CONFIDENTIAL

REPORT OF THE REVIEWING COMMITTEE

OF THE

INDIAN INSTITUTE OF SCIENCE

BANGALORE

1971

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New Delhi
Dated 23 August 1971

From

Dr. T.R. Seshadri, F.R.S.
Emeritus Professor
Department of Chemistry
University of Delhi
Delhi

To

The President of India
New Delhi

Dear Mr. President,

I have the honour to present herewith the report of the Reviewing Committee, appointed in terms of the Government of India Resolution No.F.8-12A/64/T.6 dated 10 September, 1969 to examine the working of the Indian Institute of Science, Bangalore, in all aspects.

Yours faithfully,
Sd/-
(T. R. SESHADRI)

C O N T E N T S

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1. CONSTITUTION OF THE REVIEWING COMMITTEE, TERMS OF REFERENCE, AND BRIEF OUTLINES OF THE MODUS OPERANDI

1.1 We, the Members of the Reviewing Committee of the Indian Institute of Science, Bangalore, have the honour to submit our report.

1.2 The Committee was appointed by the President of India in his capacity as the Visitor of the Indian Institute of Science and in exercise of the powers vested in him under Clause 7.2(a) of the Scheme for the administration and management of the properties and funds of the Indian Institute of Science.

1.2.1 The Committee consisted of:

Prof. T.R. Seshadri, F.R.S. (Chairman)
Emeritus Professor
Department of Chemistry
University of Delhi, Delhi

Dr. B.K. Bachhawat (Member)
Professor of Biochemistry and Director,
Neurochemistry Laboratory
Department of Neurological Sciences
Christian Medical College & Hospital
Vellore 4

Dr. A.K. Kamal (Member)
Professor and Head
Electronics & Communication Engineering
Department
Roorkee University, Roorkee, U.P.

Dr. G.S. Laddha (Member)
Director
A.C. College of Technology
Madras University, Guindy, Madras 25

Prof. K.B. Menon (Member)
Head of the Electrocal Engineering
Department
Indian Institute of Technology
P.O. Kharagpur Technology, Kharagpur

Dr.S.R. Valluri (Member)
Director
National Aeronautical Laboratory
Kodihalli, Post Bag No. 1779, Bangalore 17

Dr.A.R. Verma (Member)
Director
National Physical Laboratory
Hillside Road, New Delhi 12

Dr. W.H. Pickering (Adviser)
Director
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California, U.S.A.

Prof. M.J. Lighthill, F.R.S. (Adviser)
Department of Applied Mathematics &
Theoretical Physics
University of Cambridge
Silver Street, Cambridge, England

Prof. M.M. Shemyakin, Sc.D. (Adviser)
Member, USSR Academy of Sciences
Director, Institute for Chemistry
of Natural Products
USSR Academy of Sciences
Ul. Vavilove 32, Moscow, USSR

Shri G.N. Vaswani (Secretary)
Deputy Educational Adviser (Tech.)
Ministry of Education & Social Welfare
Government of India, New Delhi

1.2.2 The terms of reference to the Committee were:

(i) to review the working of the Institute in all aspects as a centre of advanced studies and research in science, engineering and technology;

(ii) to advise on the broad lines of development of the Institute, specially in regard to cooperation between departments in the light of new inter-disciplinary areas of science and technology and on priorities of development; and

(iii) to make recommendations on any other aspects regarding the organisation and function and reorientation of the Institute that are considered necessary for its future development.

1.2.3 The Committee held a preliminary meeting in Delhi on the 12th of December, 1969. Immediately after the preliminary meeting, all the Members of the Court and the Council of the Indian Institute of Science, as well as eminent educationists, scientists and experts were requested to send their comments and, if necessary, to meet the Committee and discuss with them regarding the future development of the Institute. A list of Members of the Court, the Council and others, who sent their comments, is given in APPENDIX A.

1.2.4 The Committee first assembled at the Indian Institute of Science, Bangalore, on 14 January, 1970 and, during the course of the review, we obtained the views of the Director, members of the staff, representatives of the students, eminent scientists, educationists and others through correspondence, personal interviews and informal discussions.

1.2.5 The Committee met the Senate on 20 January and the Council on 14 February, 1970 in Bangalore and discussed the various problems with them. The Committee visited all the departments of the Institute, the Library, the Mechanical Engineering Workshop, the Central Stores, the Students' Hostels, the Gymkhana, the Staff Club, etc. The Committee also visited Madras, Vellore, Delhi and Bombay. Dr. Kamal visited the Institute of Radio Physics and Electronics, Calcutta. The Committee made visits to various industries and institutions in Bangalore and other places. Number of sessions held and the list of various places, industries and institutions visited are given in APPENDIX B and persons interviewed are given in APPENDIX C.

1.2.6 The authorities of the Institute, as well as the representatives of the various organisations at the Institute supplied the Committee a number of documents, which are listed in APPENDIX D.

1.2.7 The work of the Committee was greatly assisted and facilitated by a series of useful notes prepared by the Director and reports from the departments and by memoranda submitted by the staff and student representatives referred to above. They provided a most helpful background for the visits and discussion meetings. We are most grateful for the material.

1.2.8 The Committee also had received many confidential replies from members of the Court and the Council, ex-students of the Institute and others, in response to letters addressed to them about their views on the work and the future development of the Institute.

1.2.9 We wish to express our thanks to the Director for the hospitality extended to us throughout our stay at the Institute.

1.2.10 We also wish to express our thanks to all the members of staff and the student bodies who assisted us during our visits and discussions and for the objective manner in which they made their representations and responded to many questions asked of them.

1.2.11 Academician Shemyakin, Adviser to the Committee, was able to come to India and visit the Institute and other places with the Committee from 24 January to 21 February, 1970. His report is given in APPENDIX E.

We were deeply grieved to know about the untimely death of Academician Shemyakin after his return to the U.S.S.R. His contributions to the deliberations at the Committee drawing upon his vast and mature experience were most valuable not only in relation to the disciplines of Chemical and Biological Sciences, but also in relation to the wider perspective in which the work of the Institute in future was projected.

Prof. Pickering was also able to come to India and visit the Institute and other places with the Committee, from 9 to 21 February, 1970. His reports are given in APPENDICES F & F-1.

We are grateful to the Advisers for their valuable advice and association with the deliberations of the Committee.

Due to preoccupation, Dr. M.J. Lighthill, the third Adviser, was unable to come to India.

1.2.12 Finally, we express our appreciation of the work of Mr.G.N. Vaswani as Secretary of the Committee. We highly value the arrangements he made and the help he gave in the preparation of this report.

Sd/-
(T.R. Seshadri)

Sd/-
(B.K. Bachhawat)

Sd/-
(A.K. Kamal)

Sd/-
(G.S. Laddha)

Sd/-
(K.B. Menon)

Sd/-
(S.R. Valluri)

Sd/-
(A.R. Verma)

2. BRIEF HISTORY

2.1 In 1896, the Founder, J.N.Tata, conceived the creation of a research and teaching Institution devoted to original investigations and post-graduate courses chiefly devoted to science and industry mainly for the promotion of the industrial and material welfare of the country.

2.2 The Institute was founded in 1909 as an Institution of higher learning devoted to research and teaching in science and technology.

2.3 A succession of Reviewing Committees appointed by the Government of India have helped the Institute in its development both in the creation of an atmosphere and the spirit of free enquiry necessary to intellectual activity and also given it the necessary guidance in maintaining close relevance to the national development.

2.4 The main event which have had a bearing on the character of the Institute are given below:

2.4.1 1910 - Scheme of organisation of the Institute

The first Director, Dr. Morris Travers, proposed in 1910 that the Institute be a homogeneous research and teaching institution devoted to pure and applied sciences with interdependent departments, taking special note of particular needs of India.

2.4.2 1921 - The Pope Committee

The Committee, noting the relative scarcity of high calibre training for research in India, stressed the importance of placing increased emphasis on pure science for broadening the intellectual horizons. The Committee considered the Institute to be unique in character in India and recommended that the regulations be amended to include instruction in addition to original investigations as an object of the Institution.

2.4.3 1931 - The Sewell Committee

The Committee suggested placing an increased bias towards those lines of research that had relevance to existing industries or might be expected to open up new ones in the country. The Committee especially emphasised the All-India status of the Institute and considered it distinct from universities.

2.4.4 1936 - The Irvine Committee

The Committee suggested to the Government to define more precisely the aims and objects of the Institute and suggested that:

1. the aim of the courses of instruction should be preparation of workers as investigators in science and technology; and

2. the research in pure and applied sciences should have special emphasis in those investigations which would directly benefit industry in India.

2.4.5 1948 - The Egerton Committee

This was the first post-independence review. The Committee noted the broad canvas that had opened up and the role of the Institute in the harnessing of science in the fullest measure to solve the national problems and develop natural resources. The original concept of the Founder was broad enough to embrace these challenges.

2.4.6 1955 - The Ghosh Committee

The Committee considered the Institute's role to be that of a higher technological institute principally concerned with the post-graduate teaching and research.

2.5 Authorities of the Institute

2.5.1 The Court, the Council, the Finance Committee, the Senate and the two Faculties, namely the Science Faculty and the Engineering Faculty, are mainly concerned with the administration, organisation and coordination of general academic and other related matters.

2.5.2 The Court reviews the activities of the Institute annually and may make recommendations to the Visitor or to the Council, on matters relating to the aims, administration and finances of the Institute.

2.5.3 The Council is the executive authority of the Institute and is wholly concerned with the proper administration and management of the Institute.

2.5.4 The Finance Committee examines and scretinises the Institute budget, considers all financial proposals, periodically reviews Institute finances and generally advises the Council on all financial matters.

2.5.5 The Senate is the academic authority concerned with all the academic and related matters.

2.5.6 The Faculties function as advisory bodies to the Senate. They initiate, formulate and consider all the academic matters, including the formulation of courses, programmes, admissions, appointment of examiners and make recommendations to the Senate.

2.6 Finances

2.6.1 Since 1956, the development of the Institute has been closely related to the Five-year Plans. The Institute is financed by the Government of India and the University Grants Commission. The former provides the maintenance grant as an average annual Block (non-plan) (for the five-year plan periods), while the latter provides the developmental grants which include all the non-recurring expenditure towards buildings, equipment, etc., and also recurring expenditure on new projects sanctioned/approved during the plan periods.

2.6.2 The Block is normally reviewed for (each plan) a five-year period and provides only for the recurring expenditure. The release of grant by the Ministry of Education is on a quarterly basis.

2.6.3 The block grant is assessed keeping in view the recurring expenditure incurred during the previous block period as committed expenditure and increased by the liability for developmental recurring expenditure in the previous plan period. The normal increments towards the salaries, including any increases in allowances, increases in cost of materials, etc., are provided for. The Block does not envisage any increase in allowances, pay scales, and/or value of scholarships, etc. The impact of such increases is actually determined from time to time and additional annual grants are made available to compensate the same.

2.6.4 The block grant given by the Government of India represents the net average requirements, assessed after deducting "other receipts" (an expression in vogue at the Institute which includes receipts from all sources other than the block, grant - viz., from the endowed properties in Bombay, grants from the State Governments, income from tuition fees, hostel and other fees, rents, etc.) from the gross estimated expenditure for the block period.

2.6.5 To facilitate a unified view of the entire activity, including development of the Institute, the Ministry of Education and the University Grants Commission jointly appoint Committees for fixing the block and also the developmental grants for plan projects and related finances.

It is now understood that under the amended University Grants Commission Act, the Commission will be solely responsible for both the developmental and maintenance grants. The Committee feels that this is a very necessary step.

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3. SALIENT FEATURE OF THE INSTITUTE GROWTH SINCE THE LAST REVIEW

3.1 The last Reviewing Committee, i.e., the Ghosh Committee, submitted its report in April 1956.

3.2 In pursuance of this report, over the last 14 years the areas of research and teaching have been changed. They have been transformed in a broad sense through an evolutionary process rather than by any quantum jumps.

3.3 The period 1956-61 was mainly one of consolidation of the academic and research activities of the Institute.

3.4 In 1958, pursuant to the recommendations of the Ghosh Committee, the Institute acquired powers to award degrees on being declared to be an institution of higher learning deemed to be an university under the University Grants Commission Act of 1956.

3.5 Some important aspects of the growth of the Institute since 1956 may be mentioned. Over the last 15 years, areas of research and training have been changed. The number of departments and sections functioning - inclusive of the Library - in 1956 was 17. In 1961, on the advice of an Expert Committee, the Department of Chemical Technology & Chemical Engineering was reorganised as the Department of Chemical Engineering. In 1963, the four Sections of the earlier Power Engineering Department were reorganised as Departments of Electrical Engineering, Mechanical Engineering, Civil & Hydraulic Engineering and High Voltage Engineering. In 1964, the Central Instruments & Services Laboratory came into being. In 1965, on the advice of the Mudaliar Committee on Management Education, the Sections of Economics & Social Sciences and Industrial Engineering & Administration were merged to form the Department of Industrial Management. In 1968, the Fermentation Technology and Pharmacology Laboratories were merged and reorganised as the Microbiology & Pharmacology Laboratory. At present, there are 19 departments/ sections, inclusive of the Library.

3.6 Figures 1, 2, 3 and 4 show the growth pattern in the number of students, staff, the academic conferments and research publications of the Institute. It will be noted from these figures that there has been significant increase over the years in the research and master's degree students' strength, whereas B.E. degree students' strength has remained essentially constant. Part-time Diploma Courses were discontinued in the year 1965 and a Post-graduate Diploma Course was started in 1967. Significant additions have been made in the cadre of professors and assistant professors, as also

lecturers and technical and research assistants from 1963 onwards. Conferments of degrees show a substantial increase from 1957 to 1962 with a brief decrease in the conferments in 1964 on account of the reorganisation of the Master's degree courses. The total annual conferments seem to have stabilised between 320 and 350 in the recent years. The number of publications have continued to increase from about 180 in 1957-58 to about 350 per year during the last 5 years. It is noted that while there has been a decrease in the publications in the Science Faculty, there has been an increase in the publications in the Engineering Faculty, thus showing the result of giving added importance to building up engineering sciences in the Institute.

3.7 The student strength has stabilised around 1000.

3.8 The pyramidal structure obtained earlier in the staff pattern was gradually changed by obtaining relatively greater increase in the number of senior staff at the level of Professors and Assistant Professors since 1963. The following table indicates the growth of staff and students in the various categories over the last 16 years.

GROWTH OF STAFF AND STUDENTS IN VARIOUS CATEGORIES 1955-1971

Year	Academic & Scientific staff upto Research/ Technical Assistants	Supporting Staff				Total Staff	Students
		Technical	Administrative	Maintenance	Total Supporting staff		
1	2	3	4	5	6	7	8
1955-56	135	172	82	283	537	672	356
1956-57	137	183	84	284	551	688	401
1957-58	155	187	85	293	565	720	419
1958-59	158	201	94	299	594	752	630
1959-60	168	207	103	319	629	797	717
1960-61	193	215	109	318	642	835	791
1961-62	182	225	107	311	643	825	819
1962-63	166	240	114	313	667	833	820
1963-64	171	247	124	311	682	853	877
1964-65	180	252	133	315	700	880	855
1965-66	230	303	147	348	798	1028	868
1966-67	251	325	159	353	837	1088	885
1967-68	254	332	164	369	865	1119	897
1968-69	285	323	160	366	849	1134	921
1969-70	289	349	163	380	892	1181	991
1970-71	332	357	170	377	904	1236	965
Sanctioned	412	404	171	446	1021	1433	1000

3.9 The out-put during 1956-1971 is as follows :

Number of research papers/publications:	4355
Ph.D.	392
M.Sc.	188
M.E.	1322
Post-graduate Diploma ...	818
B.E.	685

3.10 Among the other developments may be mentioned :

a) new material for instruction and modern methods of instruction, testing and examinations;

b) efforts in the direction of introduction of formal courses of instructions in most of the departments;

c) special attention to the fabrication and development of research equipment and creation of a central facility for this purpose;

d) initiation of some inter-disciplinary projects;

e) some deliberate promotive steps to encourage consultancy work on the part of the individual faculty members; promotion of institutional consultancy projects on a wider scale. A beginning in this direction was made in 1965 with an initial fund of Rs.50000, which has grown to Rs. 12.32 lakhs by 31 March, 1971. The Institute during this period undertook in all 103 consultancy projects, some of which have resulted in significant assistance to industry.

3.11 These results were achieved by the implementation of the last Reviewing Committee's recommendations and additional financial inputs into the Institute. These additional financial inputs were based on the recommendations of other ad hoc committees appointed by the Government/University Grants Commission to assess the Institute requirements. Given below are the details of the financial inputs and important recommendations of these ad hoc committees. This intervening period may be conveniently divided into two blocks: i.e., upto 1961 (Second Plan period) and from 1961-66 (Third Plan period).

3.12 The implementation of the several recommendations of the Ghosh Committee as approved by the Visitor was virtually completed in 1961. The results of these implementations are

shown in the figures already mentioned. We give below a summary of the financial inputs :

	Position in 1955	Reviewing Committee recommendations 1958	Position in 1961
1. Finances		(Rupees in lakhs)	
Recurring Expenditure		Additional	
Staff salaries, etc.	Rs. 16.73	Rs. 2.60	Rs. 23.89
Working Expenses	Rs. 11.64	Rs. 1.72	Rs. 14.42
Scholarships	Rs. 0.48	Rs. 6.42	Rs. 6.41
Total Recurring	Rs. 28.85	Rs. 10.74	Rs. 44.72
Non-recurring Expenditure	Rs. 30.21 from A.I.C.T.E. Schemes	Rs. 31.00 for five years sanctioned in 1958	Rs. 21.34 paid
2. Instrument Frbrication & Central Instruments & Services Laboratory	-	Recommended by the Reviewing Committee	All departments placed special emphasis on instrument fabrication. C.I.S.L. established in 1963-64.
3. Discretionary Fund at the disposal of the Director	-	Recommended by the Reviewing Committee : Rs. 1.50 lakhs per annum (average)	A fund of Rs. 1.00 lakh annually credited by the Council in 1957

3.13 The Thacker Committee appointed by the All-India Council for Technical Education recommended to the Government in 1961 that all post-graduate courses in Engineering and Technology should have two broad components :

a) acquisition of competence in analytical methods and mathematical skills, knowledge in modern concepts of Materials Science, training in the use of electronic instrumentation for research and rigorous training in the scientific bases of the chosen field of engineering; and

b) training in the methods of research and design by the actual execution of a project leading to a dissertation by the post-graduate students in engineering.

3.14 Following these recommendations, all the post-graduate courses at the Institute were reorganised into two-year courses. A salient feature of this reorganisation is the compulsory study of the core subjects, viz., Applied Mathematics, Materials Science and Electronics/Instrumentation.

3.15 In the following table, a summary exposition of the development grants sanctioned for the Third and the Fourth Plan proposals of the Institute, as also the carry-over portion of the Third Plan grants into the Fourth Plan is given.

		Equipment	Building	Others	Grand Total	Remarks
		RUPEES IN LAKHS				
III Plan Grants	For reoriented M.E. degree courses	39.23	12.48	20.00*	71.71	*Computer
	For Science Departments	19.38	7.35	22.57+	49.30	+Hostel Blocks
	Total	58.61	19.83	42.57	121.01	
IV Plan Grants	Carry-over Component from III Plan and other earlier grants	79.93	58.75	18.52@	157.20	
	Additional Grants	57.91	61.34	88.88&	208.13	
	Total	137.84	120.09	107.40	365.33	

& Books Rs 8.80 lakhs
Inst. Rs 6.00 "
11 KV Rs 3.00 "
Aug. W. Rs 5.00 "
CS/GH Rs 1.75 "
Health Centre Rs 1.00 "
Trans. Rs 0.45 "
Tele. Rs 3.00 "
Amen. Rs 1.00 "
Rec. Rs 58.88 "
Rs 88.88

@ Staff & W.E. Rs 12.17 lakhs
11 KV change-over Rs 6.35 lskhs
Rs 18.52

3.16 Block Grant: Subsequent to the Ghosh Committee review, the Block Grants of the Institute have been paid as under :

Period	Actual grants released Rupees in Lakhs
1958-59	39.28
1959-60	37.18
1960-61	40.00
1961-62	44.39
1962-63	41.69
1963-64	60.62
1964-65	56.15
1965-66	67.17
1966-67	96.23
1967-68	104.76
1968-69	119.06
1969-70	115.60
1970-71	119.14

For the years 1963-64 to 1965-66, the block grant was paid by the University Grants Commission, but subsequent to 1965-66, the block grant was being paid by the Ministry of Education, consequent on the advice of the Law Ministry that the University Grants Commission did not have the power to pay maintenance grants to institutions which are deemed to be universities. The block grant for the period 1971-74 is yet to be fixed. The requirements, however, are being assessed by a committee appointed by the Ministry of Education. Rs 7.00 lakhs was given during 1967-68 towards the Central Stores and Rs 1.35 lakhs during 1969-70 towards the expenditure on the Reviewing Committee

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4. FACTUAL INFORMATION - 1970-71

4.1 FACULTIES/DEPARTMENTS/FUNCTIONAL UNITS

4.1.1 The Engineering and Science Departments, as well as the functional and other service units in the Institute are given below :

I. Science Faculty

1. Applied Mathematics
2. Biochemistry
3. Inorganic & Physical Chemistry
4. Microbiology and Pharmacology Laboratory (includes Animal House)
5. Organic Chemistry
6. Physics
7. Foreign Languages

II. Engineering Faculty

1. Aeronautical Engineering
2. Chemical Engineering (includes Gas & Steam House)
3. Civil and Hydraulic Engineering
4. Electrical Communication Engineering
5. Electrical Engineering
6. High Voltage Engineering
7. Internal Combustion Engineering
8. Mechanical Engineering
9. Metallurgy
10. Central Instruments and Services Laboratory
11. Industrial Management

III. Other Units and Services

1. Library
2. Administration
3. Services & Maintenance, including Central Stores and other services
4. Amenities, including Dispensary, Staff Club, Hostels, Guest House, etc.

4.2 Staff

The position of academic and non-academic staff sanctioned and in position is as follows:

The position of Academic Staff as on 31.3.1971 is as follows:

		In Position		
	Sanctioned	Substantive	Personal posts	Overall
Professors	46	37	20	57
Assistant Professors	106	84 - 12*	+ 7	79
Lecturers	126	101 - 15**	-	86
Technical/Research Assistants, etc.	134	110	-	110
	412	332 - 27	+ 27	332
Non-academic Staff:	1021	904		
Grand Total	1433	1236		

Note: Assistant Professors: 84 (-) 12*

The figure (- 12) represents 12 out of the 84 Assistant Professors on promotion as Professors/Associate Professors. This number is included in 20 shown under personal posts against Professors.

Lecturers : 101 (- 15) **

The figure (-15) represents 15 Lecturers in Substantive posts now on promotion. Of these, 7 are on promotion as Assistant Professors (vide figure 7 against Assistant Professors) and 8 on promotion as Professors/Associate Professors. These 8 Lecturers and 12 Assistant Professors on promotion referred to above constitute the figure 20 under personal posts against Professors.

4.3 The number of students is as follows:-

	As on 31-3-71
B.E.	239
M.E./M.Tech./P.G. Diploma	391
Research Scholars	283
Post-doctoral Research Fellows	52
Total	965

4.4 Total Recurring Expenditure (Block and Plan) incurred during 1970-71:

i) Salaries :	Academic Staff		Rs 42.40 lakhs
	Non-academic Staff		Rs 39.50 lakhs
	Total		Rs 81.90 lakhs
ii) Interim Relief :			
	Academic Staff	Rs 1.24	Rs 3.81 lakhs
	Non-academic staff	Rs 2.57	
iii) Working Expenses			Rs 48.07 lakhs
iv) Scholarships, Fellowships - expenditure incurred			Rs 18.44 lakhs
	Grand Total		Rs 152.22 lakhs

(Department-wise breakup given in Appendices)

Staff (as on 31-3-1970)	Appendix G
Students -do-	Appendix H
Recurring Expenditure (Block and Plan for 1970-71)	Appendix I
Accommodation	Appendix J

5. REVIEW

Objectives and early developments

5.1 In 1915, Sir Dorabji Tata, in speaking of the Institute of Science, drew attention to his father's view of what the foundation should be:

> "He intended it not to be a glorified technical Institute, turning out a few indifferent chemists and electric operators, mainly intent upon making a living for themselves, but a sort of nursery and training ground to inculcate the spirit of original and specific research in different branches of science and industry, which might ultimately serve as a means for the development and prosperity of the country."

5.2 The objects clause of the Institute clearly reflects these ideals and goals when it says that the main object is:

> "to provide for advanced instruction and to conduct original investigations in all branches of knowledge and in particular in such branches of knowledge as are likely to promote the material and industrial welfare of India; to cooperate as far as possible with such recognised institutions as exist or are founded in future for cognate objects in India."

The sense of direction and social purpose that the objects clause highlights remains as refreshingly relevant to-day as when the Institute was started sixty years ago.

5.3 In the intervening decades, significant changes have taken place in the country, especially the achievement of independence and following it, the country's commitment to improve the lot of its people by the conscious application of the methods of science and technology for the development of the nation.

5.4 It will be relevant to briefly mention the developments that have taken place at the Institute during the last 60 years : the educational challenges that the Institute faced and the evolution of its character, the achievement of independence and the planned development of science and technology in the country.

5.5 The first Director planned it as a homogeneous research and teaching institution devoted to pure and applied sciences with interdependent departments, taking special note of the particular needs of India.

5.6 The Pope Committee (1921) considered the Institute to be unique in character in India. It recommended that both instruction and original investigation should be considered as coming within the objects of the Institute. The Sewell Committee (1931) emphasises the all-India status of the Institute and considered it distinct from universities. The Institute, on the advice of the Irvine Committee (1936), sharpened its definition of its aims and objects: the courses of instruction should be preparation of workers as investigators in science and engineering; its research should place special emphasis on those investigations which directly benefit industry in India.

5.7 The fourth review (Egerton Committee - 1948) was the first post-independence review. The Ghosh Committee (1955) suggested a more intensive use of the Institute facilities by larger number of students, building up certain technical facilities as central facilities and recommended that the Institute should be empowered to award degrees.

REVIEW

5.8 The present review is taking place after a lapse of fifteen years. Over the years, the Institute in the course of its functioning has interpreted its role in the development of industries and to the advancement of the nation as an educational role. Since 1958, it came under the University Grants Commission Act for the purpose of awarding degrees and considerable developments have taken place during the Third and Fourth Plan periods.

5.9 With the benefit of periodical reviews, the Institute has attempted to keep its work relevant to the needs of the country as interpreted by the successive Committees. In interpreting the objects of its great Founder, the Institute has attempted to strike a balance in the correlation of science, technology and industry. Of the four-fold characteristics of such a correlation, namely:

(a) definition of problems;
(b) application of existing knowledge;
(c) unfolding of new knowledge; and
(d) application of the results;

the Institute has emphasised the third characteristic, though it has played a role in the other three as well with varying emphasis over the years.

5.10 The Institute has played an important role in the past in supplying man-power for teaching and research in other institutions, research establishments, government organisations and industries. For a very long time, the Institute has been looked upon as a main source of supply of highly trained persons. Among others, a good number of senior academic staff of the Institute of Technology and National Laboratories were drawn from this Institute. It is important that the Institute continues to render service in this vital area in the future as well.

5.11 While the Institute has given a strong educational interpretation to its role under the objects clause, it has not neglected its duty to assist industry, though for complex reasons this has been rather weak. In recent years, it has received an encouraging measure of attention. We note that in the last few years a number of industries have approached the Institute for consultancy services and the Institute has been progressively increasing its assistance to industry. The income from the consultancy service, while not high, has shown in recent years an upward trend. We are happy to note this trend and we commend the initiative of the Institute in nurturing this activity of industrial liaison.

5.12 The Institute has been attracting a highly talented student body. With a forward looking and flexible academic programme, primarily concerned with teaching the scientific method of pursuit of knowledge and properly funded, the Institute can produce scholars that can be second to none.

5.13 For a projection of the Institute's role into the future, we feel that it is important to establish more dynamic relation between the Institute's plan and the nation's needs for a planned development of its economy. In such a projection of the Institute's role, we must, on the one hand, clearly recognise the character of modern science and technology and the developments that have taken place in the country in the organisation of science and technology and, on the other, highlight the present drawbacks at the Institute, the removal of which alone will enable the Institute to play its full role in the future.

5.14 In the days gone by, technology paced scientific progress and developments. A classic example is the invention of the steam engine. To-day, new science is pacing technology. Inventions like transistors and integrated circuits would not be possible without the prior establishment of the scientific basis. It is important that the Institute keeps in view this fundamental change and suitably plan its training and research programmes for the future.

5.15 Regarding the organisation of science, significant changes have taken place in the country. Firstly, there is the science policy resolution, which the country had adopted. In the process of industrialisation, the nation is making conscious efforts to give the industries the benefit of the developments in science and technology. A number of science based industries in the public sector have been established, many of which are in and around Bangalore. There has been development of education in science/technology and also research in the Universities and Institutes of Technology. A large number of National Laboratories have been established. The Institute has to take note of this science environment in resetting its sights for the future.

5.16 In the above context, we note certain handicaps under which the Institute has been functioning.

5.17 Obsolescence of equipment

There has been a tremendous change in the requirements of research laboratories in the post-war years. Whereas earlier, research laboratories used to construct their own equipment, in post-war years instrumentation for research purposes developed to a very great extent and there are industries elsewhere in the world to produce them. On the other hand, in India research institutions were unable to build such equipment or buy them from within or outside the country. There has, therefore, been a serious gap in the availability of modern equipment for research, specially arising out of lack of foreign exchange. In the age of sophisticated techniques in scientific research and technology, the Institute laboratories exhibit serious inadequacy of modern equipment. We, however, note that in the last two years or so, the Institute has succeeded in obtaining some modern equipment. It is also necessary that simultaneously the Institute should be enabled to build up the technical resources for designing and fabricating research equipment.

5.18 In our examination of the requirements of the various departments and during our visits to the several laboratories, we noticed items of equipment being requested by departments, while similar items not fully used were available in other departments. While for routine items of equipment like vacuum tube voltmeters, oscilloscopes, etc., duplication is unavoidable and in fact essential, for specialised expensive pieces of equipment duplication is to be avoided. In fact, we feel that such equipment should be treated as common facility for the different user departments. We had discussions on this point with the Director and the academic

staff and we were happy that there was general agreement on these points, and the Director has accordingly revised the list of equipment and has presented it in two parts, (i) specialised items of equipment, which would be housed in a separate laboratory as common facility; and (ii) items of equipment needed for individual department's work. We generally accept the revised list and recommend that the amount needed should be provided together with the foreign exchange component. The requirements are assessed at Rs 260 lakhs for the items coming as common facility and Rs 125.35 lakhs for departmental requirements. We would further like to add that it may perhaps become necessary to locate some of the common equipment in one or other existing departments as a matter of convenience. However, their utilisation should depend upon the recommendation of the Users' Committee constituted to plan and organise the location and use of such equipment. In general, we may add that a central building complex for these specialised items of equipment would play the crucial role in the Institute growth in the Seventies. In a very real sense, this recommendation forms one of the core recommendations of the Committee for the growth of the Institute in the Seventies.

5.19 Fabrication facilities

The fabrication facilities at the Institute at present are in a relatively run-down condition. In view of the importance of building as many items of equipment as possible at the Institute, we consider that the provision of modern facilities for fabrication is of great importance. We have recommended that a sum of Rs 30 lakhs is to be provided for this purpose, with about Rs 7.5 to Rs 10 lakhs being used for establishing a precision machine shop.

Functional regrouping of Institute disciplines

5.20 At present, we note that the Director functions on the administrative side through the Registrar and on the academic side through the Deans - one for the Faculty of Science and one for the Faculty of Engineering. There is also the Senate comprising inter alia all Professors at the Institute. The Senate is the body concerned with all academic policies. The Director himself is under the general guidance and direction of the Council and the Court of the Institute.

5.21 In our discussions with the Director, the Senate and the Council, we felt that the present structure was not viable for the task ahead. We understand that the Institute is considering the question of regrouping the various departments into divisions instead of two Faculties as at present. We feel that this is a step in the right direction.

5.22 In the scheme now conceived, each division may have a chairman or a dean by rotation. We expcet that in general he will be concerned with coordination of the research and teaching programmes of the division as a whole, a function which is not at present being done by the Deans for the departments or their Faculties. We further conceive that the Director would be functioning through the Chairmen/Deans of the various divisions by the constitution of a committee of Chairmen/Deans for overall operations. We also recognise the need for a Dean of Students Welfare, so as to make the Institute a closely knit corporate body. We conceive that the students will now be admitted to the division with all the advantages it accrues to the student in respect of courses available to him and faculties for research instead of being restricted to one department only.

5.23 In the light of the proposed reorganisation of the Institute into academic divisions, it would appear desirable for the Council to constitute a scientific advisory committee, including outside experts to report on matters of research and teaching work. The constitution of such a committee by the Council to advise it periodically would, we feel, be of great help in evolving more meaningful policies and procedures in matters pertaining to Institute administration.

5.24 We further suggest that representation may be given to all the Chairmen/Deans of the divisions on the Council of the Institute.

5.25 While consolidating the administration of the Institute through the divisional structure, care should be taken to see that the essential freedom necessary for the research staff of the Institute to do their work is not inhibited. We would like to suggest that the departments should be encouraged to spell out fairly clearly the financial implications of the research projects that are to be undertaken by the various senior staff members in the rank of assistant professors and above. We presume the evolution of research programmes will be the result of an integral dialogue in the divisions between the heads of departments and their respective staff members. We would like to suggest that the funding for the divisions and the departments in turn bear the project requirements so outlined and suitably adjusted. Within the limits of the fund allotted to him, a staff member should have substantial freedom for the execution of his project without referring to authorities higher up for financial sanction from time to time to carry on his work. We suggest that necessary laboratory space and supporting staff should necessarily be provided for all the senior members of the staff. However, in so far as the management of a department itself is concerned, we expect normal procedures of consulta-

tion among senior staff to evolve policies and procedures will prevail. Such a decentralisation is essential in an academic institution devoted particularly to research.

