INDIAN INSTITUTE OF TECHNOLOGY
HYDERABAD

REPORT OF THE EXTERNAL REVIEW PANEL

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भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

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Foreword by the Panel Chairman

All the stars were aligned when IIT Hyderabad (IITH) was formed. Not only was IITH lucky to be led by a dynamic, young, and innovative Director, but other factors such as a location with pre-existing facilities for a quick start, proximity to a major metropolis, availability of many qualified NRIs with a preference to be near a metropolis and therefore eager to fill the faculty positions, and qualified students with a preference for this location, made IITH the fastest-growing institute in the history of IITs since the establishment of IITKGP in 1951.

IITH has introduced many curricular innovations, such as Fractal Academics, research emphasis from the start in the UG program, and international collaborations, to name a few. The growth of faculty strength from zero to over a hundred in spite of the many constraining rules and regulations in the selection process has been gratifying. The enthusiasm and active participation of students in all campus activities is illustrative of an inclusive atmosphere that is in contrast with the ivory-tower atmosphere often prevalent at many elite campuses around the world.

Research projects at IITH, in areas such as environment and energy, digital communications, design and manufacturing, and nanotechnology and nanoscience, are equally commendable. Especially noteworthy is the unique JST-JICA joint project with Japan on sustainable development. This exciting and inspiring project involves globally relevant and challenging components such as earthquake disaster risk mitigation, a weather monitoring platform, sustainable communications infrastructure, and ICT in the service of society.

The External Review Panel, however, found the need for important and urgent changes that will help IITH flourish further. Evidence of archaic, innovation-stifling practices in areas such as selection and use of external Ph.D examiners, minimum residency requirements for B.Tech. and M.Tech. programs, inability to use online courses from highly reputed sources such as MIT and Stanford, inability to hire international faculty except as visiting professors (in contrast, almost 20% of permanent faculty at CMU are of Indian origin!), must all be addressed at various levels of the administrative structure immediately as further detailed in this report. Particularly, we recommend that many of the rules and regulations of MHRD move to promoting an exploratory and innovative culture at IITH, unconstrained by legacy practices.

Prof. Raj Reddy
Moza Bint Nasser University
Professor of Computer Science and Robotics
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Executive Summary

Probably the most important, and also the most difficult, part of starting any new institution is to ensure that it starts with the right cultural initial condition in all that it does. The Review Panel is pleased to report that IIT Hyderabad has been very successful in this regard, in all of the following foundational issues:

(i) Hiring high-quality faculty

All of the IITH faulty have been chosen very carefully, and are very active in research. It is heartening to note that IITH has not compromised on the quality of the faculty it has hired, in spite of the severe shortage of high-quality faculty candidates in general.

(ii) Faculty success in funded research projects

The faculty have already proven to be very successful in obtaining national-level funding for their research projects. Over 100 funded projects are being conducted by the faculty with a total volume of funding of 130 crs, all from the same sources that fund the older, established IITs and IISc. The average level of research funding of ₹1 cr per faculty member compares well with that of the established institutions. This is a remarkable accomplishment for such a young institution.

(iii) Research and teaching laboratories

Though young, IIT Hyderabad has been very successful in setting up labs, even in such capital-intensive areas such as nanotechnology. This is a significant success that bodes very well for the future of the institution.

(iv) Attracting research students

This new generation of IITs not only aims at high-quality undergraduate education, but also, even from their very founding, a high-quality postgraduate education and research. This is distinctly different from the older IITs, which originally aimed at mainly undergraduate education, and only later took on postgraduate education and research. IIT Hyderabad has been very successful in this regard. It has 759 undergraduate students, 87 M.Sc., 378 M.Tech., 8 M.Des., 7 M.Phil., and 411 Ph.D students, just six years after its inception. Almost 50% of its students are postgraduate students. The Ph.D student-per-faculty ratio is at 3.16, which is highly commendable.

(v) Attracting female students

Another laudable accomplishment is the percentage of female students: 24% of the incoming undergraduate students are female, as are 23% of the Ph.D students. The Panel believes this unique and laudable achievement may stand as a distinguishing feature of IITH in the years to come.

(vi) Faculty collegiality

Remarkably, the faculty of this young institution have a positive sense of camaraderie and belonging. Faculty interactions are characterized by a high degree of collegiality. They also exhibit a high level of interdisciplinary interaction. Research conversations generally straddle areas, and the whole is definitely more than the sum of its parts. Faculty also have a strong sense of ownership of their new campus, since they have participated integrally in the development of the plans for their new campus. Many cite the opportunity to be involved from the very outset in the founding of a new high-quality institution as a key factor in their joining IITH. The morale and motivation among faculty is very high, and a marks a high point for the Panel visit.

(vii) Curricular innovation

IIT Hyderabad has infused a breath of fresh air into the area of undergraduate curricular innovation. The current generation of entering IIT students often have been subjected to many hours of after-school coaching classes, which are mostly geared to performance on competitive exams and not necessarily to fostering a love of learning. Students often arrive at the IITs with little motivation for further rote-learning. There is an urgent need for IITs to graduate students who indeed have a love of learning and of high technology, students who will be creators of jobs rather than mere job-seekers. There is an overwhelming need across India for a fresh approach to the education of very bright students who are at the same time weary of rote-learning. This is a challenging task for any institution. To address this challenge, IITH has developed a new "fractal approach" to its curriculum. This allows a more flexible approaching to teaching, by exposing students to open-ended research projects very early in their education. It encourages students to compose their own curriculum to better match their interests and passion. It further fosters greater breadth. Such experimentation with curricula is much needed in India, and IIT Hyderabad's efforts are commendable, and indeed pioneering.

(viii) Design of a new campus

IIT Hyderabad's new campus, which is scheduled to be opened in 2015, is most impressive. It is world class in conception and design. For example, the pod-based design of student hostels is a refreshing break from the traditional approach. It supports collaboration while giving students their own space. The use of concrete "blinds" to keep out direct sunlight and the radiative cooling technology introduced is energy-efficient compared to the use of traditional air-conditioners; it also allows windows to be kept open bringing in fresh air. It is laudable that there has been thorough faculty involvement at all stages in the campus design. The Review Panel expects that when the institution moves to its new campus, it will significantly enhance the visibility of IITH as well as recruitment efforts both at the student and faculty level, as all parties witness the magnificence of its vision.

(ix) A dynamic Director

Much of the credit for all the above should go to Prof. Uday Desai. The Review Panel is of the opinion that IIT Hyderabad has been very fortunate in having such a founding leader. His openness to ideas, encouragement of innovation, valuing research, and fostering of curricular experimentation, not to mention his command of execution of all the myriad burdensome tasks involved in starting a new campus, are all remarkable. The Review Panel regards him as the next "Kelkar," one uniquely positioned to – and capable of – leading the next generation of institutions in India.

