimization	4	-	-
	4. Elective II	4	2	-
	5. Project Design	-	4	-
	Total	16	10	-
Elective I	1. Biomedical Instrumentation I			
	2. Advanced Computer Techniques and Applications			
	3. Digital Signal Processing			
	4. Opto Electronic Instrumentation			
Elective II	1. Biomedical Instrumentation II			
	2. Parallel Processing and Real Time Operating Systems			
	3. Flight Instrumentation			
	4. Power Plant Instrumentation			

Syllabus for Bachelor of Engineering

(Civil Engineering)

		Lecture	Practical (Hours/Week)	Draught
Syllabus for First Year				
First Semester	1. Engineering Mathematics-I	4	2	–
	2. Applied Science-I	4	2	–
	3. Elements of Mechanical Engineering	4	2	–
	4. Elements of Electrical Engineering	4	2	–
	5. Computer Fundamentals	2	2	–
	6. Workshop Practice	–	4	–
	Total	18	12	–
Second Semester	1. Workshop Practice	–	2	–
	2. Engineering Mathematics-II	4	–	–
	3. Applied Science-II	4	2	–
	4. Engineering Mechanics	4	2	–
	5. Elements of Civil Engineering	4	2	–
	6. Engineering Graphics	2	–	4
	Total	18	8	4
Syllabus for Second Year				
First Semester	1. Strength of Materials	5	–	–
	2. Materials of Construction & Concrete Technology	5	–	–
	3. Surveying-I	5	2	2
	4. Building Construction	5	–	4
	5. Testing of Materials	–	2	–
	Total	20	4	6
Second Semester	1. Engineering Mathematics-III	5	–	–
	2. Theory of Structures-I	5	–	–
	3. Building Design & Drawing	3	–	4
	4. Fluid Mechanics-I	5	2	–
	5. Geo-Technical Engineering	5	2	–
	Total	23	4	4
Syllabus for Third Year				
First Semester	1. Surveying-II	5	2	–
	2. Fluid Mechanics-II	5	2	–
	3. Engineering Geology	5	4	–
	4. Structural Design & Drawing-I	5	–	4
	Total	20	8	4
Second Semester	1. Project Management & Computer Applications	5	4	–
	2. Transportation Engineering-I	5	–	–
	3. Environmental Engineering-I	5	2	–
	4. Theory of Structures-II	5	–	–
	5. Engineering Economics, Contracts & Tenders	4	–	–
	Total	24	6	–
Syllabus for Final Year				
First Semester	1. Elective-I	4	2	–
	2. Irrigation-I	5	–	–
	3. Environmental Engineering-II	4	2	–
	4. Structural Design & Drawing-II	5	–	4
	5. Foundation Engineering	4	–	–
	6. Project Work	–	2	–
	Total	22	6	3
Second Semester	1. Elective-II	4	2	–
	2. Dams & Hydraulic Structure	5	2	–
	3. Transportation Engineering-II	4	2	–
	4. Quantity Surveying	5	–	2
	5. Project Work	–	4	–
	Total	13	10	2
Elective I	1. Air Pollution			
	2. Prestressed Concrete & Prefabricated Structures			
	3. Experimental Stress Analysis			
	4. Open Channel and Compressible Flow			
	5. Construction Management			
	6. Matrix Methods of Structural Analysis			
	7. Earth Structures			
	8. Architecture & Town Planning			
Elective II	1. Advanced Water and Waste Water Treatment			
	2. Advanced Steel Structures			
	3. Advanced Design of Structures			
	4. Water Power Engineering			
	5. Systems Approach in Civil Engineering			
	6. Advanced Engineering Geology			
	7. Rock Mechanics			
	8. Fibre-Reinforced Composites			

Syllabus for Bachelor of Engineering

(Applied Mechanics)

		Lecture	Practical	Draught
		(Hours/Week)		
Syllabus for First Year				
First Semester	1. Computer Fundamentals Theory and Practical			
Second Semester	1. Engineering Mechanics Theory and Practical			
Syllabus for Second Year				
First Semester	1. Strength of Materials Theory			
	2. Testing of Materials Practicals			
	3. Materials of Construction & Concrete Technology Theory			
Second Semester	1. Theory of Structures I Theory			
Syllabus for Third Year				
First Semester	1. Structural Design and Drawing I, Theory and Practical			
Second Semester	1. Project Management and Computer Applications			
	2. Theory of Structures II Theory			
Syllabus for Final Year				
First Semester Elective I	1. Theory and Practical			
	2. Structural Design and Drawing II, Theory and Practical			
	3. Project Work			
Second Semester Elective II	1. Theory and Practical			
	2. Project Work			

Syllabus for Bachelor of Engineering

(Mechanical Engineering)

		Lecture	Practical (Hours/Week)	Draught
Syllabus for First Year				
First Semester	1. Engineering Mathematics-I	4	2	–
	2. Applied Science-I	4	2	–
	3. Elements of Mechanical Engineering	4	2	–
	4. Elements of Electrical Engineering	4	2	–
	5. Computer Fundamentals	2	2	–
	6. Workshop Practice	–	4	–
	Total	18	12	–
Second Semester	1. Workshop Practice	–	2	–
	2. Engineering Mathematics-II	4	–	–
	3. Applied Science-II	4	2	–
	4. Engineering Mechanics	4	2	–
	5. Elements of Civil Engineering	4	2	–
	6. Engineering Graphics	2	–	4
	Total	18	8	4
Syllabus for Second Year				
First Semester	1. Engineering Mathematics III	5	–	–
	2. Fluid Mechanics (Mech.,Auto.,Mech.sw)	4	2	–
	3. Strength of Materials	4	–	–
	4. Electronics	4	2	–
	5. Machine Drawing & Computer Graphics	1	–	4
	6. Workshop Practice-I	–	4	–
	Total	18	8	4
Second Semester	1. Theory of Machines & Mechanisms-I (Mech., Auto.)	4	2	–
	2. Applied Thermodynamics-I (Mech., Auto., Mech sw.)	4	2	–
	3. Electrical Technology	4	2	–
	4. Manufacturing Processes (Mech/Auto/Ind/Mech-Sand)	4	–	–
	5. Material Science (Mech/Auto)	4	2	–
	6. Workshop Practice-II	–	2	–
	Total	20	10	–
Syllabus for Third Year				
First Semester	1. Heat Transfer	4	2	–
	2. Engineering Metallurgy	4	2	–
	3. Machine Design & Drawing-I	4	–	4
	4. Theory of Machines & Mechanisms-II	4	2	–
	5. Workshop Practice-III (Mech, Auto, Industrial)	–	4	–
	Total	16	10	4
Second Semester	1. Applied Thermodynamics-II (Mech., Mech.-sw.)	4	2	–
	2. Mechanical Measurement & Control (Mech., Mech.-sw.)	4	2	–
	3. Metrology and Quality Control	4	2	–
	4. Machine Design & Drawing-II (Mech., Auto.)	4	–	4
	5. Engineering Economics & Industrial Psychology (Mech., Mech.-sw, Auto.)	4	–	–
	Total	20	6	4
Syllabus for Final Year				
First Semester	1. Elective I	4	–	–
	2. Applied Thermodynamics-III	4	2	–
	3. Machine Design & C. A. D.	4	–	4
	4. Fluid Machinery (Mech., Mech.-sw)	4	2	–
	5. Production Engineering	4	–	–
	6. Seminar	–	2	–
	7. Project Work	–	2	–
	Total	20	8	4
Second Semester	1. Elective II	4	–	–
	2. Industrial Engineering	4	–	–
	3. Dynamics of Machinery	4	2	–
	4. Computer Applications	4	2	–
	5. Project Work	–	4	–
	Total	16	8	–
Elective I	1. Refrigeration			
	2. Non conventional Energy Sources			
	3. Plastics & Polymer			
	4. Microprocessor Applications			
	5. Welding Technology			
	6. Analysis & Synthesis of Mechanisms			
	7. Industrial Fluid Power			
	8. Operation Research			
Elective II	1. Advanced Machine Design			
	2. Machine Tool Design			
	3. IC Engines			
	4. Automobile Engineering			
	5. Air Conditioning			
	6. Robotics			
	7. Plastic Product & Mould Design			
	8. Tribology			

Syllabus for Master of Engineering

(Electronics and Telecom)

		Lecture (Hours/Week)
	Electronics Instr. and Control System	
First Semester	1. Adv. Mathematical Methods	4
	2. Microprocessor Systems & Interfacing	4
	3. Active Network Synthesis	4
	4. Advanced Communication Systems	4
Second Semester	1. Digital Signal Processing and three of following	4
	2. Microcomputer Based Design	4
	3. Electronic Instrumentation	4
	4. Control Engineering	4
	5. Biomedical Instrumention	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Microwaves	
First Semester	1. Adv. Mathematical Methods	4
	2. Microprocessor Systems & Interfacing	4
	3. Active Network Synthesis	4
	4. Advanced Communication Systems	4
Second Semester	1. Digital Signal Processing any three of the following	4
	2. Microwave Devices & Circuits	4
	3. Digital Communication	4
	4. Microwave and Optical Communication	4
	5. Avionics & Radar Systems	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Naval Weapons	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor system and interfacing	4
	3. Digital Communication systems	4
	4. Advanced Radar & Microwave Techniques	4
Second Semester	1. Missile Guidance & Control	4
	2. Sonar system Engg.	4
	3. Computer based Instrumentation and Simulation	4
	4. Electronic counter Measures and Techniques	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student

Syllabus for Master of Engineering

(Metallurgy)

