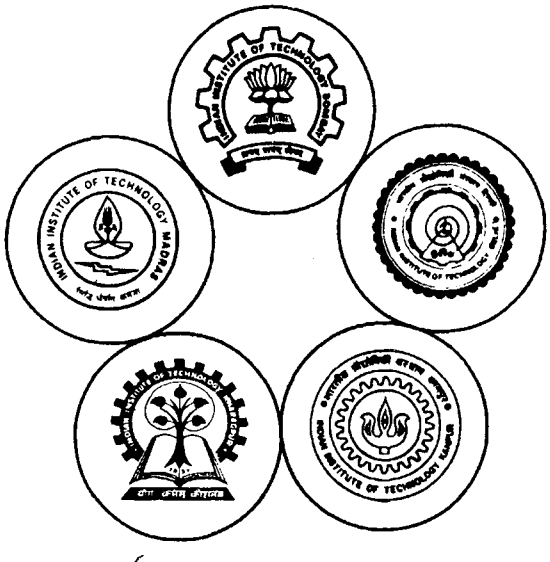
NINTH PLAN PROPOSALS

OF THE

INDIAN INSTITUTES OF TECHNOLOGY

BOMBAY, DELHI, KANPUR, KHARAGPUR AND MADRAS



JUNE 1996

NINTH FIVE YEAR PLAN

PROPOSALS OF INDIAN INSTITUTES OF TECHNOLOGY AT

BOMBAY, DELHI, GUWAHATI, KANPUR,

KHARAGPUR AND MADRAS

NINTH FIVE YEAR PLAN

EXECUTIVE SUMMARY

INDIAN INSTITUTES OF TECHNOLOGY

BOMBAY, DELHI, GUWAHATI, KANPUR, KHARAGPUR AND MADRAS

1. Preamble

The IITs have been established as Institutes of National Importance and have distinguished themselves by the excellence of their Under Graduate, Post Graduate and Research Programmes. The IITs, along with the I.I.Sc., were specifically chosen by the Planning Commission in the 8th plan for executing Technology Development Missions in several nationally important and critical areas.

The IITs are engaged in producing manpower in technological areas for the Indian Industry and R & D laboratories as well as to carry out intensive research and development to support the Indian Industry and the various national missions, for example, those of the Departments of Space, Defence, Atomic Energy, etc. Especially in the present context of economic liberalisation where Indian Industry is required to become globally competitive, the IITs have a very important role to play in Technology Development, Technology Transfer, and Technology Absorption and Adaptation. They also envision a role for themselves in technology watch world-wide for the nation and in helping, the concerned government agencies, to formulate technology policy and assisting in their

implementation. Another role that can be taken up with competence is that of technical auditors for the various technological schemes of national importance. The ninth plan requirements have been worked out with the above scenario in mind.

2. IX Plan Requirements

The Ninth plan requirements of the IITs are projected in terms of the following

- **Qualitative Upgradation**

The teaching, research and sponsored R & D and consultancy activities have to keep pace with futuristic advances and requirements. Several innovative initiatives are being proposed during the Ninth Five Year Plan period.

In order to maintain the present high standard of technological education, and to keep pace with the rapid advances in technology globally, it is essential to modernise the laboratories and infrastructure as well as to remove obsolescence. Modernisation and augmentation will be in the core laboratories, the Under-Graduate and Post-Graduate laboratories, and also Central facilities and Support services.

- **Quantitative Expansion :**

In the context of more optimal utilization of the already created infrastructure, the Synergy group has recommended the enhancement of intake, particularly to the undergraduate programmes. This requires the strengthening of the infrastructure in terms of class rooms, laboratories,

hostels and housing. It is recommended that the intake strength of the IITs be doubled over a period of 3-5 years, to meet not only the increasing need for manpower in many areas of technology but also satisfy the aspirations of bright students for studies at the IITs.

Many new thrust areas have emerged as globally important ; these areas are also to be taken up in terms of new activities, both in man-power development and R & D. These include Telecommunications, Software Engineering, Bio-Technology, New Materials (including non-metals), Technology Management, etc. Some of the avenues contemplated are establishment of Centres of Excellence, starting of new academic programmes, building up centralised sophisticated computation and diagnostic facilities, etc.

A capsule summary of the requirements is given below :

S. No.	CAPTION	AMOUNT Rs. (Cr.)
1.	New Programmes and Strengthening of Existing Programmes	230.00
2.	Modernisation/Upgradation of Existing facilities	229.40
3.	R & D - Consolidation & Augmentation and New Initiatives	259.00
4.	Computing, Networking and Library	67.10
5.	Linkages - National and International	76.50
6.	Infrastructure - Campus, Hostels	277.00
	TOTAL Rs. (Cr.)	1139.00

NOTE :

I. The 9th plan requirement for IIT Guwahati, which is being commissioned since the 8th plan, with the first batch of students admitted from 1995-1996, is to be presented separately. It is noted that they are in the initial formation phase and accordingly their requirements would be projected.

II. It is envisaged that about 15-20% of the resources required as indicated above can be generated by the IITs from sources other than MHRD. Thus the 9th plan funding from MHRD for the five IITs is expected to be about Rs.**1000 Crores**.

NINTH PLAN REQUIREMENTS OF IITs

(Rs. in Crores)

AREA	IIT BOMBAY	IIT DELHI	IIT KANPUR	IIT KHARAGPUR	IIT MADRAS
New Programmes and Strengthening of Existing Programmes	65.00	41.0	37.00	57.0	30.0
Modernisation/Upgradation of Existing facilities	37.90	50.0	48.5	40.5	52.5
R & D - Consolidation & Augmentation and New Initiatives	41.00	50.0	60.5	40.0	67.5
Computing, Networking and Library	15.10	20.0	12.0	7.5	12.5
Linkages - National and International	5.00	25.0	17.5	5.5	23.5
Infrastructure - Campus, Hostels	55.00	64.0	69.5	59.5	29.0
Total	219.00	250.0	245.0	210.0	215.0

(Rs. in crores)

New Programmes and Strengthening of Existing Programmes	230.00
Modernisation/Upgradation of Existing facilities	229.40
R & D - Consolidation & Augmentation and New Initiatives	259.00
Computing, Networking and Library	67.10
Linkages - National and International	76.50
Infrastructure - Campus, Hostels	277.00
Total	**1139.0**

NINTH FIVE YEAR PLAN

PROPOSALS OF THE INDIAN INSTITUTES OF TECHNOLOGY AT BOMBAY, DELHI, GUWAHATI, KANPUR, KHARAGPUR AND MADRAS

1. PREAMBLE

The IITs are Institutes of National Importance and have distinguished themselves by their excellence in their Undergraduate, Postgraduate and Research programmes in Engineering/Technology, Science, Humanities and Social Sciences and Management. Sponsored research for different funding agencies in the public and private sectors and industrial consultancy and continuing education programmes have also been areas in which the IITs have made significant contributions over the years. The IITs also provide opportunities for Teachers from other Engineering colleges to acquire Ph.D and Masters degrees. During the Ninth Five Year Plan period, efforts will be made to consolidate the strengths in the above areas, eliminate weaknesses and also launch new initiatives in emerging areas of technological, scientific and social relevance and importance. A significant increase in the student strength has been planned, in an attempt to provide more opportunities for aspiring youth, maintaining the present ratio of 1:1 between the undergraduate and the postgraduate students. In absolute terms, the student strength of each IIT will increase from about 3000 to 5000. This will be achieved through increased intake through the Joint Entrance Examination (JEE) for the Bachelor's degree and an innovative dual Master's and Bachelor's degree, and increased

admission to existing postgraduate programmes, and new specialisations at the post - graduate degree level.

New R & D initiatives will be launched, building upon the Technology Development Missions introduced for the first time during the Eighth Plan period. Closer interaction with the industry, spin-offs in the form of new projects and joint ventures/emergence of a significant number of engineer-entrepreneurs are the expected beneficial outcomes. R & D efforts in the form of sponsored and academic research and industrial consultancy projects would be continued and improved upon. There is a need to remove obsolescence in many of the teaching and research areas, and also to build/acquire new facilities in emerging areas. To sustain and develop new academic programmes and launch new initiatives in R & D, a state-of-the-art computing and communication environment is essential, and this implies updating and expansion of the facilities in this area.

Linkages - academic, R & D and industrial - with institutions in India and abroad are mutually beneficial, and formal mechanisms for them will be evolved and/or enlarged during the Ninth Plan period.

Each IIT comprises many (about 10) Engineering Departments, a few (about 4) Science Departments, Humanities, Social Sciences and Industrial Management Departments, apart from a number of advanced Centres and Schools. Large centralised facilities, including workshops, libraries and computer centres, offer support and services for the teaching and research activities. All the campuses are residential in character, with all students being provided hostel accommodation. Most of the faculty and staff are also provided housing on the campuses. The proposed enhanced student intake will necessarily imply the creation of

additional infrastructure, in the form of lecture halls, laboratory space and hostel accommodation. Some increase in the faculty strength and the provision of appropriate accommodation for them will also become necessary. Five of the Six IITs have now been in existence for more than 35 years. Toning up of the available campus amenities in the form of repairs/renovation to existing buildings and structures, improving the services etc. is also necessary. Two IITs (Bombay and Delhi) already experience acute pressure on available space, and are contemplating the creation of satellite campuses.

In short, the general health of the IIT system is good and is expected to become more robust during the 9th Plan period. The requisite human resources and approximate cost implications of the consolidation, expansion and enrichment in the proposed academic, R & D and industry-related activities are discussed in the following sections.

2. NEW PROGRAMMES AND STRENGTHENING OF EXISTING PROGRAMMES

The economic liberalization in the country has made possible the entry of internationally competitive organizations and the consequent introduction of the latest technologies. In order that Indian industry becomes globally competitive and meets the challenges of the twenty first century, it must be supported by a large pool of young and bright engineers who have aptitude and motivation for developing innovative technologies.

Over 90,000 candidates take the Joint Entrance Examination and amongst them only the first 2,000 or so get admission to the IITs. In order to provide more opportunities for the young aspirants, it is

proposed to take an additional 1000 - 1500 students each year from amongst the JEE qualifiers. This would meet a national requirement of the near future, viz., increased availability of hi-tech man power. Due to differences in the pattern of education at the different IITs, these additional students will be distributed in different ways in the individual IITs - increase in the strength of existing specialisations, creation of new specialisations in 5 year integrated M.Tech. degree programmes etc. Some IITs are also thinking in terms of an `academic clustering' of some of the existing departments/centres to award more broad - based degrees.

In addition to the proposed increase in student intake through the JEE, additional student enrollment (both GATE and sponsored candidates) in the post graduate programmes is also envisaged. Apart from increased intake in the established Ph.D., M.Tech./M.S.(by research) programmes, some of the IITs are also thinking in terms of new M.Tech./M.Phil. programmes and Post-graduate Diploma programmes (D.I.I.T). A cardinal principle in the choice and introduction of these expanded / new academic programmes is that they will be of national and technological relevance/significance. Constant dialogue with the various government, techno-economic units, funding agencies, industries in both private and public sectors and R & D organisations will be used extensively in identifying these programmes.

To nearly double the student-strength without loss of quality in education, it is necessary to increase the faculty strength by 20 - 25%, and to increase the number of assistantships made available to the post graduate students.

Infrastructural facilities to meet these requirements include hostel accommodation for 10,000 to 15,000 additional students, increased power and water supply expenditure, additional space for the existing departments/centres, lecture halls and teaching aids, library facilities, faculty housing, and a complex for interdisciplinary and thrust area programmes. In case of IIT Bombay and IIT Delhi, the space available on the present campuses has already been used nearly fully. Therefore, satellite campuses, with necessary amenities and easy access from the existing campuses need to be developed and investments in this regard are necessary. Thus the investments required are estimated to be:

Salaries for additional staff and increased number of assistantships : **Rs. 70 Crs.**

Additional infrastructure creation **Rs.409 Crs.**

Total : Rs.479 Crs.

Satellite campus development in case of IIT Bombay and IIT Delhi: **Rs. 45 Crs.**

3. RESEARCH AND DEVELOPMENT: CONSOLIDATION, AUGMENTATION AND NEW INITIATIVES

The IITs are well poised to attain the status of leading, internationally competitive educational and R & D Institutions. Pursuit of research in contemporary and emerging areas is an important commitment. The Institutes are equally committed to developmental work leading to systems, software and technologies of industrial relevance and utility.

The broad strategies for the pursuit of this goal - entailing global dimensions resulting from the changes in the economic and commercial policies, and India becoming a signatory to the GATT - will comprise:

1. Consolidating, modernising and augmenting facilities and services in areas of relevance in which considerable expertise exists.
2. Developing of new facilities to enable the pursuit of research in emerging areas, and, augmenting human resources in related areas.
3. Executing spin-off projects from the Technology Development Missions initiated in the Eighth Plan - in order to extract maximum benefits from the knowledge base, facilities and experience generated - with modest additional inputs.
4. Initiating Technology Development Mission Projects in some contemporary emerging and relevant areas with a view to generate internationally competitive systems / technologies / software.
5. Developing of a well-structured mechanism for establishing area - specific international research linkages for executing collaborative projects and for accessing research funding from international agencies.
6. Augmenting existing facilities and creating additiona facilities, converting some of the specialised centres into International Centres for R & D training and manpower generating.
7. Establishing extension centres in selected towns/cities to provide consultancy and continuing education services.
8. Starting of joint ventures/establishing of technical parks etc. based on research and development done in collaboation with industries or as part of entrepreneurship and/or applied research activities of the IITs.

An illustrative list of research facilities/centres in contemporary and emerging areas of technological significance that are proposed to be developed are listed in Table-1. Some of the new Technology Development Mission Projects planned to be initiated during the Ninth Plan period are given in Table-2.

The Research and Development initiatives outlined above will entail expenditure apart from those on equipment and infrastructure, on manpower, materials and consumables, equipment maintenance, repairs and spares, etc.

Total expenditure for R & D initiatives over the Ninth Plan : Rs.270 crores

Recurring Grant for maintenance, repairs, consumables etc. for the R & D activities - Rs. 30 crores

Of this 50% will be raised from sources other than MHRD. This is possible by actively pursuing sponsored research and consultancy projects for external funding agencies and industries as also from collecting the industry contribution to the Technology Development Missions.

Table 1 : Proposed Centres and Facilities in Contemporary and Emerging Areas

- Nonlinear optics
- Thinfilm technology
- Geophysical mapping
- Bioinformatics
- Computational fluid dynamics
- Optical information technology
- Advanced transportation studies
- Knowledge engineering for development policy planning
- Clean production technology
- Efficient energy engineering
- Information technology
- Educational technology
- Distance education facility
- Nanoelectric design facility
- Advanced computing with security
- Geophysical information systems
- Environmental impact assessment
- Construction engineering and management
- Ceramics and powder metallurgy

Table 2 : An Illustrative List of Proposed Technology Development Missions

- Integrated sensor development
- Healthcare monitoring and management systems
- Thermal imaging systems
- Advanced control-systems technologies
- Composites for structural applications
- Environmental engineering
- Concurrent engineering
- Transportation systems
- Rural technology
- Information technology
- Microelectronics
- Nanomaterials and Nanotechnology
- Al-Ti-B master alloys manufacture
- Industrial gases
- Microprocessor - based control system for tractors
- Micromotors development
- Advanced space propulsion system
- Superhighway systems
- Optical sensor and communication systems
- Subsea production system
- Ocean pollution control
- Fly ash Disposal

4. COMPUTING, NETWORKING AND COMMUNICATION REQUIREMENTS

Integrated, campus-wide, networked environments for the computing and information exchange needs of the various departments in the IITs require high - bandwidth ATM LAN supporting compute/file servers, high-end compute servers, high performance graphics and multimedia equipment with point-to-point voice & video.

For augmenting the computing power at the IITs the following possibilities are envisaged. The setting up of central workstation laboratories is expected to cater to the needs of UNIX based platforms using C-language, X-windows and computer graphics. The proposed laboratories will provide (i) UNIX and graphics laboratory facilities to undergraduate and postgraduate students; (ii) Graphics platform for receiving/sending multimedia through the upcoming computer network; (iii) UNIX and graphics facilities to research scholars and research workers; (iv) laboratory facilities for higher level short-term courses as continuing education programmes and corporate training programmes which may be offered by the various Departments and Centres of the IITs.

Modernisation of the PC laboratories is essential to allow the first year students exposure to windows environment and various software under it. The PCs also require heavy duty printers and other peripherals.

Estimated costs: Rs.50 crores

Computerisation and networking of the central libraries of the IITs is essential for the effective utilization of the limited library budgets. This step helps also in the better utilisation of the available space. Creation of

books data bases, computerisation of library services, creation of CD-ROM libraries based on a good collection of databases and networking will make the whole operation compact and efficient to use. This will result in faster retrieval of information available in the libraries and considerable saving of storage space, with consequent saving on building extensions. The focus will be to advance the means to collect, store and organise information in digital form and make it available for searching and retrieval via communication networks - all in user-friendly ways. Besides, through the use of Campus LANs the library computer system will be made available to any location in the Institutes and to any location in the world using the INTERNET via ERNET.

For these plans to be successful, a high processing speed and a large memory are necessary.

Estimated costs: Rs.20 crores.

5. LINKAGES - ACADEMIC, R & D AND INDUSTRY (NATIONAL AND INTERNATIONAL)

With a long track record of excellent academic programmes, proven research work of high quality, and quality inputs to industry, the IITs are now well placed to strengthen existing linkages with other academic institutions and industry and forge new linkages. The IITs have ongoing international collaborations with institutions such as M/s. Volkswagen Stiftung, Germany Queens University at Belfast; University of Tokyo; University of Bologna, Italy; University of Maryland; University of Western Ontario, Canada; IBM; Hewlett Packard; Siemens; etc.

It is proposed to establish new linkages with academic institutions - both in India and abroad. The abundant experience and expertise available in the IITs may be harnessed towards elevating the academic levels of newer institutions coming up in the country through proactive efforts and sustained interactions. The pre-eminent academic status enjoyed by the IITs could be strengthened further through international linkages with a view to providing access to the highest quality postgraduate educational facilities and opportunities at competitive costs, to personnel from other developing and developed countries. The initial dialogue established with the Sloan School of Management for long-term interaction in the area of Technology Management education by IIT-Bombay is a case in point.

A number of research areas in the IITs have an impressive record of achievements and capabilities. Excellent opportunities are now open for pursuit of collaborative, contract and other research projects, and some initiatives in this direction may open up substantial avenues for accessing funds from international research funding agencies - if the MHRD could invest a small percentage of the total project costs as a prerequisite. The investments will essentially cover exchange of personnel, travel and hospitality and communication expenses.

Another important area for strengthening and diversifying linkages has emerged out of the excellent work done by the Continuing Education Centres of the IITs. The faculty members have been giving specially-designed and packaged courses of differing duration on various topics of current technological relevance for working professionals. Requests have already been coming in from countries around us in the Middle East and the Asia-Pacific region for such focused courses, as also for

specific research and consultancy assignments. Apart from fostering international cooperation and getting us the much needed visibility in these parts of the world, such activities will also prove to be a steady source of income for the IITs.

The need for strengthening professional linkages with industry, in order to ensure that professional education is contemporary, relevant and in tune with the technological trends, is strongly felt - especially in the globalised economic environment. Initiatives such as adjunct academic positions and industrial sabbaticals are useful in setting up such linkages.

The diverse range of activities and initiatives related to strengthening of existing linkages will require investments on related infrastructure and recurring expenditure on personnel, travel and communications, preparation of course materials, proactive interaction efforts etc.

The total budget for these efforts, over the entire Ninth Plan period is estimated at Rs. 90 crores.

6. MODERNISATION AND UPGRADATION OF EXISTING FACILITIES

For maintaining the high standard of technical education, it is essential that obsolete equipment in the laboratories be continually replaced by/upgraded to modern versions. This applies both to equipment in the teaching laboratories and to the research facilities. Research and development work or prototype development performed using the latest tools and techniques is the only option that is likely to result in quality-competitive and cost - effective products and technology.

By and large, the ageing facilities in the IITs need serious revamping. It is proposed to undertake this activity in the Ninth Five Year Plan period. Further, in view of the planned increase in the number of students, the modernized and upgraded facilities will also have to be augmented in the main laboratories of the IITs.

In order to achieve the above objectives, the modernization requirements are considered in four distinct but related segments.

6.1 Core Laboratories

The first of these segments consists of core laboratories of the undergraduate programmes catering to first and second year undergraduate students. These will primarily include the laboratories in the Science departments, and laboratories in Civil, Mechanical and Electrical Engineering and Computer Science and Engineering Departments.

Total budget for modernising core laboratories : Rs. 41 crores

6.2 Undergraduate Laboratories

The other undergraduate laboratories of the institute cater to the third and the fourth year B.Tech. programmes and also to the M.Sc. programme. All Science and Engineering departments need to be covered in the upgradation drive.

Total budget for undergraduate laboratories : Rs. 60 crores

6.3 Postgraduate Laboratories

These laboratories primarily cater to the M.Tech. programmes of various Engineering departments and interdisciplinary groups. Some of the common facilities in these laboratories are also used by Ph.D. scholars. In addition, there exist specially designated research laboratories in Science and Engineering departments that have specialised facilities for focussed research. While the laboratories mentioned under the previous two sections are vital to guarantee high quality technical education, it is the postgraduate and research laboratories that account for contemporary and futuristic research. All the departments involved in postgraduate education and research have carefully planned their modernisation requirements, proposing either to revamp or replace obsolete equipment, with specific focus on areas of research of national relevance in this and the next decade. An illustrative list of the laboratories / facilities involved in the modernisation programmes is presented as Table 3.

Total budget for modernising PG laboratories : Rs. 100 crores

Table 3 : Illustrative List of Equipment to be Replaced or Added under the Modernisation Programmes

• Compression testing machine	• Laser interferometer
• X-ray diffractometer	• Towing carriage
• Instron machines	• Rheometer
• Atomic absorption spectrometer	• Gold & carbon coating unit
• Polarising microscope	• Chemigation system
• Cell culture facilities	• Turbo jet demon-stration unit
• Pollutants monitoring/ control equipment	• Gel spinning system
• Growth chambers	• Solid state NMR facility
• Electromagnetic geo-profiling	• Turbo molecular pump
• CNC machines	• Thermovision camera
• Multicylinder internal combustion engines	• Robot controller
• Cryocoding system	• Mine surveying equipment

6.4 Support and Central Facilities

Educational and research activities in all the departments and centres heavily depend upon a large number of central facilities and support services. These include the central workshops, modern design and drafting facilities based on the latest CAD equipment, supply of cryogenic fluids such as liquid Helium, etc.

Total budget for modernising these facilities : Rs. 45 crores

The total Plan amount for upgradation and modernisation in the Ninth Plan period thus works out to Rs. 240 crores

Out of this, at least 20% is expected to be raised from sources other than MHRD.

7. INFRASTRUCTURE REQUIREMENTS

With the proposed increase in enrollment to the tune of about 70 - 100 percent (i.e., about 5000 - 6000 students residing on each IIT campus) and increase in the academic programmes, the increased infrastructural requirements include additional staff housing, new roads, sewerage, water supply, electric supply, etc.

During the Eighth plan, a need for the rejuvenation of the IIT campuses was emphasized, but only limited success could be achieved due to paucity of funds. Beginning has been made to renovate the buildings in the academic and residential areas in some of the IITs. This activity needs to be accelerated in all the IITs.

As the present campuses of IIT-Bombay and IIT-Delhi are already being utilised nearly fully, satellite campuses need to be developed. A site for

the satellite campus has been identified in New Mumbai by IIT-Bombay and a similar suitable site will be selected for the satellite campus by IIT-Delhi.

These additional campuses will be primarily used for the continuing education programmes, organisation of conferences, part-time degree programmes and the establishment of technology parks. Some of the centres in the thrust areas to be established in partnership with industries also could come up there. Also, to cater to the additional water requirements for the new equipment and the increased populations in the existing campuses, extra water supply and sewage disposal systems will have to be created.

All these additional infrastructural needs have arisen out of the need to increase the student - intake, starting new teaching and research programmes, and intensifying R & D activities in all dimensions. The cost implications have already been included under appropriate items in the different sections.

PROPOSAL

FOR

NINTH FIVE YEAR PLAN

INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

April 1996

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EXECUTIVE SUMMARY

During the Ninth Plan, the Indian Institute of Technology,Bombay proposes to consolidate and strengthen its existing academic programmes and research areas, and simultaneously grow in a number of new directions.

Keeping in mind that there is a heavy demand for admission after the Joint Entrance Examination, the Institute proposes to substantially increase its intake through the JEE. Much of this additional input would be through a 5-year integrated M.Tech. Programme, in which a B.Tech.-M.Tech. double degree is offered at the end of 5 years. In course of time, it is expected that this integrated programme will be an attractive alternative to the present 4-year B.Tech. programme. In addition, a number of new specializations are proposed to be started in the 3-semester M.Tech. programme in the Institute. The Institute also proposes to offer a number of M.Tech. level courses to working professionals in the Industry during the evenings and week-ends. Some of these would lead to the postgraduate diploma (DIIT) of the Institute. .The additional student enrolment on account of all the above inputs is expected to be about 2000 thereby leading to a total enrolment of 5000 students. An additional faculty strength of about 100 faculty members will be required for this purpose (Section 2).

In order to maintain the present high standard of technical education, it will be essential to modernise some of the equipment and to remove obsolete equipment. The modernisation and augmentation will have to be done in the core laboratories, the undergraduate laboratories, and the postgraduate

laboratories. Some central facilities and support services would also need to be modernised (Section 3).

In so far as research and development activities are concerned, it is proposed to augment many existing project areas and to take up a number of new initiatives. These new initiatives would be spin-off projects from the Technology Development Missions initiated during the Eight Plan and also new projects for the development of new technologies. In addition, facilities for contemporary research and development work would need to be developed along with new centres of excellence (Section 4). New research and development initiatives and continuation of existing research and development activities would need upgradation of the computing and networking facilities in the Institute (Section 5). Academic linkages with other Institutes within the country and abroad and with industry would also need to be systematically developed (Section 6).