5.26 Given an efficient system of management, the success of the Institute would depend upon the availability and the efforts of staff. The Institute is in the process of making a large number of staff appointment at the higher levels as a result of its recent development programmes. We were informed that wherever practicable, joint appointments are being made. The success of such an experiment will depend on very careful selection and management.

Planned shift of emphasis towards physical and chemical sciences

5.27 Till the early forties, emphasis in research and training at the Institute was primarily in the natural sciences, with engineering sciences occupying somewhat lower priority. During and immediately after World War II, new impetus was given to engineering sciences, with the establishment of new engineering and technology departments. There were two development programmes planned from 1944 onwards, which while enlarging the activities of the science departments, established a number of new engineering departments at the Institute. A new balance was accordingly struck between the different disciplines at the Institute as a result of these expansions. Research in Engineering thus received a fillip whereas strong traditions in research in the science departments had been well established. With conscious efforts made to build up research in engineering departments and the organisation of a large number of master's degree courses in the Engineering Faculty, we see that the resulting inputs in engineering have been considerably more than those in science.

5.28 In view of later developments in the country in terms of large number of other institutions and the demands of the country for national programmes, the question to be asked is in what way does the Institute continue to be unique and what can be done to nurture this uniqueness as a desirable trait.

5.29 The application of scientific methods of pursuit of knowledge to the problems of engineering research and teaching has been given emphasis at the Institute. This type of training has direct relevance to the creation of a scientific tradition; it furthers the desire of the nation for attaining self-reliance in industry, especially in modern science-based technology. We conceive that the Institute in its training and research programmes should specially emphasise long-term goals. The problems of the future will necessarily be in the forefront of science and technology and would require excep-

tionally wide knowledge and background. It would obviously be impossible for the Institute or for any single institution for that matter, to plan and train all its students in any exhaustive manner. What is possible, however, is to excite the intellectual curiosity of the young minds so that they will be able to learn subsequently on their own.

5.30 For achieving the aforesaid objective and for producing engineers who are capable of doing creative work, it is necessary to orient teaching having a large component of the basic sciences. This would mean greater involvement of science faculties and greater attention to the resources of science faculties. As regards research, it is well-known that all modern technology is science-based. Consequently the staff of science faculties should be more involved in engineering and technology programmes. We would also correspondingly suggest that there should be greater involvement of engineering and technology faculties in the instruction and training programmes of science departments wherever possible.

5.31 We would very strongly urge that the Institute consciously plan this shift of emphasis immediately. While recommending grants for modernising its equipment, we have taken care of the requirements of such a shift in emphasis. We are also clear that achievement of such a goal would require an attitude of mind and policy to be adopted which would seek to achieve excellence in whatever the Institute undertakes. We, therefore, recommended to the Institute that for the Seventies, it should set its goal high and strive to continue to be a centre of excellence.

Orientation of teaching and research activities

Ph.D. programmes

5.32 We have carefully gone through the present practice obtaining at the Institute in its teaching and research programmes. We feel that a reorientation with some distinct changes is desirable.

5.33 We note that a candidate for the Ph.D. degree is putting in three to four years under the Ph.D. programme. We suggest that atleast equivalent of one year out of the above period should be spent in course work related to the main and peripheral fields of his research, so that instead of becoming a specialist in a narrow and restricted field, he turns out to be one who has a wider appreciation of related sciences.

5.34 In a certain sense, therefore, there is need for a pre-Ph.D. degree programme after the master's degree programme, to make the Institute student a better Ph.D. student. An assessment of the student's suitability for continuing the Ph.D. degree programme could then be made on completion of a year or more of course work in the main and atleast one of the related fields. The related fields may be taken in other departments so as to increase inter-disciplinary outlook.

5.35 We support the proposal of the Director for a gradual increase of the Ph.D. student body from the present level of 300 to 350.

Master's degree programmes

5.36 The Institute is offering three distinct master's degree programmes :

a) Master of Engineering degree by course-cum-project work in the Engineering Faculty only;

b) Master of Science degree by research in the Engineering Faculty only ;

c) Master of Technology degree by course-cum-project work in Physical Engineering.

5.37 The M.Tech.programme is offered by the Physics Department only in the field of Physical Engineering. We were informed that the degree is not a science degree in Physics nor is it a traditional degree in engineering. We feel, however, that a measure of uniformity should be obtained in designations of the degrees awarded by the Institute. We, therefore, recommend that all masters' degree programmes in engineering and technology should be of two years duration comprising course work and research/project work. Further, M.E. degree may be awarded to engineering graduates and M.Sc. (Tech.) degree be awarded to masters' degree holders in sciences.

5.38 At this point, it is important to take note of the introduction of the Unit System at the Institute. Under the System, the Institute is planning to offer a large number of electives to the students, so that they can have a wide choice in the courses they propose to take. We highly commend this move of the Institute; it imparts greater flexibility to its teaching programmes. It also brings efficiency in the management of the intellectual resources of the Institute by providing common courses for students from different departments wherever possible. We, however, suggest that care must be

exercised, so that the amount of effort required to teach courses is commensurate with the number of students taking the course.

5.39 We endorse the Institute's proposal to reduce the students' strength of Master's degree programmes from 400 to about 350.

Bachelor's degree programmes

5.40 The bachelor's degree programme had its origin in the diploma courses offered during the earlier years in two subjects, namely, Electrical Technology and Electrical Communication Engineering. Subsequently, a similar course in Metallurgy was started.

5.41 The continuation of the Bachelor's degree courses at the Institute had been debated on earlier occasions also. We too raised it in our discussions with the Director, the Senate and the Council and the members of the Faculties. We noticed that there was considerable amount of diversity in the views held by the Institute staff members themselves. Among the members of the Reviewing Committee also there were different views. We, however, feel that if the bachelor's degree programmes were to be continued at the Institute, it should be an experiment and innovative process for the continuous development of under-graduate programmes and it should not be the traditional type as obtaining in other institutions. In fact, we were told that conceptually the bachelor's degree programmes provide a cross-over point to science graduates to become engineers. We, however, feel that with a considerable amount of flexibility available at the Institute, if the bachelor's degree programme is to be continued, it must transform itself to become more broad-based, with a larger number of departments involved in the training programmes.

5.42 In general, however, we would like to suggest that the Institute concentrate on post-graduate programmes and offer under-graduate programmes only when fully justified. We recommend that the Institute authorities may consider this matter while deciding the future pattern of the under-graduate programmes.

Research

5.43 We had earlier stated that to be effective and to respond to the national needs, the Institute must also reorient its research programme bearing in mind the various plan proposals as broadly outlined in the five-year plans. Unrestricted freedom that an academic institution generally conceives for itself and prefers is neither possible nor necessarily desirable in the present context of the Institute activity where almost the entire funds come from the public exchequer.

It appears to us that most of the research of the Institute must be more directed and specific. We believe that problem areas can be found in basic research and applied research, which are related to national aspirations. In general, while the Institute staff should have a substantial amount of freedom in the manner of pursuit of research problems, there is a great need for relating the activities of a division, and the choice of the problem areas for the division, so that they can have a larger relevance to the country's economy and industry. We recommend that the divisions pool their intellectual resources and identify the problem areas and relate them wherever possible to the five-year plans.

5.44 In the present context, it is not reasonable to expect the Government to give any specific guide-lines for research at the Institute. We note that most of the departments have current activities or can undertake further activities that are of relevance to the country's plan proposals. The Institute as a whole is involved in post-graduate education and scientific research and its responses to these plans should be as an Institute. To us it appears logical that in the Seventies and perhaps even in the Eighties, the Institute should lay strong emphasis in these areas. For example, the development of materials - both metallic and non-metallic - has a fundamental role to play in national growth. Every year new materials are produced by the scientists and used in new ways by the engineers. In this activity, the scientist and the engineer have an important role to play. Developments in the chemical and biological sciences are turning out to be of direct relevance to the understanding of man himself. The problems of nutrition and health are vital to the well-being of the nation. It should be for the Institute to plan and identify problem areas of national interest which have long-term goals. The Institute has proposed inter-disciplinary projects in Coordinated Mechanics, Materials Science, Molecular Biology and Bio-Engineering, bearing these problems in mind. The efforts of the Institute in this direction can reach new frontiers.

5.45 We have seen some examples of the multiplicity of diverse research projects, which do not suggest any long-term planning or show any coherence among themselves. We also feel that greater relationship should be achieved in the topics of research. We believe that one of the first tasks facing the faculty at the Institute is to initiate an active dialogue among themselves to redefine the short-term and long-term objectives. In this connection, we would also like to stress the need to assess the current research programmes and close where considered desirable obsolete research

programmes of the Institute and initiate new areas of activity in consonance with scientific and technological developments that are taking place in the world. We note that the closure of these obsolete programmes will have to be gradual.

5.46 With the present intake of student body, we do not envisage any requirement of staff. Exceptional cases of recruitment may, however, be considered very carefully. We also suggest that when any senior staff is to be appointed, plans should be simultaneously conceived for providing the appropriate facilities and the infra-structure for the staff to function effectively. We suggest that the Institute appoint through normal procedures outstanding people as and when they become available. We, however, note that the Institute has made a small beginning in the appointment of visiting professors. This system offers exceptional opportunities to bring outstanding people from other Institutions and expose the students and the research staff to new disciplines and new ways of thinking. We recommend a substantial increase in the visiting appointments at the Institute. This would be of particular relevance, especially in view of the Institute's commitment to undertake and nurture extensive inter-disciplinary research programmes. As a corrolary, we also suggest that where major programmes for which adequate facilities are not available, inter-institute collaboration may be sought by the Institute.

5.47 A strong point of this Institute has been its all-India character. Every effort should, therefore, be made to maintain this character specially by way of staff and students.

5.48 School of Automation

We note that the Institute is actively involved in starting a School of Automation with some external assistance. We welcome this move. Automation in almost every avenue of engineering has come to play a key role. Much of modern technology would not be possible without application of Control Systems and Logic Devices.

5.49 Organising and strengthening central technical services & facilities

Given competent staff, a good student body and adequate working expenses, the areas next in importance for efficient functioning of the Institute central services required are: a good library, a good central stores, modern workshop facilities and central instrumentation services. We note, however, while the library is in a position to serve the needs of the Institute, neither the central stores nor the workshop and associated facilities can be said to be up to the mark in

their capability to render efficient service. We, therefore, recommend that their improvement should be undertaken on a priority basis.

5.50 Library

A detailed report on the Library, including the financial implications is given in a separate section. We note that a sum of Rs 5.37 lakhs is the expenditure for the year 1970-71. We are of the opinion that considering the nature of acquisitions, both books and periodicals, this amount is inadequate. Our recommendations for the Fifth Five-year plan period are given elsewhere and we feel that it is essential to increase the expenditure on the Library from the present level of Rs 5.37 lakhs per year to about Rs 8 lakhs per year by the beginning of the Fifth Five-year Plan to bring it in line with the University Grants Commission recommendation of 6% of recurring expenditure. The bulk of the proposed increase is to enable procurement of a substantially larger number of books and to increase the number of periodicals. After reaching the target of Rs 8 lakhs per year, our recommendation for the Library will be the normal 7% increase in expenditure during the Fifth Five-year Plan period primarily to provide for increases in the prices of books and periodicals. Even this increase will not be adequate unless utmost care is taken in the judicious selection of books and journals for which the full cooperation of the academic staff is necessary. The future growth of the Library of the Institute should keep in mind the existence of a number of sepcialised libraries in Bangalore to avoid unnecessary duplication.

5.51 Printing and Publishing Unit

The Institute has envisaged an outlay of Rs 3.0 lakhs for this purpose. We note that the Institute does not have reasonable reprographic facilities for meeting its normal requirements. Graphic arts facilities are very essential for the efficient functioning of the Institute. We, therefore, recommend a sum of Rs 4.00 lakhs for obtaining a small printing and publishing unit and providing reasonable graphic art facilities for serving Institute needs whether it is for printing and publishing or for photostat copying or for preparation of slides, photographs or other similar jobs.

5.52 Workshop

Most of the workshop equipment is obsolete except for a few recent acquisitions. In view of the continued difficulty of obtaining adequate foreign exchange and the necessity for self-reliance on the part of the Institute for designing, developing and fabricating sophisticated equipment,

Institute workshop assumes considerable importance. Many of the machine tools available at the Institute are not suitable for undertaking accurate and precision work. We feel that the Institute workshop deserves substantial financial inputs in order that it can fully respond to the increasing and changing needs.

5.53 We note that there is no well-organised design office associated with the workshop; the workshop at present is being run by the Department of Mechanical Engineering. In order that the workshop may effectively respond to the needs of the Institute at large, it would be essential to separate it from the Department of Mechanical Engineering and associate it with the central facilities of the Institute.

5.54 We recommend a sum of Rs 30 lakhs for the modernisation of the workshop and for fabrication facilities, of which about Rs 7.5 to Rs 10 lakhs should be set apart for establishing a precision machine shop. The Institute at present does not have such a facility. For effective functioning, this is an imperative need. We also recommend the creation of a design office with adequate facilities, which can interact with the scientific community at the Institute and prepare working drawings from which complicated and sophisticated equipment can be made.

5.55 Central Instruments & Services Laboratory

We note that the Institute facilities for designing, developing, fabricating and repairing of electronic equipment are also not adequate. The Central Instruments & Services Laboratory is trying to meet these needs to some extent, but its facilities are not adequate. In present day research, electronic instrumentation plays a decisive role. While items of equipment such as oscilloscopes, strip chart recorders, etc., may be obtained either from within the country or from abroad, there are a number of situations where the electronic equipment have to be tailor-made to suit specific requirements. The Institute cannot long claim to be viable research organisation and conduct research at the frontiers of knowledge if it does not have adequate supporting facilities for design, development and fabrication of electronic equipment. We, therefore, recommend a design group for electronic equipment which can work in close collaboration with the scientific staff of the Institute and prepare working drawing for fabrication in the electronic shop of the Institute. We also recommend strengthening the repair and maintenance group for electronic equipment in this section.

5.56 It has been noted already that the Central Instruments & Services Laboratory in a small way is trying to function as a common facility for maintenance and fabrication of electronic equipment for the Institute. We recommend that these facilities be extended as suggested above. We understand that considerable competence exists in several departments of the Institute towards this purpose. We suggest that as far as possible advantage should be taken of this capability.

5.57 It is sufficient to state here that a sum of Rs 60 lakhs will have to be provided for obtaining the essential Instrumentation for this purpose.

5.58 Computer Centre

The Institute, which has already acquired an IBM 360/44 Central Processing Unit and some essential peripherals, has proposed for its second phase of the development of the Computer Centre an expenditure of Rs 22.00 lakhs. The Institute can ill-afford to function without reasonable computer facilities. The central processing unit and a small memory unit and equipment of the IBM Series 360/44 Computer are not adequate. We, therefore, approve and recommend an expenditure of Rs 22.00 lakhs to fully utilise the capabilities of the Central Processing Unit of the IBM 360/44 Computer System. We recommend the Institute obtaining a few analog computers also.

5.59 Stores

The ability of the Stores at present to serve the Institute needs for urgently required consumable items is not satisfactory. Most of the consumable materials that are normally required for research were not found to be available in the Stores, whether it is for electrical sciences, physical sciences, mechanical sciences or chemical and biological sciences. If the Stores has the initial stock in sufficient quantities, then subsequent replenishments through the recurring budget could help in meeting the continuing requirements of the departments. It is understood that the Institute made a request to the Government of India to provide funds for bringing up the levels and to build up the inventory of the stores to partially compensate for this inadequacy. A grant of Rs. 7 lakhs has been given by the Government of India for inventory build-up. The present value of the stores at the Institute is stated to be about Rs 10 lakhs. All the same, Stores look empty and void of useful materials.

5.60 We were informed that quite frequently the department had to go outside to procure materials required by them owing to non-availability of the items in the Stores. This, to say the least, is a time-consuming and inefficient way of running the Stores. Besides the main difficulty of adequate finances to build up the required initial inventory, there is need for a proper inventory control and audit procedures. We recommend a thorough renovation of the existing stores building at a cost of Rs 2.5 lakhs and an additional allotment of Rs 5.00 lakhs for increasing the stores inventory in general and Rs 2.00 lakhs specifically for electronics stores, the present holding being utterly inadequate. There is also a need for a committee of departmental representatives to keep a watch on the working of the Stores.

5.61 Working Expenses

The one problem that was brought to our attention time and again in our discussions was the inadequacy of the working expenses for the research and teaching work at the Institute and for proper functioning of the Library, general academic items and for services and maintenance.

5.62 For the year 1970-71, the expenditure amounted to Rs 48.07 lakhs with the break-down as shown below :

Area	Amount Rupees in lakhs
1. Science Faculty	4.68
2. Engineering Faculty	11.25
3. Library	5.37
4. General Academic items	9.18
5. Services & Maintenance	12.11
6. Amenities	1.47
7. Administration	4.01
Total	48.07

5.63 Considering the total student body and the academic staff of the Institute, it appears to us that the working expenses available directly for research work are inadequate. During our discussions, it was suggested that on an average one may consider the following as reasonable norms for working expenses :

B.E.	Rs 1000	per student per annum
M.E.	Rs 1500	-do-
Research Scholars	Rs 2000	-do-
Academic staff (lecturers and above and post-doctoral research fellows)	Rs 2500	per member per annum

We consider these estimates as generally reasonable and recommend them as guide-lines for arriving at the requirements of working expenses. In our view, for the academic departments as a whole, it offers a fair basis for estimates. Our recommendations are based on these lines in arriving at the financial estimates for the Institute. Marginal deviations from this are to be considered for individual departments depending upon the nature of work.

5.64 To assess the requirements of working expenses, we have to take note of the size of the student body and the academic staff.

5.65 The Institute has also proposed a gradual change in the composition of the student body as follows and this appears reasonable :

	to stabilise at
Bachelor's degree students	200
Master's degree students	350
Research Scholars	350
Post-doctoral Research Fellows	100
Total	1000

This would mean that while the total admissions would essentially remain the same as at present, shift in emphasis will be towards post-graduate and post-doctoral programmes.

5.66 The academic staff consists of 222 persons in the rank of lecturers and above and about 100 post-doctoral research fellows. Based on this professional and student body, the academic working expenses for research and academic facilities would come to Rs 22.30 lakhs per annum. We thus estimate the working expenses for research in the faculties should be as suggested above. As against this, we note that a sum of only Rs 15.93 lakhs is provided at present. We consider the present allocations inadequate for efficient functioning and carrying out high standard work in the Institute. It is important that the deficiency is set right. It would seem reasonable to reach this increase gradually as indicated in our financial proposals.

5.67 Before completing the review of the various activities of the Institute, we find it important to mention briefly about the alumni. In an institution of this standing with a large alumni population holding important positions in the country and abroad, it would be in the best interests of the Institute if there is a strong alumni association and if a healthy interaction between the Institute and the alumni with consequential inputs of value both ways is fostered.

5.68 Within the Institute also there are a number of professional associations and societies. They have always played a meaningful role in the academic life of the Institute. We are sure that the authorities will promote such academically important activities.

5.69 We had discussions regarding the placement arrangements at the Institute. At the present moment, there is no centralised placement office. However, placement is looked after by individual professors. The Institute may like to consider the need for a properly organised placement office in the future. The alumni association can play a useful role in this respect.

5.70 In the chapters that follow, we have reviewed the working of individual departments and have made some specific recommendations relating to these departments. We have summarised and consolidated the various financial recommendations made in the different chapters in the chapter that follows.

5.71 Summary of recommendations:

i) A substantial input for maintenance and modernising equipment and overcoming the obsolescence, which has crept in during the past. It is imperative that the amount of foreign exchange needed for this be treated as an integral part of this input. Simultaneously, there must be an increase in the technical resources of the Institute to design and fabricate research equipment;

ii) An augmentation of the working expenses to be effected with a sense of urgency for providing the maximum support for the scientific and technological work;

iii) A functional regrouping of the Institute's disciplines to bring the various departments together in a more effective manner and to encourage greater interactions between various departments of the individual divisions. It would appear to us that the regrouping would call for creation of about five divisions;

iv) A planned shift of emphasis towards the physical and chemical sciences to bring about a better balance between the engineering and science disciplines and providing a more desirable science-base to the research efforts in the engineering disciplines;

v) Reorientations in its teaching and research activities in relation to Ph.D. programmes, Master's and Bachelor's degree courses;

vi) Undertaking certain inter-disciplinary projects, basic competence for which largely exists in the various departments of the Institute and which are of value to the nation as a whole;

vii) Organising and strengthening the central technical services, including the acquisition of sophisticated equipment for use by more than one department as a central facility.

viii) Intensifying the programme of visiting scientists and increasing inter-institutional collaboration.

ix) A strong point of this Institute has been its all-India character. Every effort should, therefore, be made to maintain this character specially by way of staff and students.

5.72 We would, however, like to mention that our recommendations are to be understood as indicating the broad lines for the future development of the Institute. We are conscious of the fact that in an established and live institution with a long record of useful work, it is appropriate that only broad indications for its future development are given, leaving it to the institutional processes to implement these with reference to details but keeping in view the spirit of the recommendations.

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6. FINANCIAL REVIEW

6.1 While making the recommendations for the Institute, financial or otherwise, we were given to understand that the present Block Grant ended on March 31, 1971 and that the fresh block starting from April 1, 1971 and ending on March 31, 1974 was proposed by the Institute for consideration by the Government/ University Grants Commission. It was felt that our recommendations are not likely to be implemented much before the closing years of the IV Plan (1973-74). As such, our recommendations are more directly relevant for the period not covered by the Institute in its present proposals to the Government. However, in order to obtain continuity in the financial planning, we have reviewed the proposals of the Institute to the Government for the intervening period 1971-72 to 1973-74 also.

6.2 In order to do this in a meaningful manner, we examined the actual expenditure during 1970-71, the budget estimates of the Institute for 1971-72 and the Institute proposals to the Government for the intervening period upto 1973-74 in some detail. We have also examined the proposals submitted by the Institute in considerable detail. We have the following comments and recommendations to offer :

6.3 Salaries

The Institute at the time of review was in the process of recruiting a large number of professorial staff into its various divisions as part of the IV Plan and filling up normal vacancies. This programme of recruitment was expected to be completed by the year 1970-71 with a possible marginal spill-over into 1971-72. It had virtually completed recruitment upto the level of assistant professors and was actively involved in the recruitment at the professorial cadre at the time of review.

6.4 Against the revised budget provision for staff salaries of Rs 83.14 lakhs the actuals during the financial year 1970-71 amounted to Rs 81.90 lakhs. This was mainly due to the time-lag occurring in the making of the appointments and the inevitable gap in time in joining of the new faculty members. There may perhaps be some spill-over to the following year since all the newly appointed staff may not join the Institute during 1970-71; with the result, there is a reduction in the projected estimates. This situation involving the recruitment of a large number of staff in a relatively short period of time is not likely to be repeated again in the near future of the Institute growth. The Institute projections for salaries for the subsequent years till 1973-74 essentially provide for only routine increments and salaries

and not for appointments, revision in the rates of dearness and other allowances. The payment of interim relief to the members of staff at the Institute (based on the recommendations of the Third Pay Commission) approved by the Government of India is shown in the following table as a separate item as required by the Government. We estimate the following salary budgets upto the year 1973-74; while there may be some marginal differences, these estimates may be considered reasonable:

Table 1

Year	as estimated salaries	Interim relief
	(Rupees in lakhs)	
1970 - 71 (Actuals)	81.90*	3.81*
1971 - 72	88.00	4.30
1972 - 73	92.00	4.30
1973 - 74	96.00	4.30
Total for 3 years - 1971-72 to 1973-74	276.00	12.90

* Provisional - subject to audit.

6.5 Working Expenses

The working expenses of the Institute for the year 1970-71 amounted to a sum of Rs 48.07 lakhs as shown below:

Table 2

Working expenses - 1970-71 (functional break-up)

	(Rupees in lakhs)	
a) Science Faculty	4.68	15.93
b) Engineering Faculty	11.25	
c) Library	5.37	
d) General academic items	9.18	
e) Services & maintenance	12.11	
f) Amenities	1.47	
g) Administration	4.01	
Total	48.07	

We note that the estimated working expenses for the academic departments are Rs 15.93 lakhs. It has already been stated that the working expenses available to the Institute staff to carry out high quality research work are inadequate. We have also suggested reasonable averages to obtain suitable estimates for this purpose. Using these averages and taking into account the Institute scientific body requiring working expenses, we are of the opinion that the Institute requires a sum of Rs 22.30 lakhs towards this purpose for augmentation of working expenses. We recommend that the increase from the present level of Rs 15.93 lakhs to Rs 22.30 lakhs be obtained gradually over a 4/5-year period and thereafter provision be made for only normal increments on account of increasing price index.

GENERAL ACADEMIC AND RESEARCH PROVISIONS

6.6 We note that the expenditure for 1970-71 under this heading is Rs. 9.18 lakhs. Much of this expenditure is concerned with academic and scientific activities of the Institute but not directly assignable to the faculties; these are nevertheless essential. We have studied the break-up of these items and recommend Rs 10.00 lakhs as a fair provision taking into account the need for the Institute to increase the quantum of expenditure in such categories such as Ph.D. examination reference expenditure, special lectures, symposia, visiting professors and experts programme. We also note that the Institute is at present publishing a journal at a cost of Rs 20000 per annum. There perhaps was a time when the publication of the journal by the Institute was justified. We feel that journals of composite character have limited readership and hence merit no serious justification for continuation. As such, we recommend for consideration discontinuing the journal and instead use the available funds for bringing out special publications wherever considered necessary.

6.7 We note that a sum of Rs 2.50 lakhs allotted in this estimate for buying computer time would be used in future for the maintenance charges and working expenses of the IBM 360/44 Computer which is installed at the Institute. The Institute will need to spend about Rs 1.5 lakhs per year from the increased working expenses for buying computer time from the proposed Regional Computer Centre to be established in Bangalore.

Library

6.8 The expenditure during the year 1970-71 was Rs 5.37 lakhs. The following situation is obtaining at present.

6.8.1 The number of volumes being procured by way of series publications, symposia, etc., are continuously on the increase. These are by nature limited editions and tend to be increasingly expensive. There are also gaps in the acquisitions of the library in the periodicals. We, therefore, recommend increasing the library budget to Rs 8.00 lakhs per annum by the year 1973-74. Bulk of the proposed increase is to enable procurement of larger number of books and increased number of periodicals.

6.9 Services and Maintenance

The expenditure during the year 1970-71 under this account was Rs 12.11 lakhs. It would be relevant to recall the following facts while discussing the provision under this account.

6.10 The Institute campus is now more than 60 years old. Many of the buildings are in a relatively run-down condition requiring fairly extensive repairs and regular periodical maintenance without which they cannot even render the minimum service that could be expected of them. It is also understood that there are frequent failures in the supply of water and power to the departments affecting their routine experimental programmes. Recognising these inadequacies and the necessity for improving the communications within the Institute, normal repairs of the roads, etc., we recommend gradually increasing the expenditure under this head to a sum of Rs 18.00 lakhs over a 4/5-year period and provide for marginal increases thereafter. The prescribed norms were borne in mind in making our recommendations.

6.11 Amenities

The expenditure during 1970-71 under this account was Rs 1.47 lakhs. We recommend that this provision be increased to Rs 1.50 lakhs. The proposed increase is mainly to improve the form and content of the dispensary services available to the students, members of staff and their families and also for making available additional grants to the Staff Club, the Tata Memorial Club and the Gymkhana.

6.12 Administration

The expenditure under this account was Rs 4.01 lakhs for the year 1970-71. Considering the fact that the total recurring budget of the Institute for the year 1970-71 was Rs 152.22 lakhs, it deserves particular mention that the working expenses on administration need to be augmented for obtaining greater efficiency. We feel there is justification for increasing this amount to at least Rs 4.5 lakhs

per year. The increase is to cover the normal growth requirements under stationery, furniture, postage, printing, etc.

6.13 General Remarks

We note the continued rise in the cost of materials generally bought by the Institute year after year. A study of the Institute expenditure on such items indicates that the price increases range between 2% and 14%. Providing the same amount of money year by year without taking into consideration the continuous increase in the price of materials would essentially reduce the actual money available to the Institute. We, therefore, recommend a 7% increase each year over the previous year's figure towards working expenses.

6.14 Fellowships and Scholarships

The actual expenditure for 1970-71 was Rs 18.44 lakhs on this account. It will be noted that we have recommended a change in the number of admissions to the Institute to give greater emphasis to the post-doctoral research programmes. It would call for the award of the scholarships and fellowships of higher values. We, therefore, suggest increasing the funds under this head to Rs 23.5 lakhs by 1978-79.

6.15 Salaries

We have examined in detail the requirements as projected by the Institute. We recommend a net annual increase of $3\frac{1}{2}\%$ in the salary budget each year from 1974-75. This will enable the Institute to have adequate funds to account for routine increments in salaries of staff in position and marginal funds for appointing outstanding new staff. The financial implications of this recommendation are given in the following table. These increases should not be affected by any possible savings arising on account of normal delays in filling up such posts.

Table 3

Expenditure recommended on salaries

Year	Salaries	Interim Relief*
	(Rupees in lakhs)	
1974-75	99.4	4.30
1975-76	102.90	4.30
1976-77	106.50	4.30
1977-78	110.20	4.30
1978-79	114.10	4.30
Total	533.10	21.50

6.15.1 We note that this recommendation does not take into consideration any statutory increases (apart from interim relief for which provision is recommended by us) that may be recommended from time to time consequent on Government decisions.

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* Interim relief which is now being paid to the members of staff of the Institute will ultimately get merged into the pay structure of the Institute when the recommendations of the Third Pay Commission are implemented. Therefore, this is reckoned as an additional requirement.

6.16 Summary of the recommendations for salaries, working expenses and scholarships

The summary is given below :

Table 4

Projection of expenditure on salaries, working expenses and scholarships - upto 1978-1979

(Rupees in lakhs)

Year	Area of expenditure			Interim Relief	Total
	Salaries	Working Expenses	Fellowships & Scholarships		
1970-71	81.90	48.07	18.44	3.81	152.22 *
1971-72	88.00	46.00	19.50	4.30	157.80
1972-73	92.00	49.00	20.00	4.30	165.30
1973-74	96.00	52.00	20.50	4.30	172.80
	276.00	147.00	60.00	12.90	495.90
1974-75	99.40	57.00	21.50	4.30	182.20
1975-76	102.90	63.00	22.00	4.30	192.20
1976-77	106.50	70.00	22.50	4.30	203.30
1977-78	110.20	77.00	23.00	4.30	214.50
1978-79	114.10	85.00	23.50	4.30	226.90
	533.10	352.00	112.50	21.50	1019.10
		12.50**			12.50
		364.50			1031.60

* Figures for 1970-71 : Actuals - provisional, subject to audit.

** Working expenses for Inter-disciplinary projects over the five-year period 1974-75 to 1978-79, ear-marked exclusively for this purpose.

6.17 Revised consolidated list of equipment

During our visits to the departments, we found that some of the items of equipment requested by one department were already available in another department and such equipment were not fully utilised in the latter department. We recognise the necessity for duplication of certain common items of equipment like vacuum tube voltmeters, oscilloscopes, etc., but we feel that duplication of specialised items of equipment which are very expensive must be avoided. Such specialised equipment should be available as common facility for all scientific workers of the Institute. This tends to promote a closer understanding of the problems of mutual interest. With this in view, we have recommended the establishment of the central laboratory facilities, wherein it is proposed to locate all specialised items of equipment which are very expensive and whose use extends to more than one department or division. This is one of our important recommendations for the growth of the Institute during the Seventies. We also recognise the fact that sometimes it would be advisable to locate such specialised equipment in a particular department as a matter of convenience. Even in such cases, the utilisation of equipment should be planned by a Users' Committee, so that the full potential of the equipment is exploited. Thus, the central laboratory equipped with specialised equipment required by more than one department is expected to play a very significant role in the growth of the Institute during the current decade. The items which are proposed to be treated as general facility, common to all departments, are given in Appendix K; the estimated cost thereof being Rs 132.00 lakhs. While the monetary indication is only a pointer, it is to be noted that acquisition of all these items of equipment is considered essential.

6.18 Fabrication facilities

It has already been stated that a sum of Rs 30.00 lakhs is to be provided for this purpose with about Rs 7.5 to Rs 10.00 lakhs to be used for establishing a precision machine shop.

6.19 Inter-disciplinary Projects

Another important area where the Institute is to direct its efforts is in the field of inter-disciplinary activities. We have examined the four consolidated projects submitted by the Institute. We are of the view that the activity in the area of Coordinated Mechanics programme does not require any special funding; the requirements for the purpose may be met through the departmental budgets.

We are also of the view that capability to undertake inter-disciplinary activities in Bio-engineering and Molecular Biology is yet to be established. We recommend a cautious approach in this direction, in collaboration with the medical profession. We recommend a sum of Rs 5.00 lakhs for purchase of equipment for both the areas. The Solid State Electronics and Materials Science projects are recommended for implementation. We recommend a sum of Rs 60.00 lakhs (non-recurring) to promote and continue the work in the fields of Solid State Electronics and Materials Science.

6.20 Computer Centre

The Institute proposal calls for a further investment of Rs 22.00 lakhs for development of the second phase of the Computer Centre. The present IBM 360/44 Series Computer will not be in a position to meet the demands of all the research problems. We, therefore, approve and recommend the investment of Rs 22.00 lakhs to fully utilise the capabilities of the Computer.

6.21 Graphic Arts Facilities

We note that the Institute does not have any reprographic facilities for meeting its normal requirements. Graphic arts facilities are essential for the efficient functioning of the Institute. We, therefore, recommend a sum of Rs 4.00 lakhs for obtaining reasonable graphic arts facilities for serving Institute needs.

