Chapter 3

IITs as Research Institutions

We live in a rapidly transforming knowledge era. Therefore we need high-level knowledge workers, with the capability to design and innovate, in large numbers commensurate with our large population and our growing economy. Further, we need to be able to produce leaders with the vision and ability to transform and to sustain ourselves in the interdependent and competitive world. Technological capability of the country and more importantly in today's context, creating an innovation ecosystem is the key to India's rapid progress towards the highest levels of economic and social development. The IITs thus have an important role in leading India's emergence as a producer of high technology in the country and the world and its translation to the marketplace.

While it is welcome and necessary for IIT education to become wider and holistic and have programmes in humanities, management, law and medicine, it is however necessary that all such programmes have focus and orientation towards technology.

While doing so, the IITs have to also make a difference to the model of inclusive development through delivery of appropriate technologies. This requires research at the IITs to be scaled up and moulded to the above-mentioned objectives. Presently, the IITs and IISc are the only institutions that produce PhD scholars in engineering in some significant numbers. This, however, is far too insignificant considering the requirement of higher technical education and research alone. In the not too distant future, we should expect industries to need PhDs in large numbers to support their own research needs. The reputation of the IITs is built largely by their B.Tech and M.Tech alumni (most Indian industries

and government institutions have a large number of IIT M.Techs). Their reputation as research institutes is not as high. Neither have they made as significant a contribution to the development of technology. Their role in identifying and defining the technologies that would be of special interest to India has so far been limited (though in some specific areas some IITs have made a small mark). It is necessary to change this focus and make the IITs into world-class institutions engaged in education, research, technology, innovation and society–industry engagement in the specific Indian context. We need to realize this goal by building on the achievements and gains realized so far.

It is also to be noted that most reputed engineering institutions in the world have acquired a certain size. The faculty strength in those institutions is close to 1200 or more and the number of students is more than 12,000. The IITs, in comparison, are small. The established IITs have about 500 or less faculty members and the number of students is around 6000. Even though infrastructure may limit the growth of certain IITs, the Committee feels that each IIT should strive to have 1200+ faculty members and student strength should be closer to 12,000. The growth, however, in accordance with the focus on research, should come mainly from PhD students.

3.1 Scaling at IITs

3.1.1 Research Scholars

A large number of highly talented research scholars working with eminent faculty in a very supportive environment is an important feature of a world-class research institute. The IITs graduate about 1000 PhD scholars per year now, though the numbers admitted have increased significantly in the last couple of years. Research scholars doing MS are also not significant. The number of M.Tech

students has slowly increased over the years and to a limited extent they contribute to research. It is here that the IITs have to change. They have to significantly increase the number of its PhD scholars up to a scale that matters. The number of PhD students graduating in India in engineering and technology is around a factor of 10 less as compared to China and USA. Considering the population and likely scale of India's economy in the near future, the number of PhD scholars graduating should be comparable.

Till recently there were 7 IITs. Eight new IITs have been set up in the last few years. These are just beginning to recruit their faculty. At the same time, the established IITs still have significantly less number of faculty members than they require. Although adding a large number of IITs in a short time has been a major challenge and perhaps should have been a more gradual process, there is an urgent need to scale up the IIT system looking at their needs. It is likely that about 5 new IIT would be set up in the coming decade (making at least one IIT in each major state). These would all require faculty. PhD graduates of IITs would form a major feeder for IIT faculty. Other educational institutes would also require PhD graduates to strengthen their faculty. At the same time, as industry becomes stronger in India, they would need large numbers of PhDs for their R&D activities.

We recommend that the IITs should strive to increase the number of PhD graduates from the currently less than 1000 PhD students graduating each year, to 10,000 research scholars graduating every year by 2024–25. As a PhD student would normally take 4 years to complete the programme, 10,000 PhD scholars need to be admitted to the PhD programme at IITs by 2020–21. This is the minimum number that would be required to meet the country's requirements. For 20 IITs, it would mean an average of 500 PhDs. The established IITs have to strive

to reach a number of 800 to 900 PhDs graduating each year, so as to provide leeway and time to the newer IITs to gear up.

The first reaction of most would be that such a scale up is not possible. While it would not be an easy task, we would suggest the means to ensure that such numbers are indeed achieved. There is little doubt that such numbers are required by India. That it would be a big challenge for the IITs is also obvious. But this becomes an opportunity not only to contribute to the nation, but also to transform the IITs.