Apart from the space requirements associated with the strengthening of the academic programmes and additional student enrolment, the campus infrastructure would need to be strengthened with new roads, increased water supply, electricity, etc. During the Eight Plan period, a beginning has been made towards rejuvenation of the aging campus buildings which have shown signs of severe distress. These efforts would need to be continued vigorously in the Ninth Plan. The Institute also proposes to initiate the first steps for establishing a satellite campus in New Mumbai (Section 7).

BUDGET AT A GLANCE

	Amount (Rs. in Crores)
• Strengthening of academic programmes	65.00
• Modernisation and upgradation of existing facilities	37.90
• Research and development	41.00
• Computing and net-working requirements	15.10
• Academic linkages	5.00
• Infrastructural needs	55.00
TOTAL	**Rs. 219.00 Crores**

1. INTRODUCTION

The Indian Institute of Technology, Bombay was established in 1958 and is now 38 years old. During this period it has played an important role in the development of human resources in Engineering, Technology and Science. The student output of the Institute at the undergraduate, postgraduate and research level has been well received. In addition, the Institute has made substantial contributions towards research and development. Sponsored research is now a major activity of the Institute with over 200 ongoing projects and consultancy activities are increasing very rapidly. In the last few years, the Continuing Education Programmes offered for industry have also been growing at a rapid rate.

During the Ninth Plan, the emphasis of the Institute will be not only to consolidate what has been achieved but to grow in a number of new directions. One area in which considerable growth is planned is student enrolment at the Institute. At the moment, the student strength is about 3000, approximately half being undergraduate and half post graduate and research students. Given the high quality of education, there has been a persistent demand from many quarters that the enrolment be increased. It is therefore proposed to increase the enrolment in steps to approximately 5000. This would be a major activity in the Ninth Plan. A significant part of the new input would be through the Joint Entrance Examination and it is proposed that there would be a large expansion in the enrolment for the 5-year integrated M.Tech. programme with a variety of new emerging specializations being offered.

A new thrust will be given towards forging new research and development initiatives. During the Eighth Plan, Technology Development Missions were

started at the IITs, IIT Bombay being concerned mainly with the Missions related to Food Processing and Integrated Design and Competitive Manufacturing. The on going projects under these missions all have industry participation and they are expected to lead to more industrial interactions and spin-offs in the form of new projects. This would be a major activity in the Ninth Plan period. In addition, R&D efforts in new areas will also be encouraged. All these would necessarily require substantial inputs in terms of hardware and instrumentation requirements. In addition, in order to sustain and develop new academic programmes and activate new R&D initiatives, it is vitally important to have a state-of-the-art computing environment, which will need continuous updating.

In certain areas it is expected that linkages with institutions within the country as well as some universities abroad would be mutually beneficial. The Institute proposes to pursue a few such initiatives in this regard as well as some linkages with industry in the Ninth Plan period.

The proposal to add on significantly to the student enrolment will require the development of considerable infrastructure in the form of more hostel accommodation, more lecture halls and more space for laboratories. There would also be a need to increase the faculty strength and to provide appropriate accommodation for the new faculty.

There are already some indications that the future long-term growth of the Institute . would need the creation of a satellite campus. A few exploratory studies on this aspect for the development of a satellite campus have been made. New Mumbai is rapidly becoming the hub of industrial activity and it is felt that the first steps for the establishment of such a campus there should be taken.

All in all, the Institute expects to grow and to grow with vigour during the next Plan period. As stated above, this growth would be reflected in terms of student enrolment, new research and development projects, more consultancy, collaboration with industry, international linkages, development of a satellite campus, etc. With these developments, the Institute would be well poised to play an important role in the nation's developmental efforts as we enter the 21st century.

Details on all these aspects are given in the remaining sections of this proposal.

2. STRENGTHENING OF ACADEMIC PROGRAMMES

The Academic Programmes at I.I.T.Bombay, have been periodically revised and upgraded and new programmes introduced taking into consideration modern scientific and technological trends. The changing global scenario following the economic liberalization in the country has made possible the entry of internationally competitive organizations and the consequent introduction of "state of the art" technologies. In order that Indian industry is globally competitive and can meet the challenges of the twenty first century, it must be supported by a substantial pool of young and bright engineers who have aptitude and motivation to develop innovative technologies.

The Indian Institutes of Technology conduct a common Joint Entrance Examination for admission to the various programmes in Engineering and Science. Nearly 80,000 candidates take the examination and amongst them only the first 2,000 or so who get into the merit list get admission to the IITs. Indeed a substantial number of students (whose All India Ranks may lie between 2000 - 4000) are equally competent to undergo courses at the IITs. The Indian Institute of Technology Bombay, therefore proposes to take an

additional 200 students from amongst the JEE qualifiers. This would indeed meet a national requirement.

Much of this additional input would be for the Five Year Integrated M.Tech. Programme. This programme leads to a B.Tech. - M.Tech. double degree at end of five years. From the academic year 1996,it is likely to be offered in the following areas.

1. Mechanical Engineering with specialization in Manufacturing Engineering
2. Electrical Engineering with specialization in Communication Engineering
3. Electrical Engineering with specialization in Microelectronics
4. Chemical Engineering with specialization in Computer Aided Design

Each specialization will have an input of 20 to 25 students.

From the year 1997, the Institute is planning to expand this programme further. Possible specializations under this category are as follows :

(1) Computer Science & Engineering with specialization in Information Technology

(2) Biomedical Engineering

(3) Materials Science & Engineering

(4) Civil Engineering with specialization in Structural Engineering

(5) Mechanical Engineering with specialization in CAD & CAM

(6) Aerospace Engineering with specialization in Aircraft Propulsion.

The students admitted to the Five Year M.Tech. Programme will be involved in their thesis work for one complete calendar year. This will significantly contribute to the efforts of the faculty towards R & D and sponsored research activities.

In addition to the increased input through JEE, some new academic initiatives are planned.

The Departments of Civil Engineering, Earth Sciences & Physics are proposing to offer 3-semester M.Tech. Programmes in the following specializations:

Civil Engg.	-	Computational Mechanics
Physics	-	Solid State Technology
	-	Laser Technology
Earth Sciences	-	Petroleum Geology and Mineral Engineering.

The Continuing Education Cell at I.I.T. Bombay has been offering a large number of programmes to meet the demands of the industry and working professionals in Bombay. From the academic year 1995, a number of M.Tech. level courses (subjects) offered to the regular students are also made open to the working professionals in the industry. These courses are offered during the evenings and are coordinated by the CEP Cell. Candidates meeting the necessary eligibility requirements may be considered for the award of the postgraduate diploma (D.I.I.T.) of the Institute if they complete the requirements of a particular specialization in a modular fashion in the evenings and weekends.

On the same lines, the Department of Computer Science & Engineering is proposing to offer a separate DIIT Programme to the working professionals in the industry from the academic year 1997. This would also be offered in the evenings and weekends in a modular fashion.

The Department of Humanities and Social Sciences is also planning to offer an M.Phil. Programme in Communication and Cognitive Science.

About 100 additional faculty members will be required as a result of the increase in student enrolment and the new programmes. The recurring expenditure on the salary component of these staff as well as the additional number of assistantships required for M.Tech. and Ph.D students is estimated to be Rs.15 crores over the Plan period.

Infrastructural facilities to meet these requirements include (a) hostel accommodation for about 2000 additional students (Rs. 28 crores), additional area for the existing departments/centres (Rs. 5 crores), Lecture hall complex (Rs.2 crores), faculty housing (10 crores), and a complex for interdisciplinary and thrust area programmes (Rs.5 crores). Thus the investment required is Rs. 50 crores.

3. MODERNIZATION & UPGRADATION OF EXISTING FACILITIES

For maintaining the high standard of technical education, it is essential that obsolete equipment in our laboratories be continually upgraded to modern & state-of-art versions that are expected to be deployed in the Industry. This applies even more to the research facilities and tools. R & D work or prototype development done using the latest tools and techniques is the only option that is likely to result in the quality-competitive & cost effective products and technology.

An exhaustive review of the facilities currently available in the Institute indicates that attempts made in the last plan period for modernisation of obsolete equipment have resulted in only some areas being benefited. By and large, the aging facilities in the entire Institute need a serious revamping on ail fronts. It is proposed to undertake this activity in the Ninth plan period. Further, in view of the planned growth in the number of students, the

modernized and upgraded facilities will have to be augmented marginally in the main laboratories of the Institute.

In order to achieve the above objectives, the Institute plan is to look at the modernisation requirements in four distinct but related segments.

3.1 CORE LABORATORIES

The first of these segments comprises core laboratories of the undergraduate programs catering to first and second year undergraduate students. These will primarily include the laboratories in Physics and Chemistry in the science departments, and laboratories in Civil, Mechanical, Electrical and Computer Science in the Engineering departments.

Total budget for modernising core laboratories **Rs. 5.80 Crores**

3.2 UNDERGRADUATE LABORATORIES

The other undergraduate laboratories of the institute cater to the third and fourth year B. Tech. program and also to the the M. Sc. program. All science and engineering departments need to be covered in the upgradation drive.

Total budget for undergraduate laboratories **Rs. 8.70 Crores**

3.3 POSTGRADUATE LABORATORIES

These laboratories primarily cater to the M. Tech program of various engineering departments and interdisciplinary groups. Some of the common facilities in these laboratories are also used by doctoral candidates. In addition, there exist specially designated research laboratories in Science and Engineering departments that have specialised facilities for focused research. Just as the laboratories mentioned under the previous two

sections are vital to guarantee top class technical education, it is the postgraduate and research laboratories that account for the state of art research. All the departments involved in postgraduate education and research have carefully planned their modernisation requirements, proposing to revamp the obsolete equipment with a specific focus on the areas of research of national relevance so as to steer the institute in the 21st century with a clear competitive edge in the emerging global scenario.

Total budget for modernising PG laboratories **Rs. 15.40 Crores**

3.4 SUPPORT AND CENTRAL FACILITIES

Educational and research activities in all the departments and centres heavily depend upon a large number of central facilities and support services. These include the central workshop, A modern design and drafting facility based on the latest CAD equipment, supply of cryogenic gases such as liquid Helium, etc.

Total budget for modernising these facilities **Rs. 8.00 Crores**

The total Plan amount for upgradation and modernisation in the Ninth plan period thus works out to Rs. 37.90 crores.

4. RESEARCH & DEVELOPMENT - CONSOLIDATION, AUGMENTATION & NEW INITIATIVES

The visions of the Institute are clearly set towards attaining the status of a leading, internationally competitive educational and R&D Institution. Pursuit of research in contemporary and emerging areas constitutes an important commitment. The Institute will be equally committed to developmental work

leading to systems, software and technologies of industrial relevance and utility.

The broad strategies for pursuit of this theme - entailing new global dimensions, resulting from the changes in the economic and commerce policies and India becoming a signatory to the GATT agreement - will comprise :

(1) Consolidation, Modernization and Augmentation of facilities and services in which substantial expertise exists.

(2) Development of new facilities to enable pursuit of research in emerging areas, and, augmentation of human resources in related areas.

(3) Execution of spin off projects from the Technology Development Missions initiated in the 8th Plan - in order to extract maximum benefits from the knowledge base, facilities and experience generated - with modest additional inputs.

(4) Initiation of Technology Development Mission projects in some contemporary and relevant areas with a view to generate internationally competitive systems/ technologies/ software.

(5) Development of a well structured mechanism for establishing research area specific International linkages for pursuit of collaborative projects and access research funding from International agencies.

(6) Augmenting existing facilities and creation of additional facilities, to convert some of the specialized centres into International R&D training and manpower generation ventures.

Outlined below are some of the initiatives envisaged.

4.1 SPIN OFF PROJECTS FROM TDMs

Food Processing

Developmental work in progress in the Technology Development Mission on Food Process Engineering has opened up enormous potentialities for Supercritical Extraction and Cryoprocessing in Food Processing and Preservation. The prospects of widening the scope of Supercritical Extraction to applications in edible oil refining, perfumery products and medicinal extracts are exceptionally high, and worthy of pursuit.

Hence it is proposed to pursue projects leading to

(1) Development of SCFE technologies for oil refining, herbal extracts and perfumery products and (2) Development of cryogenic techniques for Food Processing and Preservation

Integrated Design and Manufacturing

Computer Aided Design and Manufacturing are emerging as universal tools in the manufacturing industries related to consumer products, automotive vehicles, aerospace applications etc. Rapid Prototyping, Tool design, Computer Control for precision and quality are hence expected to become key functions.

Consequently a project on Integrated Design and Manufacturing, with a wider scope to include CAD, CAM, Rapid Tool Design, Production etc. for plastic parts as well as formed metal structures is proposed to pursued.

The project on multipurpose generic simulator needs to be pursued for upgradation purposes to build in capabilities for Energy Integration, Safety Analysis etc.

Total budget for the above five projects Rs. 6.00 crores

4.2 NEW TECHNOLOGY DEVELOPMENT MISSIONS

Technology Development Mission Projects are proposed to be initiated in the following generic areas :

- Integrated Sensor Development (to include Electronic, Chemical, Biochemical Ceramic, Glass and Polymeric sensors, and standar-dization and testing facilities
- Development of Healthcare Monitoring and Management Systems
- Development of Thermal imaging Systems
- Development of Active Control Technologies (for Flight Dynamics, Structural Dynamics & Aero Elasticity, Aero dynamics & Propulsion systems)
- Development of Composites for Structural Applications
- Development of new drugs for tropical diseases using inputs from computer modeling and protein science

Total budget for the six new Technology Development Missions — **Rs. 10.00 crores**

Additional requirements are proposed to be met through contributions from participating Industries/User agencies.

4.3 DEVELOPMENT OF STATE OF THE ART RESEARCH FACILITIES FOR R&D WORK IN CONTEMPORARY AND EMERGING AREAS

4.3.1 Basic Sciences

- Photonics, Lasers and Non linear optics
- Thin films, surfaces and nanostructures
- Geophysical research facilities
- Dynamics of fast, ultrafast, catalytic, photochemical, electrochemical and polymerization reactions
- Hardware and software for Bio informatics, DNA synthesizer, peptide synthesizer and advanced microscopy
- Mathematical and Statistical tools for computational, modelling and optimization application

Total **Rs. 6.00 crores**

4.3.2 Engineering Sciences

- Flow characterization - 3D Laser Doppler velocity meter, Weisenberg Rheogoniometer, Brandender
- Structural aspects of materials (Metals, alloys, polymers, colloids, emulsions, micro emulsions)

- Transmission Electron Microscope, Dynamic Laser light scattering equipment, Interfacial techniques, SEM special attachments, Magnetometer etc.

- Vibration, sound, strain generation measurement systems and facilities

- Microwave remote sensing, SAR Interferometry, global positioning system, radiometers

- Computational Fluid dynamics, modeling and computation mechanics

- Parallel and Distributed Computing

- Reliable computing and protocol development

- **Total** **Rs. 8.00 crores**

4.3.3 Design Engineering

- Rotor dynamic tests, hybrid dynamic simulation — Rs. 0.75 crores

- Structural Integrity and life cycle assessement — Rs. 2.25 crores

Total **Rs. 3.00 crores**

Total budget for augmenting R&D facilities in Basic Sciences, Engineering Sciences and Design Engineering **Rs. 17.00 crores**

4.4 DEVELOPMENT OF NEW CENTRES OF EXCELLENCE/ UPGRADATION OF EXISTING CENTRES INTO INTER - NATIONALLY RECOGNISED R&D AND R&D TRAINING CENTRES

- Centre for Advanced Transportation studies
- Centre for Studies in Resources Engineering for augmenting GIS/spatial database systems
- Centre for Studies in Electroceramics, Superconductors, Microwave devices etc.
- Centre for Advanced Thermal Technologies
- Augmentation of facilities and capabilities in the Centre for Environmental Science and Engineering for work related to clean production technologies and hazardous waste management methodologies
- Research related to generation of knowledge bases and providing inputs for Development and Policy Planning related to economic, environmental and ecological, and technological issues

Total budget in 4.4 **Rs. 4.00 crores**

4.5 RECURRING EXPENDITURE FOR PURSUIT OF ABOVE INITIATIVES

The Research and Development initiatives outlined above will entail expenditure on manpower, materials and consumables, equipment maintenance, repairs and spares, and other related expenditure; the estimated recurring expenditure, at approximately 10 percent, would be Rs.4.00 crores.

GRAND TOTAL FOR R&D INITIATIVES OVER THE NINTH PLAN **Rs. 41.00 crores**

5. COMPUTING AND NETWORKING REQUIREMENTS

Introduction

IIT Bombay envisions deployment of an integrated, campuswide, networked environment for the computing and information exchange needs of its various departments. A high bandwidth ATM LAN supporting compute/file servers, one high end compute server, high performance graphics and multimedia equipment with point-to-point voice & video exchange are some of the services that will be required within the IIT campus. Collaborative research between specialised groups spread across the country at five other IIT's and IISc has been on the increase and will place demands on the WAN connectivity far in excess of what ERNet is presently providing. The 6Net+ project will need to be realised during the coming years.

A phased implementation of above requirements during the next five years of the Ninth Plan will require an outiay of Rs.1510 lakhs.

Campus LAN

IIT Bombay presently has a 10 Mbps thick ethernet spanning most of the bigger departments and some of the administrative blocks. Upgradation of this to a Fibre Optic, ATM based network is under active consideration, requiring an investment close to Rs 250 lakhs. Phase I implementation of this costing Rs 58 lakhs has already been taken up and will see one ATM switch giving a 155 Mbps backbone and close to 3 km fibre cables spanning major departments, by end of 1996. Expansion of this network geographically to reach out to all academic, administrative buildings, lecture theater, CEP venues, auditoriums, student activity centre and hospital; upgrading it to 622 Mbps from 155 Mbps will require an outlay of additional Rs 150 lakhs.

Compute and File Servers

Computing requirements within the campus have grown substantially over the last couple of years. The Cyber 180/840 system which once occupied a pride of place among the community was switched off on November 15th 1995. The maintenance and other expenses of this mainframe could hardly justify the computing services it supported. A number of small servers have sprung up across the campus and are used over the network by researchers from their desktops. Two dual processor Dec Alphas (rated around 300 Mflop per CPU) presently run above 95% load for 24 hours indicating an urgent need for faster servers.

Researchers in the area of CFD from Aerospace and Mechanical Engineering, FEM community from Civil, Aerospace and Mechanical and researchers needing to solve PDE's from Chemical and other departments all require to graduate to Gflop computing over the next couple years.

Administrative computing has seen a steady growth in the Institute recently demanding high volume and fast access data storage units. With radical changes in information storage in the libraries, we will have to migrate to CD juke boxes very soon. In addition to the fast access mechanisms for our library catalogues we need to create and manage large databases of technical reports produced locally. We have to throw open the research results of the IITB by making the library visible on the WAN. Epoch file servers with read-write optical units will be an asset for such a requirement and will also help the academic community. Automatic devices for backing up network-wide data resources are equally important.

An outlay of Rs 850 lakhs is envisaged for meeting this demand.

WAN - 6Net+

The five IITs and IISc have already jointly come up with a proposal for a 2 Mbps connectivity to support two way interactive applications requiring voice and video or graphics for visualisation of scientific computing from remote machines. Additional one or more 64 kpbs (or 128 kpbs) international leased lines would increase the connectivity to world-wide Internet. The projected cost to each participating institute is Rs 260 lakhs.

Fund Requirements

The total requirement for funds during the IX Plan period towards a networked compting environment is Rs. 1510 lakhs. The yearwise details of expenditure are as follows.

A. Plans for the Year : 1996 - 1997

Description	Estimated Cost (in Lakhs)
1. LAN (Local Area Network)	
a) 1 x ATM Switch, 3 x Ether Switches Fiber Optic Cabling of Academic Area	58.00
b) Extention of Fiber Optic Cabling (Hospital, Guest House, Convocation Hall)	32.00
c) ATM interface cards, software for existing servers, ATM modules on switches	100.00
d) Fibre Optic Network troubleshooting Equipments	10.00
Total	**200.00**
2. Computing Environment	
a) General Purpose Servers (2 nos.)	50.00
b) Support for Computational Courses (20 ASCII terminals)	5.00
c) Graphics terminals (20 diskless workstations with high resolution graphics)	75.00
d) Presentation Facilities	10.00
e) Software on Servers (Finite Element Analysis etc.)	25.00
f) High Capacity Disk Servers, CD juke boxes, and Automatic Backup Devices	35.00
Total	**200.00**
Grand Total	**400.00**

B. Plans for the Year : 1997 - 1998

Description	Estimated Cost (in Lakhs)
1. LAN (Local Area Network)	
a) 2 x ATM Switches & Fibre Optic Cabling	50.00
Total	**50.00**
2. Computing Environment	
a) Giga flop Computing Server (Power Challenger/Turbo Laser Class)	200.00
b) Software	25.00
c) Hardware & Software Maintenance	25.00
Total	**250.00**
3. Wide Area Network (6Net+)	
a) Lease of circuits in India	51.00
b) Lease of International Circuit	10.00
c) Miscellaneous	4.00
Total	**65.00**
Grand Total	**365.00**

C. Plans for the Year : 1998 - 1999

1. LAN	50.00
2. High Performance Graphics Servers	150.00
3. WAN (6Net+)	65.00
Grand Total	**265.00**

D. Plans for the Year : 1999 - 2000

Description	Estimated Cost (in Lakhs)
1. LAN	50.00
2. High Performance Graphics Servers	150.00
3. WAN (6Net+)	65.00
Grand Total	**265.00**

E. Plans for the Year : 2000 - 2001

1. LAN	50.00
2. High Performance Graphics Servers	100.00
3. WAN (6Net+)	65.00
Grand Total	**215.00**

6. ACADEMIC LINKAGES

With a long track record of excellent academic programmes, proven research work of high quality and quality inputs to industry, the Institute is now poised to strengthen existing linkages with academic institutions and industry, and forge new linkages.

It is proposed to established new linkages with academic institutions - both in India and abroad. The abundant experience and expertise available in the institute could be harnessed towards elevating the academic levels of newer institutions coming up in the western region through proactive efforts, and, sustained interaction. The pre-eminent academic status enjoyed by the Institute could be strengthened further through International linkages with a view to provide access to the highest quality postgraduate educational

facilities and opportunities at competitive costs, to personnel from the other developing and developed countries. The initial dialogue established with the Sloan School of Management for long term interaction in the area of Technology Management education is proposed to be followed up with new initiatives in other relevant areas.

A number of research areas in the Institute have an impressive record of achievements and capabilities. Excellent opportunities are now open for pursuit of collaborative, contract and other research projects, and some initiatives in this direction could open up substantial avenues for accessing funds from International Research funding agencies - if the Institution could invest a small percentage of the total project costs, as a precondition. The investments would essentially cover exchange of personnel, travel and hospitality and communication expenses.

Another important area for strengthening and diversifying linkages has emerged out of the excellent work done by the Continuing Education Cell (CEP) of the Institute. Our faculty members have been giving specially designed and packaged courses of differing durations on various topics of current technological relevance, for working professionals. Requests have already been coming in from countries around us in the Middle East and Asia-Pacific region for such focused courses as also for specific research and consultancy assignments. Apart from fostering international cooperation and getting us the much needed visibility in these parts of the world, such activities will also prove to be a steady source of income for the Institute.

The need for strengthening professional linkages with industry, in order to ensure that professional education is contemporary, relevant and in tune with technological trends is very strongly felt - especially in the globalized economic environment. Initiatives leading to adjunct academic positions and industrial sabbaticals etc. are imperative.

The diverse range of activities and initatives related to strengthening of existing linkages as well as forging new linkages will require investments on related infrastructure and recurring expenditure on personnel, travel and communications, preparation of course materials, proactive interaction efforts etc. The total budget for these efforts, over the entire Ninth Plan period is estimated at Rs. 5.00 crores.

7. INFRASTRUCTURAL NEEDS

With the consideration of proposed enlargement of enrolment to the tune of about 70 per cent increase (i.e., about 5000 students on the campus) and increase in the academic programmes, the following infrastructural requirements are projected in addition to those specified in Section 2:

Continuity and Growth	**(Rs. in Crores)**
Staff housing	5.0
Infrastructural facilities like new roads, sewage, water supply, elelctric supply, etc	10.0
TOTAL	**15.0**

Campus Rejuvenation

During the 8th five year plan the need for campus rejuvenation was emphasized and an investment of Rs. 15 crores was proposed for this activity.

A beginning has been made to rehabilitate the buildings in the academic and residential areas utilising Rs. 5 crores received for this activity. However, the pace of this activity has been rather slow and needs to be speeded up. It is time to invest substantially and expeditiously .

It is proposed to provide Rs. 10 crores for this activity.

Satellite Campus

A site for the Satellite Campus has been identified in New Mumbai. The expansion of New Mumbai is taking place at a very fast rate. The campus in New Mumbai will meet the demands of :

1. Continuing education
2. Conference facilities
3. Part-time degree programmes
4. Technology park
5. A few centres of excellence for thrust area programmes in collaboration with the industry

It is anticipated that this may need about Rs. 30 crores towards land and some infrastructural facilities, as a first phase towards this activity during this plan period.