6.22 Central Stores

Mention has already been made of the inadequacy of the stores holdings by way of inventory to render the required degree of assistance to the scientific staff. We also note that the Institute does not have an adequately equipped electronic stores without which it will be difficult to undertake any work in the design and fabrication of electronic equipment on a time targetted basis. We, therefore, recommend an allotment of Rs 5.00 lakhs for general inventory build-up for the stores and a further Rs 2.00 lakhs specifically for building of electronic stores.

6.23 Equipment - departmental requirements

Our recommendations are discussed in the individual departmental reports. It may be noted that what is important is the acquisition of the items of equipment indicated. The cost is to be considered as approximate.

6.24 Expensive equipment must be properly protected against weather and electrical voltage fluctuations.

6.25 We recommend a sum of Rs 125.35 lakhs for the acquisition of equipment for the various departments.

6.26 To enable the Institute to procure the specialised items of equipment, provision of necessary foreign exchange is of great importance. Much of the sophisticated equipment needed by the Institute is not available in the country. Without such equipment the Institute cannot be expected to function in the forefront of knowledge. It is, therefore, essential that the provision of adequate foreign exchange be considered as an integral part of the sanctioning of funds.

6.27 The summary of recommendations totalling to Rs 385.35 lakhs covering equipment items is given in the following table. The details of the equipment approved by us and to be obtained are given in Appendix K.

Table 5

		Rupees in lakhs	
(A)	Research Equipment		
	1. General items of research equipment		60.00
	2. Electronics		45.00
	3. Microscopes & Cameras		5.00
	4. Instruments test & calibration		22.00
			132.00
(B)	Fabrication facilities (including Rs 7.5 to Rs 10.00 lakhs for high precision workshop)		30.00
(C)	Inter-disciplinary Projects		
	i) Solid State Electronics & Materials Science	60.00	
	ii) Bio-engineering & Molecular Biology	5.00	65.00
(D)	Computer Centre		22.00

	Rupees in lakhs
(E) Graphic Arts Facilities	4.00
(F) Central Stores (Rs 5.00 lakhs for general inventory and Rs 2.00 lakhs for electronics inventory build-up)	7.00
	260.00

Departments - equipment

1. Inorganic & Physical Chemistry	6.00
2. Organic Chemistry	4.00
3. Biochemistry	3.00
4. Physics	5.50
5. Microbiology & Pharmacology Laboratory	2.50
6. Applied Mathematics	1.00
7. Foreign Languages	1.00
8. Internal Combustion Engineering	3.00
9. Aeronautical Engineering	18.00
10. Metallurgy	15.00
11. Electrical Engineering	10.00
12. Mechanical Engineering	10.00
13. Civil & Hydraulic Engineering	10.00
14. High Voltage Engineering	12.00
15. Electrical Communication Engineering	10.00
16. Chemical Engineering	10.00
17. Industrial Management	1.00
18. Dispensary	1.00
19. Library	1.85
20. Animal House	0.50
Total:	125.35

6.28 We have carefully examined the proposals of the Institute requesting for necessary provision for construction of new buildings for departments, renovation and modernisation of existing buildings to make them functionally useful and for campus development. Our recommendations are indicated below :

(a) New buildings for departments

Sl. No.	Particulars	Amount Rupees in lakhs
1.	Central building complex to house major items of equipment, etc.	60.00
2.	Department of Biochemistry	5.50
3.	Department of Physics	4.00
4.	Department of Aeronautical Engineering (including provision for fencing the air-strip and hanger facilities)	10.00
5.	Animal House	2.00
6.	Department of Chemical Engineering	10.00
7.	Civil & Hydraulic Engineering Department	2.00
	Total	93.50

(b) Renovation and modernisation of existing buildings (including civil, electrical and other services)

Sl. No.	Particulars	Amount Rupees in lakhs
1.	Department of Inorganic & Physical Chemistry	10.75
2.	Department of Biochemistry	6.75
3.	Department of Physics	8.00
4.	Central Stores	2.50
5.	Administrative buildings	2.00
	Total	30.00

6.28.1 The Institute has envisaged an expenditure of Rs 169 lakhs of which Rs 69 lakhs is for campus development and Rs 100 lakhs for staff housing. We note the need for consolidating and integrating the boundaries of the Institute, augmentating the water supply and sewerage disposal systems, renovating the electrical transmission and distribution system within the Institute and providing an auditorium. We also note the need to expand the present Guest House facilities at the Institute for which Rs 4.00 lakhs is recommended. In our discussions with the Council of the Institute, the need for campus housing was emphasised by the Chairman of the Council. The proposal is to utilise the northern side of the campus which is at present a stretch of vacant land to build a colony, so that the Institute staff would not have the search much for obtaining accommodation. We note that with the continued growth of new industries and defence establishments in Bangalore, housing has become a serious problem. There is, therefore, merit in the Institute proposal for the housing colony. We recommend that every effort should be made to create a nucleus of housing colony by providing a sum of Rs 100.00 lakhs for this purpose. It is estimated that this would cater to only 30% to 40% of the staff at the Institute.

6.28.2 We note the lack of a large auditorium at the Institute. We were informed that the proposals for an auditorium also call for provision of some conference rooms around the auditorium. A large auditorium to accommodate 1200 persons may be useful. It is expected to cost Rs 25.00 lakhs. We do not consider this a high priority item.

(c) Details of Campus Development

Sl. No.	Particulars	Amount Rupees in lakhs
1.	Consolidation, integration of boundaries, fencing, etc.	15.00
2.	Augmentation of water supply and sewerage disposal (11 phases)	15.00
3.	Rewiring of power mains and distribution systems	10.00
4.	Women Students' Hostel	4.50
5.	Guest House	4.00
6.	Staff housing, including associated services like hospital, etc., and residential accommodation for industrial refresher/ retraining programmes	100.00
7.	Auditorium	25.00
		173.50

6.29 Given below is the summary of our recommendations of the non-recurring expenditure :

Table 6

Summary of recommendations - non-recurring items

Rupees in lakhs

I.	1) Equipment			
	a) Research	132.00		
	b) Fabrication facilities	30.00		
	c) Inter-disciplinary projects	65.00		
	d) Computer Centre	22.00		
	e) Graphic Arts Facilities	4.00	253.00	
	2) Departmental equipment requirements		125.35	
	3) Central Stores		7.00	385.35
II.	Buildings			
	a) New constructions	93.50		
	b) Renovations, modernisation, etc.	30.00		123.50
III.	Campus Development			173.50
				682.35

6.30 The overall summary of the financial recommendations covering both recurring and non-recurring expenditure upto the year 1978-79 will, therefore, be as under. This, however, does not include special projects like the establishment of a School of Automation with the USSR collaboration.

Table 7

Summary of financial recommendations - recurring and non-recurring (1974-75 to 1978-79)*

Particulars	Reference to table number for details	Amount recommended
		Rupees in lakhs
I. RECURRING		
i) Salaries	Table No.4	533.10
ii) Interim Relief	-do-	21.50
iii) Working Expenses	-do-	364.50**
iv) Scholarships	-do-	112.50
		1031.60
II. NON-RECURRING		
i) Equipment	Table No.6	385.35
ii) Buildings	-do-	123.50
iii) Campus Development (which includes housing colony)	-do-	173.50
		682.35
	Table I+II	= 1713.35

* The estimates from 1971-72 to 1973-74 are given elsewhere.

** Includes Rs 12.50 lakhs for inter-disciplinary projects.

6.31 It is to be noted that the above recommendation is to cover the period of V-Plan, i.e., 1974-75 to 1978-79 and any savings or spill-over of the Fourth Plan projects should not be reckoned against the same.

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7. DEPARTMENTAL/FUNCTIONAL REPORTS, INCLUDING REVIEW AND RECOMMENDATIONS

7.1 INTER-DISCIPLINARY PROJECTS

One of the important terms of reference to the Committee is to advise on the broad lines of development of the Institute, specially in regard to cooperation between departments in the light of new inter-disciplinary areas of science and engineering.

The Institute has a spectrum of departments and laboratories working in a variety of fields in science, engineering and technology. Inter-departmental cooperation was a subject of consideration and had been reviewed by the Ghosh Committee and earlier Committees as well. Under-graduate and post-graduate teaching programmes are being handled at the Institute with a wider faculty involvement, instruction being handled by more departments than the one in which the courses are offered. The introduction of the Unit System, in which we have referred to earlier in our review, is a step in the right direction. There are also fields of investigation (like Fluid Mechanics) which are being pursued by more departments than one, these departments, however, being interested in the field from varying angles of approach. All this provides the proper background for developing inter-disciplinary projects with the active collaboration of interested faculty from several departments.

We held extended discussions with the Director and the Senate about the general philosophy of the Inter-disciplinary activities. After discussions, the following four consolidated projects were submitted:

Materials Science and Solid State Electronics
Coordinated Mechanics
Molecular Biology
Bio-engineering

In general, inter-disciplinary and multi-disciplinary activities result from two general lines of action. In one, a scientist, over a period of years, gradually becomes involved in a field closely related to him from the standpoint of discipline, but sufficiently separate to be identified as a distinct discipline. Thus, for example, if one takes a person specialising in structural mechanics, he can use his background to study the human body as a problem in mechanics. However, whereas in the past he may have looked at metallic materials in his studies, he will now have to get himself acquainted with the response of bones and muscles to study the human body. With his added knowledge, a person studying the field of structural mechanics can thus, over a

period of time, become a person specialising in bio-mechanics. Such an inter-disciplinary activity must necessarily stem from the personal involvement of a scientist in an adjacent field. Personal motivation is, therefore, essential for a successful transition from one field to an adjacent field. The important thing to note in this transition is that generally speaking, the research is phenomenon oriented.

On the other hand, in the development of modern science and technology, there are several problems that require inputs from a large number of fields in order to successfully solve them. These are generally task oriented problems, requiring expertise from several disciplines: semi-conductor materials and making devices out of them is one such example. Successful accomplishment of the task requires collaboration between a solid state physicist, an Inorganic chemist, a metallurgist and an electronics engineer.

In order that such inter-disciplinary activities may be accomplished successfully, a considerable amount of administrative flexibility is needed. Close relationship at working level between the research workers of the different departments will be essential. While enduring relationship of such a nature can be obtained only at the working levels, its success would, to a very great extent, depend upon the general administrative procedures adopted and the understanding of the importance of the inter-disciplinary activities by the various heads of departments and their unstinted support to the idea. It would appear to us that in generating this inter-disciplinary activity, the programmes must be administered and led centrally, creating the task oriented groups to work on specific problems.

In general, we recommend continued and increased involvement in inter-disciplinary activities in the Institute. However, we would also like to strike a note of caution by stating that this experiment elsewhere in the world has not always been successful and much care is required in nurturing these programmes.

The relevant statistics, highlights, proposals, review and recommendations in respect of the aforesaid projects are given below.

7.1.1 MATERIALS SCIENCE & SOLID STATE ELECTRONICS

Relevant Statistics and Highlights

Although there has been some research activity and teaching in Materials Science and Solid State Electronics, the proposals put before the Committee for initiating activity for inter-disciplinary research are new.

The genesis of the work in this field was the organised course of instruction to students of engineering at the bachelor's and master's degree level in Materials Science.

Currently in the Institute about 40 members of the academic staff are involved in one form or other in research and teaching in these two fields. It was also stated that about 40 Ph.D. and 20 Master's degree projects were related to these two disciplines during the last ten years.

Proposals

Research and Development

The proposals of the Institute for this inter-disciplinary activity call for coordination of the existing activities and filling the gaps in the facilities for materials preparation, analysis, testing and characterisation. This, in turn, calls for (a) establishing a coordinated Materials Science Laboratory; (b) research and development work in the field of refractory semi-conductors; (c) research and development work in composite materials; and (d) extending the laboratory training facilities to students of Materials Science.

Financial

The Institute requested 25000 sq.ft. of space costing Rs 12.5 lakhs, increase in the senior and supporting staff estimated to cost Rs 2.5 lakhs per annum and working expenses amount to Rs 1.5 lakhs per annum. The proposals also include a request for equipment costing Rs 60.00 lakhs.

Review and Recommendations

We note that several of the departments have individually been concerned with research and teaching in Materials Science and Solid State Electronics. Strictly speaking, very little "inter-disciplinary" or "inter-departmental" involvement has taken place in these activities so far at the Institute in their developments. In view of the considerable benefit that can accrue from continued involvement in these inter-disciplinary fields and the close collaboration

between different departments that this involvement will generate, we feel that it is highly desirable for the Institute to be involved in this activity. It will enable the Institute staff to tackle problems in the forefront of science and technology. Science and Technology are on the threshold of new discoveries in the creation of new materials of various types literally tailor-made to suit specific requirements and new and complex techniques of fabrication. The very process of developing these techniques would necessarily build up exceptional technological competence in the Institute.

In successfully tackling research and development problems in the inter-disciplinary activities, the Institute has to innovate new organisational and management techniques not commonly found in such establishments. We suggest that where task oriented problems are to be taken up, task groups be set up from among the Institute staff from different departments.

We recommend that for the 1970s inter-disciplinary activity in Materials Science and Solid State Electronics be considered as one of the important tasks of the Institute. It offers great scope and exceptional possibilities for the Institute and can, in a sense, offer the theme for the Institute growth and channeling its efforts in the pursuit of excellence. This is a difficult task requiring exceptional scientific inputs by way of talent, equipment and the supporting facilities. We, therefore, recommend that the Institute concentrate its efforts on this programme so as to obtain maximum results.

7.1.2 COORDINATED MECHANICS

Relevant Statics and Highlights

In a certain sense, teaching and research in Mechanics had a long history in the Institute. It was stated that most of the departments of the Institute have had active research and training work and progress over many years which cover one aspect or the other of Applied Mechanics. The current activity in Mechanics relates to eight departments of the Institute and cuts across the two Faculties with about 50 staff members personally engaged in research and teaching. We were given to understand that about 100 research papers in Mechanics were published annually and about Rs 3.00 lakhs were spent each year by the Institute in support of this activity.

Proposals

The proposals call for strengthening and coordinating this activity as a coherent whole, so that developments in inter-disciplinary areas such as Geomechanics, Multi-component Flows, Non-linear Mechanics, can be nurtured. The Proposals also call for initiating activity in Particle Mechanics. Coordinated teaching programmes, common seminars and research projects are features which are sought to be developed. The financial proposals envisage about Rs 35.00 lakhs for essential equipment, suitable working expenses and some additional staff over a five to seven-year period.

Review and Recommendations

There is little doubt that in the Institute teaching and research programme Continuum Mechanics consisting of Fluid Mechanics and Solid Mechanics plays a significant role primarily in the Engineering Sciences and also in the Applied Mathematics Department. The teaching and research were generally of a high order. The proposals of the Institute to coordinate the activities between the different departments in Mechanics would, therefore, be a logical step. In the field of Continuum Mechanics, the Institute proposes to initiate activity in Geomechanics and Kinetic Theories of Matter. Some activity already exists in Acoustics, Waves, Vibrations and Non-linear Mechanics. Initiating studies in these two areas would be a logical step in the Institute programme. However, while it is clear that the studies in Kinetic Theories of Matter could perhaps be started in one or more engineering departments, it is not immediately clear to us where studies in Geomechanics would logically fit in in the absence of a specific department of geology. The Institute may perhaps give a lower priority to Geomechanics.

In the other two broad fields of Particle Mechanics and Statistical Theories of Matter and Thermodynamics, there is not much activity in the Institute at present. Studies in these two fields are important.

It would appear that in the studies of Classical Mechanics, Relativistic Mechanics, Quantum Mechanics and Electrodynamics and Plasmas, there is at present very little activity. Some of these fields are the basis of developments in modern physics and it is time that the Institute is actively involved in these fields. It does not seem reasonable to expect this Institute, which has contributed so much to the growth of physics in this country, not to be involved in the areas of modern physics.

We, therefore, suggest strengthening of the Coordinated Mechanics programme of the Institute within the additional overall increase in the working expenses and salaries recommended by us.

7.1.3 MOLECULAR BIOLOGY

Relevant Statistics and Highlights

It is stated that active research in some areas in Molecular Biology has been going on during the last few years in the Microbiology and Pharmacology Laboratory and Biochemistry Department and current investigations relate to gene structure and replication, protein synthesis and the structure of proteins and nucleotides. About ten staff members primarily from the Microbiology and Pharmacology Laboratory and the Department of Biochemistry are involved in this activity.

Proposals

The proposals call for continued work in the three fields:

a) Gene structure and replication;

b) Protein Synthesis; and

c) Structure of proteins and other molecules of biological interest.

Problems relating to these broad fields are suggested to indicate the Institute interests in this inter-disciplinary activity. The Institute indicated the requirements of a good animal house with supporting facilities. Request was also made for three assistant professors and supporting staff. Financial implications are :

Working expenses	Rs 1,00,000
Staff salaries	Rs 67,600
Equipment	Rs 4,09,000
Animal House	Rs 1,10,000
Buildings	Rs 3,50,000

Review and Recommendations

We have given considerable thought to this project and have had extended discussions with various people outside the Institute interested in Molecular Biology, their present programme, as well as their future thinking on the development of this programme. We also had discussions with our Advisers on this subject.

Although there are a number of capable and well-trained people in the Institute, it is only recently that the research activity in Molecular Biology was started in the Institute. This field has yet to grow in the Institute. The reason is that there are a number of other fields of anciliary know-how and expertise in Chemistry and Physics which are to be developed before any impact can be made and by those working in Molecular Biology in the Institute. It is felt that, in order to make an impact in this highly competitive field of Molecular Biology, projects of national or even of international importance should be identified. This, in fact, should be the first task in getting started on any meaningful inter-disciplinary activity in Molecular Biology. It is, therefore, suggested that efforts may be made to build up a body of workers in course of time, so that the subject could be recognised and organised as an area of inter-disciplinary activity.

Much of the equipment required for this activity is already included in the consolidated list of equipment submitted by the Institute as a part of either the central facilities or departmental facilities. We, therefore, recommend a sum of Rs 5.00 lakhs for obtaining some specialised equipment for Molecular Biology and Bio-engineering.

7.1.4 BIO-ENGINEERING

Relevant Statistics and Highlights

It is stated that the work being carried out at the Institute in the Field of Bio-engineering can be categorised into three broad fields, namely,

1) Studies of Artificial and Biological Membranes;

b) Bio-instrumentation; and

c) Aspects of Environmental Biology.

The studies on Artificial and Biological Membranes are being carried out in the Chemical Engineering and the Inorganic and Physical Chemistry Departments. The work in the Chemical Engineering Department is concerned with simultaneous diffusion of solvent and solute through membranes permeable to both the solute and the solvent. The work of the Inorganic and Physical Chemistry Department is related to transport of singly-charged and doubly-charged ions and solvent through artificial membranes. The work in bio-instrumentation in the Institute is primarily related to the development of digital thermometer, blood pressure indicator and other sensors. The work on aspects of environmental biology in the Institute was carried out with the financial support of the Indian Council of Medical Research and the Research & Development Organisation of the Ministry of Defence. Apparently, these investigations revealed that enzymes in the metabolic pathways which are rate-limiting or end-product regulation are the likely targets for alterations and these could arise out of structural changes at the molecular level.

Proposals

The Institute proposals call for further work in the Departments of Chemical Engineering and Inorganic & Physical Chemistry in studies related to artificial and biological membranes, development of the bio-instrumentation and studies in environmental biology involving investigations on ubiquinone in heat production during cold exposure, loss of action of the drug and Atromid-S during cold exposure. The consolidated revised list of equipment envisages an expenditure of Rs 5.83 lakhs.

Review and Recommendations

Although we note that some work in Bio-engineering has been going in the Departments of Chemical and Biological Sciences in the Institute, really significant developments in Bio-engineering in the Institute have yet to start. This is nevertheless an important field and should certainly be nurtured as an inter-departmental and inter-disciplinary activity in the Institute. Several of the engineering departments also would like to be involved in Bio-engineering. Their proposals, however, are not specific. While the desire of the departments in engineering sciences to be involved in this field is to be commended, they have to take a more careful look into this matter.

There are two broad fields that come to one's mind when one thinks of Bio-engineering. One is the biological aspects of the problem and the other the engineering aspects of the problem. It would appear that in the engineering aspects of the problem the electronics group in the Institute can play a very useful role primarily in the development of instrumentation related to Bio-engineering. The Departments of Chemical and Biological Sciences could be concerned with study of the purely biological aspects of the problem.

Our Adviser, Prof. Shemyakin pointed out that the proposed plan for Bio-engineering did not include the studies of biological systems, in particular biological membranes, whose investigations should be parallel to the studies of models and artificial systems. We agree with Prof. Shemyakin and feel that it is necessary for the Institute to undertake this work.

As in the case of Molecular Biology, strength has to be built up in the Institute before meaningful inter-disciplinary activity in Bio-engineering can be undertaken. We recommend such strengthening wherever required after a more detailed study of the proposals from the various departments. It is also necessary to have liaison with a well-equipped hospital before purposeful activity in Bio-engineering can be undertaken.

7.1.5 GENERAL RECOMMENDATIONS

Buildings

Separate accommodation for inter-disciplinary projects as such is not necessary, but additional accommodation will be required for the Central Laboratory Unit for housing the new equipment that may be acquired and the existing equipment that may be transferred from different departments to the Central Laboratory. A proper building with adequate accommodation for Central Laboratory, including the needs of the inter-disciplinary projects will, therefore, be required. A separate recommendation for buildings has been made.

Equipment

We recommend a sum of Rs 60.00 lakhs for Solid State Electronics and Materials Science and Rs 5.00 lakhs for Molecular Biology and Bio-engineering.

Staff

The proposals regarding additional staff required for the Institute as a whole, keeping in view the requirements of the inter-disciplinary projects, have also been made separately. Wherever necessary, certain joint and special appointments between the different departments have been suggested under each project.

Working Expenses

It is recommended that a sum of Rs 12.5 lakhs over a period of five years be specifically set apart for working expenses for all the inter-disciplinary projects. The amount may be placed at the disposal of the Director. This amount would meet the cost of recurring expenditure towards the fabrication of essential equipment and materials. This amount is to provide for expenditure only on items which are not covered under the normal departmental working expenses.

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7.2 CENTRAL INSTRUMENTS & SERVICES LABORATORY

7.2.1 Relevant Statistics

I. STAFF(As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in position
a)Academic Professors	2	1	..	1
S.S.O.	6	2	..	2
S.O.	6	5	..	5
Other Aca. staff	14	13	..	13
Total	28	21	..	21
b)Non-Academic Staff	39	26	..	26
TOTAL	67	47	..	47

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	..	..	..	..	..	..

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs.	Rs.	Rs.
a)Academic Staff	2,14,173	8,751	..
b)Non-Academic Staff	1,22,443	7,337	..
TOTAL	3,36,616	16,088	3,00,000

IV. WORKING EXPENSES	1970-71 Rs.	Additional working expenses requested Rs.
a) Consumables	48,970	..
b) Equipment	9,940	..
c) Others	19,625	..
TOTAL	78,535	1,25,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs.	Rs.	Rs.
Equipment	10,06,067	56,50,000	1,88,00,000*

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	22,702	28,377	28,377	4,000	5,000	3.00

VII. OUTPUTS SINCE 1956(Upto 31.3.1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	..	1	..	..	..	6

* Includes Research Equipment, Fabrication facilities, Computer Centre and Graphic Arts Facilities.

7.2.2 Main experimental facilities

Specialised research analysis instruments:

Electron Microscope (Philips) 100 EM

Carl Zeiss UR-10 Double Beam Automatic Recording Spectrophotometer

Unicam SP-700 A Double Beam Spectrophotometer

AEI MS - 10 Mass Spectrometer

2" Double focussing Mass Spectrometer (constructed in the Laboratory)

AEI MA - 7 double focussing Mass Spectrometer

Varian HA - 100 NMR Instrument

Varian T-60 NMR Spectrometer - On Order

Finch Type Electron Diffraction Unit (constructed in the Laboratory)

19" Edwards Vacuum Coating Plant

Radio Chemistry - specimen preparation and counting instruments

Optical Fabrication & Testing Instruments

Electronics - Testing & Measuring Instruments

Glass Blowing shop

IBM 360/44 Digital Computer

7.2.3 Highlights of work done

The following instruments were designed, developed and fabricated in the Laboratory

(a) Optical Instruments

Fizeau Interferometer

Multiple Beam Interferometer

Precision Optical Components of varied specifications

He-Ne Gas Laser

(b) Vacuum Instruments

High Vacuum Gauges

Rotary and Diffusion Pumps

Vacuum Coating Unit 6", 12" & 15"

(c) Electronic Instruments

Magnetostrictive Transducers

Ultrasonic Drill

Vacuum Tube Voltmeter Kits (University Grants Commission sponsored Project)

Precision Temperature Controller

Electronic Circuitry for 2" Mass Spectrometer Electron Diffraction Unit.

Special Courses/Summer Schools conducted

Summer School on Electron Microscopy - May 1966

Short-term Course on Instrument Design - May 1967

Short-term Course on High Vacuum Technology - November 1968

Get-together on Laser Development - June 1969

7.2.4 Proposals

Teaching

The staff offer specialised courses concerning the design and development of instruments, vacuum systems, optics and optical techniques, optical glass working and glass blowing and the computer sciences. It is planned to offer the following in the new academic year:

Computer Programming/Computer Applications

High Vacuum Technology

Optics and Optical Engineering

Design of Instruments

Research and Development

The main basis for the development proposals made by the Institute for the Central Instruments and Services Laboratory calls for active support by the Laboratory to the research activities of the Institute.

Specifically, the proposals call for enhanced capability for design, fabrication and servicing of electronic equipment; build-up of the second phase of the computer centre; research equipment support for various departments involving improvement and extended research services for assisting the research workers of the Institute; proposals for putting up better mechanical workshop facilities; and increase in the senior scientific staff by about 10 people and supporting staff by about 20 people

Financial

In the revised consolidated list of equipment proposed by the Institute, it was suggested that the Laboratory be given responsibility for the following equipment:

Sl. No.	Particulars	As revised by the Institute (Rupees in Lakhs)
1.	Research equipment	68.09
2.	Electronics	45.77
3.	Microscopes and Cameras	5.00
4.	Fabrication equipment	23.60
5.	Instrument test & calibration room	22.00
6.	Computer Centre	22.00
7.	Graphic Arts Facilities	3.00
		Total 189.46

7.2.5 Review and Recommendations

The Central Instruments & Services Laboratory came into being in 1964, following the recommendation of the Ghosh Committee. The work of the Laboratory comes up for review for the first time

The present responsibilities of the Laboratory involve. -

a) Servicing of equipment;

b) housing, operation and maintenance of major Instruments and facilities; and

c) designing and fabrication of equipment.

The Laboratory has made progress in servicing of equipment particularly electronic and electrical instruments. It would appear, however, that the Laboratory is handicapped due to lack of such equipment and standards as are essential for the calibration and standardisation of instruments.

We note the success of the Laboratory in the matter of housing, operating and maintaining major instruments and central facilities.

We commend the policy of the Institute in associating Faculty members from other departments with specific responsibilities in the laboratory, for example, the running of the Radio-chemistry facility. Such a policy, besides avoiding recruiting senior staff, also increases the interaction of the Laboratory with other departments.

In the matter of design and fabrication of equipment, we feel that the Laboratory has developed a reasonable degree of capability in Vacuum Technology.

We note the developments in Optics Technology and also some of the difficulties in obtaining better results. It appears that two factors come in the way of greater effectiveness: firstly, the need for greater inputs at the theoretical level and secondly the extent to which development of optical instruments hinges upon sophisticated mechanical design. The inadequacy of both precision workshop facilities and capability in mechanical design is a serious impediment. In this context, we would also like to note that the Laboratory has neither adequate scientific staff for the design and fabrication of electronic equipment, nor the back-up of components and standardisation equipment which are vital for the task. To overcome these deficiences, we have recommended provisions for equipment for fabrication, calibration and standardisation equipment and for a precision workshop.

We feel that it is important that the two distinct responsibilities of the Laboratory should be recognised and kept in view. The first one relates to the design of certain sophisticated equipment and servicing of equipment for other departments. The second relates to undertaking research in certain areas of applied technology, primarily instruments technology, whether mechanical or electronic. In view of our recommendation elsewhere in the report that the Laboratory should be entrusted with the responsibilities of looking after centralised equipment facilities for the Institute as a whole, there is even a greater need to keep these two functions of the the Laboratory distinct and apart. In a sense, it would mean the research work of the Laboratory should primarily be concentrated in the fields of instruments Technology. The Laboratory, as such, should not undertake any research that normally belongs to a department at the Institute; nor should the laboratory undertake responsibilities for the training of students for degrees.

The Laboratory should recognise and accept that its primary function is to render service on the major common facilities proposed to be obtained for the Institute for the benefit of all the departments of the Institute. This responsibility should include the operation and maintenance of such equipment. In this connection, we envisage the need for maing available trained personnel to render service on such equipment. While ordering for sophisticated equipment, care should be taken to obtain adequate spares, so that uninterrupted use of the equipment will be possible. We also visualise the constitution of "Users' Committees" to plan for efficient utilisation of these items of equipment. We are sure that the Director will make such administrative arrangements as are concerned appropriate for the purpose. For the creation of such common facilities, we recommend the following grants:

Sl. No.	Particulars	Amount (Rupees in Lakhs)
1.	Research equipment	60.00
2.	Electronics	45.00
3.	Microscopes and cameras	5.00
4.	Fabrication equipment	30.00*
5.	Instrument test & calibration facilities	22.00
6.	Computer Centre (second phase)	22.00
7.	Graphic Arts facilities	4.00
	Total	188.00

* including Rs.7.5 to Rs.10.00 lakhs for a high precision workshop. (List of equipment given in the annexure).

In the revised departmental structure under divisions and the new role that the Laboratory should play, we consider it logical that the workshop of the Mechanical Engineering Department should be transferred to and made part of the Central Instruments & Services Laboratory.

We further recommend the creation of a mechanical design office and an electronics design office. We also recommend the strengthening of the theoretical base of the optics and laser technology groups.

The Laboratory should be responsible for the operation and maintenance of the Computer. However, the Department of Applied Mathematics should be responsible for the soft-ware aspects of the Computer.

In order to house the sophisticated and common items of equipment to be obtained by the Institute, we recommend a centrally located building complex at a cost of Rs 60.00 lakhs. The building should be designed functionally to protect against weather and voltage fluctuations.

7.2.6 Financial Implications

Equipment	..	Rs	188.00 lakhs
Building (60000 sq. ft.)	..	Rs	60.00 lakhs

7.3 DEPARTMENT OF APPLIED MATHEMATICS

I Relevant Statistics

STAFF (As on 31-3-1971)	Sanctioned	In position (against substative posts)	Personal posts	Total in position
a) Academic: Professors	2	1	..	1
Asst.Profs.	6	6	..	6
Lecturers	8	5	..	5
Other Academic Staff	4	3	..	3
TOTAL	20	15	..	15
b) Non-Academic	5	4	..	4
TOTAL	25	19	..	19

II. STUDENTS As on 31-3-1971	B.E.	M.E.	Res.	P.G. Dipolma	Fellows Instt.	Other Fellows CSIR/UGC	Total
	..	..	6	..	..	4	10

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of Additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	1,29,247	5,130	..
b) Non-academic Staff	19,536	815	..
TOTAL	1,48,783	5,945	1,50,000

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	1,584	..
b) Equipment	1,664	..
c) Others	6,962	..
TOTAL	10,210	37,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	20,952	..	1,00,000

VI. BUILDING	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq. Ft.	Sq. Ft.	Sq. Ft.			
	14,272	17,841	17,841	..	..	..

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	16	..	..	..	..	174

7.3.2 Highlights of work done since the last review

The department has made significant contribution in Fluid Dynamics, especially in the study of Boundary Layers, Shock Waves and Blast Waves, Magnetohydrodynamics and Plasmas with special emphasis on Wave Propagation, Stability, Radiation and Transport Processes; Theory of Dense Gases, Study of Secondary Flows in Non-Newtonian Fluids and its Industrial and physiological applications. Further, the department has developed a range of courses in Applied Mathematics for the B.E., M.E. and Diploma Course students of the Institute and organized advanced lectures on Mathematical Techniques at research level from time to time.

7.3.3 Proposals

Teaching

The Institute proposals for the department call for short-term courses on programming languages in Numerical Methods, Applied Statistical Methods, Dynamical Meteorology, etc., in addition to a fairly heavy load of regular teaching that they are already undertaking.

Research and Development

The Institute proposals call for the continuation of the present programmes in the field of Fluid Mechanics involving research in Boundary Layer Theory, Compressible Fluid Flows, including Hypersonic Flows and Radiation Gas Dynamics, wave Propagation, Stability and Transport Properties and Magnetohydrodynamics. Proposals also call for increased activity in the fields of Non-Newtonian Fluids, Arc Plasma Discharges, Computer Science and Functional Analysis, Dynamical Meteorology, Cloud Physics, Elasticity, Oceanography and a small laboratory for developing models of Viscous Flows and Rotating Fluid Flows.

Financial

The Institute proposes an addition of six professors, three technical assistants and eight research students, plus three non-technical supporting staff. The proposals call for an expenditure of Rs 1.50 lakhs on staff, Rs 37,000 on working expenses and a sum of Rs 2,500 on furniture. Rs 1.0 lakh was requested for equipment.

7.3.4 Review and Recommendations

This department started functioning in the Institute from March 1956. Quality work has come out from the department in these intervening years and it has established itself as one of the good departments of Applied Mathematics in the country.

The department has an important role to play in the Institute's general programme of research and teaching. Much of engineering has become science-oriented with applied mathematics playing a decisive role in its growth. Nowhere can this be seen more concretely than in the fields of Solid Mechanics and Fluid Mechanics, which, in a certain sense, are the mother sciences of all engineering - other than electrical sciences. Even in electrical sciences, methods of mathematical physics are so important that it is hard to conceive a modern teaching and research institution without a strong Applied Mathematics Department.

We recommend that the research activities of this department be closely related as far as possible with the general research activities of the other departments, notably Aeronautical Engineering, Physics and the Computer Sciences.