		Lecture (Hours/Week)
	Physical Metallurgy/Process Metallurgy	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Advances in Powder Technology	4
	4. Advanced Physical Metallurgy	4
Second Semester	1. Advanced Metal Casting	4
	2. Science and Technology of modern materials	4
	3. X-ray Diffraction	4
	4. Strength of Metals and Alloys	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student

Syllabus for Master of Engineering

(Electrical Engineering)

		Lecture (Hours/Week)
	Power System	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Optimization Techniques	4
	4. Power System dynamics	4
Second Semester	1. H.V. Transmission	4
	2. Power System Protection	4
	3. Computer methods in power systems	4
	4. Special topics in power systems	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Machines	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Optimization Techniques	4
	4. Generalized theory of electrical machines	4
Second Semester	1. Transient analysis of electrical machines	4
	2. Special electrical machines	4
	3. Computer methods in electrical machines	4
	4. Special topics in electrical machines	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Control Systems	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Optimization Techniques	4
	4. State Space Analysis	4
Second Semester	1. Non-linear control systems	4
	2. Optimal Control	4
	3. Computer methods in control Systems	4
	4. Special topics in Control Systems	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student

Syllabus for Master of Engineering

(Civil Engineering)

		Lecture (Hours/Week)
	Structural Engineering	
First Semester	1. Adv. Mathematical methods	4
	2. Micro-processor applications	4
	3. Structural Analysis I	4
	4. Structural Analysis II	4
Second Semester	1. Advanced Structural Design of concrete Structures	4
	2. Elective I	4
	3. Elective II	4
	4. Elective III	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
Electives	1. Experimental Stress Analysis	
	2. Structural Optimization	
	3. Structural Dynamics	
	4. Advanced Foundation Engineering	
	5. Metal Structures	
	6. Concrete Tech and composites	
	7. Theory of electricity and elastic stability	
	8. Plates and shells	
	9. Finite element analysis	
	Construction and Management	
First Semester	1. Adv. Mathematical Methods	4
	2. Microprocessor Applications	4
	3. Construction Methods & Equipment	4
	4. Construction Techniques	4
Second Semester	1. Labour, Organizational & Legal Responsibilities in Construction	4
	2. Administration of Construction Project	4
	3. Construction Economics & Financing	4
	4. Construction Planning	4
Third Semester	1. Seminar (State of Art)	1/student
	2. Dissertation	2/student
	Hydraulic Engineering	
First Semester	1. Adv. Mathematical Methods	4
	2. Microprocessor Applications	4
	3. Fluid Mechanics	4
	4. Hydrology & Ground Water	4
Second Semester	1. Elective (any one)	4
	2. Design of Hydraulic structures	4
	3. Sediment Transport River Engg. and Flood Control	4
	4. Flow through open channels & unsteady flow	4
Third Semester	1. Seminar (State of Art)	1/student
	2. Dissertation	2/student
Elective	1. Advanced Fluid Mechanics	
	2. Systems Approach to water resources engg.	
	Soil Mechanics (Geotechnical Engg.)	
First Semester	1. Adv. Mathematical methods	4
	2. Micro-processor applications	4
	3. Advanced Soil Mechanics	4
	4. Earth Dam Engg.	4
Second Semester	1. Advanced Foundation Engg.	4
	2. Elective I	4
	3. Elective II	4
	4. Elective III	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
Electives	1. Construction Planning	
	2. Advanced Structural Design	
	3. Rock Mechanics	
	4. Soil Dynamics	
	5. Soil Structure Interaction	
	6. Engg. Geology	

Syllabus for Master of Engineering

(Civil Engineering - Town Planning)

		Lecture (Hours/Week)
First Semester	1. Historic Development and Planning Theory-I 2. Spatial and Environmental Aspects of Planning 3. Urban and Landscape Design 4. Planning for Transportation and Utility Services 5. Scientific Methods for Analysis 6. Planning Studio-I	
Second Semester	1. Advanced Planning Theory and Practice 2. Social Formation and Housing 3. Economic Aspect of Planning and Computer Programming 4. Law in Relation to Planning 5. Planning Studio-II	
Elective-I	1. Informal Sector Planning 2. Urban Renewal 3. Conservation and Preservation in Planning	
Third Semester	1. Planning Administration and Professional Practice 2. Planning Studio-III 3. Dissertation	
Elective-II	1. City Planning and city Development Models 2. Planning for Rural Development 3. Systems Analysis and City Planning	

Syllabus for Master of Engineering

(Mechanical Engineering)

		Lecture (Hours/Week)
	Heat Power	
First Semester	1. Adv. Mathematical methods	4
	2. Micro processor applications	4
	3. Advanced Thermodynamics	4
	4. Heat Transfer or Advanced Fluid mechs.	4
Second Semester	1. Refrigeration	4
	2. Air Conditioning	4
	OR	
	1. I.C. Engine-I	4
	2. I.C. Engine-II	4
	OR	
	1. Gas Dynamics	4
	2. Gas Turbines	4
	3. Solar Energy & Nonconventional Energy Sources	4
	4. Project Design (Ref. & Air)	4
	OR	
	4. Numerial Methods for Computer Solution to Mech. Engg. problems	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Design Engineering	
First Semester	1. Adv. Mathematical Methods	4
	2. Microprocessor applications	4
	3. Machine Stress Analysis	4
	4. Lubrication & Wear	4
	OR	
	Analysis & Synthesis of Mechanism	–
Second Semester	1. Design Engg. I	4
	2. Design Engg. II	4
	3. Machine Tools Design	4
	OR	
	Dynamics of Machinery & Vibrations	
	4. Process Equipment Design	4
	OR	
	Advanced Welding Technology	
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Guided Missiles	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Missile Guidance I	4
	4. Missile Aerodynamics and Configuration I	4
Second Semester	1. Missile Control I	4
	2. Missile Propulsion I	4
	3. Elective	4
	4. Elective	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
Electives (2.3 & 2.4)	1. Missile Guidance II	
	2. Missile Control II	
	3. Missile Propulsion II	
	4. Missile Aerodynamics & Configuration II	
	5. Missile Structures and Materials	
	6. Missile system analysis and Simulation	

		Lecture (Hours/Week)
	Combat Vehicles	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Material Sciences and Engg. technology	4
	4. Military vehicles and Power plants	4
Second Semester	1. Military Vehicle system Technology	4
	2. Tank Weapons and Armour	4
	3. Combat Vehicle Technology	4
	4. Nuclear Science and Technology and NBC Weapons	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Weapons	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Material sciences and Engg. technology	4
	4. Explosives and Ammunition	4
Second Semester	1. Artillery Weapons Systems Technology	4
	2. Tank Weapons and Armour	4
	3. Ballistics	4
	4. Nuclear Science and Technology and NBC Weapons	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Marine Engineering	
First Semester	1. Adv. Mathematical methods	4
	2. Microprocessor applications	4
	3. Vibrations	4
	3. Ship material Technology & Stress analysis	4
Second Semester	1. Warship Transmission Design and Tribology	4
	2. Marine Gas Turbine Design and Performance	4
	3. Marine Diesel Engine Design and Performance	4
	4. Naval Ship Installation and General Marine Engg.	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student
	Air Armament	
First Semester	1. Adv. Mathematical methods	4
	2. Micro-processor applications	4
	3. Material science & Engg. Technology	4
	4. Dynamics of missiles and Projectiles (Ballistics)	4
Second Semester	1. Aircraft Weapon Design	4
	2. Aircraft Rocket and Missile Design	4
	3. Aircraft Weapon Aiming & Installation Design	4
	4. Aircraft Weapon Testing and Valuation	4
Third Semester	1. Seminar (State of art)	1/student
	2. Dissertation	2/student

Appendix-9 List of Available Equipment

9-1 Available Equipment

(1) Electronics and Telecommunication

X-band power meter
X-band waveguide transmission line
VSWR meter
Complex pattern generator
High speed analog to digital converter
TV wobbuloscope
Antennas
Noise source
Signal generator
Vector voltmeter
Spectrum analyser
Antenna array
Phase network
Receiver
CCIR standard TV wonifors
Microwave power meter
Cavity frequency meter
Directional coupler
Terminations
U.H.F. signal generator
Communication analyser
Microwave source
Noise measurement set
Magnetron
Waveguide
Monitoring meter
X-band microwave saurce
Auto tracking system
C.R.O.
Eprom emulator
PC-XT
Download facilities

(2) Metallurgy

Tensometer
Heat treatment furnaces
Metal working equipment
Rolling mill
Microscope
Induction furnace
X-Y recorder
Thermocouple
Conductivity meter
Fabrication devices
UTM
Hydraulic press
Induction furanace
Press
Swaging unit
Electromagnet
Radiograph

(3) Electrical

Protection system simulator
Network analyser
Transmission line model
Thyristor drives
Convertors
Oscilloscopes general purpose
Stepper motor driven robotic arm
High voltage 100KV DC Rectifier
Sphere Gap

(4) Instrumentation

Digital Voltmeter
Oven
Digital Ohmeter
Signal Generator
Noise Generator
Oscilloscope
LVDT Amplifier
Differential Pressure cell
Dead Weight Tester
Vacuum Pump
Precision Vacuum Gauges
Vibration Generator
D/P Indicator
P/D Controller
Pulse Process Converter

(5) Civil

Auto levels
Theodolite
Dumpy levels
Abney levels
Drafting machine
Portable gas sampler
16mm movie camera
35mm camera
Photo enlarger
Slide projector
Pentegraph
Overhead projector