Total requirements	**(Rs. in Crores)**
(1) Continuity and Growth	15.0
(2) Campus Rejuvenation	10.0
(3) Satellite Campus	30.0
	55.0

8. TOTAL REQUIREMENTS OF FUNDS

The total requirements of funds under the Ninth Plan are as follows :

	Amount (Rs. in Crores)
(i) Strengthening of Academic Programmes	50.00
(a) Non-Recurring	
(b) Recurring	
(ii) Modernization and Upgradation of Existing Facilities	37.90
(iii) Research and Development	41.00
(iv) Computing and Networking requirements	15.10
(v) Academic Linkages	5.00
(vi) Infrastructural Needs	55.00
TOTAL	**Rs.219.00 crores**

9. CONCLUDING REMARKS

During the last year of the Eighth Plan, the IITs have been operating under a revised funding pattern. In this scheme, the block grant to each IIT has been fixed at a particular value and the IITs have been required to raise resources to meet their additional needs. As a result, considerable efforts have been expended in obtaining new sponsored projects raising revenues through consultancy work and increasing the Continuing Education Programme activities. Considerable savings have also been effected by gradually

reducing some of the staff and effecting economy in various expenses. All these measures have achieved a certain degree of success. The funding requirements requested for in this proposal during the Ninth Plan would give a strong impetus to the beneficial effect introduced as a consequence of the revised funding pattern. Modernization and upgradation of equiupment, state-of-the-art of computing and increased student enrolment would certainly result in raising more resources for the Institute.

Finally it may be worth mentioning that the Synergy Group for IITs has in its report to MHRD suggested that student enrolment at the IITs should be increased because of the heavy demand for seats. The suggestions made in this proposal are in consonance with the recommendations of the Synergy Group. It may also be worth noting that the funds requested in this proposal for creating the additional capacity of 2000 students at IIT Bombay are much less than what would be needed if a new separate Institute of Technology with about 2000 students is to be set up on its own.

INDIAN INSTITUTE OF TECHNOLOGY DELHI

9th FIVE-YEAR PLAN
(1996-2000)

PROPOSALS FOR MODERNISATION & EXPANSION
May 1996

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EXECUTIVE SUMMARY

The IITs have the mandate to produce adequate number of appropriately trained man power for use by the Indian industry and to do state-of-the-art R&D which would form the backbone of the industry. From time to time IIT Delhi has updated its undergraduate and postgraduate curricula, and have held several discussions to focus on its R&D activities.

This exercise has been done once again during the past few months and the present document gives a brief broad outline of the direction in which the Institute would like to forge itself. Clearly, this would require additional financial inputs. The proposal for modernisation and expansion is given in the pages which follow.

The budgetary requirement for the next five years for the above proposals are as indicated below.

#	Headings	Rs. in Crores		
		Total Amount Required	Amount to be Gene-rated from Sources other than MHRD	Amount being Required from MHRD
I.	Requirement on Account of Proposed Enhancement of Student Intake	100	-	100
II.	Requirement on account of Modernisation/ Upgradation of Academic/ Research facilities	50	20	30
III.	New Academic/ Research Initiatives	50	20	30
IV.	New Mission Projects	25	10	15
V.	Computer Networking, Computational Facilities & Communication Resources	26	6	20
VI.	Additional Electric Power, Water Requirements for the Existing Campus and Sewage Disposal	5	-	5
Total		**256**	**56**	**200**

Amount Required from MHRD is Rs. 200 Crores

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

Ninth FIVE-YEAR PLAN (1996-2000)

Introduction:

This document presents briefly the Ninth Five-Year Plan projections of the Indian Institute of Technology, Delhi for the period 1996-2000.

The Institute set-up in 1963 imparts training and education at B.Tech/M.Tech/MS(R)/M.Sc. and Ph.D. levels in engineering and applied sciences including management. The Institute has attained national and international recognition for outstanding quality of its graduates and postgraduates. The total faculty strength in position, spread over various Departments and Centres, is approximately 500. There are 13 academic departments and 9 centres in the Institute with a total student population of around 3000 with an aimed at proportion of 1:1 for UG and PG students population. Around 350 B.Tech, 500 M.Tech and 100 doctoral degrees are awarded each year by the Institute. The Institute lays special emphasis on undertaking relevant applied research through various national and international sponsoring agencies and industrial consultancy. In the recent past the Institute has been making vigorous efforts to increase its synergy through academic and industrial inter-linkages, while still retaining outstanding levels of education and training as its top priority.

The entire Institute infrastructure is located in an area of 312 acres; over 100,000 m^2 of academic buildings, over 1,515 dwelling units for faculty and non-academic staff, hostel accommodation for over 2000 students and other facilities such as shopping centre, students' recreational centre, guest houses, maintenance units, etc.

In order to give a concrete shape to its mission and evolve its response to the ninth five-year plan, the faculty in the departments and centres deliberated extensively amongst themselves and evolved proposals aiming at removal of obsolescence, modernisation and upgradation of its facilities and laboratories, identify new research areas, and strengthen human resource development component through increased student intake as well as find ways and means to foster more effective linkages with industry. The proposals of each department and centre were deliberated in a brainstorming mode by Board of Educational Research and Planning (BERP) over two and half days of extensive debate.

The basic planning premise in this exercise was to increase the student intake from present 3000 to a level of 5500 while retaining its policy of 1:1 mix between UG and PG population. This exercise has attempted to translate this goal into resource implications - both intellectual as well as infrastructural.

Covering the issues reviewed above, the Report presented here comprises of the following parts:

I. Resource implications for augmenting the infrastructural needs to take care of proposed enhancement of student intake during the next five years.
II. Modernization/upgradation of facilities/labs.
III. Consolidation /augmentation of existing research and development and new research initiatives.
IV. Effective interaction through academic and industry linkages as well as mission projects.
V. Computer networking, computational facilities and communication resources

VI. Additional requirements for sewage disposal, electric power and water.

I. RESOURCE IMPLICATIONS FOR AUGMENTING THE INFRA-STRUCTURAL NEEDS TO TAKE CARE OF PROPOSED ENHANCEMENT OF STUDENT INTAKE DURING THE NEXT FIVE YEARS

The Institute intends to move in the direction of nearly doubling the student strength (from the present level of 3000 to 5500). It is anticipated that the student ratio undergraduate : postgraduate will be maintained at the prevailing 1:1 and this goal will be achieved over a period of 5 years. The institute is planning to augment its intake to raise the total U.G. intake to a level of approximately 800 students at the JEE entry level. This will be accomplished by increasing the intake in some of the existing disciplines and also by starting a few new programs.

NEW ACADEMIC INITIATIVES

The Institute proposes to introduce 5 year dual degree programme with a first degree in a main discipline followed by a postgraduate degree in a specialisation. This proposal has an important merit in the fact that high quality JEE entry students will be available for specialised M.Tech. programmes. Such an important input will elevate the level of the M.Tech. programmes. However, such an addition will result in the increase of M.Tech. students to the tune of 350-400. The rest will be filled with additional intake in the existing programmes and new M.Tech. programmes as described earlier.

A few of the following new B.Tech. programmes are proposed to be initiated in the next 5 years:

a) Polymer science and Engineering

b) Dual-degree programmes in

1. Engineering Analysis and Design
2. Civil Engineering
3. Business Administration
4. Instrument Technology
5. Design

The postgraduate programmes proposed by various departments and centres are as follows:

I. Bulk Solids Handling

II. Environmental Science and Engineering

III. Remote Sensing and Resource Management

IV. Traffic and Transportation Engineering

V. Structural Design

VI. Construction Engineering and Management

VII. Integrated Watershed Management

VIII. VLSI - Design Tools and Technology

IX. Thermal Power Generation

X. MBA- Management and Systems

XI. MBA- Technology Management

XII. Concurrent Engineering

XIII. Quality Management

XIV. Technical Textiles

XV. Advanced Electronic Systems

XVI. Atmospheric Sciences

This will involve substantial expenditure on modernisation of teaching facilities, creation of additional space and hostel seats. More faculty, approximately 100, have to be recruited and additional housing facilities

have to be made available. Library facilities are to be enhanced, and extra power and water requirements have to be met, in addition to the additional administrative costs which will be required to handle the enlarged set up. As IIT Delhi in its present campus is limited in area, it would be highly desirable to have a second campus of about 100 acres. It is planned to ply buses frequently between the two campuses.

The financial requirements for the next five years are estimated as follows.

#	Kind	Rs. in Crs.
1	Upgradation of Teaching Equipment Including Computational Facilities	30.00
2	New Hostels	20.00
3	Additional Class Rooms	2.00
4	Faculty Housing	10.00
5	Library Facilities	6.00
6	Land for Second Campus at Concession Rates	11.00
7	Additional Laboratory Requirements for the Department and Working Space for Administration	10.00
8	Salary of Additional Faculty	5.00
9	Power and Water	6.00
	Total	**100.00**

II. MODERNIZATION/UPGRADATION OF FACILITIES/LABS

With the rapid advances in technology, various kinds of machines, instruments and devices have undergone spectacular changes in the recent past. These advances have necessitated periodic evaluation of the capabilities and efficacious of our laboratory facilities for our research programmes.

As a result of such exercises, we have been modernising and upgrading our experimental facilities so as to remove obsolescence. However, the quantum of financial support in the past has not completely matched and kept pace with our needs in this regard. some of the facilities acquired in the past need modemisation. It would be in the fitness of things if we give opportunity to our students and faculty to work with the state-of-art equipment if the challenges posed by globalisation of technology have to be met.

With this in view, several discussions were held involving faculty of all departments and centres to identify the laboratories/facilities/ equipment which require modemisation/upgradation. Annexure A, placed below, gives the list of laboratories/facilities which require major face-lift. List of representative equipment which need replacement/ modemisation/ upgradation in various laboratories is given as Annexure B.

The total cost of upgradation/ modemisation/ replace-ment is expected to be around	**Rs. 50 Crores**
Funds to be generated from sources other than MHRD, i.e., from industry, user government organisations (at the rate of 30% and 70% of the amount required by the Departments and Centres respectively)	**Rs. 20 Crores**
Balance amount for which MHRD is being requested for support	**Rs. 30 Crores**

Annexure A

Obsolescence Removal/Upgradation/Modernisation

Each Department/Centre has several research laboratories which require upgradation/modernisation. Detailed inter-departmental and intra-departmental discussions were held involving most of the faculty members of the Institute and some important laboratories were identified which require major obsolescence removal/upgradation/ modernisation. Representative research laboratories of the Depart-ments/Centres which require such upgradation/modernisation are as below.

Laboratories/Equipment to be Upgraded/Modernised

DEPARTMENTS	INDICATIVE BUDGET *Rs. (in Crores)*
APPLIED MECHANICS	2.00
1. Solid Mechanics Lab.	
2. Fluids Engineering Lab.	
3. Physical Metallurgy Lab.	
BIOCHEMICAL ENGG. & BIOTECHNOLOGY	1.00
1. Food Engineering Lab.	
2. Biological Waste Treatment Lab.	
CHEMICAL ENGINEERING	3.00
1. Reaction Engineering + Biomass Conversion Technologies Lab.	
2. Separation Process Engg. Lab.	
3. Power Processing Lab.	

CHEMISTRY 3.00

1. Instrumentation Lab.
2. Analytical Service Lab.
3. Enzyme Labs.

CIVIL ENGINEERING 5.00

1. Structural Engineering Lab.
2. Environmental Engg. Lab.
3. Engineering Geology Lab.
4. Surveying & Remote Sensing Lab.
5. Simulation Lab.
6. Computational Lab.
7. Geotechnical Engg. Lab.

COMPUTER SCIENCE & ENGINEERING 3.00

1. Microcomputer Lab. & Cad. Lab.
2. Networking Lab.
3. Digital Systems Lab.
4. AI & Robotics Lab.

ELECTRICAL ENGINEERING 5.00

1. Device Fabrication Lab.
2. Core Lab.
3. Power Engineering Labs.
4. Control Engineering Lab.
5. Computer Engineering Labs.
6. Communication Engineering Labs.
7. IEC Engineering Labs.
8. Photonics Lab.

MANAGEMENT STUDIES	1.00
1. Management Laboratory	
MATHEMATICS	1.00
1. Computer Graphics Lab.	
2. Image Processing Lab.	
3. Operating Systems Lab.	
4. Parallel Algorithms Lab.	
MECHANICAL ENGINEERING	5.00
1. Design and Graphics Facilities	
2. Vibration and Instrumentation	
3. Robotics Lab.	
4. CAD/CAM Lab.	
5. Industrial Engg. Lab.	
PHYSICS	5.00
1. Condensed Matter Physics Lab.	
2. Photonics/Optics & Optoelectronics Lab.	
TEXTILE TECHNOLOGY	3.00
1. Fibre Science Lab.	
2. Yarn Manufacture Lab.	
3. Fabric Manufacture Lab.	
4. Textile Testing Lab.	
5. Textile Chemical Processing Lab.	

CENTRES

CENTRE FOR APPLIED RESEARCH IN ELECTRONICS 1.00

1. Underwater Acoustic Lab.
2. Electronics Design Lab.
3. DSP Tools Lab.
4. Microwave Integrated Circuits Lab.

CENTRE FOR ATMOSPHERIC SCIENCES 1.00

1. Computational Lab.
2. INSAT Imagery Receiving Lab.

CENTRE FOR BIOMEDICAL ENGINEERING 1.00

1. Bioelectronic Lab.
2. Biomaterials Lab.

COMPUTER SERVICES CENTRE 3.00

1. Computing and Networking Lab.

CENTRE FOR EDUCATIONAL TECHNOLOGY 0.75

1. Video-recording and Editing Lab.

CENTRE FOR ENERGY STUDIES 2.00

1. Power System Research Lab.
2. Evaluation System Lab.
3. ECR Plasmas Lab.
4. Simulation lab.

INDUSTRIAL TRIBOLOGY, MACHINE DYNAMICS & MAINTENANCE ENGG. CENTRE 1.00

1. Friction & Wear Lab.
2. Lubrication Lab.
3. Machine Dynamics Lab.

INSTRUMENT DESIGN DEVELOPMENT CENTRE 1.00

1. MDIT/NMR Lab.
2. Optical/Holography Lab.
3. Ultrasonic Instrumentation Lab.
4. Photo Fabrication Lab.
5. Electro-Mechankics Lab.
6. Electronic Lab.

CENTRE FOR POLYMER SCIENCE & ENGINEERING 1.00

1. Polymer Characterisation Lab.
2. Polymer Processing Lab.
3. Polymer Testing Lab.
4. Polymer Chemistry Lab.

CENTRE FOR RURAL DEVELOPMENT & TECHNOLOGY 0.50

1. Testing of food & forest products Lab.

LIBRARY 0.75

1. Networking
2. Optical Scanning Facilities

Annexure B

List of Typical and Representative Equipment which Require Replacement/ Modernisation/Upgradation

This list is prepared to give only a brief idea of the type of instruments / facilities which require replacement / modernisation/ upgradation and by no means is an exhaustive/complete list.

1. Testing Equipment :

Instron machines;

Laser interferometer;

Rotatory encoders;

Testing Equipments (Environmental test chamber, Image analysis system, Nep Tester, Friction meter);

Wind tunnel;

X-ray diffractometer;

2.Demonstration/Instructional Equipment :

Electronic equipments;

Gauges;

Microprocessors;

Textile Chemical Processing (Flammability tester, HTHP dyeing machine, Rota dyeing machine);

Virtual reality systems;

3. Analytic Equipement :

Atomic absorption spectrometer;

Data acquisition system;

EPR spectrometer;

Fluorescene spectrometer;

Non-dispersive gas analyser;

Particle size analyser;

Elemental analyser;

Ellipsometer;

Light scattering equipment;

Polarising microscope;

Spectrophotometers;

Thermal analysis system;

4. Infrastructural Equipment :

Cell culture facilities;

Coil winding machine;

Cold room facility;

Computing facilities;

Gel spinning system;

Networking;

Spinning equipment (Airjet spinning system, static honestometer, speed frame high production card);

Replacement of CVTs with UPS;

Weaving Equipments (Rapier loom, filament winding machine);

Workstations;

5. Specialized Equipment :

ECR plasmas;

INSAT Antenna; SAM/ESCA/ AUGER spectrometers; Video recording and editing equipment; Waste disposal facilities; Power system research facilities;VHS Camcoder;

III. CONSOLIDATION /AUGMENTATION OF EXISTING RESEARCH AND DEVELOPMENT AND NEW RESEARCH INITIATIVES

Changes in economic and industrial environments have necessitated a relook at the existing academic offerings by the Institute so as to consolidate some of these arrangements and some other through remarized inputs. Some new initiatives to be in tune with the needs of the economy while matching with the internal strengths of departments and centres are proposed for the next five years. A detailed listing of these proposals for each department/centre follows. It may be stated that for the new research and development initiatives outlined here, about 30% of resources required by Departments will be attempted to be procured through sources other than MHRD; for the centres this share will be about 70% because of their role in human resource development vis-à-vis research and development. New research areas planned for the next 5 years are:

Academic Departments

1. **Applied Mechanics**
   a) New materials - Composites and Metals
   b) Atmospheric Pollutant Dispersion and Control
   c) A new initiative is proposed in the establishment of a CAD-CAE cell with principal thrust on industry related activity.
2. **Biochemical Engineering and Biotechnology**
   a) Applied Biocatalysts
3. **Chemical Engineering**
   a) Chemical Engineering of New Materials.
   b) Production and processing of fine and very fine particles (also referred to as nano particle technologies).

4. **Chemistry** (The department also proposes a process development and analytical services centre).
   a) Molecular recognition, Nanostructural Technologies and Molecular Devices.
   b) New materials-Synthesis and Characterisation.
   c) Molecular simulation and Modelling Studies.
   d) Chemistry of meta Stable States
   e) Industrial Enzymology.
5. **Civil Engineering**
   a) Geotechnology of Solid Waste Management,
   b) Environmental Geotechnology
6. **Computer Science and Engineering**
   a) Geometric Data Structures and Algorithms,
   b) Hardware-Software Codesign,
   c) Real time Vision and Robotics,
   d) High Performance Scientific Computing,
   e) Mobile Computing Agents,
   f) Large Information Systems.
7. **Electrical Engineering**
   a) Power Quality
   b) Neural Networks
8. **Management Studies**
   a) Management of Change in Industry.
9. **Mechanical Engineering**
   a) Concurrent Engineering;
   b) Dynamic Design
   c) Energy Efficient Ecofriendly Thermal Systems
   d) Advanced Manufacturing Systems

10. **Physics**

    a) Nano-engineering of Advanced Materials,

    b) Optical Information Technology.

11. **Textile Technology Department**

    a) Technical Textiles

    b) Environmental Engineering and

    c) Fibre Reinforced Composites.

Centres

1. **Applied Research in Electronics**

    a) Quasi-optical techniques

    b) SONAR simulation Tools development,

    c) Smart sensors and high frequency components for strategic and communication application.

2. **Atmospheric Sciences**

    a) Climate variability and prediction

    b) Environmental degradation.

3. **Educational Technology**

    a) Newer educational technologies

4. **Polymer Science and Engineering**

    a) Rubber Technology,

    b) High Performance Fibre/Plastics composites and

    c) Relative processing.

    d) Instrument Design and Development Centre:

    e) Sensor and Transducers Technology.

5. **Industrial Tribology, Machine Dynamics and Maintenance Engineering**

    a) Tribology of High Tech Materials and Lubricants.

The proposal referred to above requires substantial investment of funds. For the teaching programmes the infrastructrual requirements have been projected earlier. To enable the IIT Delhi to take up research in all the newly emerging areas it is proposed to mobilise substantial funding from user agencies. As spelt out earlier the academic departments will be able to mobilise 30% to 50% of the cost through external funding while centres will augment the resources to the tune of 70% of their requirement through support from outside agencies. Since all these programmes are vital to the nation from the point of view of human resource development and expertise generation in modern areas, it is essential these efforts are fully supported.

The total cost is approximately	Rs. 50.00 Crs.
Funds to be generated from sources other than MHRD	Rs 20.00 Crs.
Net amount required from MHRD	**Rs 30.00 Crs.**

IV. EFFECTIVE INTERACTION THROUGH ACADEMIC AND INDUSTRY LINKAGES AS WELL AS MISSION PROJECTS

During the 8th Five-Year Plan, Mission Projects in seven generic areas were approved by Govt. of India. These areas are :

1. Food Processing Engineering
2. Integrated Design & Competitive Manufacturing
3. Photonic Devices & Technologies
4. Energy Efficient Technologies & Devices
5. Communication, Networking & Intelligent Automation
6. New Materials
7. Genetic Engineering & Biotechnology.

Out of these areas, IIT Delhi is involved in the following four Missions.

1. Photonic Devices & Technologies
2. Energy Efficient Technologies & Devices
3. New Materials
4. Genetic Engineering & Biotechnology.

The salient features of the Mission Projects are :

1. that each Mission Project shall have an industrial partner who shall contribute 10% in cash & 15% in kind,
2. in each Mission Project, more than one IIT/IISc will be involved,
3. each Mission Project shall have identified deliverables in the form of hardware-software process, know-how development, etc.

During the 9th Five-Year Plan, it is proposed to initiate seven new missions in the following generic areas :

1. Environment Engineering
2. Concurrent Engineering & Manufacturing Automation/Robotics
3. Transportation Systems
4. New Product Development
5. Rural Technology
6. Information Technology
7. Microelectronics/VLSI Design

1. Environment Engineering

Pollution control and monitoring have become very important. In the mission on Environment Engineering, it is proposed to develop technologies for pollution monitoring, using laser spectroscopy, control of health hazard in textile industry and noise control of machinery.

2. Concurrent Engineering & Manufacturing Automation / Robotics

Following activities will be covered in the mission project on Concurrent Engineering & Manufacturing Automation i.e., the Integrated Device and Computation Manufacturing, DFM, DFA, QFD, Rapid prototyping, CAD/CAM & CIM Systems. Robotics will deal with Visual Information and Sensoring Information Processing.

3. Transportation System

Transportation System will cover electrical device for mass transportation, hybrid electric vehicles for urban transportation and development of altemative fuel low emission engines for auto vehicular application.

4. New Product Development

This mission will cover demonstration of new product development capability and development of new products such as geo-synthetics, specialty polymers, vibration monitoring and oceanographic instrumentation.

5. Rural Technology

A project on rural drinking water, sources, haulage, distribution, purification & testing, storage & handling has been funded by Rajiv Gandhi Foundation. The mission in this area will enhance the scope of this project.

6. Information Technology:

The various projects in this mission includes: advanced structural information exchange network, telecommunication and information system as well as multi-media communication and computing.

7. Microelectronics/VLSI Design

The mission involves design and fabrication of high-speed switch devices and integrated circuits including the development of VLSI tools and design libraries.

In each mission, there shall be several sub-missions. The general conditions for taking up the missions shall be same as those for the 8th Five-Year Plan. However, looking at the response from the industry for the missions during the 8th Five-Year Plan it is proposed that in case of the new missions to be initiated during the 9th Five-Year Plan, the industry contribution shall be 40% of the total cost of the mission.

FUND REQUIREMENTS

Total for all Missions	Rs. 25 Crores
Industry Contribution	Rs. 10 Crores
MHRD Components	**Rs. 15 Crores**

The funds for the mission projects shall be released only after getting firm commitment from the industrial partner.

V. COMPUTER NETWORKING, COMPUTATIONAL FACILITIES AND COMMUNICATION RESOURCES

The Computer Services Centre is expected to provide for an integrated environment for computing and communication on the campus. This resource would be available to all undergraduate, postgraduate students and to faculty. It would primarily be used for formal education, research, and industry-sponsored consultancy. All computing and software resources would be accessible over the network from within the computer centre as well as from individual departments/centres (faculty offices and laboratories), administrative offices and other central facilities. These resources would also be accessible from locations outside the institute over the country-wide ERNet and Internet. Access to ERNet resources and to Internet would also be available to our students and faculty. The latter is expected to greatly increase interaction with collaborators from industry and peer institutions (in India and abroad).

The computing resources would also be used to provide continuing education to faculty and administrative staff in the institute and to professionals from the industry. We also anticipate industry-sponsored software development projects to be undertaken, and executed using the above resources.

1. Central Computing Facilities

Computing resources centrally housed in the Computer Services Centre cover compute servers, file servers, network servers, graphic workstations, and PC based terminals to support Unix, MS Windows, and graphics-oriented computing. The centre will support a cluster of 10 high performance Unix machines, some of which will be used

primarily as number crunchers, while others will be used as file servers. Each machine (rated at 100 MFLOPS or more) will typically support 256 MB of RAM, and a total of around 100 GB of shared disk space. These will be accessible from X-terminals, PCs as well as graphics workstations, connected over a high-speed LAN. One of the servers shall also provide a Novell Netware environment, and will be accessible over the LAN from PCs (acting as Netware clients).

2. Software

Other than commonly used software tools (compilers, libraries, debuggers, etc.) for Unix servers, the Computer Centre will arrange to support software for scientific computing (simulation, numeric computation, visualisation) 3-D graphics for solid modelling, databases, etc. Network related software, such as WWW server (with integrated database), development tools for network security and network management will also be supported.

Other than providing all necessary software on PCs, the Computer Centre will act as a warehouse for software required by faculty and researchers at IIT Delhi. To this end the Computer Centre will seek campus-wide license for software popularly used on PCs and Unix machines. This shall include MS Windows 95, MS Office, Lotus Notes, AutoCAD, etc. Public domain software for PCs and Unix workstation will also be made available by the Computer Centre from its file server.

3. Campus-wide Network

The networking requirements of IIT Delhi cover those that relate to networking within the institute, and those that enable IIT Delhi's network to be connected ERNet, which in turn is part of the global

Internet. Other issues pertain to provision of network services, and their access by different communities within the institute. To the extent possible, every PC, workstation and computing and network servers will be on the network, and will be accessible from every other machine.

The institute network is planned to be upgraded from the existing 10 Mbps to 100 Mbps, particularly in respect of the backbone network and the network within the Computer Centre. The backbone network shall be formed out using 100 Mbps optical fibres and shall reach the doorstep of every department, centre, and major central facility.

4. Communication with ERNet and Internet

Issues concerning access to ERNet and to Internet include capacity of the circuits that interconnect IIT Delhi network with ERNet, channel capacities within ERNet, the capacity of circuits that connect ERNet with Internet, and access to Internet services from within IIT Delhi (and vice-versa).