Although efforts are made in teaching courses in Applied Mathematics to related physical problems, it is suggested that emphasis should be given in teaching the students the principles of reducing the mathematical models from the complex physical problems and applying the tools of mathematics for the solution of such problems.

7.3.5 Financial implications

We recommend a sum of Rs 1.00 lakh for equipment.

7.4 DEPARTMENT OF PHYSICS

7.4.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in position
a) Academic: Professors	2	2	2	4
Asst.Profs	4	2	4	6
Lecturers	4	1	..	1
Other Academic Staff	5	4	..	4
TOTAL	15	9	6	15
b) Non-Academic	19	19	..	19
TOTAL	34	28	6	34

II. STUDENTS As on 31-3-1971	B.E.	M.E.	Res.	M.Tech.	Fellows Instt.	Other Fellows CSIR/UGC	Total
	..	..	10	18	1	17	46

III. SALARIES, ALLOWANCES P.F. AND INTERIM RELIEF	1970-71		Cost of Additional Staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	2,12,245	4,138	..
b) Non-academic Staff	87,926	5,831	..
TOTAL	3,00,171	9,969	1,75,000

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	56,451	..
b) Equipment	53,846	..
c) Others	12,911	..
TOTAL	1,23,208	91,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount Originally proposed	Revised
	Rs	Rs	Rs
Equipment	10,42,770	24,50,000	4,45,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft	Sq.Ft.	
	32,523	40,651	40,651	16,960	21,200	12.00

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D.	M.Sc.	M.Tech.	B.E.	Diploma	No. of Research Papers/Reports
	57	10	5	..	..	550

7.4.2 Main Experimental Facilities

Experimental facilities are available for research in the following branches of spectroscopy and solid state physics : Raman and Infrared Spectroscopy, Crystal Growth, X-ray Crystallography, Semi-conductors, Nuclear Magnetic and Electron Spin Resonance, Ferroelectricity, Thermal and Elastic Properties of Crystals, Critical Point Phenomena and Mass Spectrometry. Most of the equipment have been built with components and raw materials available indigenously.

7.4.3 Highlights of work done since the last review

a) Work in the following branches of Solid State Physics and Spectroscopy was taken up for the first time and the necessary facilities built up:

Magnetic Resonance
Semi-conductors
Ferroelectricity
Mass Spectrometry
Lasers
Low Temperature Physics, and
Theoretical Lattice Dynamics.

b) A new inter-disciplinary course on Physical Engineering with the object of imparting a practical and application oriented course on Materials Science and Technology was started in 1968 by this department in collaboration with the Mechanical Engineering and Applied Mathematics Departments.

c) In addition to the course referred to above, the department has been engaged in some inter-disciplinary activities in instrumentation, spectroscopic studies and on the preparation of semi-conductor grade silicon and high power semi-conductor devices.

7.4.4 Proposals

Teaching

The Institute proposals for the department call for the consolidation of their two-year inter-disciplinary course in Physical Engineering at the master's degree level. They also propose to consolidate the activities initiated as a part of their previous plan and modernize their methods of teaching.

Research & Development

Lesers and Spectroscopy - The department proposes to construct more powerful Helium-Neon Lasers and other Gas Lasers as a part of modernization of the Spectroscopy Laboratory. The purpose of this modernization programme is to study the Raman Effect and Brillouin Scattering, Non-Linear Optical Phenomena and Holography.

Crystal Growth - The department wants to expand its present activities for the growth of both dielectric and optical crystals. It is proposed that this unit may supply various types of crystals required for research in the Institute.

Magnetic Resonance - The proposals call for intensification of the work in this field and the investigations of electron spin resonance and nuclear magnetic resonance with improved instrumentation. It was suggested that worthwhile progress will be possible only when adequate quantities of liquid helium become available.

Semi-conductors - The Institute proposes de-linking the growth of semi-conductor crystals from the investigations and then undertake research on semi-conductor physics.

X-ray Crystallography - The proposals call for taking up the determination of crystal structure of materials of biological significance. The department plans to take up some work on high temperature crystallography and the fabrication of miniaturised instrumentation.

Mass Spectrometry and Nuclear Geochronology - The proposals call for carrying out basic research on different types of ion sources and techniques in mass spectroscopy and continue work on geochronology.

Ferroelectricity - The proposals call for study in greater detail of ferroelectricity and Piezo-electric crystals and their applications.

Low Temperature Physics - While indicating the desire to build a small air liquefier, the proposals call for obtaining a commercial helium liquefier.

Theoretical Solid State Physics - The proposals call for creating a small group of theoretical physicists to help in teaching Mathematics and Theoretical Physics to the research workers and also collaborate in doing theoretical work in fields such as Lattice Dynamics, Band Structure of Solids, etc.

Financial

The financial implications of the above proposals are as follows.

A sum of Rs 4.45 lakhs is requested for the acquisition of equipment. We note that, perhaps inadvertently, the high field magnet was omitted. More appropriately, therefore, the requirements of the department should be taken as about Rs 5.45 lakhs. The department proposes to increase the strength of research workers to about 75 people, including the staff. The primary increase is in the research students to 50. The increase in the working expenses requested was Rs 91,000. For the M.Tech. programme, an additional request for Rs 36,000 was made. The proposals also call for increase in staff at the level of assistant professors and above by 10 and supporting staff by 5. The building programme calls for an expenditure of Rs 12.00 lakhs to put up a building of 20000 sq. ft. of plinth area.

7.4.5 Review and Recommendations

The original leadership given by Dr.C.V.Raman could still be seen. It has produced some of the most capable physicists in the country. It should be the endeavour of the Institute to sustain this tradition in the department.

Raman Spectroscopy

At one time, the work in this field in the Institute was outstanding. However, great technological progress has taken place in this field elsewhere in the world. We would suggest that the department modernise its equipment for research in Raman Spectroscopy if it wishes to be a major centre for research in this field.

X-ray Crystallography

It is a good section with fair competence. The work in this group, however, is uncorrelated to the work done elsewhere in this Institute. It would appear to us that structures of substances that do not necessarily have any relevance have been randomly picked up and solved. Attractive ideas which originated from this department could have evolved into sound engineering design and resulted in instruments of more enduring and practical value, had there been the necessary measure of mutual interaction between this and other departments.

We feel that the work in Crystal Growth is more appropriately initiated and established as a part of the multi-disciplinary activity in Materials Science and Solid State

Electronics. The study of properties of crystals grown does not form an important part of the departmental activities. We recommend strengthening of work on X-ray Crystallography and its interaction with the work of other departments, especially Organic Chemistry and Biochemistry.

Magnetic Resonance

The department did pioneering work in this country in Magnetic Resonance and we hope that it would continue to do so. We recommend the strengthening of the work in Magnetic Resonance. We have also identified the requirement of a powerful high intensity magnet.

Semi-conductors

We understand that the department has been successful in producing small quantities of semi-conductor material and pursued some research. We recommend the continuance of the work in Theoretical Solid State Physics. The production of the materials itself may be more efficiently concentrated in the newly proposed laboratories for inter-disciplinary activities in Materials Science and Solid State Electronics.

Mass Spectroscopy and Nuclear Geology

We are glad to note the developments in this group. They are directly related to the Indian scene. Capability for research and the problems chosen for research are good. We note that the Institute proposes to obtain a Mass Spectrometer. We suggest the strengthening of this group, so that it would be even more effective. The Institute may also consider association with the Department of Mines and Geology of the Mysore Government.

M. Tech. Course

This is the first inter-faculty course that the Institute has planned. It would appear that further clarification and thinking is necessary in the evolution of this course particularly in the light of the Unit System. We are sure the Institute would review this course at the appropriate time from the stand point of success and utility, especially in regard to the placement of its students.

We recommend a sum of Rs 4.00 lakhs for increase in the building area of the department. A sum of Rs 8.00 lakhs for renovation of the existing building as part of the general renovation of old departmental buildings at the Institute is also recommended.

7.4.6 Financial Implications

Equipment	:	Rs 5.5	lakhs
Additional space	:	Rs 4.0	lakhs
Renovation and modification	:	Rs 8.0	lakhs

7.5 DEPARTMENT OF BIOCHEMISTRY

7.5.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a) Academic: Professors	2	2	2	4
Asst. Profs.	6	5	2	7
Lecturers	9	6	..	6
Other Academic Staff	5	5	..	5
Total	22	18	4	22
b) Non-Academic Staff	22	22	..	22
TOTAL	44	40	4	44

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	..	28	6	1	18	53

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	3,52,964	8,890	..
b) Non-academic staff	99,134	5,597	..
TOTAL	4,52,098	14,487	5,94,000

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	70,175	..
b) Equipment	4,775	..
c) Others	9,096	..
TOTAL	84,046	1,72,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	3,72,158	20,00,000	3,30,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	19,749	24,686	26,686	24,000	30,000	38.30

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	77	12	..	..	6	599

7.5.2 Main Experimental Facilities

The department is equipped for biochemical research work having such special apparatus as high speed refrigerated centrifuges, analytical ultracentrifuge, automatic amino acid analyser, electrophoresis apparatus, freeze drying equipment, fraction collectors, spectrophotometers, etc. Facilities are also available for biochemical investigations using radioactive isotopes. The following major items of equipment are available in the department: Beckman 'E' model Analytical Ultra-centrifuge; Counting equipment for radioactive tracer work; UV Spectro-photometers, including Carry Model 14 recording spectrophotometer; Beckman Model 'L' 'Vac 60' MSE Mistral and Servall RC-2B Refrigerated Centrifuges; Gas Liquid Chromatography equipment.

7.5.3 Highlights of work done since the last review

In the last 13 years, two major areas of study in biochemistry have been developed. They are (i) the study of proteins; and (ii) lipid metabolism. The investigations in the former covered (i) structural aspects; (ii) identification of unusual amino acids; (iii) enzymic studies in delineating metabolic pathways; and (iv) inhibitors of protein hormones. In the field of lipid metabolism, the work has been concentrated mainly on absorption and functional role of carotenoids and vitamin A and its analogues and on cholesterol and ubiquinone. In addition, research work has been carried out in the following three distinct areas in experimental biology; (i) plant and microbial antibiotics and antiviral chemotheraphy; (ii) purification of sewage and industrial wastes; and (iii) yeast cytogenetics.

7.5.4 Proposals

Teaching

With the permanent staff asked for, it is proposed to organise in alternate years, short-term courses in analytical techniques in biochemistry. The diploma course in Molecular Biochemistry has been organised and started during the last year. It is also proposed to arrange special courses in the subjects such as (i) advances in biochemistry; (ii) biochemistry in relation to agriculture; (iii) biochemistry in relation to medicine; and (iv) biochemistry in relation to food and pharmaceutical industries.

Research and Development

It is proposed to intensify research in the following areas: (i) Study of Proteins; (ii) Lipid and Vitamin Metabolism; (iii) Plant Biochemistry; (iv) Endocrine Biochemistry; and (v) Nucleic Acids.

Equipment

The requirement of the department is Rs 3.50 lakhs.

Buildings

The department has requested for additional space of 30000 sq. ft. plinth area costing Rs 38.3 lakhs.

Working Expenses

Request for additional sum of Rs 1.72 lakhs per annum has been made towards working expenses.

7.5.5 Review and Recommendations

In the early history of this department, the emphasis was on agricultural aspects of biochemistry and on sewage biochemistry. The emphasis has slowly shifted in recent years into two important areas: (i) proteins and polypeptides; and (ii) lipids.

The department has a well organised training programme for Ph.D. candidates and the research scholars undergo a comprehensive course in General Biochemistry as a preparation for their research programme. In addition to this, the department has started a diploma course in advanced biochemistry. This course is well organised. To keep the programme fully effective, it needs to be reviewed regularly.

The Department of Biochemistry, which was organised in 1921, has, in the past few years, become one of the foremost centres for biochemistry in the country. It has, therefore, been reorganised as an Advanced Centre of Biochemistry by the University Grants Commission in 1968. The department has been well organised to meet the needs of the rapid developments in the discipline of biochemistry.

The department has made special contribution in some of its spheres of activity and at present is engaged in the following areas of research:

(i) Studies on proteins (identification of unusual amino acids, studies in delineating metabolic pathways in plants, inhibitors of protein hormones);

(ii) Lipid metabolism (the work has been concentrated mainly on chemistry of vitamin A and carotenoids as well as on absorption and functional role of carotenoids and vitamin A). Studies are also undertaken in relation to cholesterol and ubiquinone.

The work in these fields by the department has been well recognised and these activities should be continued. The department has also, in the past few years, been trying to develop certain aspects of chemistry and metabolism of nucleic acids.

The department has also to be complimented for the fact that it has been organised in such a way that individual groups have been developed which are capable of making definite contributions in their respective fields. A number of inter-disciplinary projects have been proposed and particular mention may be made about the environmental biology, where the effect of high altitude on the metabolism of animal has been studied.

There are possibilities that some of the following areas of research may not be as meaningful to-day as before and the department may consider whether such activities can be gradually reduced and eventually discontinued. Some of these for example are:

Plant and microbial antibiotics and antiviral chemotheraphy;

Purification of sewage and industrial wastes; and

Yeast Cytogenetics.

The existing line of investigations, particularly in the field of protein chemistry and metabolism, metabolic pathways in plants and lipid metabolism, should be fostered. In our opinion, these programmes will considerably be strengthened by laying emphasis on enzyme kinetics, since a number of investigations undertaken in the above categories involve purification of enzymes and study of their properties. Another study will be in the areas of proteins and steroid hormones. Further, the department may consider developing a programme on the structure and function of cell membranes; this will bring the departmental activities much closer and help inter-disciplinary programmes.

Inspection of department building indicates that it is not functionally suitable for research in biochemistry. The old building, therefore, needs to be renovated and modernised. The estimated cost of the renovation will be about Rs 6.75 lakhs. We also recommend an additional building space of 5500 sq. ft. plinth area, estimated to cost Rs 5.50 lakhs.

We recommend a sum of Rs 3.00 lakhs for equipment.

7.5.6 Financial Implications

Buildings - Renovation	:	Rs 6.75 lakhs
New building - 5500 sq. ft. plinth area	:	Rs 5.50 lakhs
Equipment	:	Rs 3.00 lakhs

7.6 DEPARTMENT OF INORGANIC & PHYSICAL CHEMISTRY

7.6.1 Relevant Statistics

I. STAFF(As on 31.3.1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a) Academic Professors	3	3	2	5
Asst.Profs.	4	2	..	2
Lecturers	7	5	..	5
Other Academic Staff	11	10	..	10
Total	25	20	2	22
b) Non-academic staff	23	22	..	22
TOTAL	48	42	2	44

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31.3.1971	..	..	27	..	..	9	36

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries Rs.	Interim Relief Rs.	Rs.
a) Academic staff	2,86,950	6,756	..
b) Non-academic staff	1,04,247	6,541	..
TOTAL	3,91,197	13,297	13,000

IV. WORKING EXPENSES	1970-71 Rs.	Additional Working Expenses requested Rs.
a) Consumables	43,981	..
b) Equipment	14,271	..
c) Others	10,818	..
TOTAL	69,070	81,000

V. NON-RECURRING	Capital equipment procured since 1956 Rs.	Amount originally proposed Rs.	Revised Rs.
Equipment	3,84,012	13,40,000	4,05,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now Requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs. Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	31,808	39,761	39,761	..	..	..

VII. OUTPUTS SINCE 1956 (Upto 31.3.1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	52	13	..	..	..	532

7.6.2 Main Experimental Facilities

The department is well equipped for chemical research work having such special apparatus as: Brice-Phoenix Light Scattering Photometer; Differential Refractometer; X-ray Diffraction Unit for the Powder and Single Crystals; Polarograph (both DC and AC); Spectrophotometer (UV and Visible); EEL Flame Photometer; Differential Thermal Analysis Unit; Thermo-gravemetric Unit; Magnetic Balance; Equipment for measuring Dielectric Constants of Solutions; Projection Microscope for measuring contact angles; Electron Diffraction Camera; Surface Pressure Balance; Metallurgical Microscope; Petrographic Microscope with photomicrographic attachement.

7.6.3 Highlights of work done since the last review

The bulk of the research work has been in the fields of Electrochemistry, Coordination and Surface Chemistry.

The work in Electrochemistry has centred round the development of pyrophosphate and sulphamate baths for the electroplating of metals and alloys, the study of the inhibitors and cathodic protection in counteracting the corrosion of aluminium and its alloys, and the use of polarography (DC and AC) and potentiometry to investigate metal complexes.

Research in Coordination Chemistry has been directed towards the preparation and the experimental (spectroscopic) and quantum mechanical study of the complexes of transition metals and rare earths.

Surface Chemistry studies have involved an investigation of the adsorption of gases on pure and supported transition metals and the correlation of these adsorption studies with their catalytic activity.

In addition, considerable work has been done on the compounds of sulphur in its lower valency state, on solid state transformations (polymorphic, topotactic and order-disorder transformations), on dipole moments, mineral chemistry, polymer chemistry and geochemistry.

7.6.4 Proposals

Teaching

The proposals on the teaching side are three-fold:

(i) strengthening and systematizing of two-semester course now being offered to the students joining the department for Ph.D.;

(ii) greater involvement with the Materials Science programme now being offered by the Institute to M.E. students;

(iii) offering a one-year diploma course in Electrochemical Science and Technology.

Research and Development

The department proposes to strengthen its activities in two aspects of Materials Science, viz., Electrochemistry (including the relevant aspects of Surface Chemistry) and Molecular Structure.

Work on Electrochemistry is proposed to be channelled into the areas of Electrodeposition, Corrosion and Anodic Film Formation, Batteries, Electrochemical Production of Substances, Structure and Properties of Electrolytes, Electrode-Kinetics Transport Processes, Adsorption and Interfaces and Electro-analytical Chemistry.

Work on Molecular Structure will be channelled into the following areas:

Isolation and synthesis of new compound structure determination, thermodynamic and quantum-mechanical studies and elucidation of reaction mechanics.

In addition to the above, work on polymers, sulphur and fluorine chemistry and earth science are proposed to be intensified.

Equipment

The requirement of the department is Rs 4.05 lakhs.

Working Expenses

Request for additional sum of Rs 81,000 per annum has been made towards working expenses.

7.6.5 Review and Recommendations

The Department of General Chemistry is one of the oldest departments. It was redesignated as the Department of Inorganic and Physical Chemistry in 1956.

The main fields of research in which the department has made special contributions in the last few years are:

(i) Electrochemistry;

(ii) Coordination Chemistry; and

(iii) Surface Chemistry.

In addition to these, the department has carried out some research programmes in Mineral Chemistry, Polymer Chemistry, and Geochemistry and Quantum Mechanics, with particular emphasis on molecular structure in relation to physical properties and catalytic reaction.

The present faculty has enough competence to tackle these problems. The proposals by the department also envisage strengthening the work in Electrochemistry by including relevant aspects of Surface Chemistry. These are expected to help in strengthening the inter-disciplinary project on Materials Science. Similarly, work on Molecular Structure is proposed to be strengthened with the same object in mind.

The proposal of the department to offer Diploma Course in Electrochemistry needs to be examined on the basis of overall policy of the Institute regarding this. However, at present the Committee feels that this course may not serve any useful purpose.

We feel that the department has enough space. However, the building which is occupied by the department is very old and considerable renovation is required to modernise the existing facilities. We recommend a sum of Rs 10.75 lakhs for this purpose.

Existing facilities and the know-how in the modern aspects of Electrochemistry and Surface Chemistry may be strengthened as envisaged by the department. This will help the development of the inter-disciplinary project on Materials Science. These two branches of Physical Chemistry may ultimately come close together to develop a programme on chemical aspect of surface phenomena. This may have an important impact on the future development of Molecular Biology, particularly Membrane Biology, as well as Bio-engineering.

We recommend that the department may explore the possibility of developing the field of physical and chemical aspects of Biopolymers. This development should be made in cooperation with the other branches of the department/division of Chemical and Biological Sciences. Development in this particular branch of science will also be useful to make an impact in the inter-disciplinary project on Molecular Biology.

The studies in Molecular Structure, which have already been in progress in the department, need also to be strengthened, since this field will be of importance in developing the inter-disciplinary project on Materials Science.

We envisage that there will be gradual discontinuation of certain activities in the department such as Applied Electro-chemistry and Catalysis.

We recommend a sum of Rs 6.00 lakhs for equipment to strengthen these research programmes and for undertaking research in the field of Biopolymers.

7.6.6 Financial Implications

Building (renovation)	:	Rs 10.75	lakhs
Equipment	:	Rs 6.00	lakhs.

7.7 MICROBIOLOGY AND PHARMACOLOGY LABORATORY

7.7.1 Relevant Statistics

I. STAFF(As on 31.3.1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a)Academic Professors	..	..	3	3
Asst.Profs.	3	1	..	1
Lecturers	4	3	..	3
Other Academic Staff	4	4	..	4
Total	11	8	3	11
b)Non-Academic Staff	15	14	..	14
TOTAL	26	22	3	25

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31.3.1971	..	..	8	..	4	6	18

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs.	Rs.	Rs.
a) Academic Staff	1,39,726	3,660	..
b) Non-academic Staff	69,255	4,093	..
TOTAL	2,08,981	7,753	1,20,000

IV. WORKING EXPENSES	1970-71 Rs.	Additional Working expenses requested
		Rs.
a) Consumables	39,998	..
b) Equipment	16,422	..
c) Others	9,035	..
TOTAL	65,455	17,000

V. NON-RECURRING	Capital equipment procured since 1956 Rs.	Amount originally proposed Rs.	Revised Rs.
Equipment	1,92,864	5,29,000	2,95,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs. Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	15,286	19,108	19,108	3,200	4,000	2.00

VII. OUTPUTS SINCE 1956 (Upto 31.3.1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	24	7	..	..	..	395

7.7.2 Main Experimental Facilities

The laboratory is equipped for biochemical research work having such special apparatus as Fermenter, Sharples Centrifuge, Automatic Fraction Collector, UV Spectrophotometers, pH Meters, Fluorimeters, Warburg Manometers, Colorimeter, High Voltage Electrophoresis, Freeze Drier, Liquid Scintillation Counter and Ultracentrifuge and other facilities such as glass house with aeration lines for pot culture experiments, rotary starters, reciprocal shakers.

7.7.3 Highlights of work done since the last review.

In 1968, the Fermentation Technology and Pharmacology Laboratories were amalgamated to form the Microbiology and Pharmacology Laboratory. In the last 15 years, major areas of study had been in the fields of (a) metabolism and effect of drugs on tubercle bacillus; and (b) metabolism activities of silk worm with particular emphasis on the role of lipids in this organism. In addition to these, research work has been carried out to isolate antifungal principles and anti-cancer agent from the plant sources. Moreover, the laboratories have carried out considerable amount of investigations on developing methods of retting of fibres like jangli bhendi, sissal and coir; a microbial system for fast degradation of mucilage from coffee beans.

7.7.4 Proposals

Teaching

It is proposed to organise short-term experimental courses on molecular biology of bacteria and bacterial viruses and lectures on (i) molecular pharmacology and mode of action of drugs; (ii) immunology; and (iii) basic and developmental biology, general and applied microbiology (medical, soil and industrial).

Research and Development

It is proposed to develop research in the following areas: Molecular Biology; Bacterial Physiology; Microbial Systematics, Industrial Fermentations, Soil Metabolism; Cell differentiation and programmed cell-death in Insects; Cancer - mode of action of anti-cancer compounds, immunity in cancer and environmental carcinogens; Pharmacology of synthetic and natural products; and Human Mycology.

Equipment

The requirement of the laboratory is Rs 2.95 lakhs.

Buildings

The laboratory has requested for additional space of 4000 sq. ft. of plinth area costing Rs 1.85 lakhs.

Working Expenses

Request for additional sum of Rs 17000 per annum has been made towards working expenses.

7.7.5 Review and Recommendations

In 1968, the erstwhile units of Fermentation Technology and Pharmacology were amalgamated to form the Microbiology and Pharmacology Laboratory. The work in the two sections has been coordinated so as to effect maximum economy of working expenses with improved efficiency of research and teaching activities.

The laboratory is offering short-term courses on Molecular Biology of bacterial viruses, which is well organised. Other-wise, the laboratory does not have a formal training programme for Ph.D.

The main fields of research in which the laboratory has made special contributions in the last few years are:

(a) Metabolism of drugs and their effects on tubercle bacillus; and

(b) Studies on nutritional requirements and metabolic activities of the silk worm.

The laboratory has also been actively associating in a number of industrial problems, such as developing methods in relation to retting of fibres like jangli bhendi, and microbial degradation of mucilage from coffee beans, etc.

New interests are in the field of microbial genetics and insect physiology and biochemistry. These programmes are being developed and the present faculty is competent to tackle these problems as proposed. However, it is the impression of the Committee that the Laboratory has been engaged in too many branches of research and, as such, some selection and consolidation is required.

Inspection of laboratory buildings indicates that the present Microbiology and Pharmacology laboratory has enough space and no further space is recommended.

Though insect biochemistry and physiology appropriately belong to the Department of Biochemistry, the tradition of this study in the laboratory may be continued till adjustments are made. However, silk worm diseases of bacterial origin will come within microbiology and this aspect of study should be emphasised.

We expect that there will be a gradual discontinuation, as opportunities arise, in certain activities such as classical pharmacology (Pharmacology of Synthetic and Natural Products, Human Mycology and Cancer research).

We also recommend that the field of microbial genetics and industrial fermentation should be strengthened. We further expect that the laboratory in future years may think of concentrating research activities in Microbiology alone and gradually discontinuing activities in Pharmacology.

Since there is considerable scope for development in the field of biological transformation of Steroids, it is hoped that this laboratory may develop and strengthen this programme in cooperation with the Department of Organic Chemistry. This will have an important commercial implication.

We note that this laboratory does not have any substantive posts of professors, the existing professors holding the posts as personal to them. It would be necessary to create some posts when outstanding persons in these disciplines become available to build this laboratory.

7.7.6 Financial Implications

Equipment : Rs 2.50 lakhs

7.8 ANIMAL HOUSE

7.8.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in position
a) Academic: Professors	..	..	..	..
Asst.Profs.	..	..	..	..
Lecturers	..	..	...	..
Other Academic Staff	..	..	..	..
TOTAL	..	..	..	..
b) Non-Academic Staff	7	5	..	5
TOTAL	7	5	..	5

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	..	..	..	..	..	..

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	6,763	274	..
b) Non-academic Staff	12,080	1,089	..
TOTAL	18,843	1,363	..

IV. WORKING EXPENSES	1970-71	Additional working expenses requested
	Rs	Rs
a) Consumables	26,013	..
b) Equipment	1,896	..
c) Others	1,247	..
TOTAL	29,156	19,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount Originally proposed	Revised
	Rs	Rs	Rs
Equipment	19,522	50,000	50,000

VI. BUILDINGS Included under Microbiology & Pharmabology Laboratory	Existing including those under construction		Ultimate area as at the end of IV Plan	Additons now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	..	..	..	3,200	4,000	2.00

VII. OUTPUTS SINCE 1956 (Up to 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	..	..	..	..	..	..

7.8.2 Main Facilities

The Animal House works as a central facility under the control of Microbiology and Pharmacology Laboratory. The Animal House is at present located in an old building and is being extended by new additional accommodation. The new Animal House will have a plinth area of 9625 sq. ft. and carpet area of 7700 sq. ft. The following types of animals are being maintained in the present Animal House:

Mice; rats; guinea pigs; rabbits; dogs;
Primate Colony (maintained by the Biochemistry Department).

7.8.3 Proposals

The following proposals have been made for setting up a good animal house with supporting facilities by way of equipment, staff, accommodation, etc. Additional accommodation of 4000 sq.ft. plinth area (3200 sq. ft. carpet area) costing Rs 2.00 lakhs, equipment worth Rs 50000, one technical person in charge of the Animal House in the grade of an assistant professor and seven persons as supporting and technical staff. Small workshop facilities have also been requested for maintenance of the Animal House equipment. The additional estimated cost on salaries of staff comes to Rs 35000 and working expenses of Rs 19000 per annum.

7.8.4 Review and Recommendations

The Animal House facilities are primarily made use of for the work of the Microbiology and Pharmacology Laboratory and the Department of Biochemistry, as well as the interdisciplinary projects in Molecular Biology and Bio-engineering. It needs four types of accommodation for:

a) normal animals;

b) experimental animals;

c) storage of food, bedding and cages, etc.;

d) washing, sterilizing and incineration.

It is essential that a proper animal house with adequate accommodation, equipment and staff should be provided as an integral part of the research programmes.

As the Animal House will be a common facility for a number of departments of the Institute, it should not be administratively under the control of a single department or partly being run by another department as at present. Since the Animal House will largely be used by the Division of Chemical and Biological Sciences, we recommend that it should be utilised as a common facility under the control of the Division of Chemical and Biological Sciences and should be in charge of a Technical Officer, preferably a veterinary graduate in the grade of a lecturer.

A Users' Committee may be set up for planning, organising and coordinating the work of the Animal House.

Appropriate supporting and technical staff should be provided for maintaining the animal house on proper lines.

The present accommodation and the accommodation that is proposed to be provided during the Fourth Plan period will not be adequate for the expanded activities of the various departments and the requirements of a modern Animal House. We, therefore, recommend that a provision of Rs 2.00 lakhs may be made for additional new accommodation of about 4000 sq. ft. plinth area. The requirements of a modern and functional Animal House may be kept in view while providing the new accommodation.

Separate workshop facilities are not necessary, but appropriate facilities should be provided by the Central Workshop for maintenance and repairs of the Animal House equipment. If necessary, some staff of the Central Workshop may be specially ear-marked for such maintenance, repairs, etc.

A sum of Rs 50000 is recommended for equipment.

7.8.5 Financial Implications

Buildings (4000 sq. ft. plinth area)	: Rs	2.00 lakhs
Equipment	: Rs	50000

7.9 DEPARTMENT OF ORGANIC CHEMISTRY

7.9.1 Relevant Statistics

I. STAFF (AS on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in position
a) Academic: Professors	2	2	3	5
Asst. Profs.	4	2	..	2
Lecturers	3	1	..	1
Other Academic Staff	7	7	..	7
TOTAL	16	12	3	15
b) Non-Academic Staff	23	20	..	20
TOTAL	39	32	3	35

II. STUDENTS	B.E.	ME	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	..	7	..	1	14	22

III. SALARIES, ALLOWANCES P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	1,77,965	4,221	..
b) Non-academic Staff	93,580	5,753	..
TOTAL	2,71,545	9,974	13,000

IV. WORKING EXPENSES	1970-71	Additional working expenses requested
	Rs	Rs
a) Consumables	58,976	..
b) Equipment	13,076	..
c) Others	8,861	..
TOTAL	80,913	85,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	1,94,109	4,72,000	75,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	21,972	27,465	27,465	..	..	..

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	43	5	..	..	..	148

Equipment

The requirements of the department are indicated as Rs 4.00 lakhs.

Buildings

The department is shortly to move into a new building and has not requested for any additional space.

Working Expenses

Request for additional sum of Rs 85000 per annum has been made towards working expenses.

7.7.5 Review and Recommendations

The department is one of the oldest of the departments having been started almost immediately after the Institute commenced working in 1911. Prof. J.J. Sudborough was the first Professor and Head of the department. He was succeeded in 1923 by Prof. Sir J. L. Simonson, who left in 1927. Under the leadership of Sir J.L. Simonson, studies on natural terpenes and synthetic drugs were initiated and these subjects continued to be of main interest for a number of years.

The department has a training programme for Ph.D. candidates and the research scholars are expected to participate in seminars throughout their research programme.

The main field of research in which the department has been primarily concerned and has made special contribution during the past several years in Synthetic Organic Chemistry in relation to Steroids and Terpenoids. The department is also concerned with the inter-disciplinary projects with the Microbiology and Pharmacology Laboratory on Antitubercular drugs. It has also liaison with pharmaceutical companies in developing certain steroids, which are of commercial interest. Such liaison between the industry and the department should be encouraged. Although the department has basic facility and capabilities to carry out these research programmes, it has been handicapped by lack of modern equipment and some of these are in the process of being procured.

We recommend that the proposal of the main activity as suggested by the department particularly in the field of Steroids and Terpenoids may be encouraged.

We hope that there would be a possibility of developing inter-disciplinary projects with the Microbiology and Pharmacology Laboratory in studying biological transformation of Steroids and Terpenoids.

It is envisaged that in the near future the department will be recruiting a person in the field of natural products in the rank of Professor. This will furhher strengthen the activities of the department.

We do not recommend setting up of X-ray Crystallographic Unit in the department, since it has already been recommended under the central facilities..

We recommend a sum of Rs 4.00 lakhs for procuring new items and for replacement of the old equipment.

The department has adequate space and staff. Outstanding persons, as and when they become available, may be appointed.

7.7.6 Financial Implications

Equipment : Rs 4.00 lakhs

7.10 DEPARTMENT OF CHEMICAL ENGINEERING

7.10.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in position
a) Academic: Professors	3	3	..	3
Asst.Profs.	7	6	..	6
Lecturers	7	3	..	3
Other Academic Staff	5	4	..	4
TOTAL	22	16	..	16
b) Non-Academic Staff	29	26	..	26
TOTAL	51	42	..	42

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CISR/UGC	Total
As on 31-3-1971	..	33	23	..	1	15	72

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	2,32,332	7,226	..
b) Non-academic Staff	80,643	5,556	
TOTAL	3,12,975	12,782	..

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	70,754	..
b) Equipment	34,263	..
c) Others	15,745	..
TOTAL	1,20,762	70,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	4,49,784	21,45,000	15,18,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additons now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	29,134	36,398	40,398	12,800	16,000	8.00

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	44	27	47	..	73	319

7.10.2 Main Experimental Facilities

Experimental facilities exist in the fields of Reaction Engineering, Transfer Processes Thermodynamic and Transport Properties and other areas.