(6) Mechanical Department

Slip gauge
Height gauge
Micrometer
Taper ring gauge
Vernier height gauge
Depth micrometer
Caliberated ball
Surface plate
Taper plug gauge
Dial indicator with magnetic stand
Internal-external digital micrometer
Caliberated precision ball
Bevel protractor
Spirit level
Autocollimator measuring head
Angle gauge
Straight edge
Dial indicator
Dial cliberation tester
Standard roller
Bench micrometer
Sigma comparator stand
Standard cylinder
Electrical comparator
Floating carriage micrometer
CNC machine
Conveyor system
Auto loading system
CAD/CAM workstation
Tool makers microscope
Tool and cutter grinder
Various jigs and fixtures
Press tools
Dies and accessories
Profile projector
Dual channel vibration analyser

9-2 List Of The Equipments To Be Purchased Under DCS Grants

ETC-17	MULTIUSER MULTIPROCESSOR (1989/90)
WSD-04	PROFILE PROJECTOR
WSD-05	TOOL MAKERS MICROSCOPE
WSD-07	SOUND LEVEL METER-OCTAVE ANALYSER
ETC-07	80386 BASED COMPUTER SYSTEM
ETC-06	IBM PC-AT (80286 BASED)
ETC-03	80486 BASED COMPUTER SYSTEM
ETC-05	IBM PC-XT COMPATIBLE
ETC-10	PRECISION POWER METER
ETC-11	POWER SCOPE
APM-02	TENSOMETER
APM-04	IBM PC AT 386 COMPUTER
APM-05	LABORATORY CEMENT AUTOCLAVE
APM-08	PERMEABILITY TEST APP. CONCRETE
APM-16	ELECTRONIC DIGITAL SCALE
APM-18	TILE CUTTING MACHINE
PM-17	CORE CASE WITH BITS
WSD-10	RETROFITTING OF LATHE MACHINE
WSD-09	RETROFITTING OF MILLING MACHINE
WSD-06B	VIBRATION METER AND ANALYSER
ETC-01B	FFT ANALYSER
ETC-02B	DIGITAL TRANSMISSION ANALYSER
APM-01	UNIVERSAL TESTING MACHINE
APM-03	CLASS ROOM COLOUR VIDEO SYSTEM
MET-01	IBM COMPUTER SYSTEM
MED-13	COMB BINDING MACHINE
WSD-17B	COMB BINDING MACHINE
APM-20	COMB BINDING MACHINE
ETC-17	COMB BINDING MACHINE (DTE)
WSD-02B	CONTOUROGRAPH
WSD-01B	PERTHOMETER
WSD-13	SIGNAL STORAGE & ANALYSIS SYSTEM
WSD-08	MILLING MACHINE
APM-09	PLAIN PAPAER COPIER (DTE)
WSD-18	AIR CONDITIONERS (2 TONS)
ETC-18	AIR CONDITIONERS (1.5 TONS)

APM-14 AIR CONDITIONER (1.5 TONS)

MED-14 AIR CONDITIONER (1.5 TONS)

MISCELLANEOUS EQUIPMENT

APPENDIX-10 List of Related Information of the Project

- University of Poona
  42nd Annual Report

- Department of Instrumentation & Control,
  Govt. College of Engineering, Pune
  Silver Jubilee Souvenir

- Department of Metallurgy
  Who's Who of Alumni

- Indian Institute of Technology, Bombay
  Annual Report 1989 - 90

- Rules and Application Form For Admission to The First Year of Degree Courses in Engineering and Technology

- Government of India, Ministry of Commerce Import & Export Policy For April, 1990 - March, 1993

- TATA Engineering and Locomotive Company Limited, Pune

- C-DAC 1980-90 in Review

- A.T.E Today - A Company Profile
  1939 - 1989 Golden Jubilee Year

- Norms and Standards for Engineering Colleges (Degree Programmes)
  All India Council for Technical Education, New Delhi - August 1990

- Model Curriculum and Syllabi for Core Subjects
  for Four Year Degree Course in Engineering,
  Ministry of Education & Culture, Government of India, New Delhi

- Four Year Degree Course in Engineering
  (A Model List of Laboratories, Experiments and Equipment), April 1984
  Ministry of Education & Culture, Government of India, New Delhi

· Schemes of Thrust Areas of Technical Education
Achievements during Seventh Plan (1985 - '90)
Ministry of Human Resource Development, Government of India, August 1990

· 1981 Handbook of Engineering Education
Association of Indian Universities, Din Dayal Upadhya Marg
New Delhi 110002

· 1991 - 1992, ISTE Handbook and Quality Improvement Programme Brochure
Indian Society for Technical Education

· Courses of Study, Supplement
Indian Institute of Technology, Bombay

· The Indian Journal of Technical Education
Volume 14, No. 1, January - June, 1991

· Economic Survey of Maharashtra 1990/91
Directorate of Economics & Statistics, Government of Maharashtra, Bombay

· Ministry of Human Resource Development Annual Report
Government of India, Department of Education

Appendix-11 Related Data on the Project

Table A-11-1 Selected Key Indicators

Item	Unit	1950-51	1960-61	1970-71	1988-89
Population	Million	361	442	551	812
Working population	Per cent	39	-	33	37[2]
Literacy rate	Per cent	16.7	24.0	29.5	36.2[1]
National income (at 1980-81 prices)	RS. crores	40,454	58,602	82,211	166,593[3]
Per capital income (at 1980-81 prices)	Rupees	1,127	1,350	1,520	2,082[3]
Per capita private consumption expenditure (at 1980-81 prices)	Rupees	1,006	1,193	1,322	1,828
Gross domestic saving as per cent of GDP		10.4	12.7	15.7	21.0[3]
Rate of investment[1]	Per cent	10.2	15.7	16.6	23.9[3]
Share of public sector in GDP (at 1980-81 prices)	Per cent	n.a.	9.4	12.7	26.4
Share of agriculture in GDP (at 1980-81 prices)	Per cent	56.5	52.1	45.8	34.8
Index number of agricultural productivity (1967-70=100)		77.1	94.2	107.9	155.7
Production of foodgrains	Mn. tonnes	51	82	108	170
Fertiliser consumption	Mn. tonnes	n.a.	--	2.2	11.0
Index number of agricultural production (1967-70=100)		58.5	86.7	111.5	182.7
Index number of industrial production (1980-81=100)		18.3	36.2	65.3	181.1
Production					
(i) Cotton cloth	Mn. metres	4,215	--	7,602	9,082
(ii) Finished steel	Mn. tonnes	1.0	2.4	4.6	10.9
(iii) Machine tools	Rs. million	3	--	430	5,107
(iv) Cement	Mn. tonnes	2.7	8.0	14.3	41.8
Exports	Rs. crores	606	642	1,535	20,295
Imports	Rs. crores	608	1,122	1,634	28,194
Index number of wholesale prices (1970-71=100)		48	55	100	435

Source: India, Economic Information Yearbook, 1990/91

1) Relates to the census of 1981

2) Includes marginal workers, 1981 census data

3) Gross domestic capital formation as a percentage of GDP at current prices.