In order to build further on its base of accomplishments, the Review Panel makes several recommendations, of which the most critical are summarized below. The remaining important recommendations are presented in Section 5.

The External Review Panel offers the following 9 **Key Recommendations**:

1. Significantly increase annual funding for research infrastructure development, separate from standard allocations.
2. Reform faculty hiring and promotion process.
3. Urgently supplement existing staff with extensive temporary staff hiring to relieve the young faculty from administrative burden.
4. Significantly and deliberately enhance interactions with industry for mutual benefit.
5. Increase support for international travel for undergrads, postgrads and faculty to increase International exposure of their research.
6. Improve gender diversity amongst the faculty by deliberate and planned actions.
7. Restructure Ph.D thesis committees by including external review professors from the beginning, so that they may guide the development of the scholar in preference to only providing an assessment at the end.
8. Institute a plan for not only allowing but encouraging the hiring of international faculty.
9. Raise salary of starting assistant professors to levels that are competitive with alternatives available to highly qualified Ph.D students.

These recommendations, along with a number of other important ones, are discussed further in Section 5.

Introduction

An External Review Panel consisting of international experts – Professors Suresh Garimella, PR Kumar, Jun Murai, Raj Reddy (Chair), Surendra Shah, and Kumar Sivarajan (Bios in Appendix I) – visited IITH for two days on August 11th and 12th with an explicit charge of reviewing the five-year progress of IITH with respect to the Terms of Reference provided by MHRD (Section 7of this report).

The schedule for the visit is given in Appendix II. The external review panel met with the Director, Deans, Department Heads, Faculty, Students, Staff and International Collaborators. Both the excitement in the accomplishments to date and frustrations with the slow pace (of problem-solving limited by rules and regulations that stifle innovation) were evident from our interactions.

Overall, we emerged from our two days of interactions with awe and admiration for what has been accomplished within a short span of five years. Of course, there is always scope for improvement to reach even greater heights. IITH cannot afford to rest on its laurels and must aspire to reach even greater heights and ultimately be counted as one among the world-class institutions.

The following sections provide a detailed discussion and our observations, findings and recommendations. It also includes detailed answers to the Terms of Reference.

Findings and Observations

Human resources

Students: Just over a span of 6 years, IITH had grown from a student population of 166 in 2008 to 1650 in 2014. In the current B.Tech. Batch (2014), out of 208 students, 49 are female, constituting 24% of the incoming batch. This is perhaps a first for any IIT! Overall at IITH, 21% of the students are female. IITH is also able to maintain a very healthy UG to PG ratio of 1.05. It is noted with satisfaction that there are 411 Ph.D. students at IITH, or an average 3 Ph.D. students per faculty. The statistics of students in various programs are given in the table below.

Student Strength						
Program	Student Admission Details (July 2014)			Total Strength		
	Male	Female	Total	Male	Female	Total
B.Tech.	159	49	208	633	126	**759**
M.Sc.	28	20	48	54	33	**87**
M.Tech.	145	27	172	284	94	**378**
M.Des.	5	3	8	5	3	**8**
M.Phil.	2	2	4	2	5	**7**
Ph.D.	62	18	80	318	93	**411**
Total	**401**	**119**	**520**	**1296**	**354**	**1650**

Faculty: IIT Hyderabad started recruiting faculty members in July 2009. Today the institute has 130 faculty members; 36% of them have obtained their Ph.D from universities abroad, and 60% have extensive postdoctoral experience from some of the best laboratories in the world. To attract the best candidates, each department has formed faculty search committees. A majority of the departments conduct at least 2 selections per year, although most of the hiring has been at the level of assistant professors. The number of faculty members in various academic departments is listed in the table below.

Department	Assistant Professors	Associate Professors	Professors	Total
Bio-Medical Engineering	4	-	-	**4**
Biotechnology	5	-	-	**5**
Chemical Engineering	12	2	-	**14**
Chemistry	7	1	1	**9**
Computer Science & Engineering	9	1	-	**10**
Civil Engineering	11	1	1	**13**
Electrical Engineering	15	2	1	**18**

Department	Assistant Professors	Associate Professors	Professors	Total
Liberal Arts	9	-	-	**9**
Mathematics	9	-	-	**9**
Material Science and Metallurgical Engineering	8	-	-	**8**
Mechanical & Aerospace Engineering	13	1	2	**16**
Physics	11	1	-	**12**
Design	2	1	-	**3**
Total	**115**	**10**	**5**	**130**

Several of the IITH faculty members have won national and international recognition in a very short span of time and the complete list of accomplishments by faculty members is given in the ToR (Section 7). IITH also places great importance on faculty development. Towards this end, a limited faculty members are given the opportunity to visit leading research laboratories during each summer. IITH faculty members are also very instrumental in organizing a number of workshop and symposia. For instance the prestigious IUTAM symposium on multiphase flows with phase change will be organized by IITH in December 2014.

Research @ IITH

The culture of research at IITH is evident from the number of grants and the amount of funding received from sponsoring agencies and industries, as well as from the number of publications produced by its researchers. To date, IITH has filed 10 patents and generated sponsored funding worth ₹135 crs. The total number of publications indexed by Scopus stands at 669 out of which 463 are peer-reviewed journal papers, with the remaining being peer-reviewed conference publications. This is a remarkable record considering the fact that half the faculty members at IITH are still in the process of setting up their labs. A quantum leap is expected in the number of publications in top scientific journals in the next couple of years. There are about 11 major interdisciplinary research projects, with funding above ₹1 cr, under execution at IITH as listed below:

1. Information network for natural disaster mitigation and recovery (20 cr)
2. Cyber physical systems (₹17 crs)
3. IoT for smarter health care (₹ 4 crs)
4. Self-powered wireless chipset for building to building communication (₹2 crs)
5. Cognitive radio (₹1.5 crs)
6. IUATC project (₹1.7 crs)
7. Green sensor networks for air quality support (DEITY) (₹ 1 crs)
8. Development of FRET enhanced quantum dot sensitized solar cells (₹1.33 crs)
9. Improving the efficiency of dense medium cyclone treating high NGM coal using GPU based CFD and PEPT techniques (₹2 crs)

10. Incremental sheet metal forming: Predicting modeling and validation (₹1.5 crs)
11. Evaluation of fly ash treated recycled asphalt pavement (RAP) for base/subbase construction (₹1 cr)

Several centers have been established to promote cross-disciplinary research:

- Cyber-physical systems / IoT
- Nano-X
- X-Materials
- High performance computing
- Sustainable development

IITH also has good emerging interactions with industry. Approximately ₹10 crs of the total funding obtained is from industry-sponsored projects. IITH is in discussion with more than 100 companies and is looking forward to establishing active industry-academia collaborations in the next few years.