Currently IIT Delhi is connected to ERNet using a 64 Kbps circuit and using a 19.2 VSAT channel. These are considered to be just adequate for transfer of email and occasional access to Internet. Once ERNet upgrades its channels, it will become necessary to enhance the IIT Delhi-ERNet link capacity to 2 Mbps.

A number of network services are expected to be accessible to the community at IIT Delhi. These include: email, network-news, remote login, file transfer, and WWW. The services could either be limited to the institute network, or thrown open to ERNet and Internet. It is proposed that all Internet-wide services ultimately become available to every community on campus. This would necessitate enhancing the

network servers on campus (currently provided from resources of ERNet project), and sharing of responsibility by ERNet group and Computer Centre for funding and maintaining them. It is therefore proposed to put up at least two servers: one for supporting email, and one to provide access to IIT Delhi Web site, network-wide news, public-domain software, technical reports, etc.

5. Budget

The budget estimates for the Ninth Five year plan are given below for computers, software, networking and communication.

Computers (compute/file and graphic-appiication servers, workstations)	Rs. 9.00 cr.
Software (Systems, DBMS, graphics/scientific, site-wide licenses)	Rs. 3.00 cr.
Institute networking (fibre-optic cabling, network equipment and software)	Rs. 3.00 cr.
Communication with ERNet (Network servers, high-speed link, ERNet subscription)	Rs. 2.00 cr.
Maintenance (hardware, software upgrade)	Rs. 9.00 cr
Total (Computers, software, networking, and ERNet communication)	Rs. 26.00 cr.
Amount Anticipated from Resources other than MHRD	Rs. 6.00 cr.
Net Amount Required from MHRD	**Rs. 20.00 cr.**

VI. ADDITIONAL REQUIREMENTS FOR SEWAGE DISPOSAL, ELECTRIC POWER AND WATER

In order to cope with the increase in students intake, strengthening of academic programmes including new areas of research, modenisation/upgradation of existing facilities and creating new ones and for industrial linkages to substantially increase Industrial Consultancy and Sponsored Research, there will be a need to create certain additional infrastructural facilities. Also to cater to the additional water and power requirements for the new equipment requiring airconditioning and dust-free ambiance and for additional water requirement because of increase in population in the Campus, the requirement of funds for these will be as under :

Sewage Disposal & Additional Water @ 3000 KL/day	1.00 Crores
Additional Electricity Infrastructure for approx. 2000 KVA	4.00 Crores
Total	**5.00 Crores**

NINTH PLAN

PROPOSAL FOR PLANNED ACTIVITIES

(Submitted to the MHRD)

INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

MAY 1996

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EXECUTIVE SUMMARY

Indian Institute of Technology, Kanpur has over the past 35 years established itself as one of the leading technology education institution in the world with yeoman contribution towards the development of a scientific and technological temper in the country. However, the academic programmes of the Institute have become static with no new inputs in view of severe financial constraints curbing any major expansion/modernization. If the Institute has to remain academically vibrant, as it was in its formative years, if it has to meet its obligations to the Nation as an Institute of national importance, the Institute must put greater emphasis on graduate education in various emerging sectors of science and technology. Opening up of the Indian economy concomitant with the challenges of the global competition requires massive input of trained manpower of the highest calibre into the industrial sector. This document presents a modus operandi to add to the national pool of such skilled personnel.

The Institute proposes to establish postgraduate programmes in some new areas of critical national need together with selective increase in its undergraduate population in areas of shortage, while maintaining a 1:1 ratio between the UG and the PG student population. Various new areas like Telematics and Information Technology; Environmental Engineering and Management; Advanced Manufacturing Technology and Engineering Management Education etc. have been proposed. Diversification in the format of the degree/diploma programmes to meet the need of industry

have also been proposed. For example, the Institute proposes a three-year M Engg. degree by course work with input at the B.Tech/AMIE or equivalent level.

If the Institute has to play a catalytic leadership role in providing a technology base for Indian industry to take a quantum jump in bringing out newer and innovative products of quality to the market place, the Institute must invest in R & D in various thrust areas and to create centres of excellence. The document proposes an algorithm for doing the same through technology development missions, software and technology incubator joint venture companies and the establishment of a technology park. Simultaneously it proposes the fostering of international linkages to remain in the forefront of knowledge and to share experiences.

All these avenues for growth are only possible if obsolete laboratory equipment are modernized. The infrastructural facilities and laboratories which were created some 35 years ago have, for want of adequate funding for modernization, become obsolete. Rapid changes in technology has resulted in rapid obsolescence of research equipment. The document proposes inputs to the tune of 15% per year of the total capitalised cost of equipment in position for upgradation of the laboratory facilities. Similarly research and central facilities require upgradation.

Academia cannot survive without modern computing facilities. To meet its ever-increasing information needs considerable investments are needed in upgrading the existing local area networks and providing connectivity to an information super highways like the Internet.

In the present information age, the age old system of library services is of limited value. It is imperative that we move towards the concept of an electronic library which can serve as an information resource centre not only for the institute but also for other institutions and organizations in the region, if not for the entire country. Finally, the physical infrastructural facilities like the electrical supply system, the water supply system, the airconditioning system, building and roads, hostels,students messes, etc., which were created more than three decades ago, need immediate rejuvenation before the ageing process leads to a collapse of the facilities. Special consideration is to be given to carry out immediate repair/maintenance/updating of these infrastructural facilities.

The document presents the vision of the Institute to enthuse new life into in the system. Plan funds for the 9th Plan period for various activities proposed to be undertaken are as summarised below.

FUND REQUIREMENTS AT A GLANCE

		Rupees in crores	
		Non-recurring	Recurring
(I)	New programme and Strengthening of Existing Programmes (from Section 2.4(b))	46.00	8.95
(ii)	Modernisation/Upgradation of existing facilities (from Sections 3.1, 3.2, 4.1 & 4.2)	45.00	
(iii)	R & D - Consolidation & Augmentation (from Sections 5.1 to 5.5)	50.00	
(iv)	Computing & Networking (from Section 3.3.)	15.00	
(v)	Linkages (from Section 6)	5.00	
(vi)	Infrastructure (from Sections 2.4 (a), 2.4(c) & 7.3)	88.50	
	Total	249.50	8.95

These figures do not include the normal recurring expenses of the Institute for operation of the Institute.

1. INTRODUCTION

Indian Institute of Technology Kanpur was established through an Act of Parliament to produce world class engineers/scientists. Its contribution for the development of a scientific and technological temper in the country has been well recognized. Though the Institute, through the contributions of its faculty, research workers and students, has attempted to keep pace with rapid developments in the world of technology; it has been a losing battle since the programmes of the Institute have become static with no new inputs in view of financial constraints curbing any major expansion/modernisation. If the Institute has to remain vibrant, as it was in its formative years, if it has to continue to meet its obligations to the Nation as an Institute of national importance, the Institute must endeavour to move forward in new fields of science and technology. This document presents the Institute's vision to maintain its position of academic excellence, to interact with leading institutions in the world, and to be a forerunner to usher in a futuristic technological society.

It is the considered opinion of the Institute that the nation must put greater emphasis on graduate education in various sectors of science and technology. The Indian industrial, technological and scientific scenario is fast changing due to opening up of the economy concomitant with global competition and as a result the nation will soon need a large number of trained manpower of the highest calibre with education at the postgraduate level to man various facets of its industrial and social development. It is anticipated that there will be a quantum increase in the requirement of postgraduate engineers and scientists. Meaningful graduate programmes, though at a suboptimal level in terms of size, exist in only a handful of institutions in the country. With the exponential

widening of the technological horizons, the country needs postgraduate engineers and scientists in emerging technologicai areas. Institutes like IIT Kanpur are well poised to meet this challenge. The Institute, therefore, proposes that it endeavour to establish postgraduate programmes in selected new areas of critical national needs rather than expansion in traditional disciplines. As a corollary to the above the Institute may also be in a position to increase its undergraduate population, to some extent, while maintaining a 1:1 ratio between the UG and the PG student population. The increase in UG population should only be in identified areas of manpower shortage as well as in areas of strategic need of the Nation.

During the Ninth Plan, therefore, the Institute would like to forge ahead, by consolidating and expanding its academic offerings on a need-based basis in existing areas of technology and opening new innovative programmes in upcoming areas in which national endeavours need to be concentrated.

Increase in student strength in existing areas implies only marginal increase in existing infrastructural facilities. Newer areas would, of course need additional inputs.

2. STRENGTHENING OF ACADEMIC PROGRAMMES

In view of the envisaged growth of the Indian engineering industry and its requirement to compete in the global market, there has to be both a qualitative as well as quantitative change in the human-resource requirements of the nation. It is within the mission of the Institute to provide for new initiatives to meet these requirements.

It has been increasingly felt that there are several new areas of technical education that need to be addressed, both at the undergraduate and the post-graduate levels. Also, a strong need is felt for providing for new formats of post-graduate education which aim at upgrading the existing man power in the industry by providing new channels for entry.

Thus, the Institute plans to

I. increase enrollment in the current UG/PG programme,

II. introduce two new areas for UG teaching

III. introduce eight new interdisciplinary programmes at post-graduate level. These include a comprehensive programme in management, and

IV. introduce six new formats for post-graduate programmes.

2.1 NEW AREAS

The Institute proposes to introduce the following new areas in view of their importance and pressing need.

2.1.1 AT BOTH UNDER-GRADUATE AND POST-GRADUATE LEVEL

(a) Manufacturing Systems Engineering
(b) Biotechnology (5 year integrated programme)

2.1.2 AT POST-GRADUATE LEVEL

(a) Telematics and Information Technology
(b) Environmental Engineering and Management
(c) Advanced Manufacturing Technology
(d) Engineering Management Education

  i) Operations Management
  ii) Infrastructure Management
  iii) International Business

(e) Atmospheric Science and Engineering
(f) Product Design Engineering
(g) Maintenance Engineering
(h) Advanced Process Control Engineering

2.2 NEW FORMATS

It is felt that the present pattern of engineering education which follows a strictly academic stream from intermediate through B.Tech., M.Tech., to Ph.D. is not adequate to serve the needs of industry. A variety of formats with different admission qualifications are proposed.

a) A three-year B.Engg. degree with admission at the B.Sc.level.

b) A three-year MS degree by Research with entry at the B.Tech./M.Sc. level. This programme will include one year of course work and two years of research.

c) A three-semester M.Engg. degree by course work with input at B.Tech./AMIE or equivalent level.

d) A two-year M.Tech. degree with increased research content replacing the present three semester M.Tech. degree programme.

e) A five-year dual degree programme in which students are admitted into a 5-year programme directly after JEE, and in which the two degrees are give only on completion of the full programme. This accelerates the post-graduate programme for the research-oriented students by appropriately using the electives and projects slots of the undergraduate programmes.

f) A Remote-location DIIT programme/M.Engg. programme.

g) An Integrated Ph.D. programme in Sciences after a B.Sc.

2.3 INCREASE IN STUDENT STRENGTH RESULTING FROM NEW INITIATIVES:

2.3.1 Undergraduate Programme:
Increasing the intake of the current B.Tech. programmes :

a) Computer Science and Engineering from the present level of 30 students per year to 60 students per year: 30 x 4 years	120
b) Electrical Engineering from the current intake of 75 students per year to 120 students per year: 45 x 4 years	180
c) Mechanical Engineering from the current intake of 60 students per year to 90 students per year : 30 x 4 years	120

New programmes at UG levels

a) Manufacturing Systems Engineering: 30x4 years	120
b) Biotechnology: 30 x 5 years	150
Introduction of a 3-Yr. B.Engg. in two areas 2 x 20 x 3 years	120
Total UG increase	810

2.3.2 Post-graduate Programmes:

• 3-year MS by Research 4 area x 10 x 3 years	120
• New M.Tech./Ph.D. programmes 5 areas x 40 x 2 years	400
• 5-year dual degree programmes 4 areas x 20	80
• Management Programmes 3 areas x 30 x 2 years	180
• M.Engg. Programmes 4 areas x 20 x 1 1/2 year	120
• New DIIT programmes 4 areas x 15	60
Increase in strength of existing PG programmes	260
Total projected increase in PG strength	1220

2..4 BUDGET REQUIREMENTS FOR EXPANSION OF CURRENT PROGRAMMES AND FOR INTRODUCTION OF NEW PROGRAMMES

NON-RECURRING (Rs. in iakhs)

(a) ACADEMIC AREA (UG/PG) : 95,000 sq.m. Class rooms; Seminar rooms; Committee rooms; New Laboratory offices/stores; Departmental libraries; New laboratory spaces; Computer server rooms; Research Scholars rooms etc; Augmentation of Central Library (with common areas); Electronic Library @ Rs. 5500 per sq.m. (civil/electrical/ airconditioning/developmental)	5225.00
(b) Equipment for new laboratories (expansion of UG laboratories + new areas at PG levels)	4600.00
(c) Students/Faculty housing : 80,000 sq.m. (1200 students + 180 faculty) @ Rs. 3500 per sq.m.	2800.00
	12625.00

RECURRING

(a) Faculty salary/year (Professors @ 1.7 lakh, Associate Professor @ Rs. 1.3 lakh, Assistant Professor @ Rs. 1.3 lakh) Add 30% of the above towards benefits like LTC, medical, PF, travel etc.	386.10
(b) Technical staff/Office staff at 1/3 of above	128.70
(c) Journals/Periodicals augmentation in new areas	30.00
(d) Fellowships/Scholarships	250.00
(e) Consumables/Augmentation of services	100.00
	894.80

Thus, the total outlay for having new programmes and expansion of existing programmes are as follows:

Non-recurring	Rs. 12625.00 Lakh
Recurring	Rs. 894.80 Lakh per year

3. MODERNIZATION & REMOVAL OF OBSOLOSCENCE

The Institute has approximately 200 laboratories including core teaching UG/PG instructional and research laboratories. The total cost of capatilized equipment is approximately Rs.60 Crores (Rs.40 crores from MHRD Grants and Rs.20 crore from project grants). The technology is changing at a rapid pace due to which research equipment becomes obsolete in a very short period of time. To impart state-of-the-art technical knowledge, it is essential that a substantial investment on continuous basis is made for upgradation and removal of obsoloscence. Average useful life of scientific instruments is 5-7 years, by which time either the technology changes or more sophisticated instruments come to the market. Taking into consideration the total laboratory infrastructure and the rate of obsolescence, every year atleast 15 % of the equipment be replaced which will require approximately an expenditure to the tune of Rs.9 crore per year. This implies a total plan expenditure of Rs.45 crore.

3.1 Core and UG Teaching Laboratories

Undergraduate teaching at IITs have been at par with the top most universities woridwide. However, over the last few decades IITs have not been able to keep pace with changing technology and hence the laboratories and the workshops do not reflect the state- of-art technologies. It is essential that these laboratories are continuously upgraded to impart state-of-the-art education and provide opportunity to students to work with stateof-the-art technology. This would involve an expenditure of Rs.15 crore over the plan period. The list of laboratories which need upgradation is placed at Annexure 1.

3.2 New Major Instruments, Research & Central Facilities

In addition to regular Masters and Ph.D programmes where the students are required to do research, Institute also undertakes a very large number of sponsored research activity, technology development projects and industrial consultancy. While project grants do provide for the specific equipment which may be needed for that project, the common laboratory infrastructure including major test and measurement facilities, characterization and material processing equipment etc., have to be provided by the Institute. In addition, in some of the areas where research funding is limited, research laboratories have to be sustained through Institute resources. This requires a considerable investment in acquiring and maintenance of major facilities. An expenditure of Rs.15 crore is estimated for this purpose over the plan period. The list of major instruments and facilities is given in Annexure 2.

3.3 Computing and Networking Requirement

Computers have become essential tools in all areas of science and technology. The computation equipment has, in particular, very short life span and requires replacement on an average within 3 years time frame. In addition, the whole world has now become a global village due to revolution in Communication technology. To keep abreast with the ever growing information needs considerable investments are needed in upgrading local area networks, wide area network and for access to information super highways like Internet. Estimated expenditure on this count would be Rs.15 Crore.

4. LIBRARY AND INFORMATION SERVICES

4.1 Electronic Library

With the advent of modern information and communication technology, libraries worldwide are taking a different shape. IITs always had excellent library services and can become major information service providers for the academic and research community, as well as for the industry, by converting themselves into modem electronic libraries. An effort in this direction at IIT Kanpur is expected to involve an expenditure of Rs.10 crore.

4.2 Investment in Information Resources

With the growth of intellectual property regime it becomes very essential that a strong technological information base, which is current and complete, is maintained in the country through the libraries. This requires on line access to lot of commercial data bases and maintenance and creation of such databases relevant to the country. These libraries should be seen as national resource centres and adquate provision has to be made accordingly. At IIT Kanpur, equiping the library with such resources would involve an investment of Rs.5 crore over the plan period.

5. R & D INITIATIVES

5.1 New Thrust Areas

Research and Development in Science and Engineering requires perpetual input to nurture new and changing frontier areas of research. This includes consolidation and augmentation of the existing reseach areas as well as addition of new interdisciplinary areas on an ongoing basis. Insitute has a wide spectrum of research activities. Its consolidation and augmentation requires upgradation and modernization of the existing facilities. In addition, in few selected areas the pace of the activities have

to be increased to make them effective by providing major inputs. Some of the areas where IIT Kanpur is envisaging strengthening of activities are given In Annexure 3 alongwith the associated resource requirement. A total expenditure of Rs.10 crore is envisaged.

5.2 Centre of Excellence (interdisciplinary technologies)

One of the mechanisms which the Institute has been using for advancement of interdisciplinary areas is through creation of centres of exellence. Some new centres which Institute wishes to initiate are in the areas of

- Biomedical Engineering & Biotechnology
- Natural Disaster Mitigation & Management
- Advanced Manufacturing technology including Mechatronics
- Infrastructure development & Management including Power, Communication & Transport
- Advanced Process Control & Process Synthesis for Chemical Industry
- Computational Fluid dynamics
- Environment Engg and Technology
- Informatics and Communications
- Imaging and Virtual Reality
- Natural Language Processing & Machine Translation
- Atmospheric Sciences
- VLSI & ASIC Design Technology
- Condition Monitoring

5.3 Technology Park Complex

IIT Kanpur has approximately 500 acre of land available out of which, about 100 acre may be required for further extension of IIT activities. Approximately 400 acre of land can be used for other productive purposes. The objective of such land usage is to generate additional resources as well as to improve interaction with Industrial and Consultancy Organisations. IIT Kanpur is planning to develop initially about 100 acre of land as a Technology Park Complex outline of which is given in Annexure-4.

Following kinds of activities are envisaged in the Technology Park Complex:

* Software Technology Park
* Interface organisations for small and medium size industry.
* Hi Tech small Companies likely to develop research interaction with IITK in areas such as Environment, Electronics, Communication, Prototyping and Design, Medical Instrumentations, Special Materials, Bio-Tech, etc.
* Incubators/Technology Development Companies likely to commercialise technologies developed in IITK or elsewhere.
* Special Consultancy and Design Organisations.

It is estimated that the development of about 100 acres of such a Complex will require about Rs.35 crore in addition to the value of land, which will be made available by IIT Kanpur. It is proposed that this Park be developed on a commercial line in partnership with one or more private/public sector agency and run on professional lines. To retain the control on land usage and park activity, it will be necessary that IIT maintains 51 % equity in the joint venture. It is suggested that support to the extent of Rs. 10 crore towards the equity in the proposed park company be provided.

5.4 Technology Development Mission

Technology Development in the Mission mode was initiated at various IITs during the 8th Plan in certain selected areas. Given the impact this initiative has created, particularly, in establishing linkages with industry for joint technology development programmes, it is proposed that this initiative be continued during the Ninth Plan also. Based on the strengths at IIT Kanpur and the emerging trend of technology, Technology Development Missions in the following areas are proposed. The expenditure is expected to be Rs.10 crore.

1. Medical Imaging, Telematics and Expert Systems for Medical Diagnostic.
2. Robotics including Mechatronics
3. Optical Computing and Bio-Computing
4. Medicinal Chemistry
5. Opto-Electronic Sensors and Instrumentation

5.5 Software and Technology Incubator Joint Venture Companies

IIT's through student project, sponsored research and faculty research generate technologies and software which have commercial potential. However, exploiting such software and technologies requires a commercially efficient marketing and service organisations to support it. It is proposed that IIT may participate with professional commercial organisation to set up some joint venture companies in selected areas. Some such identified areas are:

(1) Software Products in areas like Virtual Reality, Internet Service, Machine Translation of Indian languages, Computer Integrated Manufacturing Software, Hospital Systems, Library Information Systems, etc.

(2) Spin off product/Technologies from Technology Development Missions such as Instrumentation, Design Service Bureau for Rapid Prototyping, Communication Products etc.

(3) Educational Technology Products using multimedia, Video and Computer Simulation pedagogies.

To start such Ventures, equity participation for the Institute in such Companies has to be permitted. A financial outlay of Rs.10 crore is required for this prupose for the plan period.

6. INTERNATIONAL LINKAGES

It is necessary for the Institute to develop international linkages with other academic Institutes abroad for purpose of academic exchange, joint research programmes, extension and consultancy services. With libralization of economy "India Brand" can become effective only if there is a visibility of the Indian academic community internationally and in generating international quality manpower.

Rs.5 Crore will be needed to foster such linkages during the plan period.

7. IMPROVEMENT IN INFRASTRUCTURAL FACILITIES

The Institute was set up more than 30 years ago. The infrastructural facilities which are the back-bone of this Institute have been ageing for quite some time and by now these have suffered a lot of degradation due to extensive use and fair wear & tear. If these facilities are not rejuvenated without any further loss of time, the possibility of their collapse in the near future cannot be ruled out. Such an eventuality may lead to hampering of the academic and research activities of the Institute.

Sanction of a special plan grant for rejuvenation would enable the Institute to carry out immediate repair/maintenance/updating of infrastructure. On completion, the advantages would include lower electrical losses, reduction in power consumption, reduction in yearly maintenance costs, increase in the effective live span of buildings and subsystems, etc.

7.1 REQUIREMENTS

To a large extent, much of the physical infrastructural facilities created about three decades ago is in bad shape and on the verge of collapse. For example, the electrical wiring in the academic buildings, central library, hostels, residential quarters have not only become weak but have also started leaking thus resulting in frequent electric shocks, short-circuiting, disruption of circuits, etc. and in turn there is risk of fire. Further the Institute is not a beneficiary of any civic amenity from the Kanpur Mahapalika and has to fend for itself with regards to sewerage, drainage, sanitation, water supply, etc. In fact from the very inception of the Institute, it has been providing and maintaining its own sewerage and drainage systems as well as water supply system. For water supply to the campus, the Institute has tube-wells, overhead and underground water tanks, pumping stations, etc., which were constructed more than

three decades ago. All the above infrastructure is now weak resulting in frequent breakdowns. This in turn results in problems being faced by the residents of the Institute, which include the students and the employees besides various laboratories of the Institute. Similarly breakdowns in the form of frequent choakings, bursting of pipes, leakages of the sewerage and drainage systems of the Institute are also causing problems to the residents. The conditions of roads, foot-paths, boundary walls, airstrip area, etc. is also far from satisfactory and need immediate repairs, but due to the paucity of funds over the past several years, no action could be taken to renovate or overhaul any of the above mentioned civic facilities, which have a direct bearing on the functioning of the Institute. Also, the yield of various subsystems including tubewells is being affected. The special repair works, which cannot be undertaken on a day to day basis, like waterproofing of buildings, etc., have also not been properly attended to during the past several years, which had led to considerable deterioration in the condition of buildings.

7.2 PROPOSAL

The rejuvenation process of the buildings and infrastructural facilities have got to be initiated with utmost urgency so that alternate/replacement facilities/services of ageing buildings/ facilities/services can be undertaken in a planned manner over a period of time. It needs no special emphasis to state that statutory stipulations in the building by-laws dictate that after 30 years of use, systems like electric cables, old transformers, sewerage lines, etc. are to be replaced.

7.3 PHYSICAL FACILITIES REJUVENATION GRANT

Immediate requirement of funds, therefore, under this head is as follows :

	(Rs in lakhs)
1. Rejuvenation of Central Library : (Replacement of electrical wiring/false ceiling/ relaying of air-conditioning outlets/fire escape and fire alarm/relaying of floor and repair of the structure)	50.00
2. Rejuvenation of Electrical Systems/Sub-systems as well as of telephone facilities (transformers/ 33 KV lines/Cablesand fittings/electrical substation panels/ overhead lines/relaying of cables, relaying of telephone cables/replacement of present exchange/equipment)	389.00
3. Rejuvenation of civil construction (repair of boundary wall, fencing of air-field, sewer lines, sewer pump set, damaged GI lines, tubewells, relaying of water proofing treatment/overhead tank/ repair of roads; peripherals roads, recarpeting of airstrip etc.)	138.00
4. Rejuvenation of Messing Facilities (Modernisation of kitchens of halls of residences and Visitors' Hostel)	248.00
	825.00

Annexure 1

Modernization of Laboratories & Removal of Obsolescence

Department/Programme (Name of Labs)	Equipment (Rs. in lakhs)
Aerospace Engineering Structure, Propulsion, Aerodynamics, Low speed Laboratory.	80
Chemical Engineering Unit Operations Laboratory	30
Chemistry UG Core Inorganic/Organic/Physical UG Laboratories	120
Civil Engineering Engineering Geology, Environmental, Geoinformatics, Geotechnical, Hydraulics & Water Resource, Structural Engineering, Transportation	285
Computer Science & Engineering UG Systems Laboratory, Image Processing Laboratory	325
Electrical Engineering Electrical Science Core Laboratory, UG Laboratories of Electronic Circuits, Digital Systems & Microprocessor, Power Electronics & Drives, Electrical Machine & High Voltage, Control System, Signal Processing and other UG & advanced PG Instructional Laboratories.	375
Industrial & Management Engineering System Optimization Laboratory; Computer Integrated Manufacturing Laboratory.	80
Mathematics Scientific Computing Laboratory	20
Mechanical Engineering Laboratory of Fluid Mechanic, Energy Conversion, Material Testing, etc.	105
Physics Core Laboratories for UG Teaching & Other Instructional Laboratories of Modern Optics, Computer Based Experimental Techniques	55
Robotics Sensors and Controllers, Stereo vision system	25
Total	1500

Annexure-2

New Major Instruments, Research & Central Facilities

(Purpose : Postgraduate Teaching(PG), Research (R), Industry Interaction (I)
The purpose for acquiring each facility/Instrument is given in parenthesis.