Fig.A−11−2

MINISTRY OF HUMAN RESOURCE DEVELOPMENT
DEPARTMENT OF EDUCATION

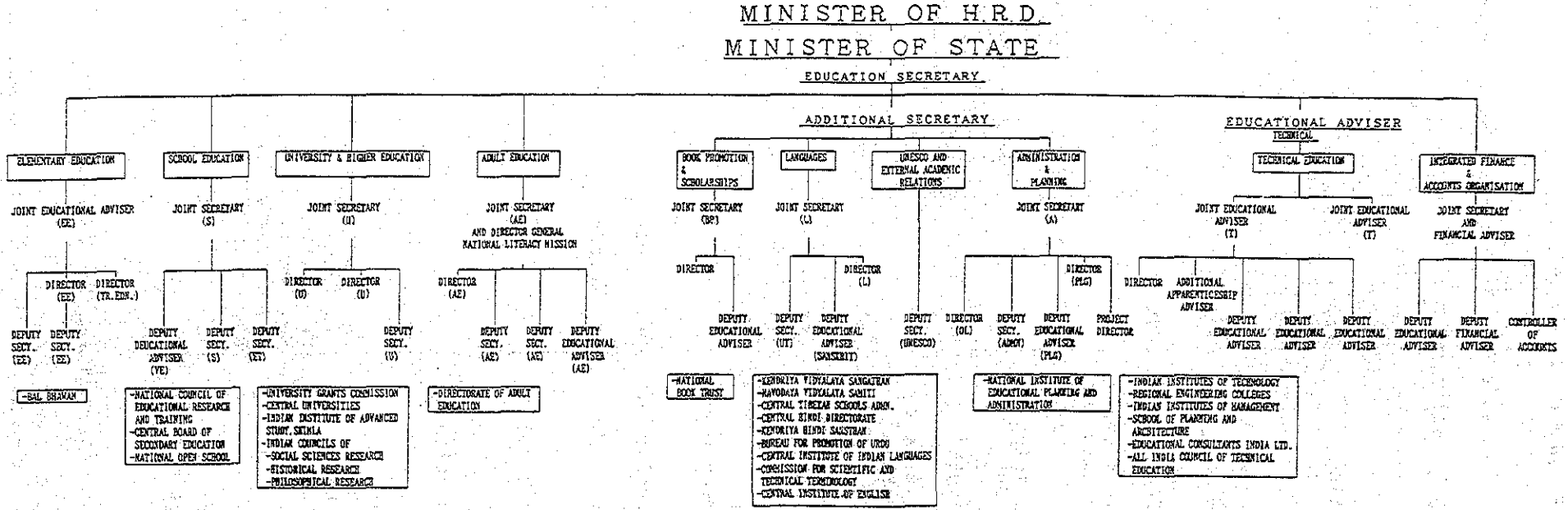


Fig. A-11-3 Organization Chart of Government of Maharashtra

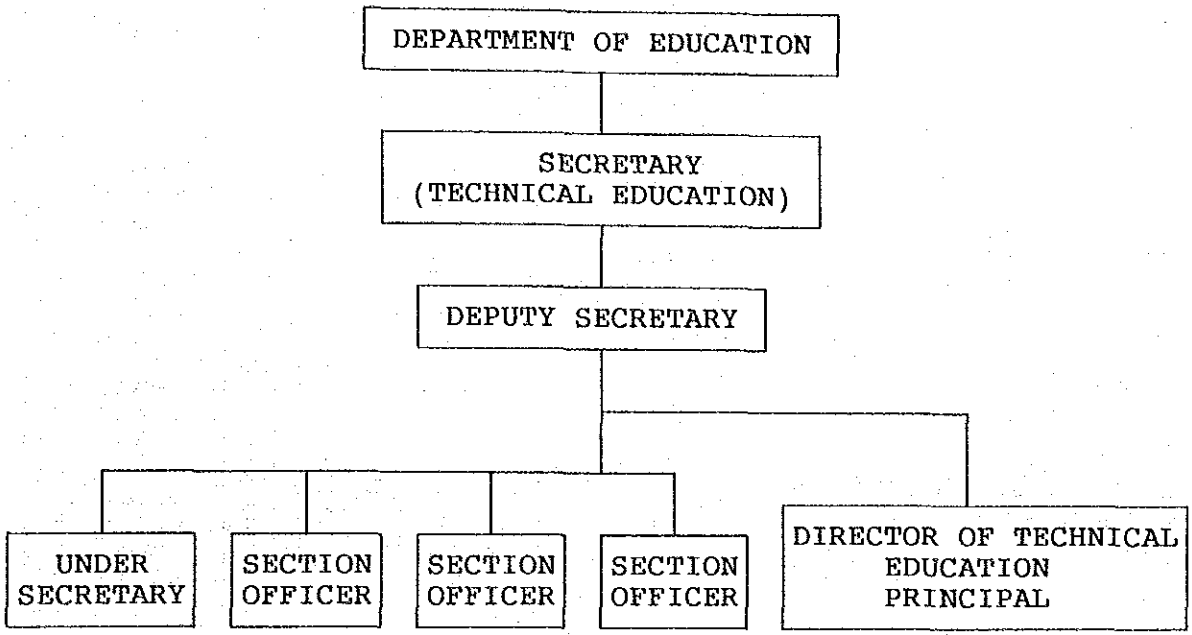


Fig. A-11-4 Organization Chart for Government College of Engineering, Pune

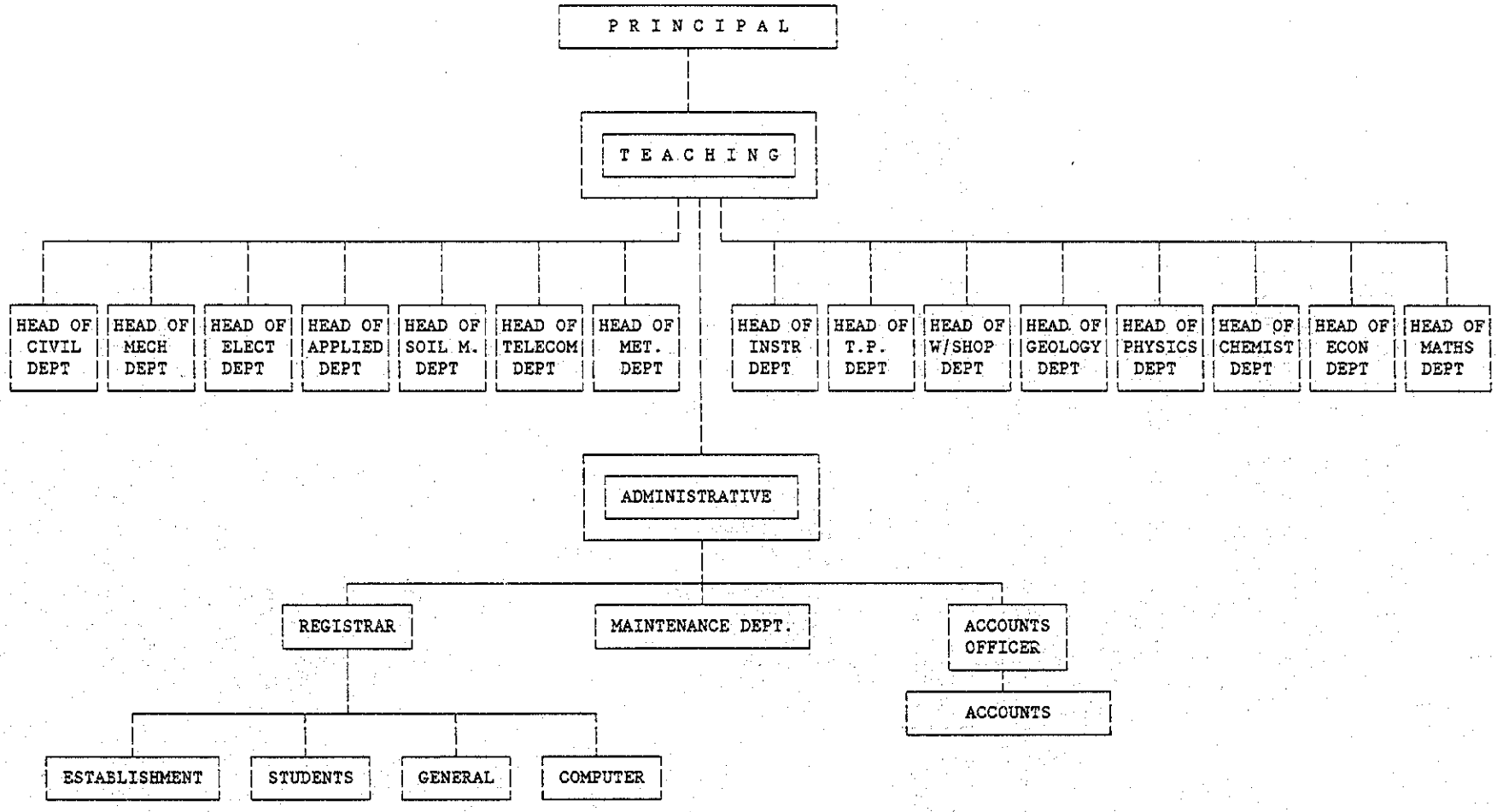


Table A-11-5 Selected Characteristics of Factory Sector Industries: State-Wise: 1986-87

State/U.T.	No. of facili-ties	Fixed capital (Rs. crores)	No.of emplo-yees (000)	Total emolu-ments (Rs. crores)	Value of output (Rs. crores)	Net value added (Rs. crores)
1. Andhra Pradesh	12,328	4,154	678	717	8,008	1,376
2. Assam	1,698	745	108	80	1,868	478
3. Bihar	3,747	5,719	352	722	6,935	1,422
4. Gujarat	10,697	6,383	677	1,010	15,150	2,594
5. Haryana	2,877	2,120	228	324	4,514	753
6. Himachal Pradesh	213	765	40	61	532	190
7. Jammu & Kashmir	395	331	34	42	344	43
8. Kamataka	5,655	2,554	387	648	5,439	1,290
9. Kerala	2,915	1,650	227	320	3,443	687
10. Madhya Pradesh	3,214	6,059	356	603	6,413	1,099
11. Maharashtra	15,148	10,746	1,200	2,842	29,692	6,074
12. Manipur	49	2	1	1	2	1
13. Meghalaya	26	1	1	1	5	2
14. Orissa	1,383	2,005	145	261	2,316	419
15. Punjab	5,325	3,034	308	371	5,478	791
16. Rajasthan	2,814	3,132	211	350	4,073	853
17. Tamil Nadu	12,616	5,678	849	1,253	14,238	2,667
18. Tripura	233	24	14	9	35	11
19. Uttar Pradesh	7,842	7,673	695	989	11,365	2,333
20. West Bengal	5,224	3,877	763	1,448	9,894	1,981
21. A. & N. Islands	46	6	5	6	18	2
22. Chandigarh	261	26	12	18	180	34
23. Delhi	2,843	294	119	170	2,357	307
24. Goa, Daman & Diu	241	180	16	29	584	108
25. Pondicherry	167	73	16	24	161	37
26. Total	97,957	67,231	7,442	12,299	1,33,044	25,552

Source: Annual Survey of Industries, 1986-87.
Note : Totals may not tally due to rounding off.

Table A-11-6 State-Wise Distribution of Registered Small Scale Industries

State/U.T.	1973	1983	1985	1987	1988
Andhra Pradesh	8,999	38,530	49,142	60,295	70,149
Assam	1,735	4,878	6,543	8,727	10,210
Bihar	6,368	33,333	44,309	53,428	59,886
Gujarat	11,599	40,004	48,733	58,958	65,553
Haryana	6,361	36,474	44,204	56,885	61,229
Himachal Pradesh	1,729	6,406	7,486	8,506	9,336
Jammu & Kashmir	1,232	11,433	13,267	17,200	18,700
Kamataka	7,062	28,214	42,359	36,710	62,534
Kerala	6,903	23,678	29,630	27,828	30,178
Madhya Pradesh	8,727	69,501	93,798	1,22,274	1,38,729
Maharashtra	17,338	33,349	41,040	49,831	54,610
Orissa	2,163	11,592	13,319	15,093	16,061
Punjab	14,827	58,724	69,753	86,521	96,519
Rajasthan	8,055	41,144	47,861	54,462	56,761
Tamil Nabu	18,547	43,988	59,756	76,836	86,499
Uttar Pradesh	13,839	58,874	88,126	1,24,336	1,45,797
West Bengal	16,904	1,13,802	1,20,692	1,28,488	1,31,656
Chandigarh	349	1,620	1,997	2,277	2,401
Delhi	5,327	17,981	19,957	22,434	23,817
All India (including others)	**1,59,321**	**6,87,418**	**8,54,843**	**10,48,253**	**11,58,765**

Source: Small Industries Development Organization, Annual Report, 1988-89.