Academics

IITH started by offering the B.Tech. program in 3 departments: Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering. Today there are 14 academic departments, all of them offering Ph.D and Masters program and 7 departments offering the B.Tech. program. In fact IITH is the only one among the new IITs to offer a full bouquet of courses to the undergraduate and postgraduate students. B.Tech in Engineering Science offered at IITH is the first of its kind in the IIT system. In this program, students take all the science and math courses as well as all engineering courses in the first two years. In the 5th semester they select their specialization – this specialization could be any branch of engineering, science, math, design or liberal arts.

In order to promote the culture of entrepreneurship among the students, the B.Tech, M.Sc., M.Tech and Ph.D. students are given the opportunity to obtain a minor degree in entrepreneurship. The entrepreneurship minor is a unique program wherein lectures are delivered by leading industrial experts, entrepreneurs and venture capitalists.

Fractal academic program: In order to promote the concept of holistic education, IITH has developed a Fractal Academic Program across all departments offering B.Tech program and in some streams of M.Techs. The core of the program is the offering of modular sets of topics ('atomization'). The program is inherently multidisciplinary and has the following characteristics:

a. The students are introduced to the core department courses from the 1st semester onwards.

b. The fractal structure follows the T-education model, with the breadth representing the horizontal part of the T and the depth represented by the vertical part.

c. About 10-16 credits (varying from department to department) are reserved as free electives, allowing the students to gain knowledge about diverse subjects of their interest.

d. The concept of holistic education is further emphasized by the fact that all courses offered are open to all IITH students.

e. 16 credits are reserved for creative arts and liberal arts – IITH is perhaps the first IIT to have a design spine in its academic program.

f. About 10-16 credits are allotted for core electives. Electives with credits ranging from 1 to 3 are offered, allowing students interested in gaining broad knowledge to pick electives with 1 credit from a large basket of courses.

g. Continuous evaluation is implemented as opposed to a mid-semester and end-semester examination pattern.

h. Details of the program are given in the Fractal Academic Course Booklet: http://www.iith.ac.in/files/pdfs/Fract%20Aacademic%20Course%20Booklet.pdf

Teaching: Teaching is considered to be very important at IITH. Student feedback on teaching quality is solicited during the middle of every semester. The average score for teaching quality based on student feedback is 4.1/5. Flipped-classroom teaching is being experimented with, and the initial results are very encouraging. There are about 102 laboratories in IITH and 37 additional labs are in the pipeline; these labs further the cause of practical learning as well as research.

International collaborations

IIT Hyderabad has 15 MoUs with major universities in the US and Japan. The IITH collaboration with Japan is very special and covers a spectrum of activities. IITH collaborates with Japan for infrastructure development, research, and faculty and student exchange. As part the collaboration, 6 iconic buildings in the permanent campus are being designed by Japanese architects and funded by JICA. Moreover 9 academic buildings, lecture hall complex, students' commons, student hostels and administrative buildings are funded through JICA support. On the research front, IITH collaborates with Japanese universities in the areas of: i) Next Generation Communication Technologies, ii) Sustainable Development, iii) Manufacturing and Design, iv) Nano-science and Nano-technology, and v) Energy and Environment. The success of the DISANET (Information Network for Natural Disaster Mitigation and Recovery) project is a fine example of active collaboration between IITH and Japanese researchers. Friendship program facilities exchange of faculty and students from both the sides. This comprehensive collaboration with Japan could emerge as one of the distinguishing and welcome features of IITH.

Student Welfare

Student welfare receives significant attention at IITH. To extend a helping hand to students in times of stress, IITH has started a counseling cell for the students called "Sunshine". IITH has appointed a counselor on an *adhoc* basis and is in the process of hiring a regular counselor. The counseling cell is headed by a faculty member in-charge and staffed by student advisors and student mentors.

Additionally there are a number of student clubs at IITH to promote extracurricular skills of the students. Elan, the cultural festival, and n-Vision, the technical festival, are the two major events organized by students on campus.

Campus Development

The new campus construction of IITH is proceeding at great speed. It is expected that IITH will start moving into the new campus by October 2014. The review committee was impressed by the vision and magnitude of the project and the momentum with which IITH is forging ahead. All the buildings have innovative designs, with water treatment, water conservation and other 'green' features. IITH expects to get a 4 Star GRIHA rating for its campus. IITH has already received the GRIHA award for construction workers' health and safety.

Social Responsibility

IITH students are actively involved in contributing to society. Open houses are conducted at IITH to promote the spirit of scientific inquiry in children from nearby village schools. In addition, NSS at IITH participates in teaching underprivileged children and organizes clothes donation and blood donation camps on campus.

Interaction with Stakeholders

IITH has a very young **faculty** and it is especially commendable that even assistant professors have enthusiastically taken on the roles of department heads. Largely, the faculty were enthusiastic about their responsibilities and appreciated the unique opportunity to build a new IIT. Some faculty voiced concerns about the administrative load and the limited international travel budget. A few others, especially in the Liberal Arts, were apprehensive of their teaching load.

The external review committee had a chance to interact with IITH **students**. Some positive remarks were offered about fractal academics. It was noted that the fractal program opens up research opportunities for B.Tech students early in their stay at IITH due the early introduction of engineering subjects.

Student interests and concerns ranged from additional entrepreneurship opportunities and training, UG research and publications, enhanced quality of teaching and learning, support for attending international conferences, and opportunities for working on collaborative research projects with post-graduate students.

Our **staff** interactions highlighted the general absence of clear job descriptions, training for doing specific jobs they might be assigned to (learning on the job), and performance evaluation. There is clearly a great shortage of staff, which needs to be remedied urgently for the healthier functioning of campus. A clear separation of the allotment of positions for administrative staff versus technical support staff is desirable, rather than all support staff being lumped into a single allocation.