3.1.2 Faculty

Scaling of PhD scholars is not possible without scaling faculty numbers.[1] In fact, while significant faculty strength is required to produce a significant number of PhD scholars every year, the PhDs produced in the IITs would become a potential input and allow the number of faculty members to grow. Some top-level research institutes in the world produce about one PhD graduate for each faculty member (who is not on leave). This ratio for the IITs is much lower.

The Committee recommends that the IITs quickly get 0.6 PhD students to graduate for each faculty member every year and then strive to get to 1 PhD student to graduate per faculty each year in the years to come, with an assumption that the IITs would not let quality decline as they scale up. These ratios will establish IITs as premier research institutions. With an average of 0.6 PhD graduates for each faculty member and a target of 10,000 PhD students graduating from the IIT system every year, faculty strength at the IITs needs to grow to 16,000 by 2020–25. This is indeed a tall task, given that the number is less than 4000

[1] Even though hiring new faculty has been difficult, the IITs have been hiring many more faculty in recent years.

today. But if we are aggressive and continue to produce over 0.6 PhD graduates for each faculty, it is possible to reach these numbers, as shown in Table 3.1 (the numbers below are just an example of what can be done):

Table 3.1 : Aggressive Growth of Faculty at IITs

Faculty at IIT: Aggressive Growth by Rapidly Expanding PhD Programme						
Year	*No. of PhD students admitted*	*No. of PhD students graduating*	*No. of IIT PhDs joining as faculty*	*No. of faculty joining from outside*	*Retiring IIT faculty*	*Total IIT faculty*
2010						4,000
2011	2,600	1,200	420	280	240	4,460
2012	3,122	1,600	560	373	223	5,170
2013	3,619	2,000	700	377	207	6,040
2014	4,530	2,400	780	420	181	7,059
2015	5,294	2,470	803	344	176	8,030
2016	6,424	2,966	890	381	201	9,100
2017	7,280	3,438	1,031	344	182	10,293
2018	8,234	4,304	1,184	395	206	11,666
2019	9,333	5,029	1,257	419	233	13,109
2020	10,487	6,103	1,221	407	262	14,475
2021	11,580	6,916	1,037	346	362	15,496
2022	12,397	7,822	978	245	387	16,332
2023	13,066	8,866	887	222	408	17,033