In Reaction Engineering, facilities exist to carry out investigations leading to the Kinetic Analysis, Process Development and Characterisation of Catalysts. Among the analytical tools, a vapour-phase chromatography unit is available. Facilities exist for carrying out work of both fundamental and applied nature in the areas of heat, mass and momentum transfer. In Thermodynamic and Transport Properties, the major field of activity is in the computation and correlation of these properties. Facilities also exist to measure thermal conductivity, heats of mixing, latent heat of vaporization at atmospheric pressure and vapour-liquid equilibria at atmospheric and above atmospheric pressures for totally miscible and partially miscible systems.

7.10.3 Highlights of work done since the last review

Since the report of the last Reviewing Committee, the teaching and research activities have increased. Industrial liaison is also growing. A two-year M.E. programme in two streams, viz., (i) Chemical Process and Plant Design; and (ii) Transfer Processes was started in 1963-64. Contributions were made in the fields of bubble and drop mechanics, computation of Thermodynamic Properties and Process Development. In the field of Thermodynamic Properties, the department is working with the International Union for Pure and Applied Chemistry in the preparation of Thermodynamic Tables. A number of monographs have been written. About 20 industries were given assistance - the assistance ranging from advice on patents to starting of chemical manufacturing units. The department has designed and fabricated instruments such as flow meters, etc.

7.10.4 Proposals

Teaching

It is proposed to increase the intake of M.E. students and also create better facilities for training, viz., course and project work. In the course work, it is planned to offer more courses, both at the present level of instruction and at an advanced level. Improved laboratory facilities both for course work as well as project work are envisaged. It is proposed to offer some courses of instruction in Bio-medical Engineering and to organize special lectures for research students on a more formal basis than it was possible so far.

Research and Development

The objective is to strengthen and consolidate the present fields of investigations by studying the projects in depth. In this, it is proposed to have a Process Development Laboratory, wherein scale-up can be studied for processes for which kinetic data have been collected. It is envisaged to set up a laboratory for experimental work on the Thermodynamic Properties at higher pressures. Studies in the field of air and water pollution are expected to be taken up. The newly started work in the field of Bio-medical Engineering is proposed to be strengthened.

In the field of Transfer Processes, the problem of generation of interfaces and heat mass transfer across them is proposed to be extended to Non-Newtonian Fluids. It is proposed to start research work in the field of Process Dynamics and Control to (i) Study dynamic characteristics of typical process systems, (ii) develop new methods for (a) analysis of transient nature; (b) control strategies; and (c) design of process equipment based on dynamic data.

Equipment

The requirement of the department is Rs 15.18 lakhs.

Buildings

The department has requested for additional accommodation of 16000 sq. ft. plinth area costing Rs 0.00 lakhs.

Working Expenses

Request for additional sum of Rs 70000 per annum has been made towards working expenses.

7.10.5 Review and Recommendations

The main fields of research in which the department has specialised in the last few years are : (i) Reaction Engineering; (ii) Transfer Processes; and (iii) Thermodynamics and Transport Properties. The new interests of the faculty are : Bio-medical Engineering, Mineral Beneficatión, Lubrication at low temperatures and low pressures and separation of solids from gases. So far, there is little contribution of significance in these subjects. The main strength of the research activity appears to be in the field of Reaction Engineering and we feel that it is in this one important area that the department is capable of producing research work at high level. We, therefore, recommend that the present activities in Reaction Engineering should be continued and consolidated for greater effort in fundamental and applied research in this area. The department should also initiate at least some

activity in experimental measurements of Thermodynamics and Transport Properties of Fluids. It would then be possible to contribute more significantly to these important subjects, which are engaging attention in some of the advanced chemical engineering laboratories in the world.

There is another important area in which good work has been reported from the department - in bubble dynamics and drop formation. New techniques have been developed in the department in the study of this subject and we recommend that this work should be continued with greater intensity in the liquid media.

The present building in which the department is functioning is not very suitable. A new functional building, measuring 22000 sq. ft. has been recently occupied. It would be in the interest of the growth of the department that it moves completely from its old building into the new one. The floor space provided will not be sufficient for the full activities of the department and we recommend an additional space of 10000 sq. ft. plinth area to be provided for the department. For the additional space of 10000 sq. ft., we recommend a non-recurring grant of Rs 10.00 lakhs taking into account cost of construction, all services, special wiring, furniture, etc.

We also recommend a grant of Rs 10.00 lakhs for the specialised equipment needed for the department.

7.10.6 Financial Implications

Building	:	Rs 10.00 lakhs
Equipment	:	Rs 10.00 lakhs

7.11 DEPARTMENT OF AERONAUTICAL ENGINEERING

.11.1 Relevant Statistics

I. STAFF (As on 31.3.1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in Position
a) Academic Professors	4	4	..	4
Asst. Profs.	10*	8*	..	8 *Includes
Lecturer	9	6	..	6 One Flight
Other Academic Staff	18	16	..	16 Instructor
Total	41	34	..	34
b) Non-Academic Staff	47	43	..	43
TOTAL	88	77	..	77

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31.3.1971	..	57	17	..	..	8	82

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970.71		Cost of additional Staff proposed
	Salaries Rs.	Interim Relief Rs.	Rs.
a) Academic Staff	4,34,823	13,571	1,00,000
b) Non-Academic Staff	1,99,305	11,114	75,000
TOTAL	6,34,128	24,685	1,75,000

IV. WORKING EXPENSES	1970.71 Rs.	Additional Working Expenses requested Rs.
a) Consumables	67,539	..
b) Equipment	18,754	..
c) Others	46,777	..
TOTAL	1,33,070	1,75,000

V. NON-RECURRING	Capital equipment procured since 1956 Rs.	Amount originally proposed Rs.	Revised Rs.
Equipment	10,46,585	66,00,000	50,60,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs. Lakhs
	Sq.Ft. 47,937	Sq.Ft. 59,922	Sq.Ft. 59,922	Sq.Ft. 24,000	Sq.Ft. 30,000	12.00

VII. OUTPUTS SINCE 1956 (Upto 31.3.1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	9	19	181	..	26	149

7.11.2 Main Experimental Facilities

Aerodynamics : (a) Subsonic facilities - 14' x 9' Open Circuit Tunnel; 7' x 5' Closed Circuit Tunnel; 15' dia. Spinning Wind Tunnel; 20" x 20" Boundary Layer Tunnel; several smaller size low speed tunnels; (b) Supersonic facilities - 7" x 5" Blow-down Tunnel; 3" x 1" Blow-down Tunnel;

Structures : Two universal testing machines; Crecp and impact testing machines; basic facilities for conducting resonance and flutter tests; two photoelastic benches and a Moire-fringe set-up; rigs for testing of skew plates, membranes, etc.

7.11.3 Highlights of work done since the last review

Basic Research : Experimental studies in transition boundary and free shear layers, supersonic flows; analytical work in wing theory, real gas dynamics, combustion of liquid and solid propellants.

Analytical studies in creep, flexure, vibration, matrix, analysis and aeroelastic behaviour of structural elements.

Project and development work : 14' x 9' tunnel commissioned and a six-component strain gauge balance installed. (Tests conducted on several of the aircraft designed at the Hindustan Aeronautics Ltd). Improvements in the 5' x 7' for closed circuit and spinning wind tunnels, supersonic pilot scale wind tunnel project for the Council of Scientific and Industrial Research, supply of 2' x 2' tunnels to various organisations in India, design of 3" x 3" shock tube, instrumentation.

Vibration studies of thick slabs and thin plates, design and fabrication of flutter models, Moire fringe apparatus and other basic experimental facilities.

A Pushpak aircraft has been acquired and instrumented and Flight Test Course organised for M.E. degree students. A new stream in Rockets and Missiles has been started.

7.11.4 Proposals

It is proposed that the Institute may take over the responsibility for flight course from the Hindustan Aeronautics Limited.

Research and Development

The proposals of the Institute for the department call for (i) consolidation and intensification of the work in the fields of conventional fluid mechanics and aerodynamics, solid mechanics, structural mechanics and structural theory; (ii) involvement in national activities in the aerospace field by developing strength in fields like propulsion and design and undertaking work in new lines such as production, rockets and missiles technology and guidance and control. In addition to improving the laboratory facilities for these purposes, the department considers it desirable to involve itself in some hard-ware aspects also. Involvement in interdisciplinary fields such as studies in design concepts, studies in optimisation, bio-mechanics and bio-medical engineering and geophysics and metrology is under consideration.

Financial

The department proposes increase in the staff salaries for flight test course and supporting staff by Rs 1.75 lakhs per year, working expenses by Rs 1.75 lakhs per year and building programme of Rs 12.00 lakhs and acquisition of equipment worth Rs 50.60 lakhs.

7.11.5 Review and Recommendations

The department of Aeronautical Engineering, which was the first department to be established in the country, has completed 25 years. It was last reviewed by the Ghosh Committee in 1956 and since then, significant developments have taken place, such as the starting of Departments of Aeronautical Engineering by Institutes of Technology among others. These departments have been primarily graduating students at the bachelor's degree level. More recently, some of the Institutes of Technology have also started graduating students at master's level. It is, therefore, important to consider the position and role of the department at this Institute in the changed situation obtaining to-day. When there was no formal instruction in Aeronautical Engineering elsewhere in the Country, it was necessary for the department to teach introductory courses in Aeronautical Engineering. However, with the changed situation, there is need to review the Institute policy on its course work and research in general in the department to enable the department to retain its pioneering role.

The main strength of the department is in Aerodynamics, both basic and applied. It has excellent facilities, primarily in subsonic aerodynamics. With its proximity to the industry in Bangalore, it would be logical to treat the Institute facilities in subsonic aerodynamics as national facilities and further build them up keeping in mind their importance in the national

perspective. The Institute should establish a wind tunnel for studies on vertical and short take-off and landing aircraft as part of national facilities in subsonic aerodynamics. The financial resources (Rs 30 to 35 lakhs) for such a tunnel should appropriately be funded by the Civil Aviation or Defence. We, however, recommend an allocation of Rs 2.75 lakhs for feasibility studies. The utilisation of the existing subsonic test facilities in the department appears to be less than optimum. The department seems to depend primarily on outside jobs, for example, from the Hindustan Aeronautics Ltd. for work in their 9' x 14' tunnel. We understand that the main reason for the low utilisation is lack of adequate finances for wind tunnel models. We recommend an additional provision of say, Rs 20000 per year for this purpose in the annual working expenses. The National Aeronautical Laboratory located in Bangalore has excellent supersonic wind tunnel facilities. There is, therefore, no need for the Institute to build up test facilities in supersonic and hypersonic aerodynamics, but plan its work in these areas in collaboration with the National Aeronautical Laboratory. We note that the Ministry of Education has asked the Institute to put up proposals for hypersonic facilities in association with the National Aeronautical Laboratory. Such facilities even at a modest scale would cost anywhere upto Rs 25.00 lakhs and we feel that such large funds must come from sources other than the Education Ministry. All the same, the Institute has to invest a minimum amount to undertake feasibility studies and some pilot scale work, for which we recommend a sum of Rs 2.5 lakhs.

It would appear that studies in the supersonic regime upto Mach 2.5 are very important in this country at present. There is also a need to appreciate the wider application of fluid mechanics and aerodynamics to meteorology and physical oceanography and industrial aerodynamics. It would, therefore, be desirable for this department to involve to some extent in these fields also. We recommend its growth in this direction as well.

The work of the structures group is organised along traditional lines, such as aeroelasticity, vibrations and structures. It is felt that greater emphasis should be placed on aircraft design in the Institute's training programme. There is a case for such an emphasis being laid. A closer association with the Hindustan Aeronautics Ltd. design staff is also to be attempted. The Government is now committed itself to indigenisation of the aeronautical industry and aircraft design will play an important and crucial role in any attempt towards self-sufficiency. Training of students in depth in aircraft design with project work in design as a specialisation would become very relevant to the needs of the country. The Institute authorities should pay attention to create the necessary facilities in this direction.

The departmental proposals for Structures, which are ambitious, need better definition and allocation of priorities. Much of the equipment proposed by the department for Structures research is more appropriately found in applied research laboratories and does not normally find a place in an academic institution. With the proximity of the National Aeronautical Laboratory, it is desirable for the Institute to undertake collaborative programmes in fields requiring such equipment. We, however, recommend a sum of Rs 4.0 lakhs for essential equipment for the structures division. For building first floors for the Structures and Aerodynamics Laboratories, we recommend a sum of Rs 5.0 lakhs.

In the field of Propulsion, the primary emphasis at present is in studies in combustion phenomena. Having regard to the importance of propulsion in aerodynamics, greater emphasis needs to be given in this area at the Institute. This could fruitfully form the basis for inter-departmental collaboration between the Departments of Aeronautical Engineering, Mechanical Engineering and Internal Combustion Engineering. We leave it to the Faculty and the Senate to work out the details of such a collaboration.

Flight Controls and Dynamics is another important area not adequately covered in the department's programme at present. With the proposed School of Automation and the development of activity in Rockets and Missiles, it should be possible for the Institute to contribute significantly in this vital area of aerospace technology.

The course in Rockets and Missiles which started with the support from the Defence Ministry should be put on a solid foundation. This would require an additional funding of about Rs 4.00 lakhs, which we recommend. The area of control of aerospace vehicles should be vigorously developed in collaboration with the School of Automation.

In the matter of research in aeronautics, it is important to note the part played by the electronics instrumentation. Very little is possible without some strength in this area. We would recommend the creation of a small group in the department to work on electronics as related to the experimental measurements relevant to this area. We also recommend the establishment of an instruments and guidance laboratory, including a section on general electronics, for design and fabrication of test equipment for aeronautics at an approximate cost of Rs 3.25 lakhs.

We further recommend the following provisions:

Rs 1.25 lakhs for augmenting workshop facilities;

Rs 2.5 lakhs for hanger facilities;

Rs 2.5 lakhs for fencing the air-strip.

The department is fairly well staffed in its academic as well as supporting staff, except in the propulsion division, where some further inputs are needed. We hope that in filling the existing vacancies, the department would keep note of this requirement.

7.11.6 Financial Implications

For acquisition of equipment	: Rs	18.00 lakhs
Hanger and fencing around the air-strip	: Rs	5.00 lakhs
Completing the first floors over the Structures and the Aerodynamics laboratories	: Rs	5.00 lakhs
For model making (to be included in the working expenses)	: Rs	20000

7.12 DEPARTMENT OF CIVIL & HYDRAULIC ENGINEERING

7.12.1 Relevant Statistics

STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in position
a) Academic: Professors	3	3	2	5
Asst. Profs.	9	5	..	5
Lecturers	9	8	..	8
Other Academic Staff	5	3	..	3
TOTAL	26	19	2	21
b) Non-Academic Staff	33	32	..	32
TOTAL	59	51	2	53

STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	45	20	..	..	8	73

SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	3,08,367	7,700	..
b) Non-academic Staff	1,51,004	9,473	..
TOTAL	4,59,371	17,173	1,30,000

WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	79,752	..
b) Equipment	38,740	..
c) Others	20,812	..
TOTAL	1,39,304	1,38,000 + 40,000 for other items

NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	8,04,990	11,72,000	10,22,000

BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	49,016	61,270	62,486	4,000	5,000	2.00

OUTPUTS SINCE 1956 (Up to 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	19	38	264	..	27	568

7.12.2 Main Experimental Facilities

Hydraulics Laboratory: Hydraulic turbines with complete speed control and loading equipment, high head (1000 ft.) multistage pump, several flumes, including a tilting flume, set-ups for cavitation work, test facilities for meters and pumps; 6" and 15" cavitation tunnels.

Structures Laboratory : Facilities for materials testing like 100-ton universal testing machine; 200-ton compression testing machine; impact and fatigue testing machines; small test frames for testing reinforced concrete beams. A test cylinder plant of 100-ton capacity with several jacks has been acquired and is under installation; strain measuring devices are also available.

Soil Mechanics Laboratory : All the equipments for soil testing; facilities for research work in soil dynamics such as Lazan Oscillator, Degebo Vibrator, pick-up;

7.12.3 Highlights of work done since the last review

Three streams in Civil Engineering are offered in M.E. degree courses.

Several new areas of research have been started and they are active now. Typical of them are: cavitation, air entrainment, flow metering, structural dynamics, including earthquake engineering, concrete structures under combined loading, photo-elasticity, structure-soil interaction, rheological study of soils, soil dynamics.

A number of experimental set-ups and instruments for research work have been designed and fabricated.

A number of research schemes sponsored by outside agencies are under active study

The staff of the department are encouraged in consultative work and are helping the Indian Standards Institution in its standardisation work.

Six international symposia on various aspects in Civil Engineering have been held.

7.12.4 Proposals

Teaching

The proposals state that work will be intensified in High Velocity Flows, Dynamics of Structures and Soil-structure interaction with respect to foundations. In particular on the teaching side,

the proposals call for introducing courses in Water Resources at the master's level. For the training of the master's degree students, they propose to depute students to river valley projects for a period of two months at the end of the first year. They also propose to arrange two or three short-term courses of six-week duration in the subjects of Pre-stressed Concrete, Cavitation, Design of Foundation Engineering, for professional people in the industry, Government organisations, etc.

Research and Development

In the research and development side, the department proposes to continue the work in Cavitation in association with the Inorganic and Physical Chemistry Department; and also to intensify the work in research in Cavitation, for which they are setting up good facilities. The proposals call for increasing the admission for research students from 20 to 50.

Financial

Increase in the staff for the Cavitation research and Water Resources course at professional and supporting levels at a cost of Rs 1.3 lakhs per year was proposed. The department proposes increase in the working expenses by Rs 1.78 lakhs per year and a sum of Rs 10.22 lakhs for acquisition of equipment. A building programme of Rs 2.85 lakhs was proposed, of which Rs 1.50 lakhs is for extension of the Structures Laboratory.

7.12.5 Review and Recommendations

By and large, the technical capability available in the department is good. The cavitation Tunnel in the department, which has been commissioned, is perhaps the only one of its kind in the university establishments in the country. Research in Cavitation should form an important part of the departmental activity. We would urge that the Cavitation Tunnel be developed as a national facility with suitable inputs of professional talent and adequate supporting technical staff and working expenses. We support the proposal of the department to offer electives in Water Resources at the master's level.

We feel that it would be desirable to develop an appropriate interaction between this department and governmental institutions either by way of consultancy by individual staff members or projects through institutional consultancy.

We were informed that there have been occasions when some activities started by the department were taken over by other

organisations for follow-up actions in their own respective establishment. We welcome the pioneering role played by the department in the initiation of such activities.

We recommend Rs 10.00 lakhs for acquisition of equipment.

The requirement of a pulsator to go along with the universal tensile testing machine, which the department already possesses, may be met from the funds recommended for equipment.

For the completion of the Structures Laboratory, we recommend a sum of Rs 2.00 lakhs.

7.12.6 Financial Implications

Building	:	Rs 2.00 lakhs
Equipment	:	Rs 10.00 lakhs

7.13 DEPARTMENT OF INTERNAL COMBUSTION ENGINEERING

7.13.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in position
a) Academic: Professors	3	2	..	2
Asst.Profs.	4	4	1	5
Lecturers	6	2	..	2
Other Academic Staff	9	7	..	7
TOTAL	22	15	1	16
b) Non-Academic Staff	44	38	..	38
TOTAL	66	53	1	54

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	27	10	..	..	..	37

III. SALARIES, ALLOWANCES P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	1,96,099	6,060	..
b) Non-academic Staff	1,76,299	12,357	..
TOTAL	3,72,398	18,417	..

IV. WORKING EXPENSES	1970-71	Additional working expenses requested
	Rs	Rs
a) Consumables	74,890	..
b) Equipment	15,847	..
c) Others	5,447	..
TOTAL	96,184	46,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount Originally proposed	Revised
	Rs	Rs	Rs
Equipment	8,66,579	5,95,000	2,95,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	29,362	36,702	36,702	7,520	9,400	3.00

VII. OUTPUTS SINCE 1956 (Up to 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	5	10	123	..	19	66

7.13.2 Main Experimental Facilities

a) Test facilities for : reciprocating engines 5 - 200 bhp, 1200 - 6000 rpm; gas turbines 1000 hp, 20000 rpm; turbojets upto 5000 lb. thrust; performance evaluation of vehicles both in the laboratory and on the road - passenger car to heavy duty trucks; auxiliaries like fuel pumps, filters, radiators, etc; b) research engines for performance evaluation of fuels and lubricants; c) altitude chamber for simulating atmospheric conditions upto 5 KM; d) air supply 0.4 kg/sec. at 8 atm and 0.15 kg/sec. at 200 atm; e) specialised instrumentation such as engine indicators, multi-channel oscilloscopes, amplifiers, digital counters, vacuum tube voltmeters, B and K spectrum analyser, X-Y recorder, hot wire anemometer.

7.13.3 Highlights of work done since the last review

Research and Development

Various aspects of combustion, fluid flow, vibration, lubrication, engine design, vehicle dynamics and performance; equipment designed and built in the department : periphery camera, electronic tachometers, pressure indicators, temperature controller, dynamometers, chassis and trailer dynamometers, altitude test facility, equipment for evaluating engine, performance of lubricating oils and fuel filters.

Industrial and other work

A number of engine and ancillary manufacturers have been helped in developing and improving their products. Also the Indian Standards Institution has been assisted in formulating standards relating to engines and ancillaries.

7.13.4 Proposals

Research and Development

The proposals of the department envisage the continuation of the present activity to meet the needs of the industry, research and teaching organisations in the country. The department proposes initiating investigations on a new concept for a heat engine, an electro-hydro dynamic lubrication, high speed bearings, full scale testing of vehicles in a new proving ground, studies on cross country vehicles involving vehicle terrain interaction, studies in biomechanics related to reaction times, fatigue limits and performance limits.

It is hoped by the department that the liaison with the industries will increase in the years to come.

Financial

The proposals of the department call for increasing the available area for the department at a cost of Rs 3.00 lakhs, increase in working expenses by Rs 46000 per year and a sum of Rs 2.95 lakhs for acquisition of equipment.

7.13.5 Review and Recommendations

While there is technical capability available in the department, it has not been coordinated towards goals which could have produced significant results. We get the feeling that the department, in a certain sense, is working in isolation, whereas coordination of its activities with the other departments, notably the Mechanical Engineering and the Aeronautical Engineering Departments could have been most fruitful for all the three departments.

We feel that there is a strong case for merging this department with the Mechanical Engineering Department as much of their work is closely related. In the new organisational structure in which creation of divisions is envisaged, we hope that the department would be able to play a more significant part in association with the other departments in the division.

It is essential that the department relates its activities in engines for aircraft propulsion with those of the Aeronautical Engineering Department and the Department of Mechanical Engineering.

Theoretical work is in progress in the combustion studies in the Aeronautical Engineering Department and this department can lend valuable support to this work by undertaking experiment oriented research in the field.

We recommend Rs 3.00 lakhs for equipment.

7.13.6 Financial Implications

Equipment : Rs 3.00 lakhs.

7.14 DEPARTMENT OF MECHANICAL ENGINEERING

7.14.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In Position (against substantive posts)	Personal Posts	Total in Position
a) Academic: Professors	3	2	2	4
Asst.Profs.	10	6	..	6
Lecturers	12	9	..	9
Other Academic Staff	13	12	..	12
TOTAL	38	29	2	31
b) Non-Academic Staff	94	81	..	81
TOTAL	132	110	2	112

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	..	55	18	..	..	1	74

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	3,92,603	12,043	3,00,000
b) Non-academic Staff	3,71,958	24,574	2,00,000
TOTAL	7,64,561	36,617	5,00,000 + 46,000 Other items (Associateships & Books)

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	71,246	..
b) Equipment	4,826	..
c) Others	18,810	..
TOTAL	94,882	78,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	17,39,325	27,00,000	11,15,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	79,812	99,765	99,765	12,800	16,000	8.00

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	5	19	258	..	35	151

7.14.2 Main Experimental Facilities

Experimental 600 K.W. Thermal Power Station comprising a water tube boiler with economiser and a turbo alternator set with condenser; evaporator and feed water heater for study of power derived from fossil fuels; equipment for the study of heat transfer processes such as conduction, convection, condensation and boiling; a low velocity wind tunnel and water tunnel designed and built in the department for studies in Fluid Mechanics; Metrology laboratory containing select precision gauging equipment; Materials Science Laboratory; Foundry laboratories for making sand, shell and plaster moulds; Metallography and Heat Treatment; Chemical analysis and sand testing; X-ray and Ultrasonics to determine internal defects in metal parts, welds and castings; instrumentation laboratory; facilities in strain gauge techniques; Vibration studies; two dimensional studies in photoelasticity; studies in mechanical behaviour of engineering materials; a Mechanical Engineering workshop, which helps in the fabrication of equipment and instruments in research for all the departments of the Institute, equipped with machine tools of all types, foundry, pattern and welding equipment. The workshop has been planned by the department for student training in workshop techniques and aiding research activities in the Institute. Several research apparatus like Shock Testing Machines, Extensometers, Fatigue Testing Machine, Attachment for Weissenberg Camera have been fabricated in the workshop.

7.14.3 Highlights of work done since the last review

The Department of Mechanical Engineering reorganised the Master of Engineering Degree Courses into a two-year pattern leading to the award of the Master of Engineering degree in Mechanical Engineering in the following three streams; Heat Power Engineering, Foundry Science and Engineering; and Machine Design. The Machine Design stream was thus introduced for the first time in 1963.

7.14.4 Proposals

Teaching

The proposals of the department envisage a consolidation of its master's degree programmes, taking advantage of the flexibility offered by the Unit System. They propose to offer a number of electives for the master's degree courses; also introduction of some electives in Automatic Control is envisaged. We were informed that the department had plans to develop the course work and research in Automatic Control in association with the School of Automation.

Research and Development

The department, in addition to offering the electives, also proposes to conduct active research in the above fields. They also propose the creation of nuclei for research in the fields of low temperature engineering, welding engineering, noise and random vibrations. They also propose inter-disciplinary activities in electronics materials and methods and research and development work in design of mechanical systems, non-linear mechanics and bio-engineering. They propose strengthening liaison with the industry.

Financial

The department has requested in support of these activities a sum of Rs 11.15 lakhs for equipment, Rs 20000 for books per year and about Rs 5.00 lakhs per year for increasing the academic and supporting staff. They have also requested Rs 26000 per year for industrial liaison work, Rs 8.00 lakhs for additional space and Rs 78000 per year for working expenses.

7.14.5 Review and Recommendations

The main strength of the Mechanical Engineering Department is in Heat Transfer as a discipline, out of which the stream of Heat Power Engineering was conceived. The department's contributions in this field in the past have been good. The department has also made contributions in Foundry Science and Engineering. Recently, the field of Machine Design is being developed. The future developments of the department, we feel, should necessarily be the outgrowth of its existing strength. In view of the importance of thermal power in the country and the strength which the department already has in this field, we recommend that efforts in this field should be strengthened, both in teaching and research work. In Heat Power, there is a case for strengthening Turbo Machinery.

We note the continued involvement of the department in Fountry Science and Engineering, but do not recommend starting of new fields such as welding engineering and forging technology.

In so far as Machine Design is concerned, the main strength of the department is in Vibrations. The Department of Internal Combustion Engineering too has an activity in Vehicle Dynamics and we, therefore, feel that there is a strong case for the two departments to coordinate their activity and develop greater strength in Vehicle Dynamics. We have elsewhere recommended the merger of these two departments.

We do not, however, recommend extensive involvement in the fields of Bearings and Power Transmission Systems, Noise Control in Machinery Tool and Die Design, Mechanical Handling and Designing for Mass Production.

We would recommend the involvement of the department in Automatic Control Systems in association with the School of Automation. The department should also interact with the Department of Aeronautical Engineering in developing good course work and research in Guidance and Control instead of involving in activities such as Pneumatic and Hydraulic Control Systems and Numerical Control Systems.

It does not appear reasonable for the Mechanical Engineering Department to initiate extensive activity in Electronics, whether it is related to process instrumentation or Mechanical systems.

We would like to say a word about the Thermal Power Station. We are concerned about the expensive equipment which is not being used to the optimum level. We suggest that the Institute carefully review the situation, replace the worn-out parts in periodic maintenance and see if it can be utilised in cooperation with other institutions.

We recommend Rs 10.00 lakhs for acquisition of equipment.

7.14.6 Financial Implications

Equipment : Rs 10.00 lakhs.

7.15 DEPARTMENT OF METALLURGY

7.15.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a) Academic: Professors	3	2	..	2
Asst. Profs	6	4	..	4
Lecturers	11	9	..	9
Other Academic Staff	3	2	..	2
TOTAL	23	17	..	17
b) Non-Academic Staff	29	21	..	21
TOTAL	52	38	..	38

II. STUDENTS As on 31-3-1971	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
	76	35	12	..	..	3	126

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	2,16,080	7,568	..
b) Non-academic Staff	91,921	6,061	..
TOTAL	3,08,001	13,629	

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	65,213	..
b) Equipment	34,003	..
c) Others	16,326	..
TOTAL	1,15,542	1,44,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	8,19,355	50,00,000	20,40,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area Sq.ft.	Plinth Area Sq.Ft.	Total Plinth Area Sq. Ft.	Carpet Area Sq.Ft.	Plinth Area Sq.Ft.	Cost Rs Lakhs
	33,820	42,276	42,276	8,000	10,000	5.00

VII. OUTPUTS SINCE 1956 (Upto 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	4	14	31	238	68	128

7.15.2 Main Experimental Facilities

Facilities are available for investigations in the following fields: (i) Chemical Metallurgy - conventional mineral dressing operations, microscopic examination of minerals, smelting and roasting of ores, kinetic and thermodynamic investigations of metallurgical systems at high temperatures, electro-plating and testing of deposits, chemical analysis of ores, alloys, slags and refractories; and (ii) Physical Metallurgy - Structure studies of metals and alloys with conventional equipments including heat treatment furnaces, X-ray unit and complete metallographic equipment; forming operations and mechanical tests on metals and alloys, production, compacting and sintering of metal powders, measurement of physical properties like electrical resistance magnetic constants, internal friction, etc. of metals and alloys.

7.15.3 Highlights of work done since the last review

The two-year diploma course has been converted into a three-year B.E. degree course.

Two M.E. degree courses have been started - one in the field of Chemical Metallurgy and another in Physical Metallurgy.

7.15.4 Proposals

Teaching

The proposals of the department for teaching seek consolidation of the master's degree courses in Physical Metallurgy and in Chemical Metallurgy, reorganisation of the three-year B.E. degree course involving a revision of the course content and offering short-term courses in a number of subjects. The proposals also call for making these subjects and practicals more industry oriented.

Research and Development

The department proposes to lay emphasis on Materials Science and enlarge the scope of research and development work in the properties of materials as a function of temperature, powder metallurgy, development of materials for aircraft, materials for electronic and nuclear purposes as well as optical, bearing and marine materials, development work in extractive metallurgy, including the operation of small pilot plants and electro-slag refining.

Financial

Requirements of additional floor space costing Rs 5.0 lakhs, increase in working expenses by Rs 1.44 lakhs per year and acquisition of equipment costing Rs 20.4 lakhs are envisaged.

7.15.5 Review and Recommendations

Teaching

B.E. degree programme : We have elsewhere made recommendations regarding the future pattern of the B.E. degree courses.

M.E. degree programme : At present, the department conducts its master's degree programme in two streams, namely, Chemical Metallurgy and Physical Metallurgy. There are proposals to replace these by offering the master's degree courses in the department allowing for specialisation through electives. The master's degree courses in future will be a core group of subjects common to the Institute and a core considered essential by the department and a number of subjects offered by way of electives.

Research

From the departmental reports submitted to us, we get the feeling that there are a multitude of problems on which the department is working. While at the initial stages of growth of the department it might have been unavoidable, we would like to stress that in future it would not be advisable to encourage such developments. If the Institute wants to make an impact on the field of Metallurgy, it has to restrict the fields of study and go in depth in the few selected fields. While we do not wish to suggest the explicit fields of research, we would like to state that the Institute should take note of the requirements of the State of Mysore and those of the neighbouring regions in evolving the future fields of research. Mysore is exceptionally rich in manganese ores, has got abundant deposits of iron ore and a fair amount of chromium ores. The neighbouring regions have large quantities of titanium ores. In so far as the requirements of the aeronautical industry are concerned, the problem that the country faces is one of establishing the relevant facilities for manufacturing alloys with the possibility of improvement in the direction of fatigue resistance, stress corrosion resistance, while retaining the increased mechanical properties such as tensile strength. Further, the Government of India has recently announced its decision to establish three steel plants in

the South. This calls for a changed thinking in the formulation of training programmes. We suggest that the Department of Metallurgy takes note of these developments while planning its future research and development activities.

We recommend equipment grant for the department totalling to Rs 15.00 lakhs, which includes an electron microscope. We recommend that while acquiring the microscope, the department may obtain an electron microprobe attachement as well.

7.15.6 Financial Implications

Equipment : Rs 15.00 lakhs.

7.16 DEPARTMENT OF ELECTRICAL COMMUNICATION ENGINEERING

7.16.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a) Academic: Professors	4	4	3	7
Asst. Profs.	6	3	..	3
Lecturers	9	6	..	6
Other Academic Staff	7	6	..	6
TOTAL	26	19	3	22
b) Non-Academic Staff	31	27	..	27
TOTAL	57	46	3	49

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31-3-1971	89	39	13	..	..	2	143

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	3,02,129	8,235	..
b) Non-Academic Staff	1,32,611	8,387	..
TOTAL	4,34,740	16,622	2,00,000

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	69,222	..
b) Equipment	30,038	..
c) Others	14,368	..
TOTAL	1,13,628	1,49,000 + 2,00,000 for Research & Development

V. NON-RECURRING	Capital equipment procured since 1956	Amount Originally proposed	Revised
	Rs	Rs	Rs
Equipment	8,46,919	18,00,000	7,34,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	36,686	45,858	45,858	4,000	5,000	2.00

VII. OUTPUTS SINCE 1956	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
(Up to 31-3-1971)	19	3	131	223	88	200

7.16.2 Main Experimental Facilities

The facilities existing in this department may be best described as those suited mainly to studies in the classical fields of communication, viz., Atmospheric Noise, Vacuum Tube and Semiconductor Circuits and Devices, Microwave Radiation and Propagation, Vibrations and Room Acoustics. Even in these areas, severe limitations have come up since practically no precision measuring equipment had been acquired for the last 14 years.