The Review Panel had extensive discussions and meetings with key stakeholders – students, faculty, staff and the leadership team as discussed above. The responses to the Terms of Reference as well as the Findings sections summarize the content of these discussions. Listed below is a **brief set of observations**:

1. Quality faculty being recruited.
2. Commendable and rapid scale-up to 1650 students.
3. Healthy percentage and absolute numbers of Ph.D. students.
4. A culture of research being inculcated at all levels.
5. General appreciation of pursuing sponsored research.
6. Good state-of-the-art research laboratories in many areas like nanoscale research, materials science, fluid dynamics, and manufacturing.
7. Good start with Research Centers, but many more needed, covering all disciplines.
8. While few industrial grants have been obtained, talks are ongoing with a large number of industries, which bodes well for significant industrial collaborations in the near future.
9. Ambition to work on mega projects – a good beginning has been made with projects like Information Networks for Natural Disaster Mitigation and Recovery, Cloud Converged Communication, Cyber Physical Systems / Internet of Things, and Sustainable Development, but the number needs to grow, and involve all disciplines.
10. High-quality teaching – average student evaluation score of 4.1 / 5.
11. Teaching innovations have been well appreciated by students. Fractal Academics is generating a lot of enthusiasm and flipped classrooms are being implemented by a number of faculty. There is good emphasis on projects, but this could be enhanced. The program in Engineering Science with specialization in any discipline also holds promise.
12. Students are quite excited to be at IITH and do find the overall learning environment invigorating. Nevertheless, there were concerns regarding lack of financial support for international paper presentations, particularly for undergraduate students who do write quality papers.
13. It is interesting that IITH started a Design Department – this could bring a design-based pedagogy to the entire system.
14. IITH needs to develop a culture where projects and research teams are formed consisting of Ph.D. students, Masters students and undergraduate students. This is one practice that could lead to enhanced research.
15. While research seminars are offered by visiting faculty and industrial researchers, a deeper culture of high-quality seminars needs to be developed, and attendance to a selection of these seminars be made mandatory for students. A vibrant seminar series is essential to developing a strong research culture.

16. IITH, though young, is already working on several nationally relevant projects, some with Defense Research and Development Organization, Department of Electronics and Communication, and several other national organizations.

17. IITH has good international collaborations with leading universities across the globe, in research, infrastructure, faculty exchange and student mobility. Nevertheless, resources need to be generated so that these collaborations are much more active and will be sustained over long durations.

18. Entrepreneurship is given emphasis at IITH, and the students are anxious to learn more about it. IITH appears to be the only IIT with a minor in entrepreneurship.

19. The Review Panel commends IITH for being proactive in setting up a Counseling cell –"Sunshine" for the students.

20. Campus development is progressing at a good pace, with highly innovative designs for all the buildings. When completed, it will be a unique campus for students to learn and develop a wholesome personality.

21. IIT Hyderabad has an ambitious future plan emphasizing various cutting-edge research centers in Digital Fabrication, Sensor Technologies, Big Data Analytics, and Automotive research.

22. Corpus-building must be an important focus area for the coming years.

In a short time, IIT Hyderabad has made very significant progress on all key fronts.

Recommendations

Based on interactions with faculty, students, staff, the leadership team of IITH, and a visit to the permanent campus, the Panel has 29 recommendations. Of these 9 are classified as Key Recommendations and 19 are classified as Other Recommendations.

Key Recommendations

1. **Significantly increase annual funding for research infrastructure development**

   As a young IIT, IITH should be allocated annual funding earmarked to spur research activities, separate from operational expense budgets. Such funds can help equip laboratories with the latest equipment so that faculty and students can pursue cutting-edge research and make a national as well as global impact.

2. **Reform faculty hiring and promotion process**

   We recommend that external letters assessing a candidate's research be obtained. A good practice is to obtain a number of letters from external experts chosen by the department head and senior leadership, with only a minority of the names being provided by the candidate as potential referees. This will motivate faculty members to conduct research that is recognized by experts as being of good quality. It will also allow more careful and thorough appraisal of candidates' accomplishments.

3. **Urgently supplement existing staff with extensive temporary staff hiring to relieve the young faculty from administrative burden**

   Young faculty members need to prioritize their activities to develop *their own* research careers in the five or six years after graduation. Even mid-career associate professors need to pay most of their attention to developing their research careers. Thus it is important to ensure that young researchers are not burdened excessively with administrative work. This is of course a challenge given the needs of a new institution, which requires a considerable amount of faculty time and effort in developing the institute and instilling a culture of expediency and transparency in administrative matters.

4. **Significantly and deliberately enhance interactions with industry for mutual benefit**

   Industrial collaborations will become increasingly important in the future, for creating technologies for the betterment of society, for economic growth and for cutting-edge research. Moreover, industry interaction will be of immense value for student placement, adjunct teaching for industry related courses. A concerted effort, including perhaps the establishment of a dedicated office for enhancing industrial collaborations, is advisable. Such an office could also be tasked with developing an intellectual property regime as well as technology transfer and commercialization protocols. The Director could lead small teams of faculty to major industries to increase awareness of IITH's strength and capabilities to solve their problems. A proactive approach must be adopted to strengthen industry

interactions. IITH should encourage all faculty to take up consultancy projects for industry, and spend summers and sabbaticals working with industry in India and abroad. This will lead to downstream effects of closer collaboration with industry on sponsored grants.

5. **Increase support for international travel for undergrads, postgrads and faculty to increase international exposure of their research**

   It is important that young faculty travel to at least two high quality international conferences each year. This will allow them to present their work on the world stage, while also meeting other world-class researchers. The current allocation of ₹3 lakhs every three years is just about adequate to travel to one major conference in three years, and woefully inadequate by current networking norms.

   It would be useful to simplify and relax approval processes, so that researchers can use their government sponsored project funds (Grant-in-Aid) for international travel. This serves an important national need in ensuring that researchers from our premier institutions are active on the world stage. In any case, the need to travel to two international conferences per year is pressing for faculty at all IITs. In addition, it is highly recommended to send undergraduate and post-graduate students to international conferences, if they have a paper to present. Faculty members may also be allowed to travel to selected international conference of extremely high repute without the requirement of presenting a paper, so that they may get exposure to the latest developments in their areas of interest.

6. **Improve gender diversity amongst the faculty by deliberate and planned actions**

   To enhance the diversity among the faculty, and to ensure that the best faculty candidates from around the globe are encouraged to consider positions at IITH, the search and screen process for recruitment, as well as the design of on-campus interviews, should be structured following global best practices. Typically these opportunities should be used for "wooing" the candidate as well as assessing their skills and fit – recruitment and interviews should be viewed as two-way interactions. In particular, a deliberate plan should be developed to identify suitable female candidates even while they are still pursuing their Ph.Ds, so that they can be introduced to potential careers at IITH. In this regard the Director may make special efforts to identify and connect with women Ph.D candidates at top Indian and overseas universities.

7. **Restructure Ph.D thesis committees by including external review professors from the beginning, so that they may guide the development of the scholar in preference to only providing an assessment at the end**

   The current system consists of sending the Ph.D thesis out to an anonymous external reviewer after all the research is done. This review comes too late to be of constructive use during the student's research. Also, the potential graduate has to wait three or more months for the external review, delaying graduation.