Table A-11-7 Principal Characteristics by Size of Capital: Factory Sector: 1985-86

Capital size class (Rs. lakhs)	Factories (nos.)	Employment ('000s)	Rs. crores		
			Fixed capital	Gross output	Net value added
Less than 1.0	34,910	764	265	3,504	685
1.0 to 2.5	18,583	438	425	3,864	605
2.5 to 5.0	13,115	411	531	4,187	656
5.0 to 7.5	6,245	246	412	3,057	476
5.0 to 10.0	3,859	185	333	2,328	346
10.0 to 20.0	6,937	442	976	6,075	921
20.0 to 25.0	1,726	134	357	2,147	288
Above 25.0	9,592	4,643	56,617	93,835	19,049
Unspecified	6,049	208	168	1,159	243
Total	**1,01,016**	**7,472**	**60,085**	**1,20,155**	**23,266**

Source: Annual Survey of Industries, 1985-86.

Table A-11-8 Exports of Principal Commodities

(Rs. crores)

Item	1950-51	1960-61	1970-71	1980-81	1983-84	1985-86	1988-89
Tea	80	124	145	335	501	626	599
Coffee	1	7	25	214	183	265	280
Cashew kernels	8	19	52	140	156	225	277
Spices	25	17	39	111	109	278	251
Fish and preparations	2	5	30	217	327	409	633
Tobacco (unmanufactured)	14	15	31	124	150	170	128
Cotton (raw and waste	17	12	16	177	149	68	28
Iron ore & concentrates	0.2	17	117	303	385	579	673
Mica	10	10	16	19	27	21	29
Mineral fuels, lubricants and related materials	n.a.	7	13	28	1,588	655	518
Vegetable oils	25	8	7	22	37	25	n.a.
Chemicals	1	7	36	235	278	497	1,534
Leather and leather products	16	25	75	337	350	770	1,490
Cotton fabrics	118	57	97	277	305	574	1,131
Jute manufactures	113	135	190	331	165	262	250
Handicrafts	n.a.	n.a.	70	935	1,683	1,881	5,194
Machinery & transport equipment	n.a.	7	83	526	497	954	2,322
Total exports	**601**	**642**	**1,535**	**6,711**	**9,771**	**10,895**	**20,295**

Source: 1. RBI, Report on Currency & Fiance, 1984-85.
2. Economic Survey, 1989-90.

Table A-11-9 Imports of Principal Commodities

(Rs. crores)

Item	1950-51	1960-61	1970-71	1980-81	1985-86	1988-89
Cereals & cereal preparations	99	181	213	100	110	631
Cashewnuts	3	10	29	9	24	61
Cotton (raw)	101	82	99	--	13	n.a.
Wool (raw)	6	10	15	43	97	158
Crude rubber	3	11	4	32	101	173
Mineral fuels, lubricants and related materials	56	70	137	5,266	4,989	4,374
Animal and vegetable boils & fats	4	5	38	709	770	n.a.
Organic & inorganic chemicals	9	39	68	358	1,089	1,940
Medicinal & pharma-ceutical products	10	16	24	85	177	202
Iron & steel	14	122	147	852	1,398	1,937
Non-ferrous metals	28	47	119	477	542	786
Metal manufactures	14	23	9	89	1,001	194
Machinery and transport equipment	124	333	395	1,821	4,084	5,316
Miscellaneous manufactured articles	n.a.	17	33	212	553	n.a.
Total imports (including others)	650	1,122	1,634	12,549	19,658	28,194

Source: 1. RBI, Report on Currency & Finance, 1986-87.
2. Economic Survey, 1989-90.

Table A-11-10 Distribution of Colleges According to Curses of Study: 1983-84 to 1987-88

(Number)

Course of Study	1983-84*	1984-85*	1985-86*	1986-87*	1987-88**
Arts, Science and Commerce	3,758	4,004	4,132	4,354	4,428
Technical/Professional Break up	563	618	655	695	719
(a) Engineering/Technology	191	223	242	253	257
(b) Medicine/Pharmacy/Ayurveda/Nursing/ Dentistry/Homoeopathy	286	303	320	342	361
(c) Agriculture	58	63	63	67	68
(d) Veterinary Science	28	29	30	33	33
Law	186	194	199	202	204
Physical Education & Education	391	430	441	479	470
Oriental Learning	283	277	321	720	714
Music/Fine Arts	65	67	68	62	62
Total	5,246	5,590	5,816	6,512	6,597

Source: Annual Report of University Grants Commission 1987-88.

Note : 1. * Excludes Junior Colleges and colleges having only Diploma/Certificate Course.
2. ** Provisional.

Table A-11-11 University-Wise List of Centres of Advanced Study in Science, Engineering and Technology as on 31.3.1987

SL. No.	University	Name of the CAS
1.	Annamalai	(1) Marine Biology
2.	Banaras Hindu	(1) Zoology (2) Botany (3) Metallurgical Engg.
3.	Bombay	(1) Applied Chemistry (2) Mathematics
4.	Calcutta	(1) Botany (2) Chemistry (3) Radio Physics (4) Applied Mathematics
5.	Delhi	(1) Botany (2) Zoology (3) Physics (4) Chemistry
6.	I.I.Sc. Bangalore	(1) Molecular Biophysics (2) Bio-Chemistry (5) Physics
7.	Jadavpur	(1) Geology
8.	Madras	(1) Maths (2) Botany, New Science Block Guindy Campus, Madras-25
9.	Punjab	(1) Maths 92) Geology (3) Chemistry
10.	Poona	(1) Physics

Total = 26 CAS.

Source: Annual Report of university Grants Commission 1987-88.

Table A-11-12

Faculty-Wise Enrolment of Women in Higher Education From 1974-75 to 1987-88

(Thousand)

Year	Arts	Commerce	Law	Education	Science	Agri-culture	Vety. Sc.	Medicine	Engi-neering	Others	Total
1974-75	363.0 (34.0)	22.1 (5.6)	5.9 (4.4)	29.0 (37.6)	106.2 (22.9)	0.3 (0.9)	0.08 (1.2)	21.0 (19.7)	1.3 (1.5)	4.1 (32.6)	553.0 (23.4)
1975-76	392.1 (36.4)	27.6 (6.6)	7.0 (5.0)	30.1 (39.3)	111.7 (24.1)	0.4 (1.4)	0.09 (1.4)	19.2 (18.3)	2.1 (2.1)	4.2 (36.1)	595.2 (24.5)
1976-77	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1979-80	397.9 (37.0)	68.0 (13.2)	11.0 (6.2)	34.5 (47.3)	140.1 (27.5)	1.1 (2.8)	0.2 (2.7)	24.4 (21.8)	4.4 (3.7)	7.4 (38.8)	689.0 (26.0)
1980-81	420.3 (37.7)	88.1 (15.9)	11.9 (6.9)	33.7 (47.3)	153.9 (28.8)	1.3 (3.3)	0.2 (3.3)	26.8 (24.4)	4.9 (3.8)	7.4 (39.8)	748.5 (27.2)
1981-82	455.0 (38.2)	105.0 (16.7)	12.3 (7.1)	34.4 (48.3)	165.7 (28.6)	1.4 (3.5)	0.3 (4.3)	29.8 (26.2)	5.9 (4.5)	7.0 (38.8)	816.7 (27.7)
1982-83	487.6 (38.7)	116.8 (17.4)	13.6 (7.4)	34.9 (47.0)	179.7 (28.8)	1.6 (4.0)	0.4 (4.8)	31.6 (27.8)	7.2 (5.0)	6.7 (36.9)	880.1 (28.1)
1983-84	517.0 (38.6)	131.4 (18.7)	15.2 (7.8)	35.3 (47.3)	189.7 (29.0)	1.7 (3.1)	0.5 (5.1)	33.7 (28.3)	8.5 (5.5)	7.3 (35.7)	940.3 (28.4)
1984-85	540.7 (39.4)	142.2 (19.3)	15.7 (8.0)	36.6 (47.8)	200.6 (30.0)	2.0 (4.9)	0.5 (5.4)	35.2 (29.6)	10.0 (6.3)	8.5 (37.9)	992.1 (29.1)
1985-86*	581.8 (40.4)	146.7 (19.1)	16.7 (8.1)	40.2 (49.0)	214.6 (30.5)	2.0 (4.3)	0.5 (4.9)	37.9 (29.5)	9.6 (5.9)	8.5 (39.5)	1058.6 (29.6)
1986-87*	618.5 (41.6)	155.9 (19.7)	17.8 (8.3)	42.8 (50.5)	228.1 (31.4)	2.1 (4.5)	0.6 (5.1)	40.3 (30.4)	10.2 (6.0)	9.0 (40.7)	1125.3 (30.6)
1987-88*	656.8 (42.7)	155.7 (20.2)	18.9 (8.5)	45.4 (51.8)	24.2 (32.2)	2.3 (4.6)	0.6 (5.2)	42.8 (31.1)	10.9 (6.2)	9.6 (41.8)	1195.1 (31.3)

Source: Annual Report of University Grants Commission 1987-88.