Department/Programme	Rs. in Lakhs
Aerospace Engineering	125
Laser Based Measurement for Aerospace Application (PG,R) Full Scale Vibration Testing Facility (R, I) High Temperature Gas Dynamics (PG,R)	
Chemical Engineering	100
Accelerated Rate Calorimetery (PG,R,I) Gas Chromotography Mass, Spectrophotometer (PG,R)	
Chemistry	200
Mass Spectrometer (R) Thermal Analysis & Calorimetery System (R) EPR Specrometer (R) Multi Nuclear High Field NMR (R,I)	
Civil Engineering	175
Specialized Biotechnology Equipment (R,I) Spectrum analyser, sensors and impact generators for geotechnical earthquake studies (R) Laser Doppler Anemometer System for Turbulence Measurement (PG,R) Mercury Porosimeter, TGA/DTA Analyser & Calorimeter; Heavy duty reaction frames with actuators; Testing facility for Structures and Construction Materials (PG,R,I)	
Computer Science & Engineering	160
Distributed System & Networking Laboratory (PG,R,I) VLSI Design Laboratory (PG,R,I) Resource Centre for Software Evaluation and Testing (R,I)	

Advanced Centre for Materials Science	180
Plasma Emission Spectroscopy for Chemical Analysis (R,I)	
Scanning Electron Microscope (R,I)	
Computerized Universal Testing 25 ton (R,I)	
X-Ray Diffraction System with Anode Generator (R)	
Laser Particle Size Analyser (R)	
Controlled Atmosphere Hot Press - 25 ton (R,I)	
Mechanical Engineering	50
Optical Measurement for Fluid Flow & Heat Transfer (R)	
Central Support Facilities	150
Liquid Nitrogen Plant (R)	
Central Nuclear Laboratory (R)	
EPR (R)	
Physics	100
Combined STM/AFM/MFM System (PG,R)	
Squid Magnetometer (PG,R)	
Laser Technology	80
Pico-Second Laser (R,I)	
High Power Tunable Semiconductor Diode Laser Facility (R,I)	
Robotics	80
Industrial Robot and AGV (PG,I)	
Welding Robot (R,I)	
Electrical Engineering	100
Opto electronics Packaging Facility (R,I)	
Solid state devices fabrication and characterization facility (R,I)	
Total	1500

Annexure - 3

New Thrust Areas

The following new thrust areas are proposed with a view to carry out research in certain frontier areas, develop emerging technologies and enhance industry interaction.

Department/Programme	(Rs. in Lakhs)
Aerospace Engineering	65
High Temperature gas dynamics studies for missiles & space launch vehicles	
Chemical Engineering	140
Environment, Health and Safety Advance Control for Process Industry Surface Science and Engineering	
Chemistry	140
Molecular Modelling & Computer Aided Drug Design Ultra Fast Chemical Dynamics Chemistry of Materials	
Civil Engineering	100
Natural Disaster Mitigation & Management In-situ Characterization of Ground & Ground Engineering Processes	
Computer Science & Engineering	100
Human-Computer Interaction Genetic & Medical Information System	
Industrial & Management Engineering	75
Manufacturing Strategy & Technology Management Infrastructure Management	

Mathematics	10
Environment & Ecological Modelling	
Mechanical Engineering	35
Computational Fluid Dynamics	
Physics	100
Scanning Probe Microscopy Technique for studies of Condensed Media	
Ultra Fast Laser Spactroscopy	
Study of strongly coupled, complex physical systems	
Robotics	75
Mechatronics & Industrial Robotics	
Electrical Engineering	140
Broadband & Wireless Telecommunication Systems	
Optical Fiber & High Speed Switching Systems	
Simulation of Industrial Control Systems	
Optical CAD	
Controllable Power Networks	
Laser Technology	20
Laser Material Processing	
Total	Rs.10 crore

Annexure - 4

Technology Park Complex

IIT Kanpur has approximately 500 acre of land available out of which, about 100 acre may be required for further extension of IIT activities. Approximately 400 acre of land can be used for other productive purposes. The objectives of such land usage is to generate additional resources as well as to improve interaction with Industrial and Consultancy Organisations. IIT Kanpur is planning to develop initially about 100 acre of land as a Technology Park Complex.

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- Incubators/Technology Development Companies likely to commercialise techno-logies developed in IITK or elsewhere.
- Special Consultancy and Design Organisations.

Software Technology Park

IIT Kanpur has been and is leader in Computer Science and Computer application related manpower development. There is a strong presence of IIT Kanpur graduates in computing related Industry. Further, extensive research is done in computer applications in Engineering, Technology and Science in the Institute. IIT Kanpur also has extensive computing facilities. thus we expect that Software Technology in close vicinity of IITK will boost research and project work considerably. It may be noted that considerable potential in the software development is in the specialised

engineering and science related software development, where both computing and Engineering skills are required. IIT Kanpur provides an ideal ground for such an environment.

The main requirements for the software park are:

- Availability of work space with air conditioning and regular power supply.
- Communication linkages
- Congenial environment to work with flexible time schedules.

To start with a software technology park (STP) under the STP scheme of the Government of India has started functioning in UPSIDC building, approximately four Km. from IIT Kanpur. It is proposed to extend this facility to software technology park at IIT Kanpur. A 64 Kbs data link has been provided by VSNL to the STP.

The proposed park will aim to have about 300 IT professionals working in the park. Fully airconditioned building with approximately 5000 sq.m. workspace is envisaged to be constructed for this purpose. Further, facilities like Guest House, apartments, Cafeteria, Sports Complex etc. also are planned. A dedicated satellite link for the communication also will be needed. VSNL is already in the process of setting up an earth station in Kanpur.

Interface Organisation for Small and Medium Size Industry

Small and medium size industry (total turnover upto Rs.10-15 crore) forms the largest segment of the industry in this country. However, most of this industry is in traditional sector and only a small fraction is in hightech sector. The technology development appropriate for this sector of industry and the interaction with academic institutions is relatively weak and is required to be strengthened. One possible mechanism for improving this

scenario is to develop an interface organisation to promote design and consulting entrepreneurs who can interface with IIT's on one hand and with SME on other. The concept is primarily of a polyclinic, where the APEX organisation provides certain common services and an umbrella for the consultants and designers to render their services. Facilities like information service, library services (data base), prototyping shop, communication, accounting, advertising etc. can be provided by the APEX organisation. The areas where consultants and designers can provide services will include environment, quality, instrumentation, process management, product development, testing, prototyping and design, technology assimilation, human resource development at the various skill levels.

Hi-tech Research and Development Units

Currently, there are few Hi-tech small scale industries specialising in the areas such as environment, electronics, communication, instrumentation etc. However, this group of industry is likely to grow at high rate. Generally, the plant size of such industry is small and they often require Hi-tech R&D support. Such organisations can work better in close vicinity of academic and research institutions. It may be possible to attract some of these companies towork in close collaboration with IIT Kanpur especially in areas where IIT Kanpur has strengths. Some such areas are instrumentation, specialised materials, bio-tech manufacturing, communications etc. In addition, it is proposed to encourage large industrial houses to set up their Research units in this park.

Incubators and Venture Capital Funded Companies

IIT Kanpur can act as a catalyst for the entrepreneurs to set up facilities to productionise technologies developed at IIT Kanpur or elsewhere, as well as to set up technology development ventures with the established companies. Venture capital can be used as the source of financing such ventures. The concept of venture capital is new to this country and venture capital funding is restricted to relatively safe (production of Technology) ventures. However, more funding for the high risk technology development is likely to become available.

Development of the Park

It is expected that this park will be developed as a joint venture between IIT Kanpur and professionally managed companies. The park will be managed on commercial lines.

Summary Sheet for Section 3

	(Rs.in crores)
3. Modernisation and Removal of Obsoloscence	Rs.45.00
3.1 Core and UG Teaching Labs (Annexure-1)	Rs.15.00
3.2 New Major Instruments, Research and Central Facilities (Annexure -2)	Rs.15.00
3.3 Computing and Networking Requirements	Rs.15.00
4. Library and Information Services	Rs.15.00
4.1 Electronic Library	Rs.10.00
4.2 Investment in information resources i.e. databases, CD ROM etc.	Rs. 5.00
5. R&D Initiatives	Rs.50.00
5.1 New Thrust Areas (Annexure-3)	Rs.10.00
5.2 Centre for Excellence (interdisciplinary technologies)	Rs.10.00
5.3 Technology Park (Annexure-4)	Rs.10.00
5.4 Technology Development Mission	Rs.10.00
5.5 Software and Technology Incubator Joint Venture	Rs.10.00
6. International Linkages	
6.1 Exchange Visits, Linkages with International Academic Community, Participation in Bilateral Scence and Technology Agreement of Government of India	Rs. 5.00

9. CONSOLIDATION OF REQUIREMENTS OF FUNDS UNDER THE NINTH PLAN

The figures given in the text above are brought here and listed under different areas :

		(Rupees in Crores) Non-recurring	Recurring
(i)	New Programmes and Strengthening of Existing Programmes (from Section 2.4(b))	46.00	8.95
(ii)	Modernization/Upgradation of existing facilities (from Sections 3.1,3.2,4.1&4.2)	45.00	
(iii)	R & D - Consolidation & Augmentation (from Sections 5.1 to 5.5)	50.00	
(iv)	Computing & Networking (from Section 3.3)	15.00	
(v)	Linkages (from Section 6)	5.00	
(vi)	Infrastructure (from Sections 2.4(a),2.4(c) & 7.3)	88.50	
	Total	249.50	8.95

These figures do not include the normal recurring expenses of the Institute for operation of the Institute.

Resource Requirements under Ninth Plan

Highlights

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New Academic Programmes	102
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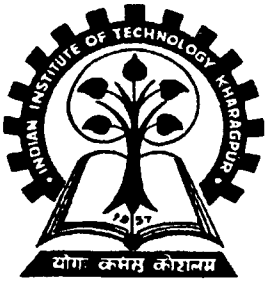
Research and Development - Consolidation, Augmentation and New Initiatives	115
Computing and Networking Requirements	120
Linkages with International Institutions	125
Infrastructure Requirements	125
Total Requirement of Funds	126
Concluding Remarks	130



May, 1996

Indian Institute of Technology

Kharagpur

1. INTRODUCTION

Established in 1951, the Indian Institute of Technology, Kharagpur is the pioneering trend setter of the chain of IITs that now girdles our country. Besides imparting technological education of the highest standards to the cream of this country, IIT Kharagpur has established itself as a world class Institution in Research and Development of Science and Technology. Apart from the conventional engineering disciplines such as civil, mechanical, electrical etc., IIT Kharagpur has some unique Departments and Centres such as Architecture and Regional Planning, Agricultural and Food Engineering, Ocean Engineering and Naval Architecture, Mining Engineering, Applied Geology and Exploration Geophysics, Rubber Technology etc. The latest additions are the Education Technology, the Biotechnology, the Vinod Gupta School of Management created with an endowment from Mr. Vinod Gupta, and the G.S. Sanyal School of Tele-communications and Networking created with an endowment from Mr. Arjun Malhotra (Both Mr Vinod Gupta and Mr Arjun Malhotra are our distinguished alumni).

IIT Kharagpur has been continually updating and modernising its academic programmes, and has introduced during the course of the eighth plan several new academic programmes such as an integrated M.Tech course in Biotechnology, a Master of Business Management course for sponsored candidates, a Masters' programme in Quality and Reliability Engineering, apart from new B.Tech programmes in Agricultural and Food Processing Engineering, Metallurgical and Materials Engineering, and Ocean Engineering and Naval Architecture.

While continuing the Research and Development activities in the frontier areas of Science and Technology, the different Departments and Centres of IIT Kharagpur collaborate extensively with a wide range of institutions and industries in the private and public sectors in India as well as abroad, and also participate in a number of Technology Development and Transfer

Missions. Unique to IIT Kharagpur is the Centre for Rural Development whose work relating to transfer of technology, environment awareness, forest management etc. .has earned projects funded by Ford Foundation, FAO, DST and Ministries of Social Welfare and Non-conventional Energy. The Continuing Education Cell of IIT Kharagpur coordinates a wide range of training programmes for personnel from various educational institutions, industrial establishments ,and R&D organisations. The Science and Technology Entrepreneurship Park and the Technology Foundation of IIT Kharagpur carry on the Eighth Plan goals of encouraging the faculty of the Institute to vigorously participate in entrepreneurial and sponsored research activities.

IIT Kharagpur has at present the following 30 Departments/Centres /Schools/ Activity Centres (shown in Table - 1) which run several undergraduate, post graduate and doctoral programmes.

Table - 1

	Department/Centre/School		Department/Centre/School
1	Aerospace Engineering	16	Mining Engineering
2	Agricultural and Food Engineering	17	Ocean Engg. and Naval Architecture
3	Architecture & Regional Plg.	18	Physics and Meteorology
4	Chemical Engineering	19	Biotechnology Centre
5	Chemistry	20	Computer Centre
6	Civil Engineering	21	Cryogenic Engineering Centre
7	Computer Science and Engg.	22	Rubber Technology Centre
8	Electrical Engineering	23	Reliability Engineering Centre
9	Electronics and Electrical Com-munications Engineering	24	Vinod Gupta School of Manage-ment
10	Geology and Geophysics	25	Rural Development Center
11	Humanities& Social Sciences	26	Centre for Education Technology
12	Industrial Engineering and Management	27	G.S. Sanyal School of Telecommunications and Networking
13	Mathematics	28	Materials Science Centre
14	Mechanical Engineering	29	Central Research Facility
15	Metallurgical and Materials Engineering	30	Central Workshops and Instrumen-tation Centre

In addition to consolidating the gains of the Eighth Plan period IIT Kharagpur envisages major breakthroughs in several areas during the Ninth Plan such as: New academic programmes in emerging and thrust areas, Expansion of consultancy services, joint ventures and entrepreneurship programmes, Creation of video based distance education programmes, Establishment of extension centres, Doubling of student strength etc.

2. NEW ACADEMIC PROGRAMMES

Although the oldest of all the IITs, IIT Kharagpur remains youthful in spirit by continuously invigorating and reshaping its academic programmes. During the Ninth Plan period, IIT Kharagpur proposes to start new academic programmes in thrust areas such as Telecommunications and Networking, Biotechnology, Food Engineering, Engineering Design, Educational Technology, and Environmental Engineering and Management, in addition to replacing several extant courses with state-of-the-art programmes:

Telecommunications and Networking:

This is an emerging hi-tech area created by the interface of communications with computers. /It is proposed to set up several new laboratories to cater to the needs of education, training and research and development activities in this programme. These include the Transmission Technology Laboratory, Switching Technology laboratory, Network Technology Laboratory, and the Information Processing and Technology Laboratory.

Food Engineering,

The proposed new programmes in this area include Floriculture Technology, Beverages Science and Engineering, Automation and Control in Agricultural Production and Processing etc. These require several state-of-the-art facilities such as the Agricultural and Food Biotechnology Laboratory, Food Analysis and Quality Control Facility, Milk and Beverages Processing Pilot Plant etc.

Engineering Design

Engineering Design is an important multidisciplinary activity incorporating a Total Design Approach to all engineering problems. IIT Kharagpur proposes to start academic programmes in this area. This will require the creation of new laboratories such as the Industrial Design Laboratory, Engineering Simulation Laboratory, Engineering Ergonomics Laboratory, Visual Communication and Graphic Design Laboratory and Interiors and Furniture Design Laboratory.

Educational Technology

It is proposed that the existing centre for Educational Technology at IIT Kharagpur be converted in to a National Centre for Educational Technology offering several programmes combining the potentials of modern technology and the principles of instruction and learning. This would call for modernizing the existing Video course production facilities, establishing computer aided learning and multimedia laboratories, constructing Video lecture theaters and providing for satellite uplinking and high speed data transmission facilities.

Environmental Engineering and Management

IIT Kharagpur proposes to set up a School of Environmental Science, Engineering and Management amalgamating and augmenting the expertise already available in this important area in several Departments such as Civil, Mechanical, Chemical, Agricultural, Mining, Energy, Architecture and Regional Planning, and Industrial Engineering and Management. Starting of new academic programmes in this field will require thoroughly equipped laboratories with facilities to measure, analyse, and monitor air, water, and soil pollution. The objective of the programme is to prepare specialists and generalists with a thorough and broad understanding of complex transdisciplinary management problems calling for ecofriendly development strategies and solutions.

Consolidation of existing Academic Programmes

Biotechnology

Being aware that biotechnology is poised to play a vital role for the benefit of mankind in diverse fields, IIT Kharagpur has already introduced an integrated M.Tech Course in Biotechnology during the Eighth Plan. In order to strengthen and expand the scope of this programme it is necessary to set up and equip several new laboratories such as the Genetic Engineering/ Recombinant DNA Technology Laboratory, Food and Fermentation Technology Laboratory, Immunotechnology Laboratory, and the Plant Cell Culture Technology Laboratory.

Replacement of extant programmes

At present, there are 15 B.Tech specialisations, 48 M.Tech specialisations, 5 M.Sc. specialisations, the Bachelor of Architecture

Programme, an integrated M.Tech programme in Biotechnology and a Master of Business Management programme offered by IIT Kharagpur through its several Departments/Centres/ Schools (shown in Table - 1). Besides these, some of the Departments and Centres offer programmes leading to M.S, and all the Departments and Centres offer research programmes leading to Ph.D degree.

The main limitation (besides under utilization of resources) of a large number of Departments and Centres each offering degree programmes has been a certain amount of duplication. This may be in the form of programmes/subjects offered, laboratories set up, and equipment and facilities procured. In addition, the different Departments offering their own academic programmes do not often provide the **much desired flexibility** in their programmes for a student to take an elective of his choice from other Departments/Centres.

To meet this situation it is proposed that during the Ninth Plan these Departments and Centres be grouped into clusters (shown in Table - 2) wherein the member Departments within a cluster have some commonness. For example Mechanical Engineering and its Manufacturing sub division, Aerospace Engineering, Ocean Engineering and Naval Architecture, and Cryogenic Engineering together form a cluster called Mechanical Sciences. It is expected that resources provided to such clusters will be more effectively utilized without unnecessary duplication. Also the academic programmes are expected to be more effective with a large number of students in the elective and core courses. In addition, any student of a specific Department in a cluster will be largely free to pursue subjects of his interest from other Departments and Centres in that cluster[†].

Table - 2

Cluster/Group	Members Departments/Centres and Schools offering academic Programmes
Natural Sciences	Physics and Meteorology, Chemistry, Mathematics, Geology and Geophysics
Chemical Sciences	Chemical Engineering, Metallurgical and Materials Engineering, Materials Science Centre, Rubber Technology.
Electrical Sciences	Electrical Engineering including the two sub divisions of Instrumentation and Energy Engineering, Elect-ronics and Electrical Communications Engineering, Computer Science and Engineering; Education Technology* , GS Sanyal School of Telecommuni-cations and Networking* (* New activity Centres)
Mechanical Sciences	Mechanical Engineering with Manufacturing subdivi-sion, Aerospace Engineering, Ocean Engineering and Naval Architecture and Cryogenic Engineering Centre
Management and Social Sciences	Industrial Engineering and Management, Vinod Gupta School of Management, Rural Development Centre, Humanities and Social Sciences
Building Sciences	Architecture and Regional Planning, Civil Engineering

† The Senate of IIT Kharagpur has already given its green signal to the concept that while choosing electives the students should be given total freedom to select them from any of the clusters.

Regarding the new academic programmes to be introduced, the present thinking is to have mainly **integrated dual degree programmes** within and even across the clusters so that any student during his five to 5 and half years of stay can get a B.Tech and an M.Tech in different fields (for example a B.Tech in Mechanical and an M.Tech in Industrial or Manufacturing or Aerospace or Ocean Engineering etc.). Further these programmes suggest a minimum number of credits to be fulfilled by the students for the award of the dual degree within a flexible time limit that

could suit the pace of the student and his other needs such as joining a job after completing a certain number of credits.

Several Departments/Centres/Schools have proposed replacement of some of their dated academic programmes with new programmes of high current relevance. These are shown in the Table - 3:

Table -3

Department/Centre/School	Proposed academic programme areas
Aerospace Engineering	Integrated M Tech programme with Mechanical Engineering minor and Aerospace Engineering major
Agriculture and Food Engg.	Several specialisations in Food Processing Engineering, Agro-environmental pollution and Management
Architecture & Regional Pig.	Industrial and Engineering Design
Chemical Engineering	Industrial Pollution Control, Industrial Biotechnology
Centre for Biotechnology	Food and Fermentation Technology, Genetic Engineering
Chemistry	Industrial Chemistry
Computer Science and Engg	Multimedia Information Systems, Neural Computing, Design and Analysis of Communicating Concurrent Systems.
Cryogenic Engineering	Industrial Gas Technology
Electronics and Electrical Communications Engineering	Mobile and Personal Communication Engineering, Information Systems and Network Engineering, Microelectronics and VLSI, Signal Processing
Electrical Engineering	Bio-medical Engineering Energy Technology and Management, High Voltage Engineering
Geology and Geophysics	Environmental Earth Sciences, Marine Geosciences, Earthquake Engineering and seismology
Humanities & Social Science	Business Economics
Industrial Engineering	Technology Management, Human Factors Engineering
Materials Science Centre	Electronic Materials Technology, Composites Technology, Polymer Engineering
Mathematics	Mathematics and Computing
Mechanical Engineering	Intelligent Machines and Systems, Eco-friendly Technologies, Integrated Programme in Mechanical Engineering with specialisation in Mechatronics.
Mining Engineering	Geotechnical Engineering
Rural Development Centre	Rural Technology and Management
Centre for Education Techno-logy	Education Technology
G.S.Sanyal School of Telecom-munications	Net work Technology and Telecommunication, Information Processing

The policy for the Ninth Plan will be to encourage as far as possible starting of only integrated dual degree programmes and dropping of the old-time Programmes that have lost some of their importance in the present day context. It is envisaged that new programmes will be in broad disciplines, fewer in number and will have the greatest flexibility in the choice of subjects by students. The goal is to maximise the effectiveness of resources through high quality and high flexibility academic programmes.

Doubling of student strength

During the 45 years of its existence there has been a phenomenal increase in the resources accumulated at IIT Kharagpur: the excellence of its academic programmes, the achievements of its faculty in the areas of teaching, research and development, the infrastructural facilities such as laboratories, library, computer centre, central workshops and central research facilities and the wide network of its outstanding alumni. However, there has not been a corresponding increase in its student strength. Considering the very high cost of imparting such high quality technical education, it is not surprising that very few engineering colleges can compete with the IITs in attracting students of the highest caliber. The rapid industrialisation of our country since independence and the increased awareness of the benefits of science and technology have created an enormous demand for graduates from IITs. Given the high standards of scientific education achieved at the higher secondary level, it is becoming an increasingly pressing social need for the IITs with their enormous resources to enlarge their student base without diluting the quality of instruction.

At present IIT Kharagpur has a student strength of about 3000 at the under-graduate, post graduate and doctoral levels. **It is proposed that this figure be doubled during the course of the Ninth Plan.** IIT Kharagpur is confident of meeting this target with an additional plan grant outlay of 20 percent towards faculty and supporting staff. Other requirements towards accommodation for students on the campus etc. are shown in Annexures I and III under the head Infra-structural Requirements.

3. MODERNISATION AND UPGRADATION OF EXISTING FACILITIES

Removal of Obsolescence

Since the setting up of IIT Kharagpur in 1951, a considerable amount of equipment and facilities have, over time, become disfunctional, prohibitively expensive to maintain and mostly obsolete. Modernisation of laboratories is therefore absolutely important since current development in **technology, materials and electronics** has left only a Hobson' s choice concerning continuing with the old systems. Obsolescence removal assumes an important dimension for IIT Kharagpur in view of its age. Maintaining the standard of academic programmes at the expected high level at IIT Kharagpur therefore requires state-of -the art equipment and facilities in almost all the Departments and Centres. This is notwithstanding the fact that many of the Departments and Centres have been removing obsolete equipment from time to time under grants from different projects. Major equipment and facilities to be removed under

this head in different Departments and Centres including the Central facilities is shown in the Table - 4.

Modernisation of facilities

Since its inception there has been a phenomenal change in the programmes, R&D activities etc. at IIT Kharagpur. Several new Departments/Centres have been added, new academic programmes started and in terms of industry interaction IIT Kharagpur is poised for a quantum jump. In order to keep the lead it has been enjoying there is an indisputable need for modernising the facilities at IIT Kharagpur. Keeping in view the shape of things to emerge in the Ninth Plan the Departments and Centres have suggested acquisition of the following facilities shown in Table -5 under modernisation plan.

The laboratories and facilities developed in the Departments and Centres are for the purpose of imparting high quality instruction as well as for pursuing the Research activities including the Sponsored Research to be discussed in the next section. These requirements have all been combined and projected in the Table - 5. Excepting the undergraduate laboratories where the facilities are mainly used for student instruction, all other laboratories are used for teaching and research.