7.16.3 Highlights of work done since the last review

In the teaching area, master's degree courses in Electrical Communication Engineering have been developed. All students have found employment practically immediately upon completing their studies.

In research, contributions have been made in the areas of atmospheric noise, electron devices and circuits, electronic instruments, computer applications, microwave engineering, circuit theory, acoustics, signal detection and information theory.

Two new laboratory facilities have been built during this period: an Electron Devices Laboratory, which provides a few basic facilities for glass blowing, production of high vacuum, etc., and the Acoustics Laboratory, which provides environmental facilities for studies in free space and reverberent sound fields.

In Industrial Liaison and consultation services, a modest beginning has been made. Some instruments developed in the laboratory have been taken up for production. Acoustical design and testing services have been rendered to some twenty buildings.

7.16.4 Proposals

Teaching

In teaching, certain major changes are being planned now. The teaching work in the Institute is now being conceived as a whole, the expertise in any department being available to every one in the Institute. A more flexible system of elective courses is being planned to satisfy the individual needs and to enable new scientific and technological fields to be brought into the curricula without delay.

This department will work in close liaison with the Electrical Engineering and High Voltage Engineering Departments and would be jointly responsible for instruction in all major areas of electrical science and technology, particularly communication, control and computation.

The department is also envisaging short-term specialized courses in co-operation with industry for mutual benefit.

Under sponsorship of the Defence Ministry, the department is also developing a Centre for Information Processing. The Centre will offer advanced instruction and carry research in areas of digital communication, elastic surface wave devices, optical and acoustical data processing methods.

Research and Development

The major areas of research work in which this department would be involved are: (i) Solid State Electronics with special reference to functional devices and Micro Electronics; (ii) Materials with special reference to the study of the properties of Semi-conductor Materials; (iii) Instruments with particular reference to Digital Instrumentation; (iv) Microwaves with particular reference to Propagation; and (v) Acoustics with special reference to Architectural Acoustics, Noise Control and Vibration Analysis.

Jointly with the Electrical Engineering Department, this department would develop research in Automation with special reference to Computers and Electronic Hard-ware.

Financial

Equipment	:	Rs	7.34 lakhs
Working Expenses		Rs	3.49 lakhs per year
Staff		Rs	2.00 lakhs per year
Buildings		Rs	2.00 lakhs

7.16.5 Review and Recommendations

The industrial revolution was characterized by the development and exploitation of the sources of power in nature. The harnessing of nuclear power nearly completed this phase of the revolution by the mid-20th century. It is now clear that we are passing through a similar phase in man's ability to communicate with his fellow men and to supplement his own mental resources by

electronic devices. Communication plays a key role in practically all modern technology and is the nerve system of modern society. It lies at the very heart of our educational system which must develop to meet the challenge of a modern technology. These remarks should be sufficient to emphasize the responsibilities this department should bear in mind.

One of the oldest schools of electrical and communication technology, this department has played a significant role in the past and its alumni have contributed greatly to the growth of the telecommunications in the country. During the period under review, the department has grown considerably in the scale of its activities.

Looking into the future of communications, one sees very clearly that the volume of information being transmitted is increasing at an exponential rate or faster. India has an almost insatiable need for communication facilities not only because of its geographical features, but also because of its large population and the multiplicity of languages. It seems, therefore, logical that the department should take an overall view of the communication problems that are going to be essential in this country, bearing in mind the future trends (in this rapidly growing field) and lay down its goals accordingly. It has to be recognised that with a developing India with its increasing defence needs, the training in Electronics and Communications should receive a very high priority. This Institute has been a pioneer in imparting education in this area, and to be able to retain its character, it must develop itself into a centre of excellence.

Some of the important problems facing the country are the development of T.V. industry and the Space programme. The Institute of Electronics and Radio Physics, Calcutta, is also an advanced centre, which fulfils the needs of such a centre of excellence to the east. In the western zone, the Physical Research Laboratories, Ahmedabad, the Tata Institute of Fundamental Research, Bombay, combined with the Indian Space Research Organisation, have taken up a lead in tackling the problems facing the nation. Two such centres would be desirable, one in north and the other in south and it is in this context that we feel that the department of Electrical Communication Engineering of this Institute can become a centre of excellence since (a) it has all the pre-requisites,, besides being a pioneer in this field; (b) it is surrounded by a cluster of sophisticated electronic industries and the Research and Development wings of Defence Electronics Establishments, not to say of Aeronautical Industry. It is however, imperative that in chalking out the programme, an

Institute of this kind, as it has been, should be able to discard those goals which easily can be taken up in either other educational institutions or which have been become somewhat out-dated in relation to the urgent needs of this country. We are sure that this department will reorient itself and remain a leader in Electronics and Communication.

This department has an advantage in that the students have come with a strong base in Physics and Mathematics and it will not be difficult to introduce such programmes which could again establish this department as a centre of excellence.

It is essential that the department should retain a broad perspective of this fast developing field to let in fresh ideas. Narrow specialization within rigid boundaries should be avoided. Long-term goals should not be foresaken for immediate requirements, however urgent and important they may appear at times. On the other hand, it should guard itself against accepting the security offered by standard lines of work. Many challenging communication problems exist at the interface between man and machine. Some of the work on information theory studies of linguistic problems carried in the department seems particularly appropriate in this connection and should be pursued vigorously.

We recommend that:

if the bachelor's degree programme is continued, it may be reorganised under the Unit System;

the department interact with the Central Instruments and Services Laboratory to assist it in design and maintenance of sophisticated electronic equipment;

periodical review and revision of the M.E. degree course programme be carried out to reflect latest developments. Broadly speaking, the teaching must be discipline oriented and science based;

reduction of research effort should be effected in out-dated programmes; and

the department should concentrate on programmes such as T.V., Space Electronics, Micro-electronics and Digital Communications.

We recommend Rs 10.00 lakhs for acquisition of equipment.

7.16.6 Financial Implications

Equipment : Rs 10.00 lakhs

7.17 DEPARTMENT OF ELECTRICAL ENGINEERING

7.17.1 Relevant Statistics

I. STAFF (As on 31-3-1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a) Academic: Professors	4	2	1	3
Asst.Profs.	7	5	..	5
Lecturers	10	9	..	9
Other Academic Staff	5	5	..	5
TOTAL	26	21	1	22
b) Non-Academic Staff	34	32	..	32
TOTAL	60	53	1	54

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows UGC/CSIR	Total
As on 31-3-1971	74	44	7	..	..	..	125

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed
	Salaries	Interim Relief	
	Rs	Rs	Rs
a) Academic Staff	2,58,699	7,928	..
b) Non-Academic Staff	1,53,762	9,866	..
TOTAL	4,12,461	17,794	25,000

IV. WORKING EXPENSES	1970-71	Additional Working Expenses requested
	Rs	Rs
a) Consumables	62,064	..
b) Equipment	36,753	..
c) Others	14,271	..
TOTAL	1,13,088	1,44,000

V. NON-RECURRING	Capital equipment procured since 1956	Amount originally proposed	Revised
	Rs	Rs	Rs
Equipment	9,47,374	23,65,000	12,33,000

VI. BUILDINGS	Existing and those under construction		Utilised area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	45,614	57,017	57,017	..	..	..

VII. OUTPUTS SINCE 1956 (Up to 31-3-1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	11	4	209	224	136	159

7.17.2 Main Experimental Facilities

The department has the following laboratories; Electrical Machines Laboratory; Standards Laboratory; Measurements Laboratory; Magnetic Testing Laboratory; Illumination Laboratory; Electronics Laboratory; Servo Laboratory.

Specialised equipment in the laboratories are : A. C. Network Analyser and Transient Analyser; Relay Panels with facilities for testing various types of relays; Bench for dynamic testing of relays; Carrier Current demonstration equipment; 5 ft. Integrating Sphere Photometer; 150 kW and 50 kW mercury Arc Rectifiers; High Temperature Furnaces; Analogue Computer.

7.17.3 Highlights of work done since the last review

Design and development of a Transient Analyser; Reactors for E.H.V. lines; Half wave length for power transmission; Improvement of transient stability limit by the use of dynamic breaking; unconventional electrical machines : Linear Oscillating Machines and Linear 3-phase induction motors; Static frequency tripler; protective relaying : three-step static distance relay; and definite time static over current relay; Static Timers; Dynamic Relay Test Bench; Phase Sequency Indicator; Static Phase Shifter; Double Mirror Photometer; D.C. Network Analyser; Multivariable Function Generator; Static Relays for Motor Control; Binary Adder-Subtractor; Electronic Differential Analyser; Digital Phase Angle Meter; Electronics Nyquist Diagram Display Unit; a Transistorised Digital Tachometer; a 230 V Electromechanical A.C. Voltage Stabiliser; Non-linear Analysis; Time Varying Systems; Multivariable Systems; Optimal Control; Random Processes; Pattern Recognition and Biological Control.

7.17.4 Proposals

Teaching

The department proposes to offer short-term courses (4 to 6 weeks) in Power System Analysis and Power System Protection.

The department also proposes expansion of laboratory facilities for practical work by upgrading the equipment and fabrication facilities in the Industrial Electronics Laboratory.

The department further proposes additional facilities for M.E. projects on simulation of small scale industrial systems such as numerical control of machines, correlation analyser using digital techniques and hybrid computers.

Research and Development

The department proposes (i) building up a group in modern methods of Power System Analysis to develop standard digital/analogue computer programmes for use by electricity undertakings; (ii) development of the relay laboratory for the design and development of solid state devices for power system control and protection; (iii) design and construction of miniature AC/DC transmission line models for studying power system problems; (iv) projects for import substitution items like vitreous enamelled, metal oxide and cement coated resistors, reed relays, ferrites, electronic flash tubes, etc.; (v) design and development of fractional horse power high speed motors; (vi) development of research activity in the field of pattern recognition; and (vii) development of bio-electronic instrumentation.

Financial

A sum of Rs 12.33 lakhs was requested for equipment. The Institute proposes increase in the working expenses by Rs 1.44 lakhs per year and Rs 25000 per year for supporting staff.

7.17.5 Review and Recommendations

The department has good facilities and competent staff for research in the fields of Power System, Protective Relaying, Electrical Machines, Control Systems and Industrial Electronics. An A.C. Network Analyser, the only one of its kind in this country, is being used regularly for the solution of power system problems, which are frequently referred to the department by the State Electricity Boards and Power Supply Companies. However, with the advent of the digital computers, this expensive installation will have rapidly diminishing commercial use in future, though it may still continue to have educational value.

The department, which now runs a post-graduate course in Electrical Engineering with specialisation in Control Systems, will have an important part to play in the development of another major project that is being vigorously pursued in the Institute, namely the establishment of an advanced centre for Automation with the assistance of the U.S.S.R.

We hope that full advantage will be taken of this programme, so that a good School of Automation can be established in the Institute.

Having regard to the facilities and staff available, we feel that there is potential in the department for augmentation of its Ph.D. programme. The present number of research scholars working for their doctorate may be suitably increased.

The department desires to undertake research work in Pattern Recognition. A similar proposal has been made by the Department of Electrical Communication Engineering also. We hope that there will be close collaboration between the two groups.

We recommend Rs 10.00 lakhs for acquisition of equipment.

7.17.6 Financial Implications

Equipment : Rs 10.00 lakhs.

7.18 DEPARTMENT OF HIGH VOLTAGE ENGINEERING

7.18.1 Relevant Statistics

I. STAFF (As on 31.3.1971)	Sanctioned	In position (against substantive posts)	Personal posts	Total in position
a) Academic: Professors	4	2	..	2
Asst.Profs.	8	6	..	6
Lecturers	6	4	..	4
Other Academic Staff	13	2	..	2
Total	31	14	..	14
b) Non-Academic Staff	39	29	..	29
TOTAL	70	43	..	43

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31.3.1971	..	19	7	..	..	2	28

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71 Salaries Rs.	1970-71 Interim Relief Rs.	Cost of additional staff proposed Rs.
a) Academic Staff	1,87,873	5,846	..
b) Non-Academic Staff	1,25,296	8,501	..
TOTAL	3,13,169	14,347	2,00,000

IV. WORKING EXPENSES	1970-71 Rs.	Additional Working Expenses requested Rs.
a) Consumables	66,419	..
b) Equipment	23,927	..
c) Others	9,115	..
TOTAL	99,461	56,000

V. NON-RECURRING	Capital equipment procured since 1956 Rs.	Amount originally proposed Rs.	Revised Rs.
Equipment	15,69,155	19,50,000	12,00,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs. Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	34,617	43,271	43,271	8,640	10,800	3.80

VII. OUTPUTS SINCE 1956 (Upto 31.3.1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	3	6	78	..	32	76

7.18.2 Main Experimental Facilities

Impulse voltage generators upto 3000 kV and Oscillographs; Repetitive surge generator; Sphere gaps upto 2 m. dia.; 200 kA impulse current generator; Testing transformer cascades; Sine wave alternator, 2.3 1V; 250 kV, 25 mA direct current generator; Electrostatic volt meters; Schering bridges and null detectors; Standard capacitors; Experimental transmission line; Controlled atmosphere room; Discharge detector; Dispersion meter; 1350°C Electric furnace; 150-ton hydraulic press; Tektronix oscilloscopes for high speed measurements; 220 kV experimental substation; High vacuum equipment; High pressure equipment.

7.18.3 Highlights of work done since the last review

Development of high voltage techniques for research activity and industrial testing; breakdown studies in solid, liquid, gaseous and vacuous media under a.c., d.c., and impulse and switching surge voltage conditions; investigational and development projects on behalf of and sponsored by the Council of Scientific & Industrial Research, Central Board of Irrigation & Power, National Research Development Corporation, National Bureau of Standards, U.S.A., Bharat Heavy Electricals, etc; development of materials and processes like silicon carbide, varistors, lightning arrestors; fabrication of high voltage and associated apparatus like impulse voltage and current generator, varistor testing kit, lightning flash counter, interfacial surface tension meter, high current shunts, Lichtenberg camera, transistorized null detector, low voltage repetitive surge generator, automatic pressure, humidity, and temperature recording equipment; inter-disciplinary work on aluminium alloys, thermistors, silicon power diodes.

A symposium on high voltage power transmission and a two-week school on high voltage laboratory techniques were conducted.

7.18.4 Proposals

Teaching

The proposals emphasise the importance of the study of the behaviour of power apparatus and systems and on the characteristics of insulating materials and insulation system. Exchange of personnel for lecturing between staff of electrical industries and staff of the department is proposed to be fostered. The proposals call for review and revision of the course content of the two-year course leading to master's degree in high voltage engineering.

The Institute proposes to hold short-term courses in (a) over voltages in power systems and insulation co-ordination; (b) selection and testing of high voltage insulation; (c) high voltage laboratory techniques; and (d) computer applications in high voltage engineering.

Research and Development

It is stated that the main fields of research in the coming years will be in (a) dielectrics, electrical insultants and insulation systems; (b) study of electrical arcs in gaseous, liquid and vacuous media; and (c) electric power systems and power apparatus, including testing apparatus.

Development of apparatus and instruments like surge diverters for extra high voltage systems, high voltage cascade rectifiers, Van de Graaff Generator for nuclear research, fast-rise pulse generators, thermistors, semi-conducting glazes, semi-conductor devices, etc.

Increased activities in industrial testing and research on 400 kV transmission line and pollution problems.

There is also a proposal that the present High Voltage Laboratory should be considered as a national centre for high voltage research and testing and should, therefore, be devolved appropriately.

Financial

The equipment requirements submitted to the Committee call for an expenditure of Rs. 12.00 lakhs for obtaining equipment for the department. The proposals also call for an annual expenditure of approximately Rs. 2.6 lakhs, of which Rs. 2.0 lakhs is for staff and Rs. 60000 for working expenses. The building proposals call for an expenditure of Rs. 3.8 lakhs for additional space.

7.18.5 Review and Recommendations

This department started functioning in 1951 after the installation of the major part of the equipment was completed. The department provides excellent facilities for post-graduate education and research as well as for development work directly related to the needs of the electrical industry.

In 1956, a three-semester master's degree course in high voltage engineering was introduced. On the implementation of the recommendations of the Thacker Committee on post-graduate education in engineering, the course was re-organised.

At present, the department also provides instruction in high voltage engineering to the B.E. degree students in Electrical Technology and to the M.E. degree students in Power System Engineering.

The department is engaged in testing of electrical equipment and conducting research and development work for the electrical industry, including power supply undertakings. The main fields of activities are: break-down phenomena in insulating materials; corona and transient of over-voltage in transmission lines; electrical break-down at the junction of metals in high vacuum at high voltages - a project sponsored by the National Bureau of Standards, U.S.A., and development of new insulating materials, high voltage equipment and accessories, and transmission line hard-ware all from indigenous resources.

The department has been pursuing research in materials science and technology in the specific areas of solid state power devices and non-linear resistors. With its interest in the inter-disciplinary projects, the department has recruited staff with back-ground in physics, chemistry and metallurgy. For its research conferments also, the department has admitted students holding degrees in science subjects. We commend this approach.

The department is involved in a fairly large amount of consultancy activity, collaborative research and development work for industry. We hope that a proper balance between post-graduate training and research in high voltage engineering on the one side and industrial consultancy work on the other will be maintained by the department.

Having regard to the facilities and work of the department, we recommend that the department should be treated and developed as a national centre for research in high voltage engineering and that its facilities should be developed appropriately.

We recommend Rs. 12.00 lakhs for acquisition of equipment.

7.18.6 Financial Implications

Equipment : Rs. 12.00 lakhs

7.19 DEPARTMENT OF INDUSTRIAL MANAGEMENT

7.19.1 Relevant Statistics

I. STAFF(As on 31.3.1971)	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
a)Academic: Professors	1	1	..	1
Asst.Profs.	4	4	..	4
Lecturers	2	2	..	2
Other Academic Staff	4	4	..	4
Total	11	11	..	11
b)Non-Academic Staff	7	7	..	7
TOTAL	18	18	..	18

II. STUDENTS	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
As on 31.3.1971	..	..	7	13	..	..	20

III. SALARIES, ALLOWANCES, P.F. AND INTERIM RELIEF	1970-71		Cost of additional staff proposed Rs.
	Salaries	Interim Relief	
	Rs.	Rs.	
a) Academic Staff	1,16,931	3,539	..
b) Non-Academic Staff	37,208	2,140	..
TOTAL	1,54,139	5,679	..

IV. WORKING EXPENSES	1970.71 Rs.	Additional Working Expenses requested Rs.
a) Consumables	2,810	..
b) Equipment	5,406	..
c) Others	5,011	..
TOTAL	13,227	..

V. NON-RECURRING	Capital equipment procured since 1956 Rs.	Amount originally proposed Rs.	Revised Rs.
Equipment	2,21,569	1,03,000	83,000

VI. BUILDINGS	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs. Lakhs
	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.	
	8,090	10,113	10,113	2,000	2,500	1.00

VII. OUTPUTS SINCE 1956 (Upto 31.3.1971)	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
	4	..	..	..	303	135

7.19.2 Main Facilities

The department has facilities for conducting research at the doctoral level in the following areas: personnel management and industrial relations, industrial and managerial economics, developmental and agricultural economics, engineering economics, industrial planning and organisation, marketing, production planning and control, ergonomics and industrial safety. The department is equipped with work study and psychology laboratories and an ergonomics laboratory is in the process of development. Facilities for statistical computation of data are available.

7.19.3 Highlights of work done since the last review

Research

Four research projects were completed and the researchers were awarded the Ph.D. degree of the Institute.

At the instance of the Planning Commission, a project entitled "An Enquiry into the Industrial Relations set-up of Public Enterprises in the Engineering Industry at Bangalore" was completed.

Teaching

A one-year full-time residential post-graduate diploma course in Industrial Management was introduced in 1967. Between 1955-65, the Institute was having part-time evening courses in Industrial Engineering and Industrial Administration.

Since July 1968, the department organised and conducted a series of management development programmes, both in general and functional areas. The department is also offering management oriented courses to other engineering departments in the Institute. The department organised two seminars: (i) the Fifth Annual Conference of the Indian Academy of Applied Psychology - 1966-67; and (ii) the Sixth Indian Conference on Research in National Income and Wealth - May 1968.

A number of lectures and seminars were organised on various aspects of management.

7.19.4 Proposals

Teaching

Starting of a two-year master's degree course in Industrial Management in place of the existing one-year post-graduate diploma course and increasing the intake of candidates from twelve to twenty per year, since 1200 candidates on an average compete for such a small number of seats every year.

Offering short-term residential programmes in specialised areas of management, since there is considerable demand from industries.

Research and Development

The department proposes to strengthen the existing research activities and to initiate new activities in the areas of ergonomics and work study. In order to achieve these objectives, the department indicated the need to augment the personnel, equipment and accommodation. The proposals of the department also include updating the departmental library and collection of Indian case material on management for effective teaching.

Financial

An expenditure of Rs. 83000 for various types of equipment;

Rs. 1.00 lakh for building.

7.19.5 Review and Recommendations

Historically, the Department of Industrial Management was formed by the aggregation of the earlier sections of Economics & Social Sciences (started in 1947) and Industrial Engineering & Administration (started in 1956). These sections were functioning side by side interacting with each other. They have also had some interaction with other departments in the Science and Engineering Faculties. In their growth, they have developed an interest in research and started admitting students for the Ph.D. degree. All these factors, one would naturally expect, contributed to the versatility of the department. For some time, the department was assigned to the Science Faculty and is now in the Engineering Faculty. The developments of these earlier sections into a full-fledged department, therefore, has decisively been influened by their

close contact with other departments and also helped in its building up research as one of its activities. It is this unique strength that the Institute should try to nurture and grow in the years to come. The department is functioning in the midst of a number of science and engineering departments. We feel that the Department of Industrial Management should be developed in relation to the challenges of management problems of the organisation in science and technology. In particular, studies of problems relating to management of research and development organisations and the special problems of management of sophisticated science based industries should be undertaken. One could also envisage the involvement of the department in the study of the development of the science policy of the country.

At present, there is very little research being conducted in this country on problems related to the evolution of policies in science and technology. Since the success of technological growth of the country is fundamentally dependent upon such policies and their evolution and implementation thereof, the Institute will be rendering important service, if it were to concern itself with preparation of source material, drawing conclusions and identifying alternatives which would be of value to the policy planners of the country.

We would also like to agree with the proposal made by the department that the present one-year post-graduate course should in course of time be developed into a two-year master's degree course in Industrial Management. We consider it as the logical outgrowth of the present teaching activities, but would feel that some further study of the proposal is called for both by the Senate and the Council. When such a change is brought about, we would like to suggest that the course should be framed drawing strength from the various departments within the Institute.

There is one other way in which the facilities of this department could be utilised by the master's degree course in the various engineering departments with considerable advantage. We note that elsewhere in the world the master's degree programmes call for the students taking some courses in Humanities also. We, therefore, recommend that at the Institute also the master's degree students from other departments may be required to take about three credits from the Department of Industrial Management in one or the

other subjects offered by the department. We also suggest that this department train people only with engineering, technology and science background.

We recommend Rs. 1.00 lakh for acquisition of specialised equipment.

7.19.6 Financial Implications

Equipment : Rs. 1.00 lakh

7.20 FOREIGN LANGUAGES SECTION

7.20.1 Relevant Statistics

	Sanctioned	In position (against substantive posts)	Personal Posts	Total in Position
I. STAFF(As on 31.3.1971)				
a)Academic. Professors	1	1	..	1
Asst.Profs.	1	1	..	1
Lecturers	3	2	..	2
Other Academic Staff	3	3	..	3
Total	8	7	..	7
b)Non-Academic Staff	2	3	..	3
TOTAL	10	10		10

	B.E.	M.E.	Res.	P.G. Diploma	Fellows Instt.	Other Fellows CSIR/UGC	Total
II. STUDENTS As on 31.3.1971	..	..	..	..	..	..	..

	1970.71		Cost of Additional staff proposed
	Salaries Rs.	Interim Relief Rs.	Rs.
III.SALARIES,ALLOWANCES, P.F. AND INTERIM RELIEF			
a)Academic Staff	73,932	2,592	..
b)Non-Academic Staff	13,841	774	..
TOTAL	87,773	3,366	6,000

	1970.71 Rs.	Additional Working Expenses requested Rs.
IV. WORKING EXPENSES		
a) Consumables	..	..
b) Equipment	1,405	..
c) Others	4,658	..
TOTAL	6,063	45,000+33,000 for short-term courses

	Capital equipment procured since 1956 Rs.	Amount originally proposed Rs.	Revised Rs.
V. NON-RECURRING Equipment	16,080	2,30,000	28,000

	Existing including those under construction		Ultimate area as at the end of IV Plan	Additions now requested		
VI. BUILDINGS	Carpet Area	Plinth Area	Total Plinth Area	Carpet Area	Plinth Area	Cost Rs Lakhs
	Sq.Ft. 5,420	Sq.Ft. 6,775	Sq.Ft. 6,775	Sq.Ft. 13,120	Sq.Ft. 16,400	6.56

	Ph.D.	M.Sc.	M.E.	B.E.	Diploma	No. of Research Papers/Reports
VII.OUTPUTS SINCE 1956 (Upto 31.3.1971)	..	..	..	..	..	..

7.20.2 Highlights of work done since the last review

Teaching

For a long time, teaching in German and French has been an integral part of the Institute training programmes. Since 1948-49, the Foreign Languages Section started functioning as a separate entity. The teaching of optional course in Russian was started in 1964-65. This course is being run on a regular basis since 1966. English as a foreign language is being taught at the Institute since October 1966.

Research

The emphasis in research is on the language of science in all these languages and Indian languages.

Translation facilities

The section also offers translation of scientific articles from other foreign languages to English.

7.20.3 Proposals

Teaching

The proposals on the teaching side call for improving and understanding the effective teaching of languages and the preparation of a hand-book of English for scientists.

Research and Development

As a part of the research activities, research in linguistics and language of science is proposed and in particular (a) problem of teaching languages; (b) problem of linguistic communication, in particular, man-machine communication; and (c) contrastive analysis of scientific English/Indian languages.

Financial

Request for a sum of Rs. 3.00 lakhs was made, of which Rs. 2.00 lakhs was for a Phonetics Laboratory, Rs. 50000 for building, Rs. 30000 for equipment for Language Laboratory, Rs. 15000 for two hand-books and Rs. 5000 for acoustic conditioning.

On the recurring side, a budget of Rs. 81000 was proposed, of which Rs. 36000 was for staff and scholarships and Rs. 45000 for working expenses.

7.20.4 Review and Recommendations

The section has been doing useful service in introducing students to the scientific information available in other countries by teaching of French and German for a very long time and Russian more recently. Many students of the Institute, who have gone abroad for further studies, were considerably helped by these language courses. Recognising the importance of Russian as a language of science, the course in Russian was also introduced in 1964-65 and was made compulsory in 1965-66.

With the present standards of teaching of English in the country and the dwindling importance that is being attached to the language, the Institute recognised the need for appropriate teaching programme as a part of the Institute training and took some concrete steps in this direction since the mid 1960s. The scheme of assistance is designed primarily to improve the communication skills of scholars in English with particular reference to writing of scientific/technical reports and articles with clarity and precision and to provide opportunities for speaking on scientific subjects. The Institute should be commended for early recognition of this problem and for the positive steps it has taken.

We understand that, since 1968, the new entrants to the Institute were being assessed for their proficiency in the English language. Those considered below a satisfactory level are being required to follow a course of instruction in English.

We note that, instead of simply continuing as a teaching section, the Foreign Languages Section has also undertaken a few research oriented problems.

We note with satisfaction that this section is engaged in the preparation of a hand-book of English for scientists. It will serve a useful need in teaching English language to the students, not only in the Institute, but elsewhere also.

We recommend a sum of Rs. 1.00 lakh for development of the Language and Phonetics Laboratory and obtaining other ancillary equipment required for the purpose. The Department of Electrical Communication Engineering can be of considerable assistance in the development of this laboratory.

7.20.5 Financial Implications

Phonetics and Language Laboratory : Rs. 1.00 lakh.

7.21 LIBRARY

7.21.1 Relevant Statistics

Sl. No.	Particulars	1956-1957	1969-1970	Increase in percentage
1.	Total collections	53469	142151	265%
2.	Additions/year	1450	9500	655%
3.	No. of books in the collection	19204	56758	295%
4.	No. of periodicals titles	820	1740	210%
5.	No. of series publications titles	55	201	
6.	No. of users	520	1200	230%
6a	Outsiders with permit Potential outside users	n.a.	365 more than 1000	
7.	No. of Readers/day	75	196	260%
7a	No. of materials issued per day	52	252	484%
8.	No. of seats	80	250	310%
9.	No. of reference queries	n.a.	4840	
10.	Inter-Library loans:			
	items received	-	64	
	items sent	-	7	
11.	Staff	17	39	230%
12.	Recurring grants for books and periodicals	Rs.45010	Rs.450000	1000%
13.	Total library grant	Rs.86500	Rs.627550*	725%
14.	Building area	10000 sq. ft.	50000 sq. ft.	500%
15.	Stack area Reading area Current periodicals Room	8000 sq. ft.	18000 10400 3000 31400 sq.ft.	392%
16.	Average number of volumes bound/day	n.a.	2500 to 3000 per year	
17.	Back log of binding work	-	5000 volumes (approx.)	

* Includes establishment and item (12) above for books and periodicals

7.21.2 Highlights

The Library moved to its new building constructed out of the University Grants Commission grant at a cost of Rs.15.75 lakhs in 1965. There has been a substantial increase in the acquisition of books and periodicals, as also the number of users of the Institute Library. The Institute Library gradually increased its working hours to 14 hours a day. During the examination time, the Library rooms are open till mid-night.

The Library has, with its limited resources, undertaken the preparation of bibliographies and reading lists and also initiated current awareness service and issue of weekly list of recent additions. With the association of the Indian National Scientific Documentation Centre, the Institute has brought out a catalogue of serials in the Library. In order to obtain greater efficiency in management of service, the Library also introduced cardex system for registration of periodicals. In view of the very large pile up of back volumes needing binding, plans are under way to expand the bindery.

7.21.3 Proposals

It is proposed that the future programmes should be more service based. In order to achieve this goal, the Library proposes spending more money for the acquisition of books and periodicals and filling up the vacancies of staff sanctioned under the Fourth Plan, so as to consolidate its existing facilities and to improve its resources and services.

Financial

The financial implications of these proposals are to the extent of Rs. 46.40 lakhs over a five-year period; of this, Rs. 24.00 lakhs is ear-marked for books, Rs. 19.54 lakhs for periodicals, Rs. 1.36 lakhs for series publications and the balance of Rs. 1.50 lakhs for binding and other activities.

7.21.4 Review and Recommendations

In the growth of an academic institution, library plays an important role. It is, therefore, important that the growth of the Library should be planned to keep pace with the growth of the departmental activities. The procedures should be modernised, so that speed with efficiency is built into them. By and large, it would appear that the management of the Institute Library is on

conservative lines. We feel that it should be more modern, designed to respond continuously to the growing needs of the Institute.

We understand that under the norms of the University Grants Commission, the budget of the University Library should be at least 6% of the University budget. In the Institute, it forms about 4% of the total operating budget and we feel that there is need for greater funding at the Institute with a view to optimising the library service.

We would like to mention particularly the desirability of a larger measure of responsibility being given to the Library for all acquisitions approved by the Library Committee and would recommend reorientation of purchase procedures where necessary.

There is a considerable back-log of bindery work and steps should be taken to augment bindery facilities.

One of the important functions of a modern scientific library in a research institute is documentation work and reprography. While a small beginning has been made in this direction with the help of the Indian National Scientific Documentation Centre, the Institute has to go a long way before it can respond to the needs of the scientific community. We, therefore, recommend a nucleus of staff in order that the Institute Library can function more effectively in rendering service in documentation and helping research students and workers. For reprography, however, either the service or the potential of the Regional Centre of the Indian National Scientific Documentation Centre located on campus, should be fully utilised.

We recommend the acquisition of micro-films and micro-film readers, where possible, and provision of reprographic facilities in association with the general graphic arts facilities of the Institute.

In the matter of books, generally speaking, the cost per year is increasing by about 10%. By the nature of its requirements, the Institute needs to order more of series publications which are comparatively expensive. Taking all these factors into consideration, we are of the opinion that there must be an increase in the expenditure for books and journals. We have elsewhere recommended that the budget of the Library for acquisitions should be increased, so that it reaches Rs. 8.00 lakhs per year by 1974. Thereafter, there should be an increase of 5 to 7% provided every year during the next five to ten years to account for continued increase in prices of books and journals. We further recommend that the Institute

exercise discretion in the choice of books and develop inter-library loan services to obtain optimum and economic service to its staff.

Most of the individual departments at the Institute have separate sub-libraries which play a useful role. We feel that the Institute Librarian should be closely associated with the running of these departmental libraries.

We have noted the part that is being played by the Senate Library Committee. We feel that this committee can be more effective. The close involvement of the academic staff in the work and development of the Library is essential for the success of the Library. We hope that such continued involvement will help the library in modernising itself and offering better library services.

We recommend a non-recurring grant of Rs. 1.85 lakhs for clearing the back-log of binding work, provision of additional seating facilities for readers and shelving space.