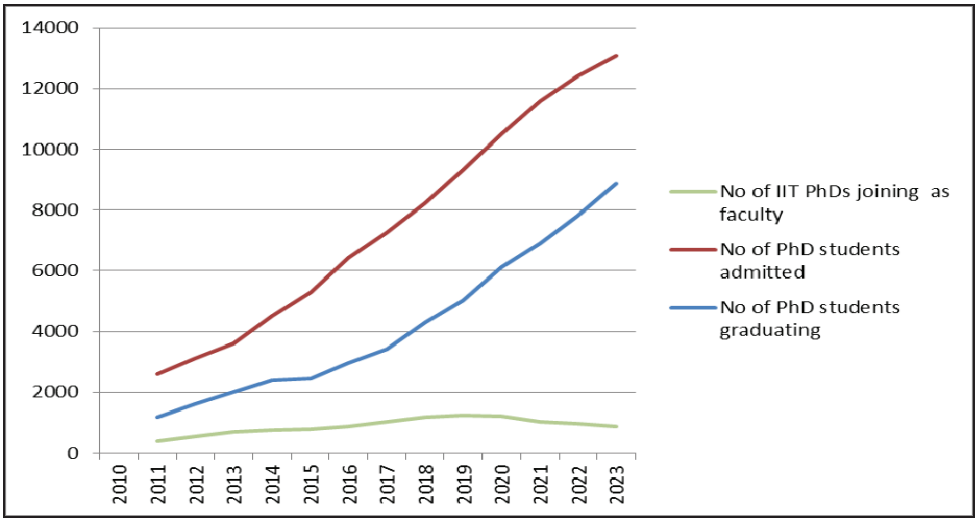

Figure 3.1 : Growth in PhD Programme

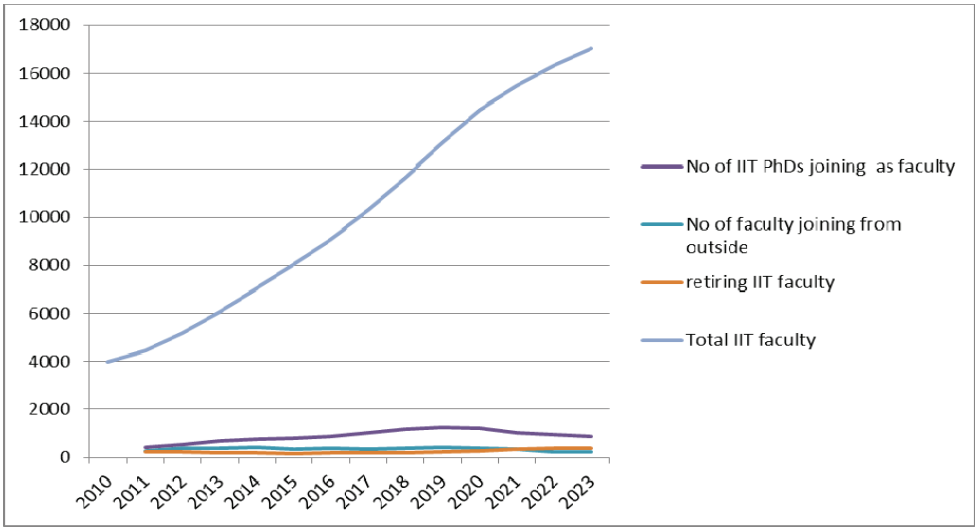

Figure 3.2 : Growth of Faculty at IITs

This assessment makes certain assumptions. These are:

(i) The number of faculty today is about 4000.

(ii) On an average, a PhD student takes 4 years to complete his/her programme. 95% of those admitted would get their degree (5% drop out).

(iii) PhD graduation in the next 4 years is assumed to be 1200, 1600, 2000 and 2400; after that, 95% of those admitted 4 years ago, will graduate.

(iv) The IITs today are aggressive in admitting PhD students. It has been assumed that the IITs will admit 0.65 PhD students for each faculty member in 2012, which will grow to 0.8 PhD students per faculty by 2016. Individual IITs may admit more.

(v) It is expected that larger numbers would join industry as they will start paying higher salaries once they recognize the importance of in-house R&D. Thus, the percentage of graduating PhDs joining the IITs as faculty will initially be high (35%), as the newer IITs have to build their faculty strength. But it will drop to 25% in a few years (30% by 2016 and 25% by 2019); that is, by the time PhD students from industry and other institutes start graduating. The number will fall further to 20% and even 10% as the IITs reach closer to 16,000 faculty numbers.

(vi) The percentage of faculty who come from outside the IIT system is initially high (40% faculty intake will initially come from this category) as the number of IIT PhD graduates are now low. But it will go down to 20% in about 10 years' time.

(vii) With these assumptions, one can reach close to 16,000 faculty by 2022 and 10,000 PhD students admitted by 2020. Even with marginal changes in these assumptions, it is indeed possible to come up with a plan to achieve the target numbers.

(viii) Retiring faculty is high in the beginning (as high as 6%); it will drop to 1.5% in about 5 years' time. This is because a number of senior faculties at the

IITs are likely to retire in the coming years. But with young faculty joining thereby forming a large base, the number of those retiring is going to go down in some years. It will again rise to 2.5% by 2025.

3.2 Where will the PhD students come from?

The next obvious question is, where would this large number of PhD intakes come from? Today, the IITs struggle to get quality intakes for their PhD programme and the number of joinees is rather inadequate. To enable a much larger number of PhD intakes (10,000 per year), the Committee suggests that the IITs consider three largely untapped streams for intake, besides the current one. These would include:

a) Admitting bright undergraduate (UG) students for PhD at the end of their 3rd year undergraduate engineering programme from any institute in India. The IITs would have to take up a programme to identify such students purely on the basis of their academic performance of the past 3 years, recommendations from their teachers and evaluation of their research potential as identified through an interview (conducted by the IITs). Once identified, these students would be admitted immediately in an IIT and would complete their B.Tech programme as well as their PhD in about 5 years' time. The UG degree could be awarded by the institute they came from and the PhD in due course by IIT. The IITs should aim to take 2500 such youngsters for PhD programmes from this stream every year.