   It would be preferable to adopt a system where a Ph.D Committee is constituted two years before the student is expected to complete his/her research. One (or more) external reviewers should be invited to be a part of the Thesis Committee. This will allow the Ph.D student to

avail of the constructive advice of the expert during the conduct of his/her research. Also, it gives the student an opportunity to cultivate a relationship with the experts in his/her field for other career advice and collaborations.

The key point is to ensure active engagement of the external members to enhance research output.

8. **Institute a plan for not only allowing but encouraging the hiring of international faculty**

   Attempts should be made to attract the best faculty members from across the globe, even if on a contract basis. In addition to the Americas, Western Europe and Asia, IITH could consider candidates from Eastern European countries such Hungary, Bulgaria, Poland, Romania and Moldova. The Director may visit major universities in these regions to promote IITH and to attract the best minds. The presence of international faculty on campus will be a healthy addition to the research culture at IITH. Broadening relations with Japan could contribute to hiring of leading Japanese faculty.

9. **Raise salary of starting assistant professors to levels that are competitive with alternatives available to highly qualified Ph.D students**

   There is a critical shortage of highly qualified faculty applying to fill the hiringneeds of IITs. For example, the Computer Science Department has only 10 faculty, and it needs many more. It cannot afford to compromise on quality of the faculty that it hires, and it has not. At the same time there are a large number of highly qualified faculty Ph.Ds who are accepting higher-paying jobs at multinational corporations and other labs. These labs offer salaries about twice those provided at the IITs. This causes a serious competitive imbalance, which needs to be rectified. Faculty shortage is a serious national issue affecting the quality of higher education fundamentally across the country, and is especially critical at our premier institutions such as the IITs. If our premier institutions are to be world-class, and they must be, we will need to be competitive in the remuneration offered. If this requires decoupling of IIT faculty salaries from the rest of the civil service, then this is an important step. The goal of world-class higher education and research, upon which a lot of other critical national objectives such as fostering innovation, start-ups, etc., rest, may require a clean-slate approach to faculty salaries.

Other Recommendations

10. **Sustain and enhance interdisciplinary collaboration**

    In the temporary campus all faculty have their offices in the same physical area, ensuring active interactions among faculty from differing disciplines. As the permanent campus is established, and faculty occupy buildings in their respective disciplines in quads that have similar departments, it is likely that interdisciplinary interactions may diminish. Large-scale project funding today is tied to interdisciplinary research. This is ultimately the only way to tackle the so-called “wicked” problems and global grand challenges. Project-based learning in education and strong joint industrial research on real-world problems would encourage multi-disciplinary activities. Thus, IITH should evolve an ecosystem that preserves active interactions among faculty and students from different disciplines.

11. **Strengthen research administration**

Since research is a key focus for IITH, with significant research funding already garnered, it is important that research administration is strengthened so that faculty time is protected and used productively for research. The office of Dean R & D office must be strengthened. It is important to create a system where professionals take care of non-technical aspects of research administration, including interfacing with industry and patent applications, so as to enable faculty and students to concentrate on the highest quality research.

12. **Create and market an IITH brand**

IITH is recommended to develop a marketing/branding plan that helps it stand out from among other IITs. With its new green campus, the significant percentage of female students in the incoming B.Tech batch (above-average for IITs), the strong connection with Japan, its Fractal Academic Program, and perhaps areas like pedagogical research, IITH should uniquely position itself. Rather than waiting for benefits to accrue from all these exciting features, IITH should develop a strategic plan for branding and marketing. This also has an added benefit of recruiting the best undergraduate and graduate students, as well as faculty.

13. **Hire visiting faculty to cover areas that are not available at IITH**

IITH has 130 faculty members, which is indeed a significant achievement this early in its establishment. Nevertheless, they do not cover the full breadth of important advanced research topics. Therefore, faculty members from reputed institutes should be invited to provide lectures on cutting-edge topics at IITH. In case the expert is a foreign national, he/she may be invited to give lectures over videoconferencing facilities. Ph.D students and post-docs from top universities around the world may also be invited to deliver lectures. Such activities can largely be supported by a sophisticated on-line education and discussion forums.

14. **Establish an active seminar series**

Every research group at IITH should have vibrant weekly seminars. There is no substitute for this for developing a thriving research culture. While it would be best to have speakers present in person, seminars could also be delivered remotely. Seminar series must be planned six months ahead to ensure that the speakers are carefully chosen and invited with plenty of notice. IITH faculty and Ph.D students should also be invited to give seminars in the institute. TED lectures may be screened once a month, coupled with discussion moderated by IITH faculty. Attendance at a seminar series should be made mandatory for students by allocating one credit with a Pass / Fail grade.

15. **Strengthen interaction among B.Tech, M.Tech and Ph.D students for productive and enhanced research work**

The undergraduate students must be introduced to open-ended research project right from the freshman year. Groups consisting of Ph.D, M.Tech, and B.Tech students should be created in every research area. The group collectively works on a specific research problem for several years. This will create not just healthy interactions among UGs and PGs but also help enhance overall research output. It will also inculcate a research culture in the

undergraduate students. This would be achieved by creating research teams consists of UGs, PGs and faculty for project-based learning and/or joint research with national and international companies.

16. **Promote faculty time management with a goal of 40% teaching, 50% research and 10% administration**

    Presently the administrative load on the faculty members is high. The Review Panel is of the opinion that administrative load on the younger faculty members must be brought down dramatically. It is recommended that faculty members do not spend more than 10% of their time in administration. Ideally 50% of their time should be spent on research and 40% on teaching.

17. **Create a group to screen M.Tech and other research projects to identify patentable ideas**

    IITH should take the initiative in forming a committee that will screen through research projects, including M.Tech and Ph.D work, and identify patentable projects. Key industry leaders and entrepreneurs may volunteer to serve on such a committee.

18. **Allocate 20% of time in the undergraduate educational program to independent reading and research courses**

    To evolve through project-based learning, mini projects should be introduced in every semester starting from the first semester. IITH should introduce synthesis courses – open up products and learn various aspects, such as a smart phone.

19. **Reform the curriculum to permit double majors in 4 or 5 years of study**

    B.Tech students should be given the opportunity to do double majors in 4 or 5 years of residency period. Each academic department should identify the courses that must be completed for the award of a second major. Thus a graduating UG can have two B.Techs in two different areas. Globally, this approach has helped students with improved career opportunities.

20. **Create optional minors for M.Tech and Ph.D students**

    At present only B.Tech students are given the opportunity to take a minor program. It is recommended that M.Tech and Ph.D students also be given the opportunity to pursue minors in their areas of interest.

21. **Promote an entrepreneurship course**

    IITH should develop an Introduction to Entrepreneurship course to be offered in the very first year.