Note: 1. Figures in Brackets indicate the enrolment of women as a Percentage of total enrolment.
2. * Estimated.
3. N.A. = Not available

Table A-11-13 Enrolment Faculty - Wise in Higher Education From 1983-84 to 1987-88

(Number)

Course of study	1983-84		1984-85		1985-86		1986-87		1987-88	
	Enrol-ment	Percent-age of total	Enrol-ment	Percent-age of total	Enrol-ment	Percent-age of total	Enrol-ment (esti-mated)	Percent-age of total	Enrol-ment (esti-mated)	Percent-age of total
Arts (including oriental Learning)	13,38,106	40.4	13,72,277	40.3	14,39,071	40.3	14,83,794	40.3	15,37,210	40.3
Science	6,53,092	19.7	6,69,563	19.7	7,03,467	19.7	7,25,328	19.7	7,51,440	19.7
Commerce	7,03,638	21.3	7,38,506	21.7	7,67,743	21.5	7,91,602	21.5	8,20,100	21.5
Education	74,679	2.3	76,522	2.2	82,131	2.3	84,683	2.3	87,732	2.3
Engineering/Technology	1,53,131	4.6	1,59,046	4.7	1,64,261	4.6	1,69,366	4.6	1,75,463	4.6
Medicine	1,18,989	3.6	1,18,890	3.5	1,28,552	3.6	1,32,547	3.6	1,37,319	3.6
Agriculture	41,588	1.3	41,741	1.2	46,422	1.3	47,864	1.3	49,319	1.3
Veterinary Science	9,268	0.3	9,413	0.3	10,713	0.3	11,046	0.3	11,440	0.3
Law	1,94,555	5.9	1,95,708	5.7	2,07,112	5.8	2,13,549	5.8	2,21,236	5.8
Others	20,603	0.6	22,430	0.7	21,425	0.6	22,091	0.6	22,887	0.6
Total	33,07,649	100.0	34,04,096	100.0	35,70,897	100.00	36,81,870	100.0	38,14,417	100.0

Source: Annual Report of University Grants Commission 1987-88

Table A-11-14 Universities/Colleges and Their Enrolment From 1976-77 to 1987-88

(Number)

Year	Universities	Institutions Deemed to be Universities	Colleges	Total Enrolment
1976-77	105	10	4317	24,31,563
1977-78	105	10	4375	25,64,972
1978-79	108	10	4460	26,18,228
1979-80	108	11	4558	26,48,579
1980-81	112	11	4722	27,52,437
1981-82	118	13	4880	29,52,066
1982-83	120	13	5039	31,33,093
1983-84	124	15	5246	33,22,939
1984-85	125	15	5590	34,04,096*
1985-86	132	17	5816	35,70,897*
1986-87	136	19	6512**	36,81,870*
1987-88	142	22	6597**	38,14,417*

Source: Annual Report of University Grants Commission 1987-88.

Note : 1. The number of Universities/Deemed Universities given above does not include 'Institute' of National Importance which are of Universties Status.
2. The number of colleges given above excludes junior colleges and those offering diploma certificate courses.
3. *Estimated.
4. **Provisional.

Table A-11-15
Out-Turn of Scientific and Technical Personnel From
Universities/UT's in India 1947-1983

(Number)

Year	Natural Sciences				Engineering & Technology						Medical Sciences						Agriculture & Veterinary Sciences					
	B.Sc.	M.Sc./ MA/ M.Tech	M.Phil	Ph.D/ D.Sc	BE/ B.Sc	Diploma Holders	B.E.	P.G. Diploma	M.E./ M.Tech./ M.Pharm./ M.Arch.	Ph.D/ D.Sc.	M.B.B.S.	D.M./ M.Ch.	P.G. Diploma	M.D./ M.S.	Ph.D./ D.Sc.	B.Sc. (Ag.)	B.V.Sc.	M.Sc.	M.V.Sc.	Ph.D./ D.Sc.	Ph.D. (Veterinary & Dairy Science)	Total
1947	5996	872	--	25	1076	1851	--	--	13	--	617	--	113	38	--	570	--	79	--	2	--	11,252
1948	6270	1053	--	56	1251	1393	--	2	26	--	959	--	135	35	--	583	--	94	--	2	--	11,859
1949	7654	1168	--	64	1544	1473	--	8	28	1	1170	--	133	31	--	1000	--	119	--	--	--	14,393
1950	9628	1438	--	79	2029	2035	--	11	39	--	1550	--	136	28	--	1000	100	154	--	4	--	18,231
1951	11,193	1856	--	81	2657	2841	--	16	55	2	1557	--	181	45	--	1041	189	192	--	--	--	21,911
1952	11,087	2146	--	119	2882	2836	5	16	54	1	1896	--	163	66	--	870	172	223	--	8	--	22,544
1953	12,329	2425	--	103	2841	2786	11	18	59	--	2164	--	196	84	--	879	209	222	--	4	--	24,330
1954	14,422	2891	--	183	3304	3485	1	14	92	3	2229	--	167	86	--	910	256	203	--	7	--	28,253
1955	15,964	3073	--	202	3947	3999	7	23	102	4	2582	--	213	107	--	905	289	197	--	9	--	31,623
1956	16,126	3226	--	181	4191	3910	6	38	188	6	2743	--	247	121	--	893	368	209	--	13	--	32,466
1957	18,045	3771	--	197	4248	5157	4	47	205	4	2732	--	312	199	--	1128	492	309	--	7	--	36,857
1958	18,920	3807	--	221	4237	6278	6	33	279	3	2802	--	346	244	--	1520	643	306	--	9	--	39,654
1959	20,627	4741	--	280	4679	7249	9	52	412	6	2839	--	403	294	--	1950	821	383	--	16	--	44,761
1960	22,693	5365	--	324	5660	7862	33	38	512	7	3119	2	411	341	--	1990	844	482	--	26	--	49,709
1961	26,157	6598	--	363	7035	10,244	69	34	600	11	3387	2	449	406	--	2608	857	610	--	28	--	59,458
1962	26,930	7184	--	386	8233	12,042	112	46	748	15	3900	1	518	570	--	2609	774	690	--	42	--	64,800
1963	35,015	8023	--	493	9005	12,938	283	64	891	13	3945	5	534	617	3	4112	802	708	--	41	--	77,492
1964	34,046	8832	--	472	9415	15,202	521	84	710	29	4289	6	620	637	2	4718	699	814	--	48	--	81,444
1965	38,150	9460	--	541	8277	17,633	827	123	947	8	4452	4	650	829	3	5569	1030	1176	--	95	--	89,774
1966	42,465	8269	1	746	13,015	16,025	1046	111	1168	62	5387	2	795	1025	7	5040	855	939	132	69	3	97,162
1967	49,769	9216	2	897	13,841	20,105	1198	188	1273	65	6558	6	734	1129	4	6180	1120	920	135	7	2	113,349
1968	59,606	10,685	--	1005	15,771	23,204	1308	235	1622	88	7628	22	806	1164	9	5902	1003	1238	139	89	15	131,539
1969	72,432	13,116	3	1070	15,642	21,700	1620	261	1886	97	8916	22	819	1292	2	5909	1145	1288	122	96	10	147,448
1970	82,610	13,214	1	1163	17,748	18,189	1505	229	1982	125	9315	20	923	1432	9	7205	1171	1432	149	178	39	158,639
1971	100,773	14,964	8	1170	18,206	16,481	1769	267	1996	112	10,407	27	1010	1546	17	5280	1013	1159	226	58	22	176,511
1972	110,606	16,213	5	1284	16,597	14,897	1540	268	2018	155	10,825	35	1019	1631	12	5600	1012	1454	194	256	27	185,648
1973	106,695	18,272	5	1335	16,255	13,387	1660	337	2043	162	11,311	41	1162	2019	25	4649	904	1281	208	110	35	181,896
1974	121,451	18,868	27	1455	14,158	14,899	1690	325	2069	151	11,364	26	1267	1955	25	4550	1018	1394	244	194	65	197,195
1975	93,567	18,469	22	1592	15,337	17,810	1817	357	2207	256	11,911	49	1449	2203	26	3851	892	1365	253	195	56	173,684
1976	95,901	18,212	23	1670	15,021	20,615	1905	343	2291	258	11,982	45	1644	2548	27	4700	1143	1462	271	230	59	180,350
1977	114,525	16,798	52	2015	15,780	23,871	1522	298	2301	289	11,962	54	1845	2775	34	4306	1183	1347	286	241	54	201,538
1978	116,596	18,326	21	2045	16,527	26,763	1549	307	2319	217	13,787	66	2040	2938	40	5075	1060	1337	307	286	58	211,664
1979	123,379	19,393	111	2070	18,156	30,075	1503	305	2675	279	12,190	93	2254	3475	34	5166	925	1585	237	300	64	224,269
1980	124,800	19,812	161	2416	18,865	30,124	1548	299	2680	265	13,083	94	2499	3890	42	5959	1347	1674	346	331	71	230,306
1981	125,030	21,339	144	2670	19,947	32,577	1294	264	2816	281	12,170	110	2604	3881	54	5986	1349	1620	360	419	82	234,997
1982	129,000	22,812	252	2689	21,200	33,533	1291	270	3160	310	12,278	134	2710	3872	30	6061	1336	1725	371	385	105	243,524
1983	131,400	22,781	208	2718	23,086	32,871	1372	244	3441	337	11,900	156	2720	4507	35	6019	1357	1592	294	471	76	247,585

Source: Report on out-turn of Scientific and Technical Manpower (Volume-I to IV).
Division for Scientific and Technical Personnel, Council of Scientific and Industrial Research.

Note : * Engineering Graduate from Professional Societies/Institutions.