b) Teachers from other institutes in India joining an IIT for PhD. The programme is to be somewhat similar to the Quality Improvement Programme (QIP) of yesteryears. Appropriately rechristened, the programme should be supported by MHRD by partially paying their salary in addition to tuition fee for the 3

years that they would spend at an IIT. With over 3000 engineering institutions in the country, it should be possible for the IITs to admit 2500 such teachers every year for PhD.

c) Attracting youngsters working in industry to join part-time PhD programmes. While the provision for such admissions exists, it has to be further liberalized; for example, these youngsters could take up their course-work on video, even while they are at the industry. Their one-semester mandatory stay at IIT could follow while they take up their research work. The IITs have to strive to get 2500 youngsters from industry every year for their PhD programme.

Each of these three streams would require some action by the IITs; they would not get the numbers by simply waiting for students to come. The IITs have to take upon themselves to attract students. If each of these three streams ensures 2500 intakes each year and another 2500 come through the existing channels, it should be possible for the IITs to attract 10,000 PhD students every year. Incentives to attract students to do PhD and later join the IIT system as faculty, as discussed later, should help the process.

3.2.1 Undergraduate Students and Student–Teacher Ratio

To sustain such a large PhD programme, we need a large UG programme of high quality as a feeder. Later in the report we will discuss the strategies the IITs need to adopt to facilitate this in institutions other than IITs. The IITs have always aimed to maintain a student: teacher ratio of 10:1, considering that it would be a research institution. They have also always strived to have a PG : UG ratio slightly exceeding 1:1. The Committee feels that these are the correct numbers to pursue. Undergraduate education in an environment of high-level research and search for

solutions of importance to industry and national development is an important feature. The IITs are the only institutions that have done this on a large scale so far. Thus, continuing with UG programmes at the IITs is important. With 16,000 faculties across 20 IITs, the total number of students would work out to 160,000. With the PhD programme outlined above, the number of PhD students would be roughly two-and–a-half times the number of faculty, or 40,000. Other PG students (Masters level) could account for another 40,000 and UG students could be 80,000. This would give a PG: UG ratio of 1:1. It is recognized that some IITs may have more PG than UG students but, overall, the IITs could strive to have 80,000 UG students thereby ensuring an intake of 20,000 per year. The numbers will stack up as follows:

(i) Faculty: 16,000

(ii) PhD students: 40,000 (10,000 admitted each year)

(iii) Masters level students: 40,000

(iv) UG students: 80,000 (20,000 admitted each year)

Such numbers at the IITs would not only make them into research institutions, but also contribute significantly towards enhancing the national strength of India in terms of academic pool, engineering research as well as technological capability. This would also lead to major improvement in the quality of other engineering institutions in the country.

3.3 Diversity on Campus

Several measures taken in the past have made education at the IITs fairly inclusive for socially underprivileged classes and today they constitute 49.5% of the student population in an IIT. This inclusiveness has however not extended to women. In 2010, only 12% of those who qualified in the Joint Entrance examination (JEE) were women. This was a mere 6% just 5 years ago in 2005. JEE data reveals that the percentage of women appearing for the examination is itself low. In 2010, only 25% of those who appeared for JEE were women (this was 15% in 2005). While the success rate in JEE is 3% for men, it is only 1% for women. National data shows that among those who earned degrees in engineering/technology in 2005, women constituted 21% [2] and this percentage must have increased over the past 6 years. The low percentage of women in the UG community in IITs has perhaps to do with coaching that underlines success in JEE. Intensive coaching that often demands long hours away from home (or even days away from one's home town) at an early age, can often be a deterrent for women aspirants.

Measures that will encourage women to seek entry into IITs are hence considered essential and the following recommendations are made towards achieving this.

- When there is a tie in total marks in JEE, the rank is decided by marks in individual subjects. It is recommended that whenever there is a tie in total

[2] 'Educational Statistics at a Glance 2005–2006', MHRD, Department of Higher Education, 2008.

marks, women may be ranked higher than men. Individual subject marks may then be used to rank within men and women as before. This will help women get better choices of branch. Also, some more women at the bottom of the merit list may benefit from such a system.

- Women, who get admitted and are required to pay a fee, may be reimbursed 50% of the fee amount by the Government.