22. **Require every student to take a Basic Biology course (not biotechnology) to broaden basic literacy in the sciences**

    Biology is a critical research area for the 21st century; therefore, along the lines of courses in Chemistry, Physics and Mathematics, IITH should offer introductory courses in Biology. The two credits currently allocated to a biotechnology course could be replaced with a biology course.

23. **Ensure that basic science courses focus on depth rather than breadth**

    Since the students enter IIT through the JEE, they already have breadth in freshman-level college physics, mathematics and chemistry, and are adept at solving highly specific problems. Therefore, courses in these subjects at IITH should emphasize depth over breadth. For example, the math course should emphasize analysis and rigorous proofs, and the physics course should emphasize the solution of longer problems that involve many interrelated concepts.

24. **Reduce teaching load, particularly for liberal arts faculty**

    The teaching load of Liberal Arts faculty should be brought down.

25. **Improve communication skills and soft skills of all students**

    The English language skills of students leave a lot to be desired. IITH has already taken the initiative of imparting soft skills by engaging an external agency and not burdening the Liberal Arts Department. IITH may further enhance this English proficiency by motivating students to read classics and also enacting the classics on stage. This way, learning English would be an enjoyable experience.

26. **Ensure timeliness of funding by government bodies**

    Faculty members face significant difficulty in obtaining funds even when a proposal has been chosen for funding. Delays in making sanctioned funds available can create situations where competing research teams elsewhere in the world may have completed the research work ahead of the IITH faculty, and Ph.D students' theses are delayed. Funding agencies must follow through on funding in a timely manner, and keep investigators promptly and fully informed about the schedule for the receipt of research funds.

27. **Encourage senior faculty to write short books or notes along the lines of the Berkeley Mathematics Lecture Notes**

28. **Create regular training and orientation programs and a formal appraisal system for the staff**

    Presently there are no formal training and orientation programs for the staff, and this should be remedied to get the greatest benefit from them.

29. **Create a 1 credit course on legal matters**

    IITH currently offers a minor in entrepreneurship; a course on legal matters would form a good complement.

Summary

In summary, we believe that IITH has made a strong beginning and is poised to reach great heights, building on its vibrant student body, young and enthusiastic faculty, seasoned Director, and new world-class campus.

We hope that MHRD will support this growth of IITH as a crown jewel of the Indian higher-educational system, with a strong potential for making its way into the top rung of internationally ranked universities. We hope that the constructive recommendations we offer above serve as a guide for action.

Terms of Reference and Responses

Preamble

The review is envisaged as an institutional review principally focusing on the core academic activities of teaching, research, as also interaction with the industry. Due importance, however, should be attached to a review of matters that influence academic performance, such as governance, management structure, support systems and institutional culture. All of these should be such as to enable the Institute being reviewed to realize the goals enunciated in its Vision and Mission statements.

The Review Committee should assess the performance of institution and make recommendations at two levels: the general and the specific. Some aspects that must necessarily be covered under each are listed below.

I. ***General considerations***

The Committee should opine on A) where the Institute reached in relation to charters and projections spelt out in the past; B) its plans for the future; and C) the metrics that the Institute adopts in assessing itself.

A. ***Progress in relation to previous projections****. The IITs were set up as outlined by the Sarkar Committee Report, which also spelt out their charter. Charter has undergone minor changes to keep pace with the times and as reflected in the IIT reviews of 1972, 1986 and 2004. Furthermore, each Institute may have enunciated its own Vision and Mission statements. Progress may be reviewed under two major heads:*

- *In relation to the IITs' charter*
- *In relation to the Institute's existing Vision and Mission statements.*

The IITs were established according to the recommendation of the Sarkar committee report to provide high quality engineering education at the undergraduate and postgraduate levels. IITs have done exceedingly well in terms of providing high quality education. Over the years IITs transformed from undergraduate schools to institutes of research.

Vision of IITH

Indian Institute of Technology Hyderabad will be the cradle for inventions and innovations. It will advance knowledge and scholarship to students in science, technology and liberal arts, and equip them to handle the challenges of the nation and the world in 21st century.

Mission of IITH

To be recognized as ideators and leaders in higher education and research, and to develop human power with creativity, technology and passion for the betterment of India and humankind.

It is probably too early to judge IITH's performance based on its vision and mission statements. Nevertheless, IITH has taken all possible steps to achieve the long-term goals set by its vision

and mission statements. To put the institute in the right direction, it was envisaged to have a UG to PG ratio of 1:1, which IITH has achieved just within 5 years after its inception. In June 2009, when Prof. Desai took charge as director, IITH had zero faculty members with 120 B.Tech students, 32 M.Tech students and 14 Ph.D students. IITH students were then taught by IITM faculty. Today IITH is totally independent of IITM and has 130 faculty members on roll with a total student population of 1650 spread across 14 academic departments. The number of Ph.D students at IITH is 411 – an average of 3 Ph.D. students per faculty, a significant achievement for a new IIT having less than 6 years of history. IITH is the only IIT among the new IITs having B.Tech and M.Tech program in all the branches of engineering. IITH has tried to implement many innovations in academic activities. To encourage research among the undergraduate students, a 1 credit independent project is offered in the first semester and the students are allowed to do any project of their choice. Summer Undergraduate Research Fellowships (SURF) are provided to inculcate research culture in the undergraduate students. The research and teaching labs at IITH are well equipped and today IITH has a total of 102 labs in operation and 65 labs in pipeline. 80% of the faculty at IITH do have sponsored projects that ranges anywhere between 20 Lakhs to 20 crs. IITH has nearly 10 cores of industrial sponsored projects and consultancy.

B. Plans for the future.

Along with Vision and Mission statements, a strategy may have been articulated by the Institute as to how to reach its goals. The Committee could therefore remark on:

- *Projections made*
- *Strategies formulated*

India today requires a large pool of talent capable of performing large-scale research at the highest levels of excellence to meet its economic growth plans. IIT Hyderabad has created a research based ecosystem by creating multidisciplinary research clusters (such as nano-X, sensors, Cyber Physical Systems, X-Materials, etc). IIT Hyderabad's vision is to graduate, on an average, 1 Ph.D student per faculty member every year after 4 to 5 years of joining. This would lead to the creation of a large pool of Ph.D graduates capable of performing cutting edge research and teaching, which is one of the suggestions put forward by the Kakodkar committee report. Presently Electrical Engineering Department at IITH has ~5 Ph.D students per faculty member. The total number of Ph.D students at IITH stands at 411. All major engineering departments have close to 3 Ph.D students per faculty member.