7.21.5 Financial Implications

To clear the back-log of binding	Rs. 50000
Additional seats for readers	Rs. 35000
Shelving space	Rs.100000
Total	Rs.185000

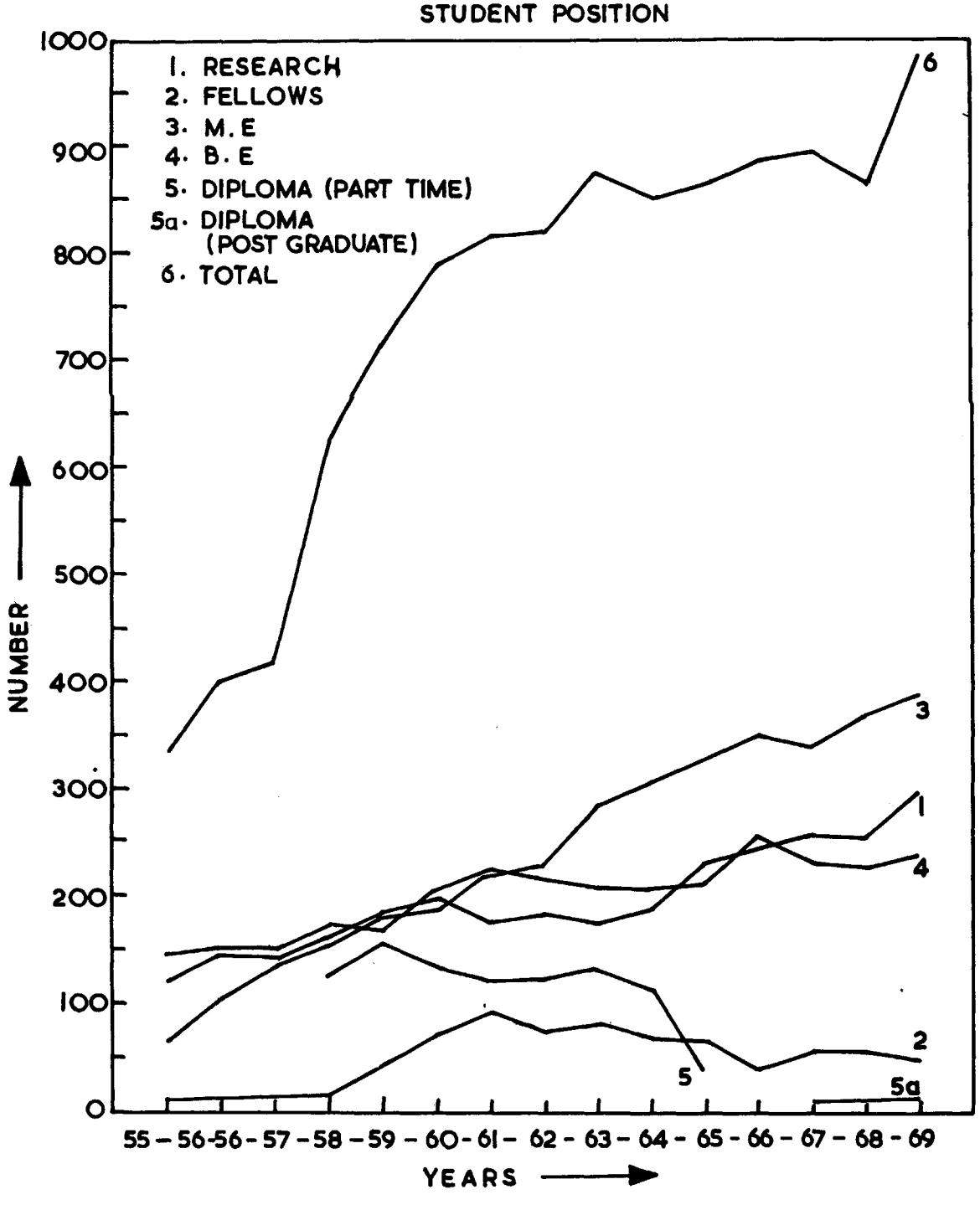
STUDENT POSITION
1. RESEARCH
2. FELLOWS
3. M.E
4. B.E
5. DIPLOMA (PART TIME)
5a. DIPLOMA (POST GRADUATE)
6. TOTAL
NUMBER
YEARS
0
100
200
300
400
500
600
700
800
900
1000
55-56
56-57
57-58
58-59
59-60
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
1
2
3
4
5
5a
6

FIG. 1

STAFF POSITION

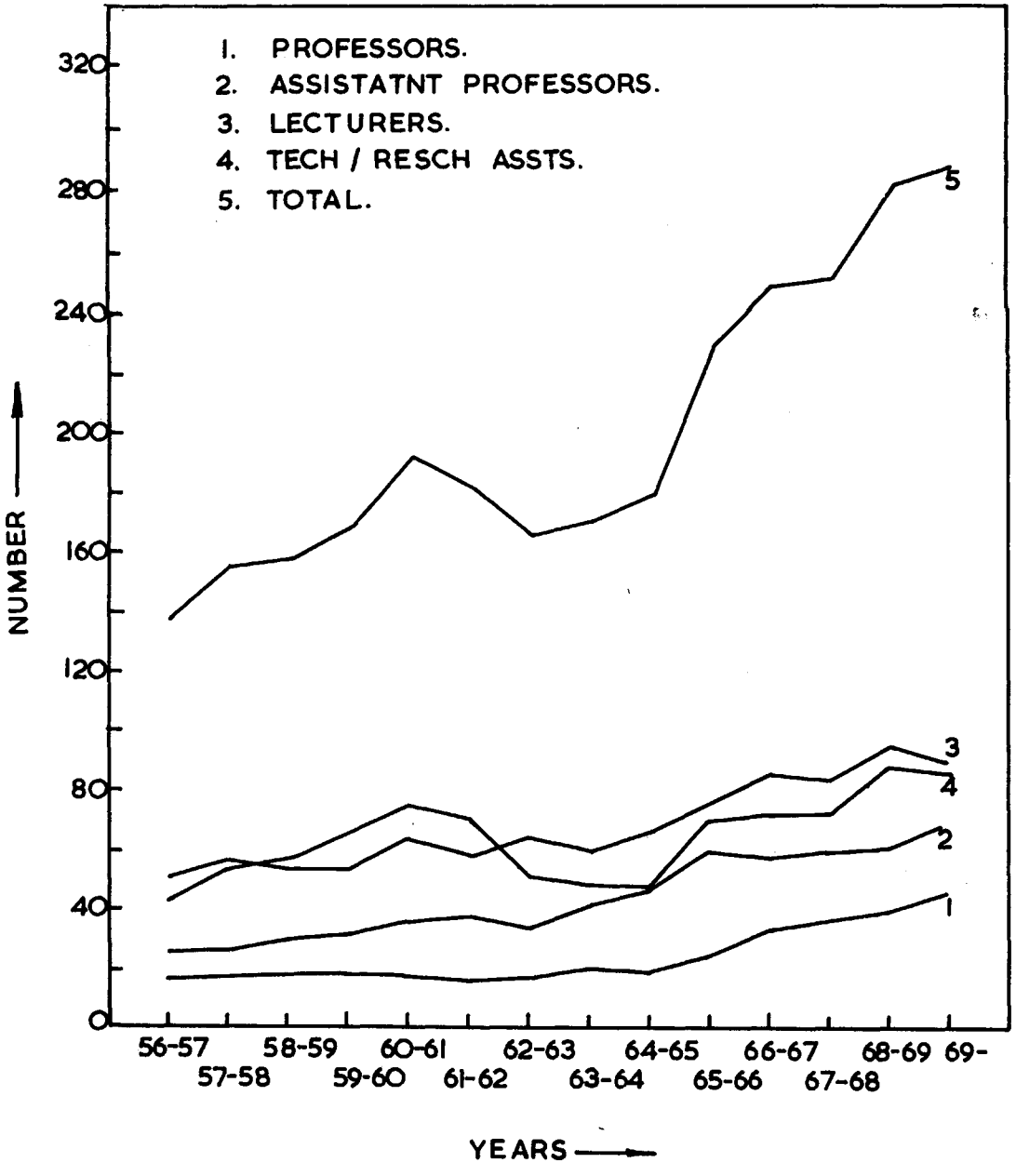

FIG. 2

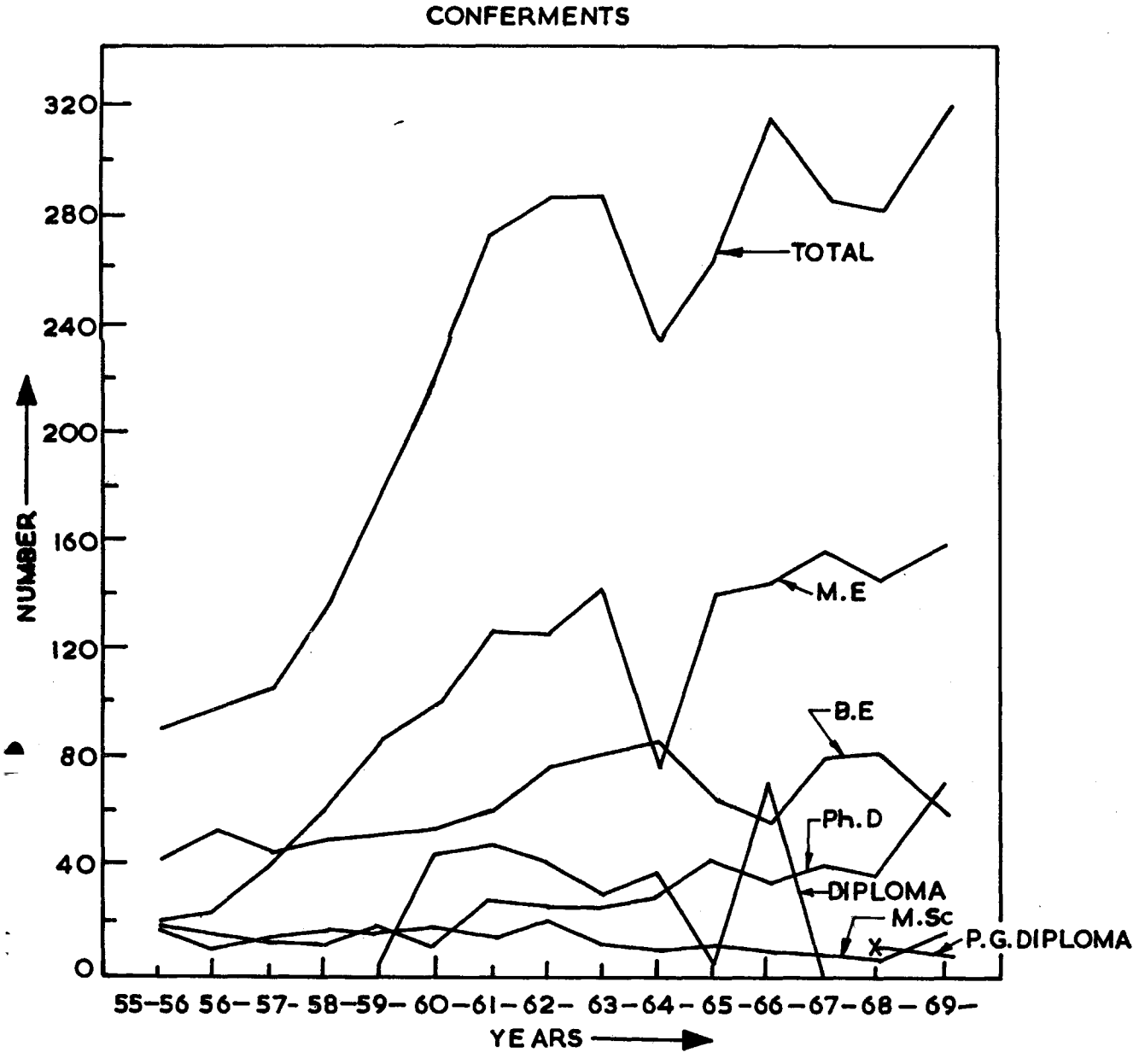
CONFERMENTS
320
280
240
200
160
120
80
40
0
NUMBER
TOTAL
M.E
B.E
Ph.D
DIPLOMA
M.Sc
P.G.DIPLOMA
55-56 56-57- 58-59- 60-61-62- 63-64- 65-66-67-68-69-
YEARS

FIG. 3

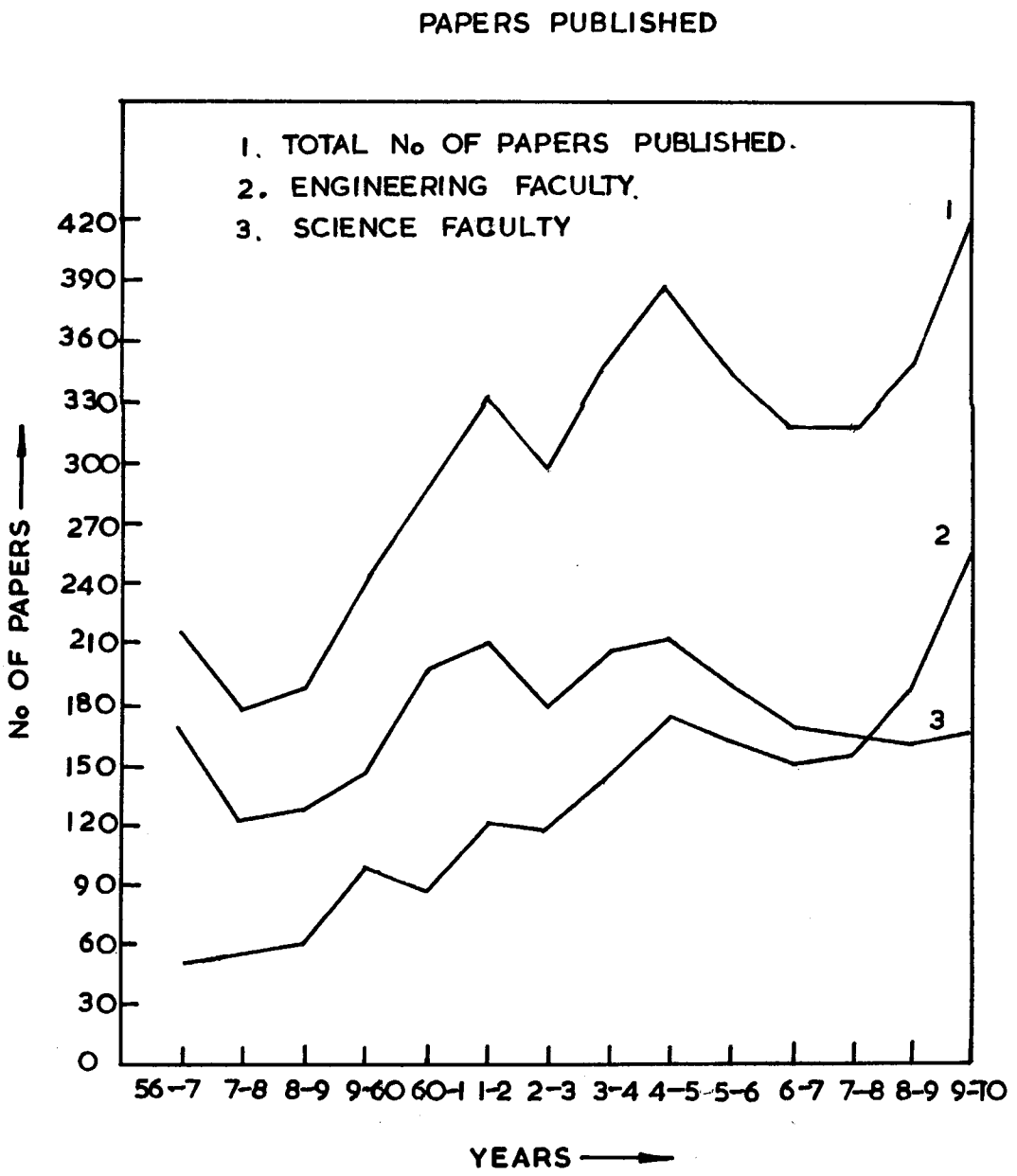
PAPERS PUBLISHED
1. TOTAL No OF PAPERS PUBLISHED.
2. ENGINEERING FACULTY.
3. SCIENCE FACULTY
No OF PAPERS
420
390
360
330
300
270
240
210
180
150
120
90
60
30
0
1
2
3
56-7 7-8 8-9 9-60 60-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10
YEARS

FIG. 4

APPENDIX A

A. List of Members of the Court and the Council, whose views were obtained through correspondence

Prof. H.N. Ramachandra Rao
Dr. B.L. Shanthamallappa
Mr. R.N. Kathju
Mr. K. Santhanam
Dr. D.C. Pavate
Mr. Ramakrishna Hegde
Mr. A.K. Banerjee
Dr. Sudhir R. Sen Gupta

B. List of persons other than the Members of the Court, the Council and the Staff, whose views were obtained through correspondence

Air Cdr. V. Ganesan
Prof. P.J. Madan
Mr. Ravi L. Kirloskar
Dr. B.K.R. Prasad
Mr. A.G. Pai
Dr. Amarjit Singh
Dr. G.N. Ramachandran
Prof. R. Narasimhan
Dr. B.R. Seth
Prof. B.D. Tilak
Dr. C.N.R. Rao
Dr. K.S.G. Doss
Dr. S.N. Anant Narayan
Dr. M. Manohar
Dr. P.S. Mene
Dr. K.L. Joshi
Prof. P.V. Indiresan
Prof. R. Natarajan
Dr. D.P. Ganguly
Dr. P.K. Katti
Prof. Santi R. Palit
Dr. R.R. Hattiangadi
Dr. T.R. Anantharaman
Dr. G.B. Ramasarma
Mr. C.M. Ramachandra Rao

APPENDIX B

LIST OF PLACES VISITED BY THE REVIEWING COMMITTEE

19 January, 1970	Electronics & Radar Development Establishment, Bangalore
20 January, 1970	National Aeronautical Laboratory Bangalore
20 January, 1970	Bharat Electronics Limited Bangalore
	Industrial Estate Rajajinagar, Bangalore
22 January, 1970	The University of Agricultural Sciences, Bangalore
11 February, 1970	Indian Institute of Technology Madras
12 February, 1970	Christian Medical College and Hospital, Vellore
18 February, 1970	Indian Institute of Technology Delhi
19 February, 1970	National Physical Laboratory Delhi
20 February, 1970	Tata Institute of Fundamental Research, Bombay
21 February, 1970	Indian Institute of Technology Bombay
	Bhabha Atomic Research Centre Bombay
11 April, 1970	Dr. Kamal visited the Institute of Radio Physics & Electronics Calcutta.

SESSIONS HELD BY THE REVIEWING COMMITTEE AT BANGALORE

14 - 24 January, 1970

12 - 14 February, 1970

17 - 22 May, 1970

26 - 29 May, 1971

APPENDIX C

List of persons Interviewed by the Reviewing Committee

A. BANGALORE

Dr. S. Ramaseshan

Students' Advisory Council
Indian Institute of Science

Managing Committee Members
Indian Institute of Science Gymkhana

Dr. B.K.R. Prasad

Prof. K. Sreenivasan

Dr. G.N. Ramachandran
(presented two schemes to the committee :

(i) 5-year integrated M.Sc., course for talented students;

(ii) inter-disciplinary courses at the graduate and the doctoral level)

Shri A.G. Pai

B. DELHI

Dr. V.K.R.V. Rao

Dr. Nag Chaudhuri

Dr. Atma Ram

Dr. S. Bhagavantam

C. BOMBAY

Dr. Vikram A. Sarabhai

Prof. M.G.K. Menon

Dr. G.B. Ramasarma

Mr. P.K. Kurup

Mr. H.S. Kulkarni

Mr. B.N. Sibal

APPENDIX D

List of departmental reports, memoranda, inter-disciplinary projects, etc.

Director's Report

Departmental Reports:

Applied Mathematics

Biochemistry

Foreign Languages

Inorganic & Physical Chemistry

Microbiology & Pharmacology

Organic Chemistry

Physics

Aeronautical Engineering

Central Instruments & Services Laboratory

Chemical Engineering

Civil & Hydraulic Engineering

Electrical Communication Engineering

Electrical Engineering

High Voltage Engineering

Industrial Management

Internal Combustion Engineering

Mechanical Engineering

Metallurgy

Library

Inter-disciplinary Projects:

Solid State Electronics &
Materials Science

Molecular Biology

Bio-engineering

Coordinated Mechanics

Financial Statements
(1955-56 to 1970-71)

Memoranda/Representations

Students' Advisory Council
Indian Institute of Science

Hon. General Secretary
Institute of Science Gymkhana

Mr. P. Varadarajan
II Year B.E. student

A B.E. Student

APPENDIX E

REPORT FROM PROF. M.M. SHEMYAKIN

The Indian Institute of Science (Bangalore), one of the most important scientific centres of India is a unique institution comprising a complex of departments and laboratories working in a variety of fields in the natural and technical sciences. As a rule, the departments and laboratories are manned by a capable staff, headed by major scientists. All these are sufficient grounds for welcoming the Inter-disciplinary Project of the Institute, which deals with several broad and stressing problems and for expecting much success in this endeavour. Of the problems involved, the reviewer feels competent to pass judgement on two, namely:

'Molecular Biology'

'Bio-engineering'

The approach to these problems as described in the paper on the project is as a whole scientifically sound. However, with regard to 'Molecular Biology', the necessity has been overlooked of concurrent study within the IISc of the physics and chemistry of biopolymers (primarily proteins and nucleic acids) without which it is impossible to foresee any significant advances in most of the problems proposed by the Institute in this area (the planned use of only X-ray analysis is quite outdated, since there are now a large variety of physical and chemical techniques for studying bio-polymers in the solid state and in solution).

In the area of 'Bio-engineering', the proposed plan does not include study of biological systems, in particular, biological membranes, whose investigation should parallel the study of model and artificial systems.

In order to obtain the fullest reward from the inter-disciplinary studies in the IISc a number of other pre-requisites should be fulfilled.

1. The I.I.Sc. should be equipped with first class instruments systematically brought up to date. Since sophisticated scientific equipment is in general very costly, it is feasible to concentrate such equipment in a special instruments department under the direct supervision of the Director of the Institute rather than to have it distributed among the various departments and laboratories. Such instruments will serve the needs of all

the other divisions. The IISc. has almost no such equipment at present and without it, it is very difficult to make major progress in the planned directions.

It is also highly important to considerably strengthen the now existing Central Instruments Laboratory in the IISc.

2. Successful development of inter-disciplinary problems is possible only by correct guidance and coordination of the efforts of sufficiently high level groups of scientists working in the various departments and laboratories of the I.I.Sc., otherwise problems attacked will be isolated more than coordinated and more of a particular than fundamental nature, so that it will be difficult for the I.I.Sc. to become one of the basic centres in India dealing with the frontier problems of modern physico-chemical biology. This, therefore, stresses both the necessity of a firm, guiding hand on the part of the Director and Senate and of sufficiently proficient groups (systematically reinforced by talented youth) in those departments and laboratories that are working on the inter-disciplinary problems.

3. Since both inter-disciplinary problems discussed here are intimately related with a number of areas in biology not touched upon in the I.I.Sc., it is feasible to carry out the study of the former in close consultative and perhaps even collaborative contact with existing biological centres in India. With respect to molecular biology, one might expect especially fruitful contacts with the Bio-physics Department of the Madras University and the Tata Institute of Fundamental Research (Bombay) and also with the Neurochemistry Laboratory of the Christian Medical College (Vellore).

APPENDIX F

REPORT FROM DR. W.H. PICKERING

During the past week I have had the opportunity of visiting most of the departments of the Indian Institute of Science, the Bharat Electronics Ltd., and the National Aeronautical Laboratory. Based on this admittedly brief experience, the following comments are submitted.

1. Role of the Institute within the Indian Education System:

The Institute has played an important role in the development of scholars in science and engineering for many years. In view of the recent expansion of the Indian Institutes of Technology, as well as the growth of the total university system, and various engineering schools, it is necessary to review and clarify the role that the Institute will be expected to play in the future.

To be effective, the Institute should continue to emphasize research training of highly qualified and motivated students. This means that the student body should be limited to approximately its present size and that the major academic programs should be higher than the bachelor degree. It also means that the staff should be competent to select and direct research programs of the highest quality. In order to attract and hold such staff, a proper working environment, including modern and convenient facilities, instruments and shops is essential. It is also important that working regulations be held to a minimum, and that adequate funds be available.

In view of the growing national resources for both graduate and under-graduate instruction in science and engineering, it is essential that the Institute strive to become a "center of excellence" in all that it undertakes.

Students who graduate from the Institute will be employed in government, industry or the educational system. Because of rapidly changing conditions in the country, it is essential that the Institute carefully evaluate the needs of these three sectors of the economy and adjust both its academic and research programs to reflect these needs. Industrial liaison has traditionally been an Institute policy. With the rapid development of "high technology industry" in the nation there is both the opportunity and the requirement for increased liaison if the needs of industry are to be met.

In other words, the Institute should graduate students who can do good research, who have a broadly based education in the fundamentals of modern science and technology, and who can work in all sectors of the Indian economy. India will change rapidly in the next few decades. Science and Technology will catalyze this change. Students from the Institute should be able to provide the leadership to government, education and industry in applying science and technology to the problems of India. They may not make major contributions to the problems of to-day, the graduates of the I.I.Ts will undoubtedly do that, but they will be needed to formalize and solve the problems of tomorrow.

2. Development of the Institite:

The ideal location of the Institute, in one of India's most charming cities, is a valuable asset in attracting faculty and students. However, the physical facilities must be of a reasonable standard. Since many of the laboratory buildings are old and out-moded, and since faculty and student housing is limited, the Institute undoubtedly suffers by comparison with some of the newer Institutions. Plans for extensive additions and improvements to the facilities should be implemented as soon as possible.

A complete modernization of facilities will require air-conditioning in many areas. If this cannot be provided at the time of construction, plans should be made so that later addition of air-conditioning is a simple matter. Similarly, modern research experiments and equipment frequently need uninterrupted power supply for long periods of time. The modernization of the facilities should recognize this fact with special attention paid to internal wiring and with special power station to Institute transmission line and sub-station considerations.

Research equipment at the Institute is frequently limited and not up to modern standards. This means that many experiments cannot be conducted, or that the research scientist or engineer must spend his time building an instrument which is commercially available. While a certain amount of equipment building is essential for the development of a good researcher, it would in fact be better if the student learned to build new types of equipment, or used existing equipment in novel ways. Again, the Institute suffers in comparison with the newer I.I.Ts which have received large amounts of equipment through the foreign aid programs.

The equipment problems can be solved by the provision of foreign exchange to the Institute. Foreign aid can also be promoted, and would be of value, but a more direct approach would be to allow the Institute sufficient foreign exchange to acquire the specific items of equipment which the research staff deems necessary.

Buildings and equipment do not make a successful institution; an excellent staff is also needed. In my contacts with various staff members, I met some who were very impressive and other who were less so. However, I have great confidence in the present Director, under whose leadership I feel the Institute will attain a high level of excellence in its faculty. Because of the history of the Institute and its graduates, it is clear that there is already a tradition of excellence upon which to build. Given the encouragement of support for new facilities, the Institute should encounter no problem in attracting the most promising staff.

As far as students are concerned, the Institute apparently has large numbers of applicants seeking admission and is, therefore, able to be quite selective. It is essential that the Institute continue to be selective so that the academic program is not held down by poor students. Again, the Institute's tradition of excellence is the principal magnet which will attract quality students from all regions of India. It might be well, at some future time, to give consideration to expanding the "all-India" make up of the student body to include students from neighboring countries.

The academic program should be developed by the faculty to meet the broad objective of producing research scholars who are alert to the needs of India. It does seem to me that there is a need for more inter-disciplinary instruction, more interchanging of students from one department to another and there is also a need for uniformity in the required course work for research students.

3. Management of the Institute

The problem of managing a research establishment is largely one of attaining the correct compromise between the freedom of action demanded by the research scientist and the necessity of living within boundaries established by finances, law and the general policies and objectives of the organization. In the case of the Institute, the Director is well aware of the problems involved and is maintaining an excellent climate for research within the constraints imposed upon him. There are other areas, however, which require further comment.

The Institute appears to have too many departments, each of which develops its own program and individuality. It would be more efficient to reorganize the departments into fewer units and to emphasize total Institute objectives. Students should be admitted to the Institute rather than to a department, and each should find essentially the same over-all rules applying to his area of study. It is understood that the Director has made suggestions along these lines. I recommend that his suggestions be acted upon as soon as possible. The inter-disciplinary research programs proposed by the Director should also be encouraged.

At our meeting with the Council on February 14, I was pleased to note the understanding they displayed of these problems.

4. Relations between the Institute and Industry

Although the Founder stressed that the Institute should be alert to the needs of industry, the fact is that industry employs a relatively small fraction of the graduating students. This reflects the situation currently existing in India, namely, that industry does not at present need a research-oriented staff. However, with the current development of "high technology industry", change will come very rapidly. The Institute should, therefore, strive to broaden its base of working relations with industry. New ideas should be explored. The short courses geared to industrial needs should be expanded to the extent that the faculty finds possible. Industrial engineers and scientists should be invited to the Institute to hold seminars and give lectures. Industrial Committees should be formed to advise on research programs. The Industrial Consultancy program should be expanded. In this connection, some concern was expressed regarding the acceptance of industrial funds at the expense of other resources. To encourage a closer relationship with industry, the Ministry of Education and the University Grants Commission should allow the Institute to receive industrial grants without prejudicing its other sources of financial aid. At the same time, the Institute must be aware that support by industry for a particular area will not automatically continue at government expense when industrial support ceases. It must also be alert to the danger of allowing industrial support to dominate the program to the point that it becomes unbalanced.

In the final analysis, the ultimate objective of the Institute must be the education of students in the complete spectrum of engineering and science skills, while at the same time keeping before them the specific needs of India.

APPENDIX F-1

SUPPLEMENTARY REPORT FROM DR. W.H. PICKERING

Following my brief stay at the Indian Institute of Science at Bangalore, I had an opportunity to visit I.I.T-Kanpur, I.I.T-Delhi, I.I.T-Bombay, National Physical Laboratory and Tata Institute of Fundamental Research. As a result of these contacts, I would like to supplement my previous remarks.

In the past the Institute of Science has been almost unique in India in its ability to develop top flight engineers and scientists. There is no reason to doubt its ability to continue to be a major national resource. To do so, however, it must receive adequate financial support. The I.I.Ts, with their new buildings and foreign assistance, are tending to dominate the technical education field. Actually, India needs both the I.I.Ts and the I.I.Sc to educate the large number of engineers and scientists which will be required to bring about the technological modernization of the country. There is also need for a number of highly competent research scientists and engineers to lead the country beyond simply copying what has been done in the industrialized countries. The traditions established at Bangalore should continue to make it the principal source for these men.

In my previous report I emphasized the need to modernize both facilities and equipment at the I.I.Sc. My visits to the I.I.Ts and to TIFR convince me that India has the resources for such modernization as evidenced by the TIFR which was built entirely with Indian resources. Foreign aid can be an advantage, and I.I.T-Kanpur has a great deal of equipment supplied by U.S. aid. It seems to me, however, that it should not be necessary to seek this kind of blanket support for I.I.Sc except for specific facilities, instruments or programs such as, for example, the Automation Centre developed with Soviet help.

At present there is a modest amount of new construction at I.I.Sc and plans have been drawn up for considerable more. These plans should be supported. Many of the existing buildings are badly out-dated for modern scientific research projects. These should be modernized, if it can be done economically, otherwise the buildings should be completely replaced.

Various departments have submitted requests for new instruments and apparatus. In general, I support these requests. However, in view of the costs for modern instruments, major instruments at the Institute should be controlled by the Central Instruments and Services Laboratory. This would have two objectives: first, it would avoid unnecessary duplication

of expensive instrumentation, and second, it would insure that available instruments are properly maintained and utilized. With this arrangement, it would be essential that Central Instruments and Services Laboratory adopt the proper "service" attitude. An instrument lying on the shelf is of help to no one. Instrument costs are justified only by their use. Central Instruments and Services Laboratory therefore, must be concerned with seeing to it that instruments work properly and are used in active research programs.

With regard to the objective of extending inter-disciplinary work at the Institute, the move towards a small number of divisions is clearly helpful. However, care should be taken to ensure that the existing trend towards highly individualized departmental requirements is not exaggerated when the Institute is divided into only five divisions. This problem can be alleviated by appropriate changes in present regulations. For example, students could be admitted to the Institute rather than to a division. Uniform rules could be established across all divisions, and students could be required to take courses from divisions other than their own.

Inter-disciplinary research projects may prove difficult to establish unless staff from one division actually transfers to another division, or unless the inter-disciplinary project is set up as a new and separate organization. The latter move is appropriate if the inter-disciplinary project is a specific piece of applied research. In the United States several technical universities have established separate laboratories to carry out applied research in close cooperation with the parent institution. These have sometimes grown into activities larger than the parent organization as in the case of the jet Propulsion Laboratory which is now several times larger than Caltech. The motivation for such growth has usually been a request from the Federal government to solve a specific set of problems which cannot effectively be accomplished by either industry or government. It is not necessary for I.I.Sc., Bangalore to plan for any such large activity; however, serious thought should be given to searching for an appropriate problem on which to focus an inter-disciplinary research program. After the immediate problem has been solved, the inter-disciplinary team will be available for further research, either pure or applied.

If an applied research project activity is to be undertaken, the funding must come either from industry or government. In order to maintain the proper academic environment it is much better to have the finances supplied by government. This has been the normal practice in the U.S.A. In recent years some

criticism has been levelled at academic institutions which have taken on significant projects of a classified nature for the Defence Department. I do not know whether such projects would pose a problem in Indian Universities,. But I believe it would be well to be warned of the potential difficulty.

Industry should support other kinds of work at I.I.Sc. in my previous report I suggested a number of ways in which relations with industry might be expanded. I believe such a relationship is important, both for the I.I.Sc and for industry. It is essential for Indian Industry to develop a greater appreciation for the value of research and for the contributions that an institution such as I.I.Sc Bangalore can make. If this cannot be made clear to industry, India will never develop its own technological capability.

One of the shortcomings of Indian students seems to me to be their lack of "Practical" engineering and science experience. They have a reputation for being interested in theoretical and abstruse problems, and of not wanting to participate in real experimental work. Assuming that this is indeed the case, the I.I.Sc and the I.I.Ts should be concerned with the nature of the laboratory experience given to the students, and the manner in which the laboratory courses are conducted. Experimental thesis research topics should be emphasized and the student should be required to do much of the work with his own hands. Only by wide scale development of the practical approach can it be given the "status" required for general acceptance by the students. Until graduating engineers and scientists are prepared to undertake practical engineering and science problems, India will have difficulty in developing the technological resources necessary for the modern State. Although the I.I.Sc plays a somewhat different role than the I.I.Ts in emphasizing research oriented graduates, it cannot neglect this problem of practical training as a part of advanced education.