Table -4

Indian Institute of Technology, Kharagpur

Modernisation and Upgradation of Existing Faciiities

Department	Equipment to be removed under Obsolescence
Agricultural & Food Engg	Instron machine for agricultural material; Data acquisition system; Force, Strain, Temperature, Pressure, Energy, Frequency, ...multiparameter recorder; Growth chamber; Amino acid analyser, Hydro probe, Tractor and implements, Ultramicrotome laminar flow, growth chamber microscope
Chemical Engineering	Infrared analyser, Automatic adiabatic calinmeter, High temperature furnace; co_2 analyser; Double pipe heat exchanger; Fin tube A-EThermal conductivity determination app for metals, powder, liquid, gas amissivity determination apparatus; Thermogravemtric analyser, Digital balances, Compressor, Pressure transducer, UV Spectrophotometer. Gas Liquid chromatograph; High pressure liquid chromatograph , Laboratory chemical reactors and fermenters etc
Chemistry	90 Mhz NMR/polarograph Cary17 UV/VIS, Surfectometer, GC
Computer Science and Engineering	Several outdated computing systems including pcs, workstations, servers, printers including colour printers and line printers and equipment and accessories in hardware laboratory such as kits, Oscilloscopes; function generators etc
Computer Centre	Servers, work stations, pcs, graphic terminals, plotters , printers, Line Printers, UPS,
Electrical Engineering	Considerable equipment in Electrical Machines Lab, Electrical measurements lab setup 43 years ago; outdated equipment in microprocessor laboratory
Electronics & Comm. Engg	Two no.s of HP9000; Workstations and pcs; several oscilloscopes; signal generators, transmission analysis equipment; spectrum analyser; sonograph, signal analyser; Benchmark signal processor router; optical power meter and space communication link; DI water plant, vector scalar network analyser, photo resist spinner; LPCVD unit, sputtering unit, Radar set; optical test bench, network analyser, spectrum analyser; Scientific atlanta antenna positioner with transmitter and receiver; VSATS Q-meter
Geology and Geophysics	MMS02E Magnetotelluric Equipment from Metronix; SCINTREX CG-2 Gravimeter; GS-100 NGRI Electromagnetic Profiling Equipment; GRS-23B Gamma Ray Spectrometer, JEOL electron probe Microanalyser

Table - 5

Indian Institute of Technology, Kharagpur

Modernisation and Upgradation of Existing Facilities

Department	New Equipment and Facilities to be Added (list is representative and not exhaustive)
Aerospace Engineering	GT-100 Turbo Jet Demonstration Unit; High and Low Temperature Chambers for INSTRON 1342; Vibration Test System from Denmark ; Laser Doppler Velocimetry
Agricultural & Food Engg	Farm Power and Machinery Testing Facility TD2000; Automated Irrigation and Drainage Facility Chemigation system; Agro-eco system pollution measurement and control facility; Milk and beverages processing pilot plant; Food Analysis and quality control facility
Chemical Engineering	Proximate Analyser; cryobath with control system; Microwave applicator; Dielectric property determination apparatus; closed circuit grinding with hydrocycles flotation cell; Process control system; Solvent extraction unit; bubble size analyser; Mercury porosimeter; pollutants monitoring and control equipment
Chemistry	HPLC, CHN analyser; FTIR; NMR- 90 Mhz EPR GC-MS Luminescence; Solid state NMR and Upgradation of existing NMR facility
Civil Engineering	GDS, data logger, dynamic testing facilities for foundations
Computer Science and Engineering	Work stations; video camera etc for multimedia labs; ATM switching equipment for parallel processing lab, facilities for neural computing etc.
Cryogenic Engineering	UHV systems for space research and electronic industry; vacuum metallurgy equipment; vacuum furnace; heat exchanger test facility
Electrical Engineering	Equipment for the following labs: calibration and standards; Instrumentation; Real time systems; Energy; High voltage, Power systems; Power electronics; control and automation; Biomedical Engineering. Also Photovoltaic power plant; solar arry simulators; Test facility for wind energy systems.
Electronics & Comm. Engg	Spectrum and Network analysers; High speed switching equipment, Photoresist spiner; Diffusion furnace; FPGA system; contactless resistivity monitor; Time domain system Textronix; Equipment for student labs such as VHF/UHF generators
Geology and Geophysics	Scismic, Electromagnetic, Electrical and Gravity magnetic instruments; Microscopes-Petrological and binocular; Granulomic analysis x-ray radiography; Electron microprobe
Materials Science	Fourier Transform Infrared spectrophotometer; Electron Spin Resonance Spectrometer (X and Q band); Rapid thermal processing; Raman Spectrometer with facility for micro-Raman Spectroscopy; Mechanical Analyser; Twin Screw Extruder; Vacuum Coater; Filament winding

Table - 5 Department	.....*Continued on the next page* *(Continued from previous page)* **New Equipment and Facilities to be added**
Materials Science(contd)	equipment; Film Density Tester; Lab model pug mill cum extruder; Eurotherm temperature controller programmers; UHV Scanning Tunneling Microscope; Turbo Molecular pumps
Mechanical Engineering	Laser vibrometer; Dual channel spectrum analyser; Digital Oscilloscopes; Multi - channel instrumentation DAT; Ultrasonic and acoustic emission inspection system; Pulsed TIG welding equipment; 3-Axis Nano positioner 50x50x50 mm; Exeimer Laser system 1 to 2 J/pulse; Acoustic emission system for tool wear; Telemetric Milling Dynamometer; CNC surface grinder; Laser dopler anemometer; Psychometric chambers; High sub-sonic wind tunnel; Energy systems test set-ups; Aerosol creating equipment; Spectrophotometer; Thermo-vision camera; Cryogen delivery system; Gaschromotograph; Fibre-composition testing setup - COD, MTS; Composites making setup; Process control computer; Visualisation system & Head mounted display; Automated visual inspection, grabbers, cameras; Multi-media support on Pcs; Digital servo trainer; Hydraulic servo trainer; Process control trainer; Robot controller; Sensory glove, body suit; Wind turbine trainer; Wear testing machine.
Metallurgical Engineering	Vacuum melting casting unit; Analytical facility XRF, C, N, H, S, P analysers; Instrumented Rolling Mill; A HIP; Mechanical Testing Units UTM; Hardness, Fatigue and creep testers; Physical Testing - Reststometry; dilatometry and Magnetometer; Automatic Image analyser; Workshop facilities and Non destructive testing facilities;
Mining Engineering	Equipment required for Geotechnical Engineering, Mine surveying and Mining Machinery laboratories.
Naval Architecture	State-of-the-art wave basin; Equipment for hydrodynamics and structures laboratories; Ocean Research Ship
Physics	D.C. and A.C. magnetic measurement apparatus; Cryocoding system with temp. Controller; RF/LF Impedance analyser; X-ray diffractometer with accessories; Photo luminescence spectrometer; Raman laser spectrometer; Excited state life time measuring system; Ti-Saphire laser; Fabry-Perot interferometer; Laser annealing of thin fim; INSAT receiver; R.A.S.S. (Radio Acoustic sounding system).
Rubber Technology	Rubber Extruder; Laboratory Banbury Mixer; Vulcanising Press; Brookfield Viscometer and equipment for latex laboratory
Rural Development Centre	Workshops for training and Farm and nursery development including provision of water for irrigation
Biotechnology	Equipment and Accessories for Engineering/r DNA technology, food and fermentation technology; immunotechnology; plant cell culture technology laboratories
Telecommunications & Networking	Transmission Analysers and Measuring Equipment; switching equipment; wireless communication systems; Data communications and protocol analysers; multimedia work stations
Education Technology	SONY Video CameraDXC-637PM; UMATIC?betacam VTR; Monitors, Mixers, control equipment; Pentium based multimedia workstations with MPEG-2 coder. softwaretools ..... *Continued on next page*

Table - 5	*.....Continued from previous page*
Department	**New Equipment and Facilities to be added**
Central Research Facility	Scanning Electron Microscope and Energy Dispersive X-ray Micro Analyser including Gold and Carbon Coating Units; Twin Anode XPS with SIMS attachment; Energy Dispersive X-ray Microanalyser attachment for TEM; Fibre Characterisation machine; Computer Aided Controller with real time interface for INSTRON.; Electron Probe Micro Analyser; Time resolved Fluorescence Spectral System
Central Workshops + Cwiss	Special purpose machine tools; non conventional machining units; CNC systems; precision measuring equipment's; Training equipment for fabrication, Robotised welding, machining etc copying lathe, 4th axis drive for Machining Centre; ulstosonic flaw detector; Optical microscope, x-y table and fixtures for plasma spraying system; Spot and seam resistance welding machine; workstation
Library	CDROM databases; Computers; communications; Networking and on-line access facilities CD writer and associated software. 64 bit processor
General requirements	Teaching aids, Projectors and projection facilities; computers and enlarging facilities for class room requirements

Video based distance education centre

IIT Kharagpur proposes to establish a strong video based distance education centre through which its faculty can impart specialised training to the personnel of various educational institutions, R&D organisations and Industries in advanced areas of Science and Technology. To start with these will take the shape of short term training modules which can eventually be upgraded to **credit based Masters' Programmes.** In addition to increasing the accessibility of the wealth of the IIT resources to the off campus personnel, these programmes are expected to generate an ever expanding continual revenue. This will also require the establishment of multimedia laboratories, high speed and high bandwidth network facilities along with satellite connectivity.

4. RESEARCH & DEVELOPMENT - CONSOLIDATION, AUGMENTATION & NEW INITIATIVES

Sponsored research and industrial consultancy

Considering the escalating costs of higher education and research in modern science and technology, emphasis in the funding pattern of IITs has shifted more towards self reliance, generation of resources and active collaboration with industries and R&D organisations. During the course of the Eighth Plan the IITs have been operating under a revised funding pattern with a fixed block grant to each IIT. Additional needs were required to be met by resources generated by the IITs. IIT Kharagpur has already embarked successfully on this enterprise and generated considerable funds through its Sponsored Research and Industrial Consultancy activity.

The Institute has entered into an MoU with OPTEL Telecommunications Ltd. to set up The Optel-IIT Research Centre for research, development and consultancy work in the design and manufacture of special/active optical fibres. IIT Kharagpur has also entered into MoUs with an Usha Martin Subsidiary for technical collaboration in Computational Fluid Dynamics and Structural Analysis; with the International Rice Research Institute to implement the regional version of the IRRI designed Engineering for Rice Agricultural Course (ERAC) in India; and with the National Research Development Corporation for Transfer of Technology.

The Centre for Rural Development has several Sponsored Research and Consultancy Projects. Their thrust is in work relating to Socio-Economic Factors, Transfer of Technology and generating Environment Awareness. Typical among the projects are :Participatory Forest Management, Dechloriphication of betel leaves, Horticulture Development in West

Bengal etc. These projects are funded by Ford Foundation, FAO, DST, and Ministries of Social Welfare and Non-Conventional Energy.

Thus the range of institutions with which the faculty of IIT Kharagpur has sponsored research projects is very wide. These include the ARDB, MHRD, ICAR, FCI, WBSEB, DoE, INSA, IOC, NSTL, DRDO, DST, CSIR, ITI, CGCRI, CMRI and AICTE in the public sector. IIT Kharagpur also interacts with organisations in the private sector such as Du PONT, Tata Steel, Power Grid Corporation of India Ltd., Grindwel Norton, Antifriction Bearings Corporation, Optel, Hind Motor etc. The total amount procured by the faculty in these projects during the last year exceeds Rs. 50 million. Our consultancy earnings for this year have exceeded the Rs. 10 million mark. Some of the major consultancy jobs are : Evaluation of surface and ground water potential for Jalpaiguri district, Quality control investigation of building materials, Geo-physicohydrological studies in river basins, Construction of biogas plant, Analysis and design of detection systems, Effective utilisation of iron and steel scrap, Yield improvement studies in Steel making, Design of stope pillars, Implementation of cosmopackage, Software for sea keeping etc.

Typical areas of our sponsored research are: Aircraft structural elements with flaws, Electromagnetic fields around torpedoes, Real time digital simulators for power systems, Antennae for Satellite Mobile Earth Station, Satellite imagery, Ship design, Cryogenic turbines, Semiconductor lasers, Fibre optics, Rubber, Polymer and Ceramics, Laser heat treatment, etc. Among the other collaborative and consultative areas are : Development of Santiniketan-Sriniketan, Preservation of Lord Jagannath Temple at Puri, and Dakshineswar Temple at Calcutta, Multimedia presentation of tourist information for the Government of Sikkim, Development of environmental data bank for the Asansol area of Coal India Ltd., Ocean

wave induced forces on off-shore and coastal structures, invitro production of sandalwood seedlings, and preparation and characterisation of nanoparticles of ceramics. The Jawaharlal Nehru Centre for Advanced Scientific Research and the Rajiv Gandhi Foundation have also sponsored studies on the visibility properties of polygons with applications to illumination modelling. In order to bring these efforts to the take off stage IIT Kharagpur requires development of firm infrastructural foundations such as connectivity to internet through high speed, high bandwidth connecting links, electronic library, modern communication facilities like telephone and Fax services etc. These needs are projected in Sections 5 and 7 while the equipment and facility needs to make this sponsored research activity productive has been listed under Section 2 which is about Modernisation and Upgradation of Existing Facilities.

Extension Centres

In order to bring the expertise of IIT Kharagpur within easy reach of industry clusters and other interested groups, and liaise with them in providing consultancy services and continuing education programmes, it is proposed to set up a number of extension centres during the Ninth Plan period. Calcutta already has an IIT Kharagpur extension centre, and another is being set up at Bhubaneswar. Successful working of such centres require network accessibility and pathways of communications besides creation of basic facilities such as conference hall, guest rooms etc.

NEW INITIATIVES

Joint ventures

IIT Kharagpur has been the trail blazer in the establishment Joint Ventures for production, Research and Development and Consultancy Services with several organisations for the benefit of both . These Joint Ventures have been in a wide variety of areas such as Software Development, Fibre Optics, Floriculture, Simulation, Financial Management Services etc. (Please see **Table - 6**) It is envisaged that during the Ninth Plan there will be a manifold increase in such Joint Ventures coordinated by the Technology Foundation, SRIC and STEP. The various infrastructural facilities mentioned earlier will go a long way to bring these efforts to fruition.

Table - 6

S.No	Orgainisation with which tie-up has been made	Joint Venture Objectives
1	Hortind Technology Ltd	To establish Horticulture projects for cultivating cut flowers, ornamental and aromatic plants for the purpose of export.
2	Mastek Limited	Mastek shall participate in B.Tech., M.Tech. & MBM courses on data base management and will held at IIT Kharagpur in the laboratory teaching on INGRESS. Mastek and IIT shall jointly take up software development projects and other aspects connected with data base management.
3	Optel - IIT	Optel-IIT will convert the Fibre Optics facilities available at CRF, IIT KGP into a joint venture "Optel-IIT Fibre Optics R&D Centre, Kharagpur". Also to develop special grade preforms and optical fibre and carry out other R&D activities related to the Optical Fibre Technology. To provide consultancy services to other R&D organisations besides promoting a strong academy-industry interaction.
4	Pressman Financial Services	Financial and management services
5	Price Water House	Auditing and management services.
6	R. P. Lahiri & Associate (RPLA), New Delhi	To take up projects jointly with IIT KGP in areas like project management, quality management, marketing, projects related to environmental issues, infrastructure development and other R&D activities.

7	Rawatsons Engineers Pvt. Ltd., Calcutta	To promote a new company "SimTech Ltd."; (ii) School of Simulation Studies to popularise application of simulator and simulation technology and related R&D wo
8	Spearhead Consultants & Evaluators Pvt. Ltd., Calcutta	To set up an Energy Audit and Power Research School. The school will carry out research, analysis, feasibility studies besides bringing out publications in these areas.
9	Technology & Management Consultants, New Delhi	IIT KGP and TMC will take up joint R&D activities relating to waste land development, environment engineering, rural development, solar energy, mini-hydel projects etc.
10	Usha Beltron Limited	UBEST will collaborate with IIT KGP in the areas of software development and marketing, electro-magnetic and its applications.
11	VEDIKA International Pvt. Ltd	A Web server will be set up overseas which offers fast reliable connectivity to the internet. The Web server will host multiple database on India, Indian business, government agencies, R&D sectors, etc.

Technology Development Missions

IIT Kharagpur is participating in four Technology Development and Transfer Missions with grants of over Rs. 10 crores from the Planning Commission. These are: Computer Networking and Intelligent Automation, Photonics, Genetic Engineering and Biotechnology, and Food Process Engineering. Table - 7 shows the Industries with which MoUs have been signed in connections with the TDMs. New proposals for the Technology Missions along with fund requirements are shown in Annexure IV. These fund requirements are exclusive for the TDMs and are as such to be added to the Total Fund Requirements projected on pages.

Table - 7

S.No	Companies with which TDM tie -ups are established
1	Balmer Lawrie & Co. Calcutta
2	Crompton Greaves Ltd. Bombay
3	Grain Processing Industries (I) Pvt.Ltd., Calcutta
4	Indian Telephone Industries Ltd., Bangalore
5	Indus Food Products & Equipment Ltd., Calcutta
6	N. V. Industries (P) Ltd., Calcutta
8	Research & Development Centre for Iron & Steel, Ranchi
9	Steel Authority of India Ltd., Ranch
10	Tarsons Products, Calcutta
11	Tata Consultancy Services, Bombay
12	Tata Limited , Calcutta
13	Tata Iron and Steel Co. Jamshedpur
14	Triveni Food Products, Calcutta

5. COMPUTING AND NETWORK REQUIREMENTS

Modern Local Area Network

The need for a modern high speed computer network with broad band width has become very acute. This is expected to provide ever increasing demand for computing power at every desktop, access to worldwide information sources, multimedia communication for research and distant education, access to electronic library, cooperative/multidisciplinary/ multi-institutional developmental projects spanning different departments, Institutes, Industries and even nations. IIT Kharagpur has worked out a complete plan for a state-of-the-art ATM network comprising of three phases. The first phase is to create a Institute wide backbone on fibre. The second and third phase will consist of creation of intra-departmental networks and providing the front end accessing devices (about 1000 nodes including PCs, terminals etc.).

Network Access at Hostels

Round the clock access to Computing and Network services and facilities has become a part of the necessary infrastructure for education at both postgraduate and undergraduate levels. In order to allow wide access to these facilities created centrally and operated round the clock, it is proposed that terminals be provided in the students' hostels so that they can access the computing facilities, the electronic library, the Internet services, on-line classroom etc.

Realising the urgency of the project, the Institute has already gone ahead with the first phase at a cost of Rs. 1.8 crores. However, the second and third phases (extending the network to all departments, hostels etc. and providing the appropriate front-ends at all necessary places) of the job has to be financed from the grant from the Ninth Plan and the expected expenditure for this is included under Total Fund Requirements shown later.

Central Compute/File Servers

The Central Computing needs of the Institute was being served by an old CYBER 180 system which was in operation from 1984. This system has now been phased out as the system is now obsolete and the running cost of the system is very high. Currently the Institute has only two small servers as central facility and two more are being procured to tide over the present situation. However this is grossly inadequate, and to meet the ever increasing demand for computational power even for undergraduate and postgraduate education, to give Institute-wide support to cutting edge research and development and to fully utilise the high speed LAN which is being set up, high end servers need to be deployed.

The central computing facility is expected to cater to about 3000 to 4000 users, with about 600 to 1000 users using the system(s) at any given time. Considering the changed technological scenario, it is desirable to replace a single central big machine by a number of systems. For general computational needs, it is proposed to procure two to four mid to high end servers with four to eight processors, symmetric multiprocessing capabilities and 256 MB to 1 GB memory in each. For handling problems which need very high floating pint computational capabilities, a parallel processing machine with parallelizing compilers is proposed to be procured. For file servers, two to four machines are suggested for procurement with 16 to 32 GB disk space in each.. For name servers and other services, four to six small machines are to be employed.

Central Workstation Laboratory

The Institute has been considering the setting up of a Central Workstation Laboratory for quite sometime for the use of UG and PG students. The Laboratory is expected to cater to the needs for UNIX based platforms using C-Language, X-Windows and Computer Graphics. The proposed Laboratory will provide (i) UNIX and Graphics Lab facilities to undergraduate and postgraduate students; (ii) Graphics platform for receiving/sending multimedia through the upcoming Computer Network; (iii) UNIX and graphics facilities to research scholars and research workers; (iv) laboratory facilities for higher level short term courses as continuing education programmes and corporate training programmes which may be offered by various Departments and Centres of the Institute. It is, therefore, necessary to have a Workstation Laboratory comprising of 40 Workstations - 10 of these will have **64 MB RAM, 2 GB**

HDD and 19" colour monitor while the other 30 may have **32/64 MB RAM, 1 GB HDD** and 15"/17" colour monitor.

Modernisation of the PC Laboratory

This Laboratory has been set up in 1987 and has 50 PC-XTs. It needs modernisation to give it a fresh lease of life as well as to allow the first year students an exposure to windows environment and various softwares under it. The First year **Introduction to Computing** course and the Second year **Programming and Data Structure** course which are taken by students of all disciplines. Besides the PCs the laboratory requires heavy duty printers etc.

Central Library with Computerisation and Network Facilities

IIT Kharagpur has an excellent library with an yearly budget exceeding Rs. 150 lakhs **excluding salaries and overheads**. The costs of books and journals are increasing to such an extent that it is becoming practically impossible to allot the required amounts of money to cope with the demand for journals and books. If a good level of service is to maintained at the library, its budget has to keep pace with the rising cost of journals and books. It is evident that if the resources do not meet the aspirations other sources of funding have to be explored.

In addition to the resources crunch, there is also the problem of ever increasing size of library holdings, requiring larger and larger space, difficulties of maintaining catalogues, efficient system of issue and retum, information retrieval and problems associated with purchase of books and journals. The volume of material published all over the world is increasing at such an enormous rate that it would be impossible to

physically browse through the technical journals of interest and keep abreast of the developments in one's field of specialization.

With the implementation of previous MHRD project for **Modernization and Automation of Library**, a book database of nearly 2 lakh volumes housed in the library has already been developed. Besides all the services (typical to big libraries) have been computerised as part of library automation and all the users are familiarised with these computerised services. Presently two 486 based Pcs and one EISA 486 minicomputer with 1 GB HDD etc are supporting this activity. A few softwares have been developed in-house and one commercial software acquired to augment library operations and facilities.

A massive effort is required to modernise the present library in order that the users make the best utilisation of library resources. Creation of CD-ROM library based upon a good collection of database and networking will make the whole operation very compact, and very efficient to use. This will result in better utilization of existing sources, faster retrieval of information available in the library and considerable saving of storage space with the consequent saving of building extensions. The project's focus is to dramatically advance the means to collect, store and organise information in digital forms and make it available for searching retrieval via communication networks - all in users friendly way. Besides, through the use of Campus LAN the library computer system is being made available to any location in the Institute and to any location in the world using INTERNET via ERNET.

For all this very soon the computing systems provided in the library have to be replaced by servers with high processing speed and large memory for which money is to be provided under Ninth Plan and the estimates are given in the Annexures I and II.

6. LINKAGES WITH INTERNATIONAL INSTITUTIONS

The Institute also has ongoing international collaborations with M/s. Volkswagen Stiftung, Germany, Queens University at Belfast, University of Tokyo, University of Bologna, Italy, Voronezh State University, Russia, University of Western Ontario, Canada, IBM and Hewlett Packard. The Department of Chemistry has collaborative projects with Du Pont and is negotiating with Overseas(USA) R&D Laboratories for another project. The Department of Mechanical Engineering is likely to have collaboration with Department of Machine Tools and Production Engineering of University of Hannover. Germany and with European System Simulation Society on Simulation of Systems. The Department of Metallurgical Engineering wants to develop collaboration with US Naval Research Labs on solubility of phases in HSLA-100 and with University of Stuttgart on Laser surface modification and with Bremen on Nanocrystalline materials by mechanical alloys with New South Wales University of Australia on Composites. The Rubber Technology Centre is developing research contacts with universities in France and US. Similarly the Aerospace Engineering Department has contacts with University of Osaka and Texas A&M. Several other Departments too have their proposals at different stages of negotiation. The fund requirement under Ninth Plan for developing these proposals into projects and tie-ups is indicated in Annexure II.

7. INFRASTRUCTURE REQUIREMENTS

The proposed doubling of student population in the Ninth Plans places the following demands on the infrastructure of IIT Kharagpur.

1. Extra class rooms for large student strength (80 or more) in the main building
2. Extra class rooms in the Departments/ Centres
3. Extra laboratory space in Department and Centres
4. Additional faculty and supporting staff accommodation in view of increase in the numbers of both.

Besides the 45 year old IIT Campus needs immediate attention concerning:

1. Renovation of faculty and supporting staff quarters ,
2. Renovation of Hostels
3. Repairs and Augmentation to the Electricity and Water supply systems
4. Repairs and Augmentation to the existing health care facility
5. Repairs and Augmentation to the Gymkhana and Playgrounds
6. Maintenance of Campus Roads, Parks, Service Centres such as market etc.
7. Augmentation of existing telephone, Fax, e-mail services

Fund requirement under Ninth Plan for these and others is shown in Annexure-III

8. TOTAL REQUIREMENTS OF FUNDS

The **vision** for the Ninth Plan envisaged above has been collated from the responses received from the various Departments and Centres of IIT, Kharagpur. The fund requirements for the successful implementation of these proposals, which amount to **Rs 20500 lacs,** have been projected in two different ways:

1. Fund requirements under New Academic Programmes ,Modernisation and upgrading of existing facilities, Research and Development, Computing and Networking requirements, Linkages with international institutions, and Infrastructural requirements (shown in Table - 8)
2. Fund requirements at the Departmental/Sections level and Fund requirements for Infrastructural needs. (Shown in Table - 9)

The items under the main heads in both these Tables are further broken up into several subheads whose details are shown in Annexures I, II and III. These include fund requirements for removal of obsolescence and creation of new infrastructure.