3.4 Research Infrastructure

To support such a large research programme, we need considerable augmentation of research infrastructure at the IITs. Further, such a research environment should be broad based, covering several aspects such as research to push the frontiers of knowledge, research to address the challenges in science, and development as well as research to meet the needs of national technology development and industry. The IITs are already in the mode of taking up large programmes involving several disciplines and research groups drawn across all institutions (IITs, NITs, IISERs, IISc, etc.) to address certain key national challenges. The Committee recommends further augmentation of this trend over and above the expanded research activity through research projects brought in by the expanded faculty. Other aspects of augmentation of the research infrastructure at IITs are discussed in the following sections.

3.5 Technology Leadership

(i) Each IIT should aim to acquire technology leadership in at least 3 or 4 areas. To be world-class universities, the IITs should strive to be among the best institutes in some discipline(s). No university can be uniformly good in all areas. At least to begin with, it has to excel in any one area. The IITs should

put in place a system which allows, enables, encourages and supports it to start excelling in areas that it can. The aim should be that within 7 to 10 years, each IIT should be among the best universities in at least 3 or 4 areas.

(ii) There has to be a conscious effort to attain leadership as this does not happen automatically. World-class excellence is not acquired by simply choosing some areas and allocating funds. The IIT system has to consciously allow areas it excels in, to forge ahead. It has to be done at the department levels as well as at the institute level. The simple representative system in committees would not encourage select areas to get ahead, but will act as a leveller.

(iii) As the IITs attempt to recruit the best faculty in each area,

i. They have to watch in what areas *faculty members are excelling*

ii. Where *natural groups are being formed* (one cannot become the best in technology today without a sizeable group of faculty members and research scholars from multiple disciplines working together)

iii. Where they are *able to attract national and/or international attention* and acquire funds, attract *fresh talent* from India and abroad and where they are able to *collaborate with industry and make a difference* there. As such, areas and groups are identified; institutes need to pay special attention to the area and the group. They need to provide more internal funding and space and make special efforts to hire more faculty members and research scholars in the area. Only at this stage do the IITs need to declare these as special or core areas. These areas need to emerge in a competitive manner (high peer interest in emerging frontline areas, attracting external research funding, strong interest among young talent, recommendations of institution/department review, stakeholder interest in frontline research, etc.) and not identified by some internal committee/director. Such groups

should be funded to their maximum absorptive capacity. The IITs have to then protect these groups from committees and departments that may discourage them and sometimes resent the special attention paid to such specific areas and groups.

iv. At the national level, such groups need to be identified, promoted and challenged to do more. The Department of Science and Technology and other ministries need to provide higher funding and use such groups to do more. Industrial collaborations in such areas need to be taken to new heights.

3.6 Industry Interaction

Encouraging industry to set up their research labs at IITs Indian industry has been changing rapidly in the last 10 to 15 years. Today they want to become the world's best. Unlike in yesteryears when they depended entirely on import of technology, today Indian industry recognizes the necessity to carry out and participate in R&D to master their technology. Unfortunately, they have little understanding or experience in conducting research, though they may have acquired the ability to indigenize and productize technologies.

The IITs, on the other hand, have shown over the last 50 years to be islands of excellence in India. They have built an academic and research culture par excellence, untouched by many ills of the society around. They however have had limited experience in working with industry.

The IITs and industry form a perfect complement to each other in such a situation. They however do not understand each other. Living in their own world, they do not communicate and hold on to the opinion that the other is of little good. IIT faculty would often say that if only Indian industry was like that in the

West, they would have had no difficulty. Industry, on the other hand, believes that the academia in the West would deliver and are more willing for tie-ups with industry and fund them generously. It is imperative that both of them break this logjam.

IIT Madras recently created an IITM Research Park (IITMRP) to overcome this problem. They helped create an infrastructure just outside IITM for industry to set up their R&D facilities. In many ways, it is just like any other infrastructure which would house R&D centres of companies. But situated at the boundary of IIT (with a proposed flyover providing a connected campus), this has one difference. One of the conditions for setting up their research laboratory in this Park is that they must collaborate with IITM. In fact, IITM has evolved a measure of this proposed collaboration in the form of credits earned by industry for every interaction and require that industry acquire a minimum number of credits for each square feet of area that they occupy at the Research Park. Having placed industrial R&D and faculty (and students) on a connected campus and creating an obligation for industry to collaborate with IIT, would soon begin breaking the logjam discussed above.