Unlike the older IITs, IIT Hyderabad's master plan is designed for a population of ~20,000, which is again in tune with the recommendations of Kakodkar committee report. IITH always wanted to place a strong emphasis on research and development, which is not possible without a large population of post-graduate students. Therefore, IITH's vision is to maintain a UG:PG ratio of 1:1. Six years after its inception, today IITH has a UG:PG ratio of 1.01. M.Tech for working professionals is another initiative taken by IITH. The department of Mechanical and Aerospace Engineering has started an M.Tech program for working professionals. All efforts are underway at IITH to retain the M.Tech and B.Tech students into the Ph.D program. The M.Tech students are given the opportunity to convert to the Ph.D program in their 3rd semester. The

B.Tech students are given the opportunity to convert to the Ph.D program at the end of 6th semester. B.Tech students are also given the opportunity to convert to the M.Tech program at the end of 6th semester or 8th semester. Thus all efforts are underway at IITH to retain the students for higher studies.

Projections made

1. 6,000 students by 2018 and 9,000 by 2021
2. 30 Post Docs by 2018 and 100 by 2021
3. Approximately 400 faculty by 2018 and 600 by 2021
4. Increase multidisciplinary research and to be excellent center in the areas of sustainable development, next generation communication technologies, nano-science and nano technology, manufacturing and design, energy and environment.
5. Strong industry partnership
6. About 500 crs of sanctioned research funding by 2018
7. Executive M.Tech program for industry
8. Starting a center for green technology
9. Increase the outreach through programs such as TEQIP, CEP courses and open house for neighboring village schools.
10. Increase foreign students to 200 by year 2018
11. Create more entrepreneurial ecosystem. A minor program on entrepreneurship is already operational
12. A third of the faculty having an H-index of 20 or more in 8 to 10 years
13. 50 patents filed in 8-10 years
14. 15 INAE fellows in 10 years and 10 NASI, IAS or INSA Fellows
15. 15 International Society Fellows (like IEEE, ASME, AIChE, ASCE, etc.)
16. At least 10 international awards (like senior Humboldt, Humboldt professorship, JSPS, Elsevier Scopus young researcher, etc.) in 10 years
17. 5 Swarnajayanti Awards in 5 years
18. 2 Bhatnagar awards in 8 to 10 years
19. Industry and sponsored research worth 500 crs in 8 to 10 years
20. Active participation in national development goals; health care, infrastructure, smart cities, digital India, interlinking of rivers, food security, defense, space, atomic energy, etc.
21. Translational research: 10 technologies to be transferred (ToT) in 8-10 10 years
22. Incubate / Nurture at least 20 companies in next 10 years
23. Host at least 5 leading international conferences in next 10 years
24. At least 2 IIT Directors from IITH faculty in the next 10 years

C. Measures adopted toward A and B above

The Institute may internally assess its own performance using a set of criteria and metrics. The Committee may opine on the suitability and robustness of these.

The performance of the institute is internally assessed in terms of the following parameters

1. Number of publications in peer reviewed journals
2. Number of publications in peer reviewed conferences
3. Number of keynote/invited/contributed talks given in international conferences
4. Number of keynote/invited/contributed talks in national conferences
5. Number and value of projects
6. Number of patents filed/approved
7. Number of Ph.Ds graduated
8. Awards and recognitions received by faculty/students.
9. Infrastructure for teaching labs
10. Student placements

Specific Indicators

The Review Committee should consider separately the Institute's performance in the arenas of its core academic activities: teaching and research. A selection of indicators is listed below.

1. ***Curriculum and Courses Offered***

IIT Hyderabad started functioning in the year 2008 with 3 B.Tech programs; Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering. Each of these programs had an intake of 40 students through JEE. In 2009 IITH started admitting Ph.D students in various departments and in 2010 almost all engineering departments started offering M.Tech programs. M.Sc programs started in the year 2010 with Chemistry Department and in the subsequent years, Physics and Mathematics started their M.Sc programs. M.Phil program was also stated in the year 2012 by the Liberal Arts department. Today IITH offers 8 B.Tech programs, 17 M.Tech programs, 3 M.Sc programs, 1 M.Des program, and 5 M.Phil programs. Total student strength at IITH today is 1650 which includes 759 B.Tech. students, 87 M.Sc. students, 378 M.Tech, 8 M.Des, 7 M.Phil, 411 Ph.D students.

i. Range of degrees and disciplines

B.Tech programs

Chemical Engineering
Civil Engineering
Computer Science and Engineering
Electrical Engineering
Engineering Science
Engineering Physics
Mechanical Engineering
Materials Science and Metallurgy

M.Sc
- Chemistry
- Mathematics
- Physics

M.Tech
- Biomedical Engineering
- Biotechnology
- Chemical Engineering
- Infrastructure Engineering (Civil Engrg. Dept.)
- Soil and Structure Engineering (Civil Engrg. Dept)
- Structural Engineering (Civil Engrg. Dept)
- GeoTechnology (Civil Engrg. Dept)
- Environmental and Water Resourse (Civil Engrg. Dept)
- Computer Science and Engineering
- Micro Electronics & VLSI (Electrical Engrg.)
- Power Systems and Power Electronics (Electrical Engrg.)
- Communication and Signal Processing (Electrical Engrg.)
- Control (Electrical Engrg.)
- Materials Science & Engineering
- Manufacturing Engineering (Mechanical & Aerospace Engrg.)
- Design Engineering (Mechanical & Aerospace Engrg.)
- Thermo fluid Engineering (Mechanical & Aerospace Engrg.)

M.Phil
- Anthropology
- Cultural Studies
- Economics
- Fine Arts
- Psychology

M.Des

Ph.D
- All branches of Engineering, Natural Sciences and Liberal Arts

ii. *Consistency of curricula with academic vision*

The curricula of undergraduate and post graduate programs are tailored to equip the students with knowledge and skills to handle the challenges of the nation and 21st century world. The current curriculum followed at IITH is made after carefully examining the curricula of top universities around the globe.

The total credits for B.Tech program in any branches of engineering is between 142 to 148. At IITH one credit is for one contact hour with a slight variation for laboratory courses. Emphasis is given to projects for every possible course. Although summer internship is not a requirement for the award of a B.Tech degree, students are encouraged to do summer internship and Summer Undergraduate Research Fellowships (SURF) are introduced.

The total credits for M.Tech program in any branches of engineering is 60 to 62 credits that comprises of Department core theory, Department Lab, Department electives, Free elective, seminar and thesis. 30 credits are allotted for thesis, which is uniform across all departments. Every department conducts minimum 2 stages of thesis evaluation and maximum of 3 stages.