Table - 8

Indian Institute of Technology, Kharagpur

Consolidated Fund requirement during Ninth Plan

Item No	Main Head	Fund Requirement (lacs of rupees)
1	New Academic Programmes in the Departments and Centres and in thrust areas	5720
2	Modernisation and Upgrading of Existing Facilities	4050
3	Research and Development	3980
4	Computing and Networking Requirements	735
5	Linkages with International Institutions	85
6	Infrastructural Requirements	5930
Grand Total of Fund Requirement during Ninth Plan (lacs of rupees)		20500
Fund required for the Four TDM Proposals (For details please see Annexure IV)		456.6
Grand Total including the TDM projects		20956.3

The detailed breakup of Items No. 1-6 is shown in Annexure I

Table - 9

Indian Institute of Technology, Kharagpur

Consolidated Fund requirement during Ninth Plan

Item No	Main Head	Fund Requirement (lacs of rupees)
1	Requirement at the Departmental/Sections level (excluding construction needs)	10000
2	Infrastructural needs, and funds for additional faculty and supporting staff (recurring expenses capitalised).	10500
Grand Total of Fund Requirement during Ninth Plan (lacs of rupees)		20500
Fund required for the Four TDM Proposals (For Details please see Annexure IV)		456.6
Grand Total including the TDM projects		20956.3

The details of breakup of Items No. 1 - 2 are shown in Annexures II and III

9. CONCLUDING REMARKS

This document embodies a vision of the IIT Kharagpur and its expanding role during the ninth plan. The focal points are :doubling of student strength, introduction of new academic programmes with emphasis on dual degree programmes, phasing out of dated academic programmes, more efficient utilization of resources through formation of a cluster of Departments etc.

A new direction is envisaged for the growth of Research and Development activities which ensures that IIT Kharagpur would be able to generate a much larger share of its needs from Sponsored Research and Consultancy Activities. Some new concepts which facilitate this mobilization are : **Joint Ventures, Extension Centres, Video-Based Distance Education, etc.**

It is hoped that with these emphasis adjustments, IIT Kharagpur would be able to achieve a larger measure of self-reliance with a much keener Institute-Industry interaction.

ANNEXURE I

Indian Institute of Technology, Kharagpur

Detailed Breakup of Consolidated Fund requirement during Ninth Plan

Item No	Main Head	Sub Heads Item	amount (lacs of rupees)	Fund Requirement (lacs of rupees)
1	New Academic Programmes in the Departments and Centres and in thrust areas	**New Academic Programmes at the Masters and Integrated 5 and half year level Projected student strength of 6000** ❶ Faculty and supporting staff needs for new academic programmes as well as for increased student population.(all recurring expenses have been capitalised and shown) ❷ Cost of additional class rooms and laboratories Centres of excellence in thrust areas (Environment, Biotechnology, Telecommunications and Networking, Education Technology, Engineering Design (most part of this could also go under R&D head but it is included here considering the importance of education in these areas) ❺ Cost of buildings: ❻ Cost of Equipment and Facilities:	3720 600 500 900	**5720**
2	Modernisation and Upgrading of Existing Facilities	❶ Removal of Obsolescence in various departments and Central facilities for Teaching and Research and Consultancy ❷ Upgrading/Acquisition of new facilities	750 3300	**4050**
3	Research and Development	❶ Removal of obsolescence in Central Research facility and Central Workshops ❷ Provision of Computing Equipment at Departmental level (used mainly for research) ❸ Provision of new equipment and facilities at CRF & CWISS ❹ Upgrading/Acquisition of new facilities in Departments /Centres (For Research and Consultancy needs) ❺ Provision for additional Journals & books in library during 9th plan	130 100 500 3000 250	**3980**

.....Continued on the next page

		.....Continued from the previous page		
Item No	**Main Head**	**Sub Heads** Item	amount (lacs of Rs)	**Fund Requirement** (lacs of rupees)
4	**Computing and Networking Requirements**	❶ Addition of new systems at central and departmental levels ❷ Establishment of Network ❸ Establishment of front ends for the users.	335 300 100	**735**
5	**Linkages with International Institutions**	❶ Funds required to pursue the international linkages mainly needed for Research and Consultancy	85	**85**
6	**Infrastructural Requirements**	❶ Construction of new hostels to accommodate 3000 more students ❷ Repair and renovation of existing student hostels ❸ Repair and renovation of student Gymkhana and play grounds ❹ Repair and renovation of existing faculty accommodation ❺ Creation of accommodation for 150 more faculty ❻ Additional water supply to augment the present 30 year system for the Campus ❼ Additional power supply system to take care of the increase load requirements ❽ Augmenting the existing health care facility ❾ Augmenting the existing Telephone exchange ❿ Automation of Registry with improved facilities in academic and administrative offices ❶❶Augmenting the Institute Sponsored Research Division with automation, provision of additional space and construction and publicity ❶❷Improving the campus facilities like parks, market, club, roads and also the prestigious Nehru Museum located inside the old IIT building.,	2250 700 600 400 600 200 200 100 200 200 200 280	**5930**
		Grand Total (lacs of rupees)		**20500**

Annexure II

Indian Institute of Technology, Kharagpur

Details of Requirements at the Departmental/Sections Level

Department /Centre / Facility	New Equipment	Obsolescence Removal	Computer Facilities	Foreign Collaboration
Aerospace Engineering	250	40	15	-
Agricultural & Food Engg	300	40	20	10
Architecture & R Planning	200	10	20	-
Chemical Engineering	300	40	20	-
Chemistry	200	20	10	-
Civil Engineering	300	40	20	-
Computer Sc.& Engineering	300	40	25	15
Computer Centre	150	30	15	-
Cryogenic Engineering	150	20	5	10
Electrical Engineering	550	55	20	-
Electronics & Comm. Engg.	550	55	20	10
Geology &Geophysics	200	20	10	-
Humanities & Soc. Sciences	50	10	5	-
Industrial Engineering	100	10	15	-
Reliability Engineering	100	10	5	-
Material Science	150	20	5	-
Mathematics	150	10	15	-
Mechanical Engineering	550	60	20	15
Metallurgical Engineering	300	40	10	-
Mining Engineering	300	35	5	-
Naval Architecture	300	40	10	15
Physics	300	45	10	-
Rubber Technology	150	10	5	5
Rural Development Centre	50	5	5	-
Biotechnology	200	5	10	5
Telecommunications & Networking	100	-	20	-
Education Technology	200	10	10	-
Central Research Facility	350	80	10	-
Central Workshops + Cwiss	150	50	-	-
Library	100	20	30	-
Gymkhana	600	-	-	-
Hall Management Council	700	10	50	-
General requirements(Dn - ac)	150	-	-	-
Total (lacs of Rupees)	8600	880	435	85
	Grand Total (lacs of Rupees)			10000

ANNEXURE III

Indian Institute of Technology, Kharagpur

Details of Requirements for Infrastructural Needs etc.

S.No	Item	Fund Requirement (in lacs of rupees)
1.	For 10 central class rooms with furniture to take care of the needs of doubling the student strength. Total area of the 10 class rooms of 40x60 sft each will be 24000 sft. At the rate of Rs 500 per sft this amounts to-	120
2.	For additional 100 class rooms+laboratories (of 1200 sft each) in the Depa -rtments/Centres to cater to the increased student strength. The total con-struction area is 120000 sft & at a cost of Rs 400 per sft this amounts to-	480
3	Construction requirement to house the thrust area centres viz Schools of Biotechnology, Telecommunications and Networking, Environmental Engg, Education Technology, and Engineering Design	500
4.	Additional resources needed (for Laboratories) to set up School of Environment and School of Bio-technology	400
5.	Strengthening the SRICC, staff, space, publicity activities etc	200
6.	Automation in the Institute administrative sections	200
7.	Student hostels to accommodate additional 3000 students at Rs 1.5 lac per room (total 1500 rooms) including furniture	2250
8.	Faculty Accommodation for extra 150 faculty at Rs 4 lac for each apartment	600
9.	Augmenting the Telephone Exchange with 800 additional lines	200
10.	Water supply to the Campus - For additional Well in the river bed located 10 km away from the Campus	200
11.	Electric supply to the Campus- Changes required in view of the large increase in consumption due to addition of labs, workshops, class rooms, quarters, etc	200
12.	High Speed Network extending to all the Departments Centres, and Student Hostels with appropriate front ends	400
13.	Augmenting the existing Health Care facility	100
14.	Repair and renovation of Faculty and employee quarters, water and electricity and sewer systems	400
15.	Community facilities (parks, markets , roads, museum etc)	280
16.	Additional faculty at faculty student ratio of 1: 9 at least 150 additional faculty would be needed. At Rs 14,000 salary + Rs 14, 000 overheads per month total 5 year requirement is ---	2520
17..	Addition of 100 supporting staff at senior level at a salary of Rs. 10,000 per month and 100% overheads total 5 year requirement is -	1200
18.	Additional grant to library for procurement of Journals and Books at the rate of Rs 50 lacs per year for 5 years)	250
	Grand Total (lacs of Rupees)	**10500**

Annexure IV

TDM Proposals

S.No	Proposal	Fund Requirement in lacs of rupees
1	Nano materials and Nanotechnology	124.8
2	Development of Technology for the Manufacture of Al-Ti-B Master Alloys	71.5
3	Industrial Gases	200
4	Microprocessor based Control system for Tractors	60
Total Fund Requirement (in lacs of Rupees)		**456.3**

TDM PROPOSAL FOR NANO MATERIALS AND NANOTECHNOLOGY

Objectives

Development of production process for synthesis of nanosized powders of the following systems and nanocomposites for the different end uses mentioned there in:

a) Nanometer sized alumina for fabrication of (I) transparent ceramics for use in high power rf tubes, radomes, (ii) substrates and (iii) flexible ceramic bodies

b) Nanometer sized stabilised zirconia for use as (I) flexible ceramics, (I) substrates for the electronic industry

c) Toughened alumina and zirconiafibers with nano sized grains for fabrication of tiles to be used as high strength high temperature insulation materials of re-entry vehicles

d) Aiumina-zirconia nanocomposites for structural application

e) Nanometer sized PZT and PLZT powders for use as transparent ceramics for optoelectronic applications

f) Toughened adhesives using polymer matrix ceramic nanocomposites for structural adhesive applications.

Project Leader : Dr. D. Bhattacharya, Materials Science Centre

Team Members : Prof. M. Chakraborty (Dept of Met. & Mat. Engg)
Prof. P. Pramanik (Dept of Chemistry)
Prof. A. K. Banthia, (Materials Science Centre)

Relevance to the needs of the country and organisations which will be interested in the project

1. Nanomaterials and nanocomposites are very high value added technologies which are the sole preserve of only a few countries and licensing of the technology to other countries will not be allowed even in distant future.
2. Such materials are to find their use in near future in defense, nuclear and space applications. Their spill over to civilian fields are still far aware even in the Japan, USA or Germany.
3. The industries which will be interested in the technology transfer are those which are closely associated with BARC, ISRO, DRDO, DOE etc.

In the area of densified nano ceramics the organisations are :

a) M/s. Associated Cement Co. Ltd., Bombay who have already expressed their desire to cooperate with us in future depending on the nature and extent of technology developed.
b) M/s. Sandvik Asia, Pune
c) M/s. Widia (India) Ltd., Bangalore
d) M/s. Grindwell Norton, Bangalore
e) M/s. Webel Electroceramics Ltd., Calcutta

In the area of toughened plastics and structural adhesives :

a) M/s. Cibatul Giegy, Bombay
b) M/s. Dr. Reddy's Laboratory, Bombay
c) M/s. Bata India Ltd., Calcutta
d) M/s. Dr. Beck's Laboratory, Bombay
e) M/s. Pidilite Industries, Bombay

The following areas are proposed to be undertaken during the project :

A) Scale up of production process of nano sized oxide ceramic powders and fibers of the systems stated above in objective. These powders can be processed to yield the desired densified products. Depending on the requirement of the particular industry, fabrication of densified bodies from these powders for specific application may be also taken up.

B) The nano-sized ceramic powders will be used to fabricate polymer matrix toughened adhesives which when cured form composites (PMCs) for various applications which involves - (i) Scale up synthesis of polymers like low molecular weight DGEBA or NOVOLAC which are liquid polymers and can be blended with nano sized ceramic powders; (ii) Scale up of the said polymer matrix ceramic composites using nano-ceramic powders or fibres will be undertaken for various specialty applications like structural materials, adhesives applications.

Review of expertise available with group :

The Indian investigators have a long standing interest in the area of synthesis and characterization of nanophase materials. The group has

patented the synthesis of 10 nm sized powders of alumina, stabilized zirconia, barium titanate, lead lanthanum zirconate, magnesium aluminate, ferrites, coloured powder coatings for automobiles at temperatures not exceeding 350°C. Technology for synthesis of nano-sized magnesium aluminate hydrate for refractory binder applications has been transferred to M/s. Associated Cement Cos. Ltd., Bombay. U.S. Army is collaborating on a project for development of laboratory synthesis process of 5 to 10 nm sized spinel powders and scaling up of the process. Ceramic fibres (with diameter not exceeding 100 nm) have been synthesized by pyrolysis of polymeric fibres by a process to be patented shortly. Microwave absorbing paints and acrylic paints have been also developed and the technology has been transferred.

Time period of completion : 5 years

Available infrastructure :

1. UHV compatible Scanning Tunneling Microscope for characterisation of the nanoceramics
2. Facility for measurement of electrical and magnetic properties upto 10K
3. Surface profilometer
4. Plasma torch for plasma spray deposition of coatings
5. Ceramic processing facilities like furnaces (upto 1400°C), planetary ball mills etc.
6. Microwave processing facility
7. Polymer synthesis and characterisation facility like, IR, NMR, UV-vis spectrophotometers etc.
8. DSC, DTA/TGA/TMA for evaluation of thermochemical and thermomechanical properties
9. Minimat tester for stress-strain adhesion test etc.
10. Atomic absorption spectrophotometer.

In the Institute as Central Facility :

1) EM-301 Transmission Electron Microscope, 2) ESCA/Auger system, 3) Scanning Electron Microscope with EDAX, 4) X-ray diffractometer, 5) Instron testing machine, 6) Microhardness tester, 7) Inductively couples plasma, 8) Brookefield viscometer.

Equipment to be procured in the year 1996-97 :

1. Hot isostatic press (1700°c) : Rs. 30.0 lakhs in FE
2. Top loading balance : Rs. 1.0 lakh
3. Ultrasonic agitator : Rs. 1.0 lakh

Total for equipment : Rs. 32 lakhs

Accessories to be procured in the year 1996-97 :

1. Attachments for spectrophotometers : Rs. 3.0 lakhs in FE
2. Attachments for DSC/DTA/TGA/TMA : Rs. 3.0 lakhs in FE
3. Attachments for Instron (grips for ceramics and composites) : Rs. 1.0 lakhs in FE
4. Steel reaction vessels, stirrers, collector cyclones etc. : Rs. 3.0 lakhs

Total for accessories : Rs. 10.0 lakhs

Consumables required over the project period :

1. SiC, $MoSi_2$ heating elements : Rs. 2.0 lakhs
2. Recrystallised alumina tubes, crucibles : Rs. 4.0 lakhs in FE
3. Quartz ware : Rs. 4.0 lakhs in FE
4. Chemicals for synthesis of nanoceramics (Rs. 2 lakhs per year) : Rs. 10.0 lakhs
5. Chemicals for synthesis of polymers (Rs. 1 lakh per year) : Rs. 5 lakhs
6. Gases for HIP, polymer synthesis and nano ceramic powder synthesis : Rs. 5.0 lakhs

7. Polishing medium and accessories	: Rs. 0.5 iakh
Total for consumables	: Rs. 30.5 lakhs
Contingencies : @ Rs. 1.0 lakh per year	: Rs. 5.0 lakhs
Staff : Contractual technical staff	: Rs. 16.0 lakhs
Operating cost for the period of project	: Rs. 5.0 lakhs
Testing charges for samples, infrastructure and library support, implementation measure @ Rs. 1 lakh per year	
Travel/meeting/symposia in the country and abroad for the period of project	Rs. 10.0 lakhs
Cost of the project	Rs. 108.5 lakhs
Overhead @ 15%	Rs. 16.3 lakhs
GRAND TOTAL COST OF PROJECT (Over 5 years)	**Rs. 124.8 lakhs**

Development of Technology for the Manufacture of Al-Ti-B Master Alloys for Grain Refinement of Al and its Alloys

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Principal Investigator : Prof M Chakraborty
Principal Co-Investigator: Dr B S Murty
Department of Metallurgical & Materials
Engineering, IIT,
Kharagpur 721 302

Preamble

Aluminium and its alloys find wide applications in various fields of engineering. These alloys are to be grain refined by a suitable grain refiner prior to casting to get various favourable properties in the final casting. Al-5Ti-1B master alloy is one such grain refiner, widely used to grain refine Al and its alloys in industries. Annually, very large tonnages of Al and its alloy castings are converted into useful components. As a result, requirement of grain refiners is high at any time.

Al-Ti-B group of master alloys are generally prepared by the chemical reaction of the molten Al with complex halide salts. The grain refining performance of these master alloys is highly sensitive to raw materials, process parameters, type of furnace and tools used during their production. It is due to this fact that the manufacture of a good Al-Ti-B master alloy is a very difficult process and can lead to wastage of lot of money and time if one

tries to produce this alloy without proper knowledge. In fact, in the world, very few companies like LSM Co Ltd., Anglo Blackwells Ltd., U.K. etc. are presently manufacturing these master alloys in the form of rods and ingots. Many countries are importing these grain refiners from UK and USA and India is no exception. Even though India has good resources of Ti and Al, it is still in the developmental stage in production of these master alloys. In fact, this is one of the area where India can save considerable foreign exchange by indigeneously developing the technology of manufacture of Al-Ti-B master alloys.

Objective

- Development of technology for the manufacture of fast acting, long lasting and economical Al-Ti-B master alloys as grain refiners of Al and its alloys in the form of ingots and rods on a large scale.

Target Industries

- Manufacturers of Al-Ti-B master alloys (trial based) and other type of grain refiners like NFTDC Hyderabad, Saru Aikoh Chemicals Pvt. Ltd., Meerut (collaboration with Aikoh chemicals Ltd., Japan)*, Foseco India Ltd., Pune etc.
- End users - Al and its Alloy based industries like INDAL, NALCO, BALCO, HINDALCO, Defence and Aerospace Industries (DMRL, Hyderabad), Ordnance Factory, Ambajagari etc.

*Has already agreed to work with us on this project.

Duration of the Project

3 Years

Existing Expertise at IIT Kharagpur

The Principal Investigator, Prof M Chakraborty is amongst the first in India to initiate research in the area of grain refinement of Al and its alloys. The pioneering work by his group under his able leadership has led to the basic understanding of the reactions between Al and halide salts that involved in the production of the Al-Ti-B master alloys. His group has the honour of having first international publications in this area. His group could successfully develop correlations between various process parameters involved in the production of Al-Ti-B master alloy with their grain refining efficiency. These correlatioins give vital clues to develop fast acting, long lasting grain refiners. In fact, the group has recently developed them on a laboratory scale. Keeping in view of the large scale demand in Al industries in India, the group is presently attempting to develop a technology for their mass production both in ingot and rod form. The group is also the first to identify the reasons for the poisoning effect of Cr, Zr and high Si on the grain refining response of Al alloys containing these elements. The group has the expertise required to suggest remedial measures to over come the poisoning effect of any element.

Existing Facilities at IIT Kharagpur

- All types of mechanical equipment for cutting ingots and machining purpose.
- Melting facilities include Pit type furnaces attached with good temperature controllers and induction furnaces (upto 5 Kg).
- Grain refining test mould and subsequent etchants.
- Metallography facilities.
- Characterisation facilities like XRD, optical microscopes, SEM/EDS, X-ray microanalyser, Image Analyser, TEM, ESCA, DTA/DSC etc.

New Facilities to be created

- Induction furnaces (25 Kg)
- Semi continous casting machine
- Quantovac analysis set up for chemical analysis

Proposed Budget (For 3 Years)

Manpower		
(1 Engineer + 1 Tech. Asst.)	:	2 lakhs/annum (2 x 3 = 6 lakhs)
Contigency/Consumables	:	2 lakhs/annum (2 x 3 = 6 lakhs)
Travel	:	1 lakh/annum (1 x 3 = 3 lakhs)
Equipment	:	50 lakhs
IIT Overhead	:	6.5 lakhs
Total Budget	:	71.5 lakhs

Technology Development Mission Project

Title: INDUSTRIAL GASES - Production, Transportation and Application

Justification:

Modern industrial processes consume a huge quantity of industrial gases, either as basic raw materials or as important intermediate products. Some of the major items in the category are:

1) Oxygen - Steel fertilizer, metallurgical furnaces, welding, hospitals, recketry etc.

2) Nitrogen - Fertilizer, chemical industry, electronic industry, biotechnology, food freezing.

3) Argon - Welding, ferrous and non-ferrous metallurgy.

4) Acytelene - Welding

5) Nitrous Oxide - Medical applications

6) Hydrogen - Petrochmicals, rocketry, future fuel.

7) Helium - Ocean engineering, atomic energy, superconducting magnets including medical applications.

8) Light Hydrocarbons (Natural gas) - Fuel, feedstock.

The national investment in this sector is in billions of rupees. Still, most of the technology used today is either obsolete or completely imported. As the country is experiencing a rapid growth in industrialization, the demand for these gases is increasing everyday. It is time to initiate a major programme for the development of indigenous technology in the field of industrial gases.

The necessary infrastructure in Cryogenic Engineering exists at IIT Kharagpur and a strong rapport has already been established with the Industry. Results of research are expected to be absorbed quickly.

The proposed project will cover:-

(1) Design of cryogenic process plants and selection of equipment.

(2) Development of major components - compressors, heat exchanger, expansion machines, purification and separation systems.

(3) Cryogenic storage and transport vessels.

(4) Development of equipment for application of industrial gases, in both liquid and gaseous forms - furnaces, electronic processing, chemical processing, food and biological applications, medical applications.

(5) Instrumentation and Safety

Budgetary Estimates:

Equipment and Instruments	:	Rs.120 lakhs
Staff	:	Rs. 20 lakhs
Infrastructural facilities	:	Rs. 20 lakhs
Recurring expenses	:	Rs. 40 lakhs
Total	:	Rs.200 lakhs

Collaborating Industries:

Several industries are keen to join hands with the Government in supporting research in this field. Among them are:

(1) M/s Superior Air Products, New Delhi.
(2) M/s Titan Engineering Company, Durgapur.
(3) The All India Industrial Gas Manufacturers' Assosication, New Delhi.

Investigators:

A team of faculty members of the Cryogenic Engineering Centre, led by:

Prof Sunil Sarangi
Professor & Head, Cryogenic Engineering Centre
IIT Kharagpur

Technology Development Mission Project

Title: Development of Microprocessor Based Control System for Farm Tractors

Justification

The design and performance of tractors have changed considerably since the first Nebraska Tractor Test, USA in 1911. Information available indicate that the tractors continue to have a greater power to mass ratio. Tractors sizes had also increased with increasing farm sizes in the beginning of the century. However, during the last two decades the situation has changed. There is a sharp decrease in the number of larger hp tractors made world over and India is no exception. Further, tractors made world over have some special features pertinent to their country's requirements. In the developing countries like India where fuel is a scarcity there has been a shift towards production of DI tractors which give fuel economy.

In the present scenario of fast industrialisation, the tractor Industries have also come into heavy scrutiny and the tractor manufacturers have started thinking about incorporating several modifications in their tractors. The present day consumer is more knowledgeable and demanding. The preference is towards faster moving tractors. Comfortable ride, less fuel expenditure, more choice of speeds, better matching of implements less vibration and noise pollution, efficient cooling and hydraulic system and above all more work output per unit time.

Furthermore, the level of tractor power losses are enormous from the crackshaft to the drawbar. There are several reasons for this, namely, loss in transmissions, heat losses in cooling and lubrication, hydraulic system and soil friction. Moreover it has been observed that farmer's more often than not operate their tractors at improper settings of the governer and a lower optimum transmission ratio. Therefore, an optimization is essential to obtain torque and fuel characteristics under all conditions of the tractor use. There are several factors which require consideration for efficient utilisation of all systems of the tractor keeping in view the safety, and welfare of the operator as well as higher work output from the tractor implement system.

Under the circumstances, the development of microprocessor based control systems for efficient operation of the farm tractor including sensing of the wheel slip, tractor fuel economy, ease of operation of the controls, minimum losses in the various systems, sufficient drawbar power, better matching of the implements to the power source are the envisaged results.

Budgetary Estimate

Equipment and instruments	:	30 lacs
Staff	:	10 lacs
Infrastructural facilities	:	10 lacs
Recurring expenditure	:	10 lacs
Total outlay		Rs. 60 lacs

Collaborating Industries

1. Eicher Tractors Ltd., Faridabad
2. Escorts Tractors Ltd., Faridabad
3. M & M Ltd. Mumbai
4. TAFE Ltd., Madras

Investigator: Dr V K Tewari
Asstt. Professor
Agril. & Food Engg. Deptt.
IIT Kharagpur 721 302.

NINTH PLAN PROPOSALS

INDIAN INSTITUTE OF TECHNOLOGY

MADRAS - 600 036

MAY 1996

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NINTH FIVE YEAR PLAN PROPOSAL

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

EXECUTIVE SUMMARY

IIT Madras is involved in three kinds of activities: teaching, research and broadly speaking, service activities. Major initiatives of significant thrust in all the above activities are envisaged during the Ninth Five Year Plan period. Efforts will also be made to consolidate existing strengths, eliminate weaknesses and initiate work in new and emerging areas, of social relevant and technological and scientific importance.

In order to develop and maintain the high standard of technical education in both the existing as well as new areas, it is essential that obsolete equipment in the laboratories be condemned and replaced by or up-dated to modern state-of-the-art versions. This modernisation/upgradation activity is envisaged in Core Laboratories, Undergraduate Laboratories, Postgraduate Laboratories and centralised Service Facilities.