In other words, it is highly desirable that industries set up their R&D labs on campus (or adjacent to campuses). Industry will benefit immensely from such an arrangement. This will help them get acquainted with the faculty and research scholars and understand their expertise and abilities. Using them for their R&D activities would then be only a matter of time. They would be able to train their research personnel with short-term courses, and part-time MS and PhD programmes offered by the IITs. They would also be able to identify bright youngsters to hire and involve students on a part-time basis in their research. They would be in position to create an industry–academia consortium to

influence policies where required, make contributions and influence the standards and bid for larger projects. At the same time, they would be in a position to quickly learn the basics of research and tap the IITs to learn about the latest research going on anywhere in the world. As the IITs have multiple departments, industrial research could leverage their cross-disciplinary expertise.

For IITs and faculty, such labs would enable them to transform themselves. To begin with, the faculty could learn the commercial aspects of the products and services in the areas that they work on. They would be able to understand the technical challenges faced by industry, and also analyse what it takes to make research commercially usable and enriching, and expand their R&D. They would also learn how to productize research. They would be able to tap experienced personnel as part-time MS and research scholars. Besides, together with industry, it could set up on campus (or adjacent to campus) research facilities they would not have dreamt of setting up alone. They would jointly be able to attract larger government funds in addition to getting funding from industry. It would help to know that China has around 300 research parks, and, in Sweden 56 science parks and incubators host around 4500 companies.

3.7 Interaction With Government Agencies

Encouraging and enabling various government departments and ministries to set up R&D labs at IITs Most government departments and ministries (for example Power, Railways, Airlines, Surface Transport, Mines and Minerals, Communications, Alternative Energy, Coal, Oil and Gas, Industries and others) do not spend much on R&D. They need to spend a minimum of 2% of their total budget on R&D and help create and develop technologies which could transform their respective sectors. As India continues to grow, it is important that

government departments use R&D to push industry to higher technological capabilities in their respective sectors.

The problem is that most ministries know little about R&D and would not know where to begin. The R&D culture in many ways is an anti-thesis of the bureaucratic culture. While the latter may be useful for governance, control and management, R&D in such a framework will be a non-starter. The IITs, on the other hand, have created an R&D culture at their institutes and know what it takes to pursue excellence. It will be highly desirable if each ministry sets up its R&D labs at one or more IITs. Procedures would have to be evolved so that while a board chosen by a government ministry (which includes IIT and laboratory representation) defines the broad objectives and budget and approves specific projects proposed by the lab, the governance issues, research leadership and detailed programme development comes from within the lab and IIT. It would be also advisable that the ministries then encourage industries in their sectors to set up their R&D labs around such government R&D labs.

One of the purposes of these labs set up by various ministries would be to stay on top of the state of art in its sector. It would identify how India could acquire strategic advantage and define the technologies it needs to develop and acquire in the years to come. Working with industries in its sector, it would learn to take technology from lab prototypes to products and make them commercially viable. It would identify the role that technology could play in taking its industries to a commercially advantageous situation.

For the IITs, these labs would be a great boon. Besides bringing in funds, equipment and industrial contacts, it would enable their research to become more industry focused. Their research scholars and students would gain a lot by working in such labs, complementing their theoretical knowledge with practice. In

this context, the development of Chinese capability in High Temperature Reactor offers a good example. The programme was visualized and developed in Tshingua University as a technology need of the future. Today, the entire national technological capability in this area of high future potential is with the University, including a small operating nuclear power reactor based on this technology. Internationally, it is now recognized that this would be one of the key technologies to support sustainable carbon dioxide-free fluid fuel supply in the future.

3.8 Executive M.Tech Programme for Industry

Industry in India employs a large proportion of the half a million engineers graduating every year in India. As many of them are not adequately trained, industry spends significant time and effort to train them. But as industry becomes increasingly stronger, it feels the need for their employees to acquire a higher academic degree while still working. The opportunity to acquire higher qualification is a strong motivation for employees and helps in reducing turnover with professionals focusing on specific areas of specialization. One critical constraint is that the employees cannot spend any significant residency period at the IITs or other institutes. The entire programme has to be based on online interaction, and supervision of projects, etc. by qualified mentors at their workplaces. The pace at which an employee goes through the programme has to be variable, depending on the employee's abilities and workload at different times. As such, the constraints imposed by the course structure/schedule must be as few as possible. Despite these constraints, the programme must be innovative and create degrees with high intrinsic and brand value.