Table A-11-16

Educational Qualifications of Personnel Engaged in R&D as On 1-6-88

Discipline	Sector	A. Institutional									B. Industrial			
		Sector									Sector			
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	1.	2.	
		DAE	SCSIR	DRDO	ICAR	ICMR	DST	Space	Environment	Other Instt. under the Central Govts.	State Govt.	Public Sector	Private Sector	Total
Ph. Ds.	Nat. Sc.	622	1636	171	248	45	219	0	7	246	205	397	897	4693
	Agri. Sc.	4	79	0	1052	0	3	0	0	27	2697	15	58	3935
	Engg. Sc.	30	338	12	48	0	7	39	0	278	29	262	350	1393
	Med. Sc.	13	7	3	0	12	8	0	0	43	30	6	60	182
	Soc. Sc.	0	10	12	53	8	15	0	0	11	22	0	3	134
	Total	669	2070	198	1401	65	252	39	7	605	2983	680	1368	10337
Post Graduates	Nat. Sc.	1329	1384	527	298	54	138	0	10	768	305	536	1995	7344
	Agri. Sc.	12	55	3	857	0	2	0	0	75	5230	9	113	6356
	Engg. Sc.	208	718	282	91	0	24	294	0	391	156	1532	1705	5401
	Med. Sc.	142	15	4	2	26	51	0	0	272	81	5	132	730
	Soc. Sc.	3	47	36	97	44	134	0	0	45	136	7	20	569
	Total	1694	2219	852	1345	124	349	294	10	1551	5908	2089	3965	20400
Graduates	Nat. Sc.	968	614	455	38	46	96	0	1	387	107	620	2465	5797
	Agri. Sc.	13	64	2	16	0	0	0	0	29	720	7	125	976
	Engg. Sc.	1028	442	741	20	0	28	44	0	1011	242	3563	4341	11460
	Med. Sc.	76	13	1	0	9	6	4	0	214	32	3	124	482
	Soc. Sc.	0	8	0	79	3	51	0	0	33	2	37	118	331
	Total	2085	1141	1199	153	58	181	48	1	1674	1103	4230	7173	19046
Diploma Holders	Engg. Sc.	604	196	922	6	0	0	0	0	704	55	1818	2251	6556
	Med. Sc.	0	0	1	0	0	0	0	0	0	1	0	3	5
	Total	604	196	923	6	0	0	0	0	704	56	1818	2254	6561
Others	Nat. Sc.	0	36	623	212	22	48	0	0	254	126	472	972	2765
	Agri. Sc.	0	38	0	230	0	0	0	0	3	4696	3	69	5039
	Engg. Sc.	158	123	672	16	0	18	0	0	638	14	3260	2359	7258
	Med. Sc.	0	1	3	0	3	0	0	0	15	5	0	68	95
	Soc. Sc.	0	6	1	12	2	7	0	0	10	32	45	63	178
	Total	158	204	1299	470	27	73	0	0	920	4873	3780	3531	15335
Total	Nat. Sc.	2919	3670	1776	796	167	501	0	18	1655	743	2025	6329	20599
	Agri. Sc.	29	236	5	2155	0	5	0	0	134	13343	34	365	16306
	Engg. Sc.	2028	1817	2629	181	0	77	377	0	3022	496	10435	11006	32068
	Med. Sc.	231	36	12	2	50	65	4	0	544	149	14	387	1494
	Soc. Sc.	3	71	49	241	57	207	0	0	99	192	89	204	1212
	Total	5210	5830	4471	3375	274	855	381	18	5454	14923	12597	18291	71679

Source: Data collected and complied by DST

Table A-11-17 R&D Expenditure by Central Ministries/Departments

(Rs. Lakhs)

Ministry/Department	R&D Expenditure		
	1986-87	1987-88	1988-89
Agriculture & Cooperation	1403.83	1557.29	1755.91
Rural Development	286.10	253.00	400.00
Fertilizers	1488.77	1935.61	2230.70
Commerce	485.18	517.95	518.99
Textiles	845.66	939.80	1181.63
Supply	219.13	263.00	327.00
Posts	2.12	5.00	6.00
Telecommunications	4322.68	5003.28	5875.03
Defence	6.48	10.50	20.50
Defence Production & Supplies	6103.62	8391.58	12970.30
Coal	873.06	2015.84	2467.25
Power	684.79	949.68	1475.59
Food	236.11	315.16	1356.17
Civil Supplies	349.82	478.62	516.60
Health	1210.78	1252.38	1517.23
Family Welfare	345.63	882.42	386.02
Home	260.95	499.96	707.18
Education (including Univ.)	3914.24	5025.21	4918.65
Culture	652.30	753.77	821.47
Industrial Development	1315.36	1990.84	4417.68
Petrochemicals	926.36	1177.89	1263.13
Public Enterprises	5954.23	6046.95	6221.20
Information & Broadcasting	94.45	133.66	174.34
Labour	293.82	265.70	355.79
Petroleum & Natural Gas	3503.68	3386.76	3910.63
Steel	2809.26	3130.74	3422.82
Mines	661.77	929.03	1412.03
Railways	1562.40	2358.77	3514.76
Civil Aviation	107.34	134.71	227.07
Surface Transport	533.73	705.75	1124.96
Urban Development	107.49	142.91	189.97
Water Resources	1386.82	1436.43	2352.10
Public Sector under Major Scientific Agencies	678.59	989.99	1545.84
Joint Sector Undertakings	1000.14	1196.95	1749.54
Total	44626.69	55057.13	71234.08

Source: Data collected and complied by DST.

Note: R&D Expenditure by Public Sector Undertakings under Major Scientific Agencies and State Undertakings are also included in the Table.

Table A-11-18 Expenditure on Research and Development by State Governments

(Rs. Lakhs)

State	R&D Expenditure		
	1986-87	1987-88	1988-89
Andaman & Nicobar Island	0.00	0.00	0.00
Andihra Pradesh	1461.38	1484.30	1731.55
Arunachal Pradesh	0.00	0.00	0.00
Assam	469.63	490.49	422.85
Bihar	879.62	806.18	985.49
Chandigarh	0.00	0.00	0.00
Delhi	0.00	0.00	0.00
Dadra & Nagar Haveli	0.00	0.00	0.00
Goa. Daman & Diu	0.00	0.00	0.00
Gujarat	1336.41	1465.88	1616.45
Haryana	552.92	655.37	571.30
Himachal Pradesh	377.51	551.97	656.50
Jammu & Kashmir	178.21	196.03	215.63
Karnataka	881.72	1197.32	1882.03
Kerala	1241.34	1075.91	1533.82
Lakshadweep	0.00	0.00	0.00
Madhya Pradesh	683.20	820.85	1226.13
Maharashtra	3268.40	3771.74	4272.99
Manipur	0.00	0.00	0.00
Meghalaya	0.00	0.00	0.00
Mizoram	0.00	0.00	0.00
Nagaland	0.00	0.00	0.00
Orissa	224.75	256.54	282.98
Pondicherry	0.00	0.00	0.00
Punjab	847.93	1012.95	2791.56
Rajasthan	998.47	1233.66	1388.42
Sikkim	0.00	0.00	0.00
Tamil Nadu	1213.43	1320.66	1501.16
Tripura	0.00	0.00	0.00
Uttar Pradesh	1653.40	1857.86	1978.50
West Bengal	188.00	194.17	233.49
Total	16456.31	18391.85	23290.87

Source: Data collected and complied by DST.

Table A-11-19 R&D Expenditure by Cooperative Research Associations

(Rs. Lakhs)

Association	R&D Expenditure		
	1986-87	1987-88	1988-89
Ahmedabad Textile Industry's Research Association	137.96	157.81	200.42
The Silk and Art Silk Mills Research Association	79.70	193.40	322.40
The South India Textile Industry's Research Association	94.08	107.05	135.34
Bombay Textile Research Association	176.12	202.54*	232.92*
Indian Plywood Industry's Research Association	55.20	94.47	80.86
Tea Research Association	283.74	313.45	348.25
Indian Jute Industry's Research Association	165.53	176.78	2229.07
Wool Research Association	14.46	17.70	9.90
National Council for Cement and Building Materials	539.68	620.63*	713.72*
Indian Rubber Manufacturers Research Association	8.39	17.17	14.00
Automotive Research Association of India	818.74	941.55*	1082.79*
Electrical Research and Development Association	38.79	54.46	78.60
Man Made Textile Research Association	35.67	50.47	52.38
Northern India Textile Research Association	26.13	23.44	52.55
Total	2474.19	2970.92	3553.20

Source: Data collected and complied by DST.