It is proposed to achieve significant growth in the Research and Development activities of the Institute in a number of ways such as; consolidation, modernisation and augmentation of the already existing facilities, commissioning of new facilities, optimal exploitation of the Technology Development Missions carried out/completed in the Eighth Plan, starting of new Technology Missions in Nanotechnology, Software Engineering, Composite Materials Technology, Engineering Design, Advanced Manufacturing Engineering, Photonics etc., development of some new Centres in areas of national importance like Finite Element

Analysis, Computational Fluid Dynamics for Internal Flows, Signal Processing, Robotics, Construction Engineering and Management, Metallurgical Analysis for Creep and Related Processes and Knowledge based Systems and Development of a well structured mechanism for establishing research - specific international co-operation.

An essential requirement in this age of Information Technology is an integrated campus-wide networked environment for information exchange using high bandwidth ATM LAN supporting compute/file servers, high end compute servers, high performance graphics and multimedia equipment with point to point voice and video facilities. It is proposed to establish a Digital Library with computer networking to derive maximum benefit with a limited budget.

In the Ninth Plan period, it is proposed to strengthen the existing national and international linkages with academic as well as industrial organisations in India and abroad and establish new symbiotic linkages.

In order that Indian industry is globally competitive and meets the challenges of the next century, it must be supported by a large pool of young and bright engineers and scientists who have the aptitude and the motivation for developing innovative technologies and processes. IIT Madras proposes to increase both the UG and the PG output by about 60% through the existing programmes as well as new and innovative ones.

In particular, it is proposed to start a School of Management, a School of Information Technology and a separate programme on Environmental Technology and Management.

All the proposed activities have financial implications which are summarised in the following Table under six headings.

S.No.	Area	Budget estimate (Rs. in crores)
1	Modernisation	52.5
2	Research and Development	67.5
3.	Infrastructure including Networking	41.5
4.	National & International Linkages	23.5
5.	Teaching-related Programmes	30.0
6.	Recurring	26.0
	Total	241.0

NINTH FIVE YEAR PLAN PROPOSAL

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

I. PREAMBLE:

IIT Madras was started over thirty five years ago as an institution for providing excellent undergraduate education. The Post-graduate programmes followed soon after, while the institution also initiated research programmes leading to the Ph.D. degree in Science and Engineering by the mid-sixties. The funding from the Indian Government as well as the Federal Republic of Germany were generous. Nearly 80% of the infrastructure in terms of buildings in the Institute sector and 50% of the buildings in the hostel sector were built during this initial phase.

The Seventh Five Year Plan was the first organised attempt at a bottoms-up planning approach at IIT Madras. The major activity during the Seventh Plan period was the modernization of laboratories and removal of obsolescence. Industrial Consultancy and Sponsored Research began to assume importance as an integral part of IIT's activity, contributing significantly to funding of research at IIT-M. The Seventh Five Year Plan document requested financial support to the tune of Rs.2191 lakhs. The actual funds received were Rs.1500 lakhs. The plan targets were proportionately met.

The Eighth Plan was a period of great change. A new funding pattern for the IITs was introduced by the MHRD. The main feature was that the grants were frozen at the 1992-93 level with a marginal one-time increase of 10% to meet inflationary costs. Additional inputs were provided by the Planning Commission through the MHRD to carry out time-bound and

need-based research projects with active participation of industries and user agencies. These have been called Technology Development Mission projects where the deliverables are clearly identified in consultation with the industry and the user agencies. Of the eight generic areas approved by the Planning Commission, seven have been taken up under mission-mode with leadership provided by one of the other IIT/IIsc.

S.No	Area	Lead Institute
1.	Food Processing Engineering	IIT Bombay
2.	Integrated Design and Competitive Manufacturing	IIT Kanpur
3.	Photonic Devices and Technologies	IIT Delhi
4.	Energy Efficient Technologies	IIT Madras
5.	Communications, Networking and Intelligent Automation	IIT Kharagpur
6.	New Materials	IIT Madras
7.	Genetic Engineering and Biotechnology	IISc Bangalore

IIT Madras is the lead institution in the areas of New Materials and Energy Efficient Technologies and Devices. In the former area, projects relating to Polymers and Polymer Composites, Metal Matrix Composites and Magnetic Materials, for a total value of about 10 crores have been undertaken of which IIT Madras has a 40% share. In the latter area, projects to the tune of about 8 crores have been undertaken of which IIT Madras has a 75% share.

A new concept in the funding pattern during the eighth plan is the creation of a Corpus Fund with provision for a matching grant from the MHRD. IIT

Madras has so far created a Corpus Fund with its own contribution amounting to about Rs.2 crores.

IIT Madras is involved in three kinds of activities: teaching, research and broadly speaking, service activities. The last mentioned is in the form of interactions with industry by way of consultancy, and continuing education programmes for training and knowledge-upgradation of personnel working in the industry. Assistance to other Engineering and Science Colleges in the form of advice on curricular issues as well as by way of teacher training is also provided.

Major initiatives of significant thrust in all the above activities are envisaged during the Ninth Five Year Plan period. Efforts will also be made to consolidate existing strengths, eliminate weaknesses and initiate work in new and emerging areas of technological, scientific and social relevance/importance.

II. MODERNISATION AND UPGRADATION OF EXISTING FACILITIES

In order to develop and maintain the high standard of technical education in both the existing as well as new areas, it is essential that obsolete equipment in the laboratories be condemned and replaced by/up-dated to modern versions. This modernisation/upgradation activity is envisaged in four types of Laboratories and a Regional Instrumentation Facility:

- Core Laboratories which are mainly for first and second year undergraduate students and involve laboratories of the Science Departments as well as those of Civil, Mechanical and Electrical Engineering and Computer Science and Engineering Departments.

- Undergraduate Laboratories which include the laboratories of the third and fourth year B.Tech. programmes, and the M.Sc. programmes in all the Science Departments.
- Postgraduate Laboratories which cater to the M.Tech. programmes of the various Engineering departments and inter-disciplinary groups. These laboratories are also used by Ph.D. scholars. There are also several designated Science and Engineering laboratories which house specialised equipment and facilities. It is essential that all these laboratories are equipped with the latest versions of equipment to ensure teaching and R and D of internationally acceptable quality. While carrying out these modernising and upgradation activities the technological and scientific needs of the nation will be kept in mind.
- Central Facilities catering mainly to the research workers. Educational and Research activities at IIT Madras depend heavily upon a number of central facilities and support services, e.g., the Central Workshops, Design and Drafting facilities, Central Gas Supply Unit including the supply of cryogenic fluids like liquid Helium etc., and the Central Electronics Centre. The Central Workshops and the Central Electronics Centre will be modernised for optimal utilisation in the teaching as well as the training programmes. Drafting facilities will be completely modernised using both hardware and software inputs and computer graphics.
- The Regional Sophisticated Instrumentation Centre is a unique facility of IIT Madras which provides services in advanced instrumental and analytical techniques, not only for the students and researchers of IIT Madras, but also to those of the other academic institutions in the region. Some of the sophisticated analytical equipment housed in this Centre are old and need replacement with more modern versions.

There is also a need to acquire equipment in those new areas which are being identified for teaching and research.

III. RESEARCH AND DEVELOPMENT: CONSOLIDATION, AUGMENTATION AND NEW INITIATIVES

Many research activities of IIT Madras have good international reputation. It is proposed to achieve significant growth in the Research and Development activities of the Institute in a number of ways:

I. Consolidation, modernisation and augmentation of the already existing facilities where considerable expertise is available and where national and international reputation has been built up.

II. Commissioning of new facilities to start research in emerging areas and also increase the throughput of scholars and postgraduate degree holders to cater to the needs of the expanding Indian industries and Research and Development laboratories.

III. Optimal exploitation of the Technology Development Missions carried out/completed in the Eighth Plan to execute spin-off projects.

IV. Starting of new Technology Missions in Nanotechnology,Software Engineering, Composite Materials Technology, Engineering Design, Advanced Manufacturing Engineering, Photonics etc.

V. Development of some new Centres in areas of national importance to achieve visible success. Centre for Finite Element Analysis and Design, Computational Fluid Dynamics for Internal Flows, Signal Processing, Robotics, Construction Engineering and Management, Metallurgical Analysis for Creep and Related Processes and Knowledge Based Systems are under consideration.

VI. Another area in which research is expected to be started as a Thrust Area is Intelligent Structures and Processing which includes the development of new sensors and real-time response systems for on-line control of processes in the various engineering disciplines.

VII. Development of a well structured mechanism for establishing research - specific international co-operation in areas of strength as also in emerging areas. In this regard, the MoUs that have already been signed with Institutions in U.S.A, Japan, Germany, Singapore, Malaysia, Belgium, Malta and Austria may be mentioned. Mechanisms for accessing funds available with foreign agencies will also be put in place.

IV. COMPUTING, NETWORKING AND COMMUNICATION REQUIREMENTS

An essential requirement in this age of Information Technology is an integrated campus-wide networked environment for information exchange using high bandwidth ATM LAN supporting compute/file servers, high end compute servers, high performance graphics and multimedia equipment with point to point voice and video facilities.

A Central Workstation Laboratory is proposed to be set up to cater to the needs for UNIX based platforms using C-language X-windows and computer graphics. Heavy duty printers and other peripherals are also required with the PCs. It is essential to establish a Digital Library with computer networking to derive maximum benefit with a limited budget. Creation of a CD-ROM library based on a good collection of data bases is essential. The library computer system will be made accessible from different locations in IIT Madras through the campus LANs and also from any location in the world through the INTERNET.

V. LINKAGES - NATIONAL AND INTERNATIONAL

IIT Madras has intensive research interactions in different areas with ISRO, DRDO, IGCAR and many other national laboratories and agencies. IIT Madras has also entered into long-term agreement with National Institute of Ocean Technology (NIOT) for the promotion of

activities relating to ocean engineering coastal management, ocean energy exploitation etc. It is proposed to enter into active research collaboration with organisations like CECRI on Corrosion, CLRI on Effluent Treatment, SERC on Design of Structures, and CFTRI on Food Technology. Starting of joint ventures and establishment of technical firms based on know-how generated at IIT Madras through entrepreneurship programmes are also envisaged.

Industrial Consultancy and Sponsored Research activities have grown tremendously in the last few years. Our consultancy and sponsored research earnings meet about one third of our budget requirements for research. In view of the increase in interactions with industries and for the convenience of the user industries it is proposed to start Extension centres at different places in the region, for example, Coimbatore, Hyderabad, Bangalore and Thiruvananthapuram.

International Consultancy at IIT Madras has immense potential: for example, Analog Devices, U.S.A., alone have provided funding to the tune of about one half million US dollars towards research leading to the development of a state-of-the-art product. IIT Madras hopes to intensify international consultancy in several other areas during the Ninth Plan period.

VI. NEW PROGRAMMES AND STRENGTHENING OF EXISTING PROGRAMMES

Economic liberalisation in the country has made possible the entry of internationally competitive organisations and the consequent introduction of latest technologies. In order that Indian industry is globally competitive and meets the challenges of the next decade, it must be supported by a

the undergraduate and the postgraduate populations.

B.Tech. recruitment will continue to be through the JEE, while the postgraduate admissions will be through GATE as well as sponsored schemes. Furthermore, the input to the postgraduate programme will be increased under the QIP scheme through sponsorship by the educational institutions themselves, in addition to the candidates supported through AICTE fellowships. The introduction of an Integrated Dual Degree Programme, including a one year project, leading to both a B.Tech. and an M.Tech degree in specific disciplines is under active consideration. Table-I lists the existing undergraduate and postgraduate course programmes at IIT Madras.

Table 1 : Existing UG and PG Course Programmes

Programme	
B.Tech. (4 years)	M.Tech. (1-1/2 years)
1. Aerospace Engineering	1. Aerospace Engineering
2. Chemical Engineering	2. Applied Mechanics
3. Civil Engineering	3. Chemical Engineering
4. Computer Sci. & Eng.	4. Civil Engineering
5. Electrical Engineering	5. Computer Sc. & Engineering
6. Mechanical Engineering	6. Electrical Engineering
7. Metallurgical Engineering	7. Industrial Management
8. Naval Architecture	8. Mechanical Engineering
	9. Metallurgical Engineering
	10.Ocean Engineering
	11.Solid State Physics

In recognition of the fact that most of the new technologies require an inter-disciplinary approach, IIT Madras is revamping the structure of the B.Tech. programmes. The proposed new structure will enable students to have a major area of specialisation as well as a minor area. The courses in the minor area will be in the form of structured electives leading to a reasonable degree of specialisation in that area. In order to get the B.Tech. degree, students will have to satisfy certain credit requirements in both the major and the minor areas.

IIT Madras has also commenced an exercise to examine ongoing programmes at the B.Tech. and M.Tech. degree levels in order to introduce new programmes as well as weed out outdated programmes.

In view of the importance of Management in the career options of engineers, it is proposed to start a School of Management with two streams: a Business stream and a Technology stream, with emphasis on TQM in both. Similarly, a School of Information Technology is proposed to be started in recognition of the importance of Information Technology. A separate programme on Environmental Technology and Management with special emphasis on Industrial Pollution Control is expected to be started.

A twinning programme in which students can do a part of their course work at I.I.T Madras and the rest in an interacting Institution in India or abroad is also being considered. Serious thoughts are being given to restarting the P.G. diploma programme (DIIT) which was in vogue in the 1970s but was discontinued in the 1980s. This is mainly to enable persons working in industry to acquire higher qualifications with a view to upgrading their technical knowledge.

VII. FINANCIAL IMPLICATIONS

All the activities outlined above have financial implications. These implications have been worked out in the form of a Table given in an Appendix under six headings representing budget estimates for, Modernisation, existing and new Research and Development activities, Infrastructure Development, International Linkages and existing and proposed teaching - related programmes.

The budget has also been worked out department/centre-wise. The total budgetary requirements for IIT Madras in the Ninth Plan under different heads are summarised in Table 2 below.

TABLE - 2: Ninth Plan Budget Estimate for IIT Madras

S.No.	Area	Budget Estimate (Rs. in crores)
1	Modernisation	52.5
2	Research and Development	67.5
3.	Infrastructure including networking	41.5
4.	National & International linkages	23.5
5.	Teaching-related programmes	30.0
6.	Recurring	26.0
	Total	241.0

APPENDIX : DETAILS OF BUDGET PROPOSALS

The Ninth Plan Budgetary expenditure of IIT Madras are presented in this appendix in the form of a matrix consisting of rows and columns. Rows represent the Departments/Centres. The Columns represent the areas detailed in the budget proposals. The expansions for the entries in the table are given in the form of M.N where M corresponds to the rows and N corresponds to the columns. For example the entry under 7.3 indicates the Infrastructure including Networking budget estimate for the Electrical Engineering Department in lakhs of rupees. The column totals represent the budgetary estimate for the different heads while the row totals represent the total budget for each department.

1.1

- Strengthen existing links with Germany and USA
- Establish new links with Singapore

1.2

- Modernisation of structures lab, rocket & missiles lab
- Improve computer facility, shock tube facility
- Acquire Hot wire anemometer, Pressure scanner
- Develop PC based instrumentation and computer controlled operation of facilities

1.3

- Create additional floor space of 400 square meters

1.4

- Support for participation in the existing Technology mission on New materials

1.5

- Infrastructure and Equipment for a new Mission on Advanced Space Propulsion & Energy Conservation

1.6

- New courses on Avionics, Control theory and Computational Fluid and Solid Mechanics
- Computing facility for teaching
- Develop new research programmes in Aerodynamics, Propulsion and Structures

2.1

- Establish collaborations in areas of Micromechatronics, Underwater Structures, Biomechanics

2.2

- Experimental facilities in Fluid Mechanics, Solid Mechanics, Biomedical Engineering, and Machine Dynamics
- Computer Hardware and Software

2.3

- Create additional floor space of 400 square meters
- Computer networking and office equipment

2.5

- Infrastructure and Equipment for a new Mission on Microsensors and Applications

2.6

- New M.Tech. programmes on Wind Engineering and Vehicle Engineering

3.1

- Strengthen existing links with West Germany and UAE
- Establish new links with Cavendish Lab (UK), ETH (Switzerland), CRNS (France) and University of California, Santa Barbara (USA)

3.2

- Experimental facilities in the areas of Biochemical, Environmental, Polymers, Mineral Processing, Process Control and Design, Reaction Engineering and Transfer Operations
- Computer Hardware and Software

3.3

- Space for classrooms, research laboratories & seminar hall
- Computer networking, teaching aids & office equipment

3.4

- Support for existing Missions on Energy Conservation and Integrated Design and Competitive Manufacture

3.5

- Infrastructure and equipment for new missions in Process Synthesis and Advanced Process Control

3.6

- New M.Tech programmes in Environmental and Biochemical Engineering
- Initiate research programmes in Colloids and Interface Science, Food processing and Electronic Materials processing
- Establish Centre for CAD, Control & Optimization
- Establish Centre for Simulation of Mineral Processing

4.2

- Equipment for characterisation of materials
- Computer Hardware and Software

4.6

- Establish research programmes in the areas of Energy, Environment, Materials & Computational Techniques

5.1

- Support for Indo-German and Indo-Dutch projects on urban transportation and port management
- Initiate new links in the areas of Rain Harvesting, Construction Engineering & Management, Environmental Geotechniques and Geosynthetic Soil Structures

5.2

- Acquisition of experimental facilities for different laboratories
- Computer Hardware and Software

5.3

- Additional lab. space of 300 sq. m.
- CAD teaching facilities and office equipment
- Upgradation of towing tank facility

5.4

- Support for existing Mission on Natural Hazards Mitigation

5.5

- New Missions on Fly Ash, Drinking Water, and Super-Highway Systems Engineering

5.6

- Strengthen research in areas of Rock Mechanics, Coastal Shore Management, Water Management, EIA, Nuclear and Power Plant Structures, GIS Applications
- Establish Centre for Construction Engineering and Management
- Upgrade Survey & Rock Mechanics labs
- Acquisition of construction equipment models

6.1

- Fellowships to Visiting Professors
- Conference participation

6.2

- Upgradation of Servers and Software

6.3

- New laboratory space and airconditioning
- UPS, protection equipment

6.5

- Centre of Excellence in Information Technology
- Program on Software Engineering
- Special processors for new Mission on Advanced Computing Environment with Security

6.6

- Architecture and Design of reliable Ultra High-Speed Networks
- Design of new generation of Operating System Software
- Speech and Image Processing, Natural Language Processing, AI Applications

7.1

- Wireless in Local Loop, Computer Networking, Mechatronics, HBTs and High Efficiency Solar Cells Power Device Modelling, Power Electronics VLSI Design

7.2

- Anodic/Fusion Bonding Facilities, clean room facilities, DSP lab, Intra and inter deparmental Networking, Internet and E-mail Facilities
- Computer Hardware and Software

7.3

- High Speed Oscilloscopes, High Speed Logic Analysers, Precision Signal Sources, Field Programmable Gate Arrays, Modernising HV Generators, Software-oriented Dynamic Test Bench Facility for Power System Relay Lab, Power System Simulators for educational purposes, Real Time Control of Drives

7.4

- Fabrication and Testing facilities for micro motors designed or High density permanent magnets. Development facilities for precision transducers

7.5

- VLSI/ASIC design - development centre with complete facilities. Nano electric design facility

7.6

- Additional faculty in emerging areas with suitable grant to set up new laboratories

8.2

- Upgrading the Language Laboratory and setting up a media room and self-access centre
- Upgrading the computing facilities

8.3

- Establishment of a business school requires additional space for a new building with seminar rooms etc
- Hostel for students and participants in short term courses
- Library

8.6

- New faculty recruitment

9.1

- Tie up with exchange programmes of faculty, research students and research projects in the areas of computational fluid dynamics, industrial mathematics, mathematical modelling, nonlinear analysis, theoretical computer science

9.2

- Modernisation of existing computer laboratories
- Provision of PCs, email and internet facilities

9.3

- Space for class rooms, conference room
- New computer laboratories in the areas of Operations research, Discrete mathematics, Numerical methods and statistics
- Teaching aids and Office equipment

9.5

- Theoretical support to existing and future technology missions in the areas of specilisation of the department

9.6

- Undertake technical appreciation programmes, continuing education programmes, book writing, summer and winter term schools for college teachers
- Promotion of industrial mathematics and consultancy

10.1

- International linkages

10.2

- Modernisation of Thermal Engineering, Machine Design and Manufacturing Engineering labs.

10.3

- Create new lab. facilities in Energy efficient technologies, Product design, Robotics & Automation, Mechatronics

10.5

- New missions in mini & micro hydel plants, equipment for space, nuclear & cryogenic applications, machine elements testing centre

10.6

- Additional facilities for higher intake of M.S. & Ph.D. students

11.1

- Linkages with US and Germany in the area of bonding techniques for new materials

11.2

- Material characterisation equipment
- Mechanical alloying facilities
- Modernisation of workshop
- Computer Hardware and Software

11.3

- Improvement of department seminar hall & office equipment
- Audio-visual aids in teaching
- Computer networking

11.4

- Support to exisiting mission on development of new MMC materials

11.6

- Equipment for B.Tech./M.Tech. laboratories

12.1

- Linkages in the areas of condensed matter physics, photonics & applied optics, atomic & molecualr physics and nonlinear dynamics

12.2

- Modernisation of existing computer facilities

12.3

- Improve infrastructure of department office, workshop, library & stores
- Improve lecture halls and seminar room

12.4

- Support to existing mission on Magnetic Materials

12.5

- New missions on equipment for medical imaging and diagnosis, Optical sensor and communication systems, thin film devices & micromachining and nonlinear dynamical systems

12.6

- Improve experimental facilities of laboratories

- Set up an advanced laboratory for Magnetism & Super-conductivity

13.1

- Strengthen collaborative B.Tech. programme with German Universities
- Establish collaborative research on Underwater Robotics, Ocean Pollution and High-performance Materials from Industrial Waste

13.2

- Modernize current random wave-cum-current flume facility
- Build shallow water wave basin with portable wave makers
- Strengthen CAD facility

13.3

- Additional building space of 500 sq. m.
- Office automation equipment

13.4

- Support to existing missions on Wave Energy development, Coastal Management, and Ocean Instrumentation

13.5

- New missions on Subsea Production Systems and Ocean Pollution Control strategies

13.6

- Modern teaching aids
- Models laboratory for Ocean Engineering
- Subscription to technical journals

14.2

- Additional support for subscription to existing journals
- Subscribe to new journals
- Augment Reference collection
- Acquire CD-ROM databases
- Library automation
- Upgradation of Media Resource Centre & Bindery

14.3

- Office equipment
- Relocation to new library building

14.6

- Training of staff in the use of modern methods of library operations

15.2

- Acquire CNC machines, cranes and closed forging dies

15.3

- Purchase new vehicles and auto repair equipment

15.6

- Purchase equipment for training
- Setup FRP workshop

16.1

- Linkage in training and development of Solar PhotoVoltaic Systems
- Setting up CEC in other countries

16.2

- Strengthen training facilities
- Strengthen Service/Calibration facilities
- Networking and Upgradation of existing computer facilities

16.3

- Additional space of 75 sq. m
- Expansion of Renewable Energy Sources lab.
- Recruitment of additional staff

17.2

- Modernisation of computer systems

17.3

- Networking infrastructure
- Recruitment of additional staff

18.3

- Completion of new library buiding
- Construction of additional classrooms
- Construction of new residential quarters
- Improvement of hostel facilities

18.7

- Long term, one-time repairs/maintenance of water supply system, sewer/waste disposal system, electrical power supply/ distribution system for the IIT Madras.

19.2

- Facilities for evaluating performance of Composites

19.3

- Establish research facility for high-performance thermoplastic matrix composites

19.6

- PG Programmes in composite materials

20.4

- Support for exisiting missions on Energy efficient technologies & devices, and New Materials

21.1

- Establish links with France (CAEN), USA (Northwestern U), Singapore (National U), Germany (U of Munster), Japan (Tokyo Instt. of Technology), EEC (Instt. of Catalysis)

21.2

- Upgradation of facilties for Materials Synthesis

21.3

- Maintenance of sophisticated equipment
- Airconditioning facility

21.6

- Initiate new research programmes in thin film devices, sensors, and new materials
- Start inter-disciplinary programme on Material Science & Engineering

Ninth Plan Budgetary Estimates of IIT Madras

(Rupees in lakhs)

	Areas / Dept/Centre	1 Modernisation	2 Research and Development		3 Infrastructure including networking	4 International Linkages	5 Teaching & related programmes	6 Recurring	Total
			Existing	New					
1	Aerospace	45	130	325	90	25	25	40	680
2	App. Mech	390	-	86	54	25	25	40	620
3	Chemical	830	50	172	248	100	25	110	1535
4	Chemistry	450	-	-	355	100	50	50	1005
5	Civil	580	-	846	244	200	88	80	2038
6	Comp. Sci.	350	-	516	154	40	90	50	1200
7	Electrical	490	100	172	238	500	100	100	1700
8	Hum. & Soc. Sci.	120	-	690	135	25	25	30	1025
9	Mathematics	50	-	-	25	25	35	10	145
10	Mechanical	580	-	1725	595	400	335	350	3985
11	Metallurgy	290	30	-	45	800	15	75	1255
12	Physics	480	50	1725	530	25	1030	360	4200
13	Ocean	100	-	-	25	50	25	50	250
14	Central Library	115	-	-	95	-	860	50	1120
15	Central Workshop	95	-	-	73	-	168	105	441
16	CEC	30	-	-	24	-	-	30	84
17	Computer Centre	115	-	-	105	-	-	20	240
18	Eng. Unit	-	-	-	1065	-	-	1000	2065
19	FRPC	35	-	-	10	25	23	10	103
20	IC & SR	-	130	-	-	-	-	10	140
21	MSRC	50	-	-	25	25	85	20	205
22	XRD	50	-	-	-	-	-	10	60
	Total	5245	490	6257	4146	2365	3004	2600	24096

Note: Column 7 (Recurring) indicates the additional requirement for the Ninth Plan period. This requirement is for the academic activities of the departments (except 18.7) and is over and above the non-plan budget of IIT Madras including Force Majeure provisions which reflect salaries, pension, maintenance and routine establishment expenses.