STAFF IN POSITION 1970-71

Sl. No.	Department/Laboratory/ Section	ACADEMIC STAFF			Other Academic Staff	Total (Col. 3 to 6)	Supporting staff	Total (Col. 7 + Col. 8)
		Prof.	Asst. Prof.	Lect.				
1	2	3	4	5	6	7	8	9
1	Central Instruments & Services	1	2	5	13	21	26	47
2	Applied Mathematics	1	6	5	3	15	4	19
3	Physics	4	6	1	4	15	19	34
4	Biochemistry	4	7	6	5	22	22	44
5	Inorganic & Physical Chemistry	5	2	5	10	22	22	44
6	Microbiology & Pharmacology	3	1	3	4	11	14	25
7	Animal House	-	-	-	-	-	5	5
8	Organic Chemistry	5	2	1	7	15	20	35
9	Chemical Engineering	3	6	3	4	16	26	42
10	Aeronautical Engineering	4	8*	6	16	34	43	77
11	Civil & Hydraulic Engineering	5	5	8	3	21	32	53
12	Internal Combustion Engineering	2	5	2	7	16	38	54
13	Mechanical Engineering	4	6	9	12	31	81	112
14	Metallurgy	2	4	9	2	17	21	38
15	Electrical Communication Engg.	7	3	6	6	22	27	49
16	Electrical Engineering	3	5	9	5	22	32	54
17	High Voltage Engineering	2	6	4	2	14	29	43
18	Industrial Management	1	4	2	4	11	7	18
19	Foreign Languages	1	1	2	3	7	3	10
20	Director's Research	-	-	-	-	-	2	2
21	Library	-	-	-	-	-	42	42
22	Administration	-	-	-	-	-	107	107
23	Services & Maintenance (including Central Stores & other services)	-	-	-	-	-	186	186
24	Amenities (including Dispensary, Hostel, Staff Club, Guest House)	-	-	-	-	-	96	96
	Total	57	79	86	110	332	904	1236

* Includes one Flight Instructor

APPENDIX H

STUDENTS STRENGTH AS ON 31 MARCH 1971

Sl. No.	Department/ Laboratory/ Section	B.E.	M.E.	P.G. Dip.	Research	Fellows Institute	Other Fellows CSIR, UGC etc.	Total
1	Central Inst. & Services	-	-	-	-	-	-	-
2	Applied Mathematics	-	-	-	6	-	4	10
3	Physics	-	-	18*	10	1	17	46
4	Biochemistry	-	-	6	28	1	18	53
5	Inorganic & Phy. Chem.	-	-	-	27	-	9	36
6	Microbiology & Pharma.	-	-	-	-	4	6	18
7	Animal House	-	-	-	-	-	-	-
8	Organic Chemistry	-	-	-	7	1	14	22
9	Chemical Engineering	-	33	-	23	1	15	72
10	Aeronautical Engineering	-	57	-	17	-	8	82
11	Civil & Hyd. Engineering	-	45	-	20	-	8	73
12	Internal Combustion Engg	-	27	-	10	-	-	37
13	Mech. Engg.	-	55	-	18	-	1	74
14	Metallurgy	76	35	-	12	-	3	126
15	Elec. Comm. Engineering	89	39	-	13	-	2	143
16	Elec. Engg.	74	44	-	7	-	-	125
17	High Voltage Engineering	-	19	-	7	-	2	28
18	Ind. Management	-	-	13	7	-	-	20
19	For. Languages	-	-	-	-	-	-	-
	Total	239	354	37	220	8	107	965

* M. Tech.

APPENDIX I

WORKING EXPENSES FOR 1970-71 BLOCK & PLAN

(Actuals + Commitments)

Sl. No.	Dept/Lab./Section	Consumables	Equipment	Others	Total
		Rs.	Rs.	Rs.	Rs.
1	Central Inst. & Services	48,970	9,940	19,625	78,535
2	Appld. Maths	1,584	1,664	6,962	10,210
3	Physics	56,451	53,846	12,911	1,23,208
4	Biochemistry	70,175	4,775	9,096	84,046
5	In. & Phy. Chem.	43,981	14,271	10,818	69,070
6	Micro. & Pharm.	39,998	16,422	9,035	65,455
7	Animal House	26,013	1,896	1,247	29,156
8	Organic Chemistry	58,976	13,076	8,861	80,913
9	Chemical Engg.	70,754	34,263	15,745	1,20,762
10	Aeronautical Engg.	67,539	18,754	46,777	1,33,070
11	Civil & Hyd. Engg.	79,752	38,740	20,812	1,39,304
12	Int. Comb. Engg.	74,890	15,847	5,447	96,184
13	Mechanical Engg.	71,246	4,826	18,810	94,882
14	Metallurgy	65,213	34,003	16,326	1,15,542
15.	Elec. Comm. Engg.	69,222	30,038	14,368	1,13,628
16	Elec. Engineering	62,064	36,753	14,271	1,13,088
17	High Voltage Engg.	66,419	23,927	9,115	99,461
18	Ind. Management	2,810	5,406	5,011	13,227
19	Foreign Languages	-	1,405	4,658	6,063
20	Director's Research	3,533	3,213	372	7,118
21	Library	2,404	-	5,34,559	5,36,963
22	Services & Maintenance	1,22,266	49,716	10,39,501	12,11,483
23	Amenities	66,014	20,777	59,913	1,46,704
24	General Academic Research provisions	-	-	9,18,133	9,18,133
25	Administration	-	-	4,01,462	4,01,462
	Total	11,70,274	4,33,558	32,03,835	48,07,667

APPENDIX J

ABSTRACT SHOWING THE PLINTH AREAS OF BUILDINGS

Buildings	Plinth Area Sq. Ft.
1. Academic Departments	7,04,472
2. Library	60,112
3. Hostels	2,25,613
4. Houses	75,411
5. Others - such as Services, Amenities, etc.	1,02,436
Total	11,68,044

ACCOMMODATION AVAILABLE (INCLUDING ALL CONSTRUCTIONS UNDER IV PLAN)

Sl. No.	Dept/Lab/Section	Existing, including those under construction		Ultimate area as at the end of IV Plan
		Carpet Area sq. ft.	Plinth Area sq. ft.	Total Plinth Area sq. ft.
1	Central Instruments & Services	22,702	28,377	28,377
2	Appld. Mathematics	14,272	17,841	17,841
3	Physics	32,523	40,651	40,651
4	Biochemistry	19,749	24,686	26,686
5	Inorganic & Physical Chemistry	31,808	39,761	39,761
6	Microbiology & Pharmacology	15,286	19,108	19,108
7	Animal House	-	-	-
8	Organic Chemistry	21,972	27,465	27,465
9	Chemical Engg.	29,134	36,398	40,398
10	Aeronautical Eng.	47,937	59,922	59,922
11	Civil & Hydraulic Engineering	49,016	61,270	62,486
12	Internal Combustion Engineering	29,362	36,702	36,702
13	Mechanical Engg.	79,812	99,765	99,765
14	Metallurgy	33,820	42,276	42,276
15	Electrical Comm. Engineering	36,686	45,858	45,858
16	Electrical Engg.	45,614	57,017	57,017
17	High Voltage Engg.	34,617	43,271	43,271
18	Industrial Management	8,098	10,113	10,113
19	Foreign Languages	5,420	6,775	6,775
	Total	5,57,828	6,97,256	7,04,472

APPENDIX K

Institute requirements of Equipment as recommended by the Committee

	Rs.
1. PART - A.	
Common Equipment as a General Facility	2,60,00,000
2. PART - B.	
Specialised Equipment for various groups	1,25,35,000
TOTAL ..	3,85,35,000

P A R T - A

COMMON EQUIPMENT AS A GENERAL FACILITY FOR ALL DEPARTMENTS

A B S T R A C T

		Amount Recommended Rs. in lakhs
1.1	RESEARCH EQUIPMENT	60.00
1.2	ELECTRONICS	45.00
1.3	MICROSCOPES AND CAMERAS	5.00
1.4	FABRICATION EQUIPMENT	30.00
1.5	INSTRUMENT TEST & CALIBRATION ROOM	22.00
1.6	SOLID STATE ELECTRONICS & MATERIALS SCIENCE	60.00
1.7	BIO-ENGINEERING	5.00
1.8	MOLECULAR BIOLOGY	
1.9	COMPUTER CENTRE	22.00
1.10	GRAPHIC ARTS FACILITIES	4.00
	CENTRAL STORES - for building up Inventory (General Rs. 5 lakhs + Electronic Stores Rs. 2 lakhs)	7.00
	TOTAL ..	260.00

The cost estimates are approximate. It is important that the equipment listed is acquired.

Sl. No.	Description of the Equipment	Number required
	1.1 RESEARCH EQUIPMENT	
1.	Powder X-ray Diffractometer + Fluorescent attachment	1
2.	Far Infrared Fourier Transform Spectrophotometer	1
3.	Single Crystal X-ray (Semi-automatic) Difractometer with attachments	1
4.	Liquid Helium Plant & Intense Magnetic Field Equipment	1
5.	Leak Detector System	1
6.	Integrating Micro Densitometer	1
7.	Liquid Scientillation Counter	1
8.	Electron Microscope	1
9.	Hilger Manual Spectropolarimeter Range 190-655 mu	1
10.	Spectro Fluorimeter	1
11.	Centrifuges:-	
	a) Accessories for existing Analytical Centrifuge (Microcomparator & U.V. Optics)	1 Set
	b) Preparative Ultra Centrifuges (Beckman)	2
	c) High speed refrigerated Centrifuges	6
12.	Ultraviolet Spectrometer - Non-recording 3 Recording 1	4
13.	Infrared Spectrophotometer	1
14.	Mossbauer Spectrometer (partly to be fabricated)	1
15.	Lyophilizers	3
16.	Potentiostats	2

Sl. No.	Description of the Equipment	Number required
17.	Instron type Universal Testing Machine for studies on Materials	1
18.	Czerny - Turner Double Manochromator with wave number drive, grating goniometer cells and cell holder assembling - Thermostating and essential spare parts and photoelectric spare parts and photoelectric detection system and power supplies and recording system.	1
19.	Ruby-Laser with necessary ancilliary equipment.	-
20.	Fabry-Perot Interferometer with pressure scanning arrangement and photomultiplier detection and recorder assembly.	1
	Total cost about Rs. 60.00 lakhs	
	Amount Recommended Rs. 60.00 lakhs	
	1.2 ELECTRONICS	
21.	Frequency Synthesizer (0-500 M c/s)	1
22.	Frequency Counters (0-200 M c/s)	4
23.	Digital Voltmeters (varying ranges)	7
24.	Electronic Desk Calculators	4
25.	Equipment for Signal Analysis:-	
	a) Wave analyzing and recording equipment (covering the range from audio to microwave frequencies)	2
	b) Spectrum analyzing, recording and calibrating equipment (for octave band analysis and constant per cent bandwidth analysis)	2

Sl. No.	Description of the equipment	Number required
	c) Correlation and Signal Analyzing equipment with auxiliary units for time delay, etc.	3
26.	High speed Oscillograph Recording Cameras	3
27.	Signal Generators covering audio to microwave frequency ranges	1 set
28.	General Purpose Recorders:	
	a) Fast Recorders (preferably strip chart with 0.25 sec. response)	8
	b) High speed General Purpose Strip Recorders - single channel	13
	c) Multi channel strip Recorders	15
29.	X-Y Recorders	12
30.	Tape Recorders (D.C. & F.M.) (for research)	2
31.	Cathode Ray Oscilloscopes (Tektronix - Fast) 547	15
32.	Storage C.R.O. (Tektronix)	7
33.	Sampling C.R.O.	2
34.	Vibration Generating and Control Equipment	1
35.	Transducers and Sensors covering the amplitude and frequency ranges of interest	1
36.	Real-time digital and analog data analyzing equipment	1
37.	Instrumented vehicle for mobile data collection and analysis	1
38.	High Pressure Equipment	1

Total cost about Rs. 45.77 lakhs

Amount Recommended Rs. 45.00 lakhs

Sl. No.	Description of the Equipment	Number required
	1.3 MICROSCOPES AND CAMERAS	
39.	Metallographic Projection Microscope	1
40.	Microscope for high temperature work	1
41.	High speed camera (Fastax), 40,000 frames/sec.	1
42.	Ultramicrotome	1
43.	16 mm Cine Recording Camera and Projector	1

Total cost about Rs. 5.00 lakhs

Amount Recommended Rs. 5.00 lakhs

1.4 FABRICATION EQUIPMENT

44. High Precision Machines (for Central Fabrication Facility)

(a) Precision Lathes
(b) Instrument Milling Machine
(c) Instrument Shaping
(d) Ultra High Speed Drill
(e) Cylindrical Grounding Machine
(f) Instrument gear hobling machine
(g) Centering Lathe with Bed Cap
(h) Profile cutting machine
(i) Wiredrawing machine
(j) Carbide Tool Grinder & Laser
(k) Precision Planing Machines
(l) Small jig borer
(m) Wood routing machine
(n) Machanical Press (50 Tons)
(o) Precision engraving machine
(p) Spot welding machine
(q) Swaging machine
(r) Equipment for precision machine shop

Total cost about Rs. 30.00 lakhs

Amount Recommended to Rs. 30.00 lakhs

CENTRAL INSTRUMENTS AND SERVICES LABORATORY

Description of the equipment

1.5 Instrument Test & Calibration Room

1. Primary standard cells
2. Standard set of precision resistors, capacitors, potentiometer and inductors
3. Kelvin & Wheatstone bridges (Precision types)
4. Frequency Counters
5. Platinum Resistance Thermometer
6. Universal Ratio set for checking potentiometers, resistors and bridges
7. Power Factor Calibrator
8. A.C. Calibrator, A.C. Voltage and current standards.
9. Type 549 Tektronix or 564 & Plug-in Units
10. AC/DC Thermal Transfer Voltameter (Hermach-Engelhard)
11. Standard of Frequency
12. Standard Signal Generator, H.F. & L.F.
13. Impedance Bridges
14. Precision Sound Level meter
15. Distortion Analyser
16. Electrometer Amplifier
17. Digital Noise Generator
18. Pulse Generator
19. A.C./D.C. Meter Calibrator
20. Variable Phase Generator
21. Low Frequency Generator
22. Digital Oscillator

23. Sweep Signal Generator

24. VH F Signal Generator

25. Standard Quartz Thermometer

Instrument Pool & Electronic Component Store

26. Functional Amplifiers - High Impedance, Low Noise, High Gain, Bandwidth Selective etc.

27. Power supplies of various types

28. Field strength meters

29. Pico-Ampers and Coulomb Meters

30. Conventional types of meters (AC/DC)

31. Spectrophotometers

32. Strain guage Bridges

33. Precision Electronic Components Store

Total cost about Rs. 22.00 lakhs

Amount recommended Rs. 22.00 lakhs

1.6 SOLID STATE ELECTRONICS & MATERIALS SCIENCE

Description of the equipment

1. Atomic Absorption
2. Optical Spectrograph ARL or Quanta UV Spec or similar
3. Accessories (like High temperature Khudsen Cell) for Mass Spectrometer
4. Activation analysis (Multichannel Analyser and Neutron source)
5. Clean Room facilities
6. Chemical Laboratory facilities for analysing and preparation
7. X-ray micro focussing
8. Lang Camera for X-Ray Topography
9. High temperature X-Ray Camera
10. Vacuum crystal growth apparatus
11. High pressure crystal puller (for compound semiconductors) and hydrothermal crystal growing apparatus
12. Epitaxial reactor
13. Diffusion furnace
14. Electron beam melting furnace
15. Crystal cutting, grinding, lapping polishing
16. Ultrasonic dicer
17. Ultrasonic cleaning equipment
18. Welder for encapsulation
19. Brazing (Induction, R.F.)
20. Photomask alignment equipment
21. Students metallurgical microscope - 15 Nos.
22. I R Microscope
23. Angstrometer

24. Research microscope with multiple beam attachment for domain structure studies

25. Infrared monochrometer

26. Perkin-Elmer calorimeter for specific heat measurement

27. Plasma torches

28. Rotary and diffusion pumps and measuring gauges

29. Vacuum evaporation unit

30. Tetrahedral anvil and associated high pressure equipment

31. Capacitance bridges

32. Dielectric test set (microwave)

33. Electromagnets (6" dia)

34. Electromagnets - 3 Nos. (4" dia)

35. No - break power supplies

36. Voltage stabilizers, Rectifiers, Power supplies, etc.

37. Oscilloscopes, electronic bridges, Power supplies, recorders, etc.

38. Polishing Wheels 3 Nos.

39. Specimen mounting press - 2 Nos.

40. Heat treatment furnaces

41. Ovens 0-300°C - 2 Nos.

42. Hydraulic Press - 5 ton capacity 1 No.

43. Mechanical Press

44. Sintering furnace

45. T Machine 10 ton capacity

46. Hardness testers (a) Vickers (b) Rockwell

47. Testing machine for plastics, rubbers, etc.

48. Impact testing machines

49. Vacuum Induction furnaces

50. 1000 Cycles, 15 kw - 1 No.

51. High Frecuency, 20 kw - 1 No.

52. Vacuum fusion furnace (for refractory materials)

53. Testing equipment for creep and behaviour at high strain rates, similar to Instron Unit

54. Dialatometer - 2 Nos.

55. Main frequency induction furnace - 250 Kgs.

56. Special materials of construction for preparative work like very pure metals and compounds, refractive like pure fused quartz, zirconia, thoria, etc. (To be stocked)

Total cost about Rs. 60.00 lakhs

Amount Recommended Rs. 60.00 lakhs

1.7 BIO-ENGINEERING

Description of the Equipment

1. Fast rise time storage oscilloscope for recording transient response of voltage across membrane

2. Polarography Unit - complete with oxygen electrodes and micro-electrode for oxygen - 50 numbers

3. Circulation Thermostats

4. Circulation pumps, incubators, colorimeters, gas density detectors, thermal conductivity cells, polythene membrane and special membranes, A.C. voltage stabilizers, variacs and other electrical measuring instruments, other accessories necessary for gas density detectors, thermal conductivity cells, and other accessories

5. Digital Voltmeters

6. Thermistors, resistors, transistors, Nixic tubes power supplies, VTVM's, pump to slowly inflate the cuff miniature lamps, photo-conductive cells, choppers, wide angle lens etc.

7. Autoanalyser

8. Equipment for studying physiological functions like cardiovascular and respiratory systems, central nervous system, etc, in experimental animals.

9. Spectrophotometer with recording attachment for enzyme rate studies

10. Oxygraph for measurement of oxygen absorption

11. Oxymeter for measurement of atmospheric oxygen

Total cost about Rs. 5.83 lakhs

Amount recommended Rs. 5.00 lakhs for both the projects i.e. Bio-Engineering and Molecular Biology

1.8 MOLECULAR BIOLOGY

Description of the Equipment

	Number required
1. Chromatographic tanks	12
2. High Voltage Electrophoresis	1
3. -20 Freezers	3
4. Refrigerators	3
5. Cold Room	1
6. Fraction Collectors	8
7. U.V. monitoring for fraction collectors	2
8. 200 litre fermentor	1
9. Isco density gradient fractionator	1
10. Electrofocussing equipment	1
11. Pressure dialysis apparatus	1
12. French Press	1
13. Flash evaporators	4
14. Gyratory shaker	1
15. Refrigerated baths	3
16. Incubators	4
17. Sigma metering pump	1
18. Autoclave	1
19. Bench centrifuges	4
20. Sonic disintegrator	1
21. Phase contrast microscope	1

Total cost about Rs. 4.09 lakhs

Amount recommended Rs. 5.00 lakhs for both the projects i.e. Bio-Engineering and Molecular Biology

Description of the Equipment	Number required
1.9 COMPUTER CENTRE	
On-line-Units	
(a) Input/Output Remote Terminals	5
(b) Analogue/Digital Converters	
(c) Auto-Plotter	
(d) Mag-Tape Units	3
(e) Mag-Disc. Units	2
(f) Visual Display Units	1
(g) 64-K Core Storage Module	
Off-line-Units	
(h) IBM 029 Punches	4
Total cost about Rs. 22.00 lakhs	
Amount Recommended Rs. 22.00 lakhs	
1.10 GRAPHIC ARTS FACILITIES (GENERAL FACILITY)	
Xerox Machine with accessories	1
Cost about Rs. 3.00 lakhs	
Amount recommended Rs. 4.00 lakhs	

P A R T - B

SPECIALISED EQUIPMENT FOR VARIOUS GROUPS

ABSTRACT

Sl. No.	Department/Section	Amount Recommended
		Rs. in Lakhs
1.	Inorganic & Physical Chemistry	6.00
2.	Organic Chemistry	4.00
3.	Biochemistry	3.00
4.	Physics	5.50
5.	Microbiology & Pharmacology Laboratory	2.50
6.	Applied Mathematics	1.00
7.	Foreign Languages	1.00
8.	Internal Combustion Engineering	3.00
9.	Aeronautical Engineering	18.00
10.	Metallurgy	15.00
11.	Electrical Engineering	10.00
12.	Mechanical Engineering	10.00
13.	Civil & Hydraulic Engineering	10.00
14.	High Voltage Engineering	12.00
15.	Electrical Communication Engineering	10.00
16.	Chemical Engineering	10.00
17.	Industrial Management	1.00
18.	Dispensary	1.00
19.	Library	1.85
20.	Animal House	0.50
	TOTAL	125.35

1. DEPARTMENT OF INORGANIC & PHYSICAL CHEMISTRY

Description of Equipment	Number required
Atomic Absorption Unit (for the analysis of trace elements present in rocks and minerals)	1
Electron Spin Resonance Unit (to be built with the help of Physics Department)	1
Equipment for measurement of relaxation periods	1

Amount Recommended : Rs. 6.00 lakhs

2. DEPARTMENT OF ORGANIC CHEMISTRY

Description of Equipment	Number required
CHN Analyser, Model 185 Hewlett-Packard	1
C-1024 Time Averaging Device * -attachment for Varian NMR HA-100 D	1
Varian - Aerograph Moduline 1868-4 Analytical and Preparative Gas Chromatograph	1
Dupont 280 Liquid Chromatograph	1
Photoelectric Polarimeter	1

Amount Recommended Rs. 4.00 lakhs

* This is an attachment to the NMR Spectroscope which was recently acquired by the Institute as a central facility. It is expected that the need for this attachment will be felt in about 5 years. Funds for acquiring this accessory should be obtained from the central resources.

3. DEPARTMENT OF BIOCHEMISTRY

Description of Equipment	Number required
Photoelectric colorimeter	4
Automatic Fraction Collector	6
Ultraviolet Scanning Unit	2
Turrox Homogenizer	1
Virtis Homogenizer	1
Raytheon Sonicator	1
Gilson Automatic Cuvette Changer	1
Auto Gamma Counter	1
Oxygraph	1
Microcomparator	1
Electro Focussing Equipment	1
Zeiss Stereomicroscope	1
Ice Flaking Machine	1
Accessories for Zeiss PMQ Spectrophotomer with TLC Plate Analyzer Attachment	1 set
Single Pan Balances	6

Amount Recommended .. Rs. 3.00 lakhs

4. DEPARTMENT OF PHYSICS

Description of Equipment
Klystrons, wave guides and microwave components
Gratings alone (for visible and ultra-violet and for the Infrared) for instrumentation
Infrared detectors with ancillary equipment (Solid State and Golay Cell)
Electron Multipliers E.M.I. and Bendix
Research Microscope (Interferometric and phase contrast)
7-Decade Potentiometer (RUBICON)
Temperature Recorders and measuring devices
Minor measuring equipments and special components and materials like fused silica tubes, high temperature materials, electronic components, cryostats for low temperature work, geared motors, potentiometers, microvoltmeter, electronic null detector, lock-in-amplifier etc.
High field magnet

Amount Recommended .. Rs. 5.50 lakhs

5. MICROBIOLOGY & PHARMACOLOGY LABORATORY

Description of Equipment	Number required
Fluorescent Microscope Leitz	1
Dark Room Accessories for autoradiographic studies	
Research Binocular Microscope with Photographic accessories	1
Sonic Disintegrator	1
Metler P. 1200 direct weighing Balance	1
Radiometer for pH measurement and titration	1
Air Pressure Pump & Soil seive shaker	1
Roller drums & spinner flasks and other specialised apparatus	1
Inoculation chamber with glass partitions and facilities for complete sterilization, air conditioner and germicidal lamps	L.S.
High Voltage Electrophoresis	1
-20°C Freezers	2
Refrigerators	3
Fraction Collectors	8
U V Monitoring for Fraction Collectors	2
200 Litre Fermenter	1

Amount Recommended .. Rs. 2.50 lakhs

6. DEPARTMENT OF APPLIED MATHEMATICS

Amount Recommended ..	Rs. 1.00 lakhs

7. FOREIGN LANGUAGES SECTION

Description of Equipment	Number required
Hifimultiple tape copying unit	1
Hi-Fi. Main Console Unit with multiple connections and controls with 16 Nos. subsidiary Units for individual booths	1
Amount Recommended ..	Rs. 1.00 lakhs

8. DEPARTMENT OF INTERNAL COMBUSTION ENGINEERING

Description of Equipment	Number required
True RMS Voltmeter	1
Electrical Dynamometer	1
Hydraulic Vibrator	1
Torque Meter	1
Amount Recommended ..	Rs. 3.00 lakhs

9. DEPARTMENT OF AERONAUTICAL ENGINEERING

Description of Equipment	Number required
Precision Milling Machine for Workshop	1
V/STOL Wind Tunnel	1
Hypersonic Test Facilities (Small size tunnels)	
Equipment for Rocket Propulsion Lab.	
Instrumentation for Guidance Lab.	
Vibration exciters, pickups, measuring and recording equipments etc. including an NAL built Digital Strain indicator	
Photostress equipment for studies on load diffusion cut-outs, joints, composites, etc.	

Amount Recommended .. Rs. 18.00 lakhs

10. DEPARTMENT OF METALLURGY

Description of Equipment	Number required
Metallographic Microscope	1
Extrusion Press	1
Diamond & Tungston Carbide Die sets for wire drawing	1 set each
Recorders for Densitometer, Microcalorimeters etc.	
High Tension Unit for Field Ion/ Electron Field Emission Studies	
Ultra High Vacuum Unit for Thin film studies & High Temperature materials, vacuum components and accessories	
High Temperature Rolling Mill	
Oscilloscopes, Vac. Tube VTVM Dimmerstats, Voltage St.	
High Current Transformers for Electron Migration studies, Electrometallurgy, Rectifiers	
High Temperature Creep Unit	
High Precision Potentiometer, Galvanometer & Accessory for Calorimetric studies, etc.	
Quartz Spiral Bourdon Gauges, etc.	
Flame Photometer	
Electroplating equipment, accessories & thermostating	
Equipment for Ore Dressing, Mineralogy, etc.	
Equipment for Mechanical Metallurgy Testing Laboratories	

Description of Equipment	Number required
Equipment for heat Treatment Laboratory	
Accessories for Spectrograph	
Amount Recommended .. Rs. 15.00 lakhs	

11. DEPARTMENT OF ELECTRICAL ENGINEERING

Description of equipment
High frequency alternator
High frequency measuring instruments like Voltmeters, ammeters, power meters, p.f. meters inductance and capacitance
Furnace with different temperature zones & controls
Sealing arrangement
Hydraulic press and dies
High Frequency furnace
Components for development of electronic flash tubes
Vacuum tube voltmeters
Transistorised power supplies
Pulse generator
Audio Oscillators
Power supplies (0-300 V)
Time mark generator
Pulse generator - Low frequency
Phase anglemeter (digital)
Universal Valve tester
Paper tape recorder
A-D Converter
Components: SCR's,FET's,UJT's, Tunnel diodes, integrated circuits, Nixic tubes, special courses, photo diodes, high power transistors, etc.

Amount Recommended .. Rs. 10.00 lakhs

12. DEPARTMENT OF MECHANICAL ENGINEERING

Description of the equipment
Thermo couple potentiometers
Aircompresors (oil free)
Temperature measuring devices
Combustion equipment
High vacuum pumps
Electronic balance
Platinum resistance thermometers
Vacuum & Pressure gauges
Components
Melting units: electric crucible furnace
Baleout furnace
Cell count apparatus
Potentiometer
Shell sand mixer
Core shaker
Land mixer (200 Kg)
Moulding M/c
Magnetic vibrator
Thermal calorimeter, low temp. bath
Resistance welding unit
Inert gas atmospheric welding unit
Testing equipment for welded components
Amount Recommended .. Rs. 10.00 lakhs

13. DEPARTMENT OF CIVIL & HYDRAULIC ENGINEERING

Description of the equipment
Instrumentation for cavitation tunnel
Dynamometer
Variable speed motor
Super high speed motor
Addition to the existing test cylinder plant for vibration studies
Fabrication for the test frame
Vibration measuring instruments
Subsurface exploration and sampling equipment
Constant temperature and humidity rooms and equipment for high pressure testing of soils
Equipment for soil structure identifications

Amount Recommended .. Rs. 10.00 lakhs

14. DEPARTMENT OF HIGH VOLTAGE ENGINEERING

Description of the equipment
Three testing transformers, 500 Kv, 1000 Kva continuous
Lifting facilities for heavy test objects
Chamber for Pollution studies
Environmental chamber
Ovens and humidity chambers
Furnace heating elements
Tracking test equipment
Analytical instruments like PH meter, Colorimeter and Refractometer
Vacuum systems with associated gear
Electrometers
Crygenic thermostats and associated controls
Components for fabricating equipment and instruments in the Laboratory
Ultrasonic flaw detector
Arc chambers
Generators & capacitors
Measuring equipment
For 2 MeV Van de Graff Laboratory:
a) Building with radiation shielding to house the generator and associated equipment
b) Air conditioning plant for generator room
c) Instrumentation for irradiation studies
Amount Recommended .. Rs. 12.00 lakhs

15. DEPARTMENT OF ELECTRICAL COMMUNICATION ENGINEERING

Description of the equipment	Number required
Two-tone AF Oscillator	1
R.F. Oscillators (300 MHz)	2
A.F. Oscillators	2
Distortion Analyzer	1
Loudness Analyser	1
Vector Voltmeter	1
Noise figure meter	1
Bridges for measuring of R-L-C etc.	2
Beat-frequency Oscillators	2
Sound level meter set	2
A.F. Spectrometer	1
Level recorders with accessories	2
Statistical distribution analyzer	1
Condenser microphones with adopters and Proamplifiers etc.	5
Microphone calibration equipment	1
Random noise voltmeter	1
Accelerometers and preamplifier set	1
Vibration exciter	1
Sine-random generator	1
Vibration meter	1
Vibration programmer	1
Sound Spectrograph	1
Hi-fi-loudspeakers	8

Description of the equipment	Number required
Stereo record player	1
Impact noise analyzer	1
Analog correlator for noise work	1
Universal filters	2
Decade amplifier	2
General purpose microphones	10
Optical microscope	1
Ultrasonic cleaner	1
High resolution camera	1
Electromagnet	1
250 W HF/VHF AM transmitter	1
Communication receivers	2
Instrumentation type CCTV	1
Ridged wave guide test equipment 3.75 KMHz - 40 KMHz	
Klystrons and other microwave tubes	
Stroboscope	1
Pulse generators	2
Frequency-response tracer	1
Audiometer	1

Amount Recommended .. Rs. 10.00 lakhs

16. DEPARTMENT OF CHEMICAL ENGINEERING

Description of the Equipment

Vapour phase chromatograph

Pulfrich refractometer

Surface Area measuring equipment

Porosimeter

Adsorptomat

Differential thermal analysis

Particle size Analysis Apparatus

Sedimentation balance

High pressure Latent Heat of Vaporization apparatus

P V T Apparatus

High Pressure Compressor

J-T. Coefficient Apparatus

Vapour-pressure Determination Apparatus

Schlieren (To be fabricated)

Thermodynamic and transport properties laboratory

Process Development Laboratory:-

20 Litre reactors in stainless steel, cast iron and aluminium

Stainless steel tubular reactor (1 ft. diameter and 6 ft. length)

200-litre storage tanks, stainless steel, and glass lined

Rotameters (10 to 100 litres/hr.) for gas and liquid flow measurements

Description of the Equipment

On-stream analysers:

(a) Non-solution type
(b) Solution type

Circulation pumps and thermostats

Separation Equipment

Blowers

Interferometer

Combined Interferometer and Schlieren

Pology raphy unit with implantable microelectrides for oxygen

Circulation Thermostats

Incubators

Calorimeters

Gas Density Detector

Thermal Conductivity Cells with accessories

A.C. Voltage Stabilisers

Process Control Equipment:

Measuring, indicating, recording and transmitting equipment for different process variables like temperature, pressure, level, flow-rate, density, chemical composition etc.

Pneumatic, electronic and hydraulic controllers

Accessory equipment for pneumatic and electrical instruments

Control valves and valve positioners

Pneumatic-electronic transducers

Pneumatic Signal generators

Description of the Equipment
Electronic measuring and testing equipment, like oscilloscope, vacuum tube voltmeters, digital voltmeters, amplifiers etc.
Analog-digital converters
Fluidic devices
Special purpose process control computers
Amount Recommended .. Rs. 10.00 lakhs

17. DEPARTMENT OF INDUSTRIAL MANAGEMENT

Description of the Equipment
Electronic time study device
Kymograph
10 Work Study films
Maestrochrom timing device
Ergograph
Anemometer
Globe thermometer
Sling Psychrometer
Sound level meter
Photo meter
Respirometer
Bicycle Ergometer
Electronic pulse counter
Continuous Stimulator
Action Analyser
Polygraph
Orthorater
Pnemograph
Discrimination reaction tester
16 mm. Projector for Seminar Hall R.C.A. type with 2" lens spare

Amount Recommended .. Rs. 1.00 lakh