Note: * Estimated

Table A-11-20
Industrial R&D Expenditure on Advertising, New Plant and Machinery Versus Sales Turnover

(Rs. Lakhs)

Year	R&D Expenditure (Rs. Crores)		Advertising Expenditure (Rs. Crores)		Expenditure on New Plant & Machinery (Rs. Crores)		Sales Turnover (Rs. Crores)		R&D Expenditure as % of Sales Turnover		Advertising Expenditure as % of Sales Turnover		New Plant & Machinery Expenditure as % of Sales Turnover	
	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector	Public Sector	Private Sector
1986-87	235.70	269.80	22.23	227.73	1820.63	2216.67	37199.84	41863.75	0.63	0.64	0.06	0.54	4.89	5.29
1987-88	288.47	287.04	26.32	268.87	2284.75	2925.18	41968.02	49838.68	0.69	0.58	0.06	0.54	5.44	5.87
1988-89	361.32	336.55	28.22	286.40	1325.86	1595.04	46662.48	54208.36	0.77	0.62	0.06	0.53	2.84	2.94

Source: Data collected and complied by DST

Table A-11-21 R&D Expenditure by Industry Groups for Public Sector Industries

(Rs. Lakhs)

Sl. No.	Industry Group	Number of Industries	Total R&D Expenditure			R&D Expenditure As % of S.T.O.		
			1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1.	Metallurgical Industries	24	3336.43	4522.59	5229.45	0.37	0.42	0.43
2.	Fuels	5	1620.16	1386.18	1873.71	0.11	0.08	0.11
3.	Boilers & Steam Generating Plants	1	38.03	142.20	22.77	0.40	0.96	0.15
4.	Prime Movers	0	0.00	0.00	0.00	0.00	0.00	0.00
5.	Electronic & Electrical Equipment	21	5116.85	5514.39	6225.01	1.63	1.54	1.55
6.	Telecommunication	12	3306.72	31744.45	3717.15	1.03	1.06	0.93
7.	Transportation	4	174.75	107.16	354.34	0.24	0.14	0.45
8.	Industrial Machinery	7	147.85	78.26	245.32	0.81	0.43	1.01
9.	Machine Tools	3	465.06	614.31	606.73	2.95	3.61	2.68
10.	Agricultural Machinery	2	169.11	159.02	168.19	0.91	0.78	0.62
11.	Earth Moving Machinery	0	0.00	0.00	0.00	0.00	0.00	0.00
12.	Misc. Mechanical Engg. Industries	1	29.00	14.50	25.00	32.95	15.93	26.32
13.	Commercial, Office, Household Equipment	0	0.00	0.00	0.00	0.00	0.00	0.00
14.	Medical & Surgical Equipment	0	0.00	0.00	0.00	0.00	0.00	0.00
15.	Industrial Equipment	1	169.02	155.75	232.19	2.34	1.81	2.21
16.	Scientific Instruments	0	0.00	0.00	0.00	0.00	0.00	0.00
17.	Math. Surveying & Drawing Instrument	1	16.62	16.15	23.67	1.78	2.09	2.47
18.	Fertilizer	6	911.66	1000.35	1142.17	0.45	0.48	0.40
19.	Chemicals (other than fertilizers)	6	685.56	1101.62	1327.99	0.67	0.90	0.96
20.	Photographic Raw Film & Paper	1	85.55	304.91	105.00	0.72	2.22	0.70
21.	Dyestuffs	0	0.00	0.00	0.00	0.00	0.00	0.00
22.	Drugs & Pharmaceuticals	6	420.61	382.70	422.96	1.58	1.60	1.53
23.	Textiles (Dyed, Printed, Processed)	2	58.09	76.06	162.20	0.41	0.50	1.01
24.	Paper & Pulp	1	35.00	29.30	32.50	0.64	0.53	0.54
25.	Sugar	0	0.00	0.00	0.00	0.00	0.00	0.00
26.	Fermentation Industries	0	0.00	0.00	0.00	0.00	0.00	0.00
27.	Food Processing Industries	1	3.35	2.14	4.13	0.08	0.05	0.09
28.	Vegetable Oil & Vanaspati	0	0.00	0.00	0.00	0.00	0.00	0.00
29.	Soaps, Cosmetics, Toilet Preparations	1	3.87	4.25	8.30	0.09	0.10	0.11
30.	Rubber Goods	1	8.14	9.42	7.81	0.70	0.50	0.39
31.	Leather goods & Pickers	0	0.00	0.00	0.00	0.00	0.00	0.00
32.	Glue & Gelatin	0	0.00	0.00	0.00	0.00	0.00	0.00
33.	Glass	1	1.62	1.64	13.65	1.78	1.62	6.04
34.	Ceramics	1	2.44	4.26	6.46	0.25	0.41	0.47
35.	Cement & Gypsum	2	60.81	98.77	157.88	0.26	0.36	0.45
36.	Timber Products	0	0.00	0.00	0.00	0.00	0.00	0.00
37.	Defence Industries	8	6103.62	8391.58	12970.30	5.32	6.60	8.60
38.	Miscellaneous Industries	2	599.97	984.59	1046.67	3.15	4.97	4.31
	Total	121	23569.89	28846.55	36131.56	0.63	0.69	0.77

Source: Data collected and complied by DST.

Note: S.T.O.: Sales Turnover

Table A-11-22 R&D Expenditure by Industry Groups for Private Sector Industries

(Rs. Lakhs)

SL No.	Industry Group	Number of Industries	Total R&D Expenditure			R&D Expenditure As % of S.T.O.		
			1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
1.	Metallurgical Industries	56	1245.16	1397.28	2263.64	0.28	0.28	0.39
2.	Fuels	8	153.17	101.70	168.05	0.48	0.30	0.47
3.	Boilers & Steam Generating Plant	3	45.36	40.46	55.58	0.34	0.34	0.34
4.	Prime Movers	3	304.44	431.52	432.29	1.15	1.22	1.60
5.	Electronic & Electrical Equipment	146	4368.97	4944.23	5577.50	0.86	0.82	1.01
6.	Telecommunication	32	530.33	383.88	548.32	2.05	1.74	1.37
7.	Transportation	35	1858.14	2088.90	2419.25	0.62	0.63	0.69
8.	Industrial Machinery	79	2189.04	2570.49	2720.72	0.31	0.31	0.25
9.	Machine Tools	15	275.92	356.24	329.95	0.28	0.33	0.21
10.	Agricultural Machinery	6	298.04	312.49	493.90	0.48	0.45	0.57
11.	Earth Moving Machinery	1	0.67	0.82	1.70	0.14	0.14	0.25
12.	Misc. Mechanical Engg. Industries	6	87.23	77.78	93.98	0.82	0.65	0.65
13.	Commercial, Office, Household Equipment	6	230.47	238.01	695.61	0.52	0.42	1.03
14.	Medical & Surgical Equipment	2	37.26	39.75	50.25	2.83	2.35	2.06
15.	Industrial Equipment	31	1112.45	211.27	247.43	9.73	2.04	1.89
16.	Scientific Instruments	11	153.95	160.04	203.35	1.09	1.06	0.86
17.	Math, Surveying & Drawing Instrument	2	34.60	36.18	28.83	6.78	6.03	3.93
18.	Fertilizer	2	92.51	155.81	223.60	0.22	0.40	0.48
19.	Chemicals (other than fertilizers)	156	4053.22	4395.94	5336.61	0.95	0.89	0.97
20.	Photographic Raw Film & Paper	2	27.92	10.94	15.30	1.61	0.56	0.68
21.	Dyestuffs	10	359.50	434.39	518.44	0.76	0.92	0.93
22.	Drugs & Pharmaceuticals	78	4216.21	4719.17	5177.49	1.82	1.76	1.60
23.	Textiles (Dyed, Printed, Processed)	27	1216.38	1191.76	1213.64	0.33	0.24	0.35
24.	Paper & Pulp	12	163.13	150.99	166.21	0.37	0.33	0.35
25.	Sugar	13	334.59	439.47	418.06	0.48	0.54	0.44
26.	Fermentation Industries	5	38.49	37.98	54.88	0.13	0.12	0.19
27.	Food Processing Industries	20	927.89	974.99	1091.58	1.59	1.32	1.34
28.	Vegetable Oil & Vanaspati	2	13.52	18.78	19.61	0.06	0.09	0.08
29.	Soaps, Cosmetics, Toilet Preparations	7	867.68	836.55	840.56	0.64	0.52	0.50
30.	Rubber Goods	13	628.42	763.90	966.61	0.31	0.30	0.35
31.	Leather goods & Pickers	0	0.00	0.00	0.00	0.00	0.00	0.00
32.	Glue & Gelatin	3	44.15	13.83	29.66	0.24	0.06	0.11
33.	Glass	4	38.61	35.15	35.28	0.55	0.54	0.45
34.	Ceramics	10	267.32	281.40	376.97	1.19	1.19	1.26
35.	Cement & Gypsum	3	525.89	572.34	596.36	0.57	0.59	0.56
36.	Timber Products	2	23.03	50.74	34.00	0.34	0.67	0.42
37.	Defence Industries	0	0.00	0.00	0.00	0.00	0.00	0.00
38.	Miscellaneous Industries	17	216.45	228.75	210.05	0.33	0.14	0.13
	Total	828	26980.11	28703.92	33655.27	0.64	0.58	0.62

Source: Data collected and complied by DST.

Note: S.T.O.: Sales Turnover

Table A-11-23
Selected Key Indicators Major Research Projects Funded by University Grants Commission in Science and Engineering/Technology by Subjects (1974-1988)

(Number)

Subjects	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*	1988*	Total	%
Physics	10	63	36	44	28	37	19	64	54	41	21	28	12	45	29	531	16.03
Chemistry	18	100	58	72	46	81	28	60	69	69	53	107	53	49	94	957	28.90
Biosciences	9	88	101	85	79	126	57	163	92	92	108	157	133	N.A.	55	1345	40.60
Geology	2	23	4	14	8	3	14	7	19	8	12	11	1	1	4	131	3.95
Geography	N.A.	N.A.	18	10	2	3	7	4	7	2	12	8	7	N.A.	11	81	2.44
Mathematics & Statistics	N.A.	18	3	4	4	10	5	8	14	11	16	24	9	7	6	139	4.19
Engineering & Technology	N.A.	N.A.	33	22	10	10	10	18	2	2	22	N.A.	N.A.	N.A.	N.A.	129	3.89
Total	39	292	243	251	177	270	140	324	257	225	244	335	215	102	199	3313	100.00

Source: 1. Bulletin of Higher education, University Grants Commission, December 1984.
2. Annual Report of University Grants Commission 1982-83, 83-84, 84-85 and 1985-86.
3. * University Grants Commission (unpublished estimated data)

Note : 1. N.A. = Not available.