It is suggested that a new degree, called Executive M.Tech degree, be created to distinguish it from the existing residency based M.Tech programme. An

Executive M.Tech degree from an IIT would however be considered equivalent to its regular M.Tech programme for admission to IIT's PhD programme, if necessary with some specifications on additional preparation. Many leading universities adopt such an approach.

The Executive M.Tech (EMT) programme will consist entirely of online (live video lectures and web-based assignment/examination) courses offered in the evenings or on weekends, and a project supervised entirely by a qualified mentor at the workplace. The courses will be taught by IIT faculty and the evaluations will also be done by them. There will be no evaluation of the assignments that may be given. The course may have some discussion sessions for assignments. Solutions may be uploaded by the teacher. The student will not be required to visit any IIT for either attending courses or taking exams. There will be no lab courses (except where off-site labs can be accessed using virtual labs). The project will also be evaluated by IIT faculty. First, the proposal will be evaluated and approved, and then the thesis and student will be evaluated. The student will be physically present for the viva. It is also possible to include at this time a breadth-oriented comprehensive viva based on the courses taken. This viva evaluation could be done only for the purpose of feedback to the employer on the degree of transformation that has occurred in him/her. It could also be given credits if desired.

The project is a very important component of postgraduate education in the IIT system. While online courses and absence of labs enable the programme to scale, it is equally important to make the projects locally supervised without IIT faculty co-supervisors for scaling to happen. In order to ensure that the potential supervisor, employer and student clearly understand what is expected, a detailed document will be provided that will explain (i) the types of projects (analytical,

simulation, modelling, experimental, prototype development, research oriented), (ii) the amount of work expected, (iii) the quality of literature, survey and reporting on the thesis, and (iv) sanity checks on the experimental and simulation results expected. IPR issues will be also be dealt with. Sample theses representing the different types and quantum of work that is acceptable, will also be provided.

Project evaluation will be done by an independent faculty committee. If desired, an interim evaluation can also be obtained by a committee member based on a video-conference presentation in order to ensure the project is on the right track. This evaluation will be informal and not count for the final grade.

Two operational modes are possible for the programme with each IIT having its own or a common programme jointly operated by the IITs. The latter may have difficulties associated with Senate jurisdiction and awarding of a degree. The former may work quite well for the established IITs and may even lead to healthy competition, but the newer IITs may be required to partner with their erstwhile mentors for some time. Further, to give the students the maximum possible latitude in taking courses at times when their workload is less, we may need to allow a student to register for a course offered by a sister IIT, maybe up to a maximum of 50% of the total credits. At the end of the course, the course grade will be transferred to the IIT with which the student is registered.

It is possible to scale up to 10,000 Executive M.Tech graduates every year. The programme could be initially started in 4 or 5 areas and more specializations may be added over time. The programme could also contribute significantly to the finances of the IITs as each M.Tech programme could be charged Rs 5–7 lakh.

More details and rationale of the suggested programme is given in Appendix IV.

3.9 International/Foreign Students and Faculty

For research and innovation to flourish, we need to nurture an environment where plenty of new ideas can emerge and where there is competition even for the best performers. It is also important that the research culture is maintained at its best. Continuous exposure and exchange with external high-level research environs is thus important to maintain research at the frontiers of knowledge. We should thus welcome high-quality international presence in our academic and research institutions. There is however some difference between conditions prevailing here and those in the West. While we need to create wider access for our own people to higher education, in the West there is a serious shortage of local people to meet their national programme needs and they need to get bright minds to come from outside. Even so, a selective presence of external high-level intellect in our institutions must be encouraged. A recent decision of the IIT Council to facilitate limited presence of foreign faculty and students in the IITs is thus a welcome move.

Ten percent faculty and 20% graduate students could be overseas students. The IITs have to evolve into global education institutions and become a larger part of the global knowledge network by welcoming a sizable number of overseas faculty and students. This has strategic advantages for India as it enhances India's soft power globally.