From 2014-2015 academic year onwards, IIT Hyderabad introduced fractal academic program in all B.Tech programs. The fractal program is an atomized program to enable holistic education. Under this program, all B.Tech students have the option to take a total of 10-15 credits of free electives right from the first semester onwards. This is in addition to a total of 16 credits of Liberal Arts and Creative Arts elective. More about the fractal program in explained in the next section.

iii. *Vision for curricula and academic offerings 5-10 years in the future*

IIT Hyderabad started with the typical semester system curriculum followed at most IITs. In a semester system it becomes increasingly difficult to incorporate the advancement of subjects into the core curriculum with 3 or 4 credit courses. Therefore, IIT Hyderabad is trying out a fractal academic program. The department of Electrical Engineering implemented the fractal curriculum from 2013-14 academic year onwards. All the students admitted to B.Tech program in 2014-15 academic year at IITH will be fallowing the fractal academic program. The fractal curriculum designed by IITH has the following characteristics:

a) The students are introduced the core department courses from the 1st semester onwards
b) Most courses are split into 2 parts; part-I introduces the subject in breadth and part II takes the subject into its depth. The breadth courses are taken by students from other departments besides the students from the parent department.
c) About 10 -16 credits (varies from department to department) are reserved as free electives; allowing the students to gain knowledge about subjects of their interest.
d) The concept of holistic education is further emphasized by the fact that all courses on offer are opened to all students of IITH
e) 16 credits are reserved for Creative Arts and Liberal Arts
f) About 10 -16 credits are allotted for core electives. Electives with credits ranging from 1 to 3 are offered, and this allows students who are interested in gaining a broad knowledge to pick electives with 1 credit from a large basket of courses.
g) Continuous evaluation is implemented as opposed to mid semester and end semester examination pattern.

The details of the program are given in the Fractal Academic Course Booklet: http://www.iith.ac.in/files/pdfs/Fract%20Aacademic%20Course%20Booklet.pdf

Some departments are also implementing the fractal curriculum for the M.Tech programs. IITH is also contemplating on the following aspects:

- B.Sc-M.Tech program
- Technology management program

- Medical school (if approvals and permissions are given)
- Executive M.Tech program
- Allowing bright B.Tech students from centrally or state funded institute to spend 4th year at IITH and absorbing them into the Ph.D program on successful completion of B.Tech (Mechanism need to be worked out). This is along the lines of the Kakodkar Committee recommendation.

iv. *Quality of programs (Under-graduate/ Post-graduate)*

a. *Relevance to recruiters (Industries/ academic institutions/ R&D labs)*

IITs as the premier technical institutions in the country cater to a large spectrum of students who want to do higher studies, pursue a career in industry, or an alternate career. Therefore, the curriculum at IITH is designed to cater to the needs of this wide spectrum on needs and wants of the students. There is, of course, a strong component basic sciences, math and engineering. Large emphasis is given on project works as part of courses, which equip the students with skills that are generally sought after by industries. Although, summer internship is not mandated by the curriculum, IITH strongly encourages students to take up summer internship in industry or academia. IITH also offers B.Tech. Minor and B.Tech. Honors programs. A unique offering at IITH is a minor in entrepreneurship to all students so that IITH students can be job creators rather than job seekers. This minor is taught by entrepreneurs and industry personnel. People from industry are also invited at IITH to offer fractional credit courses in special domains of engineering, arts and other areas.

b. *Periodicity of curriculum review at both UG and PG level*

In general the curriculum is reviewed in every 10 years at older IITs. IITH started in 2008 adopting a typical IIT curriculum. After 5 years the whole curriculum was reviewed as part of developing the Fractal Program. Since IITH is in an evolutionary mode, the review will be done every 5 years.

c. *Mechanism for program review at the UG and PG level*

The programs are reviewed by every department once in 3 years, and the institute will be reviewing the program once in every 2 to 4 years. IITH will keep upgrading the program as and when the need arises or when the department thinks new subjects and practices needs to be introduced. The quality of teaching is evaluated by collecting course feedback from the students, and the average score for IITH faculty members is 4.1/5.

d. *Course work mandated for Masters students and the average courses done per Masters student*

Every Masters student takes ~25 credits of courses. Some department offers all 3 credit courses and some offer a mix of 3 credits and 2 credits. Each Masters student takes an average of 8 courses. The number of courses done by an M.Tech student in the fractal curriculum will be equivalent to 32 credits.

e. *Course work mandated for Ph.D students and the average courses done per Ph.D student*

The course credit mandated for Ph.D students is 12. As per the earlier curriculum of IITH, all the courses were of 3 credits and that translates into 4 courses for Ph.D students. However, the Doctoral Committee and the supervisor can recommend additional courses to the student depending on the project requirement. If the student has completed M.Tech from IIT, then the mandated course credit is 6.

f. *Student placements*

IITH had its first graduating batch of M.Tech students in the academic year 2010-11. Of this 23 students enrolled for placements and 18 of them got placed in 10 companies. The next academic year 2011-12 had seen the first major placement season with both M.Tech and B.Tech students taking part. Out of 136 students, 119 got placed in 42 companies. The year 2012-13 had 114 students placed out of 162 registered students. M.Tech, M.Sc and B.Tech students participated in campus placements and the offers came from 45 companies. In the academic year 2013-14 out of 176 registered students, 117 got placed in 53 companies and students from M.Tech, M.Phil, M.Sc and B.Tech participated in campus placements.

2. ***Teaching environment***

a. *Teachers Adequacy: (e.g. Teacher-student Ratio for each academic department)*

Department	Student to faculty ratio
Biomedical Engineering	8.75
Biotechnology	6.2
Chemical Engineering	11.28
Civil Engineering	13.41
Computer Science and Engineering	24.0
Chemistry	10.11
Design	4.33
Electrical Engineering	21.16
Liberal Arts	2.8
Mathematics	3.77
Mechanical and Aerospace Engineering	18.6
Materials Science and Metallurgical Engineering	7.37
Physics	6.45

The above numbers have to be taken with a pinch of salt, since departments like Physics, Chemistry, Mathematics, Design, Biotechnology and Liberal Arts offer courses to all B, Tech. students on a regular basis. Thus, the faculty student ratio for these departments will be higher than what is indicated in the above table.

b. *Average number of tutors in courses with more than 100 students*

7 TAs in classes with more than 100 students.

c. *Quality of engagement of teachers with students. (Student feedback on courses and curricula.)*

The student feedback on every course taught is collected during the mid of the semester. A carefully prepared set of parameters to judge the quality of teaching and engagement of teacher with student is used to measure the quality of teaching. The average score at IITH is 4.1/5.

d. *Number of students who were motivated to opt for careers in engineering/ science/ technology sectors. Based on available data, for at least last five years).*

Sector	2011	2012	2013	2014
IT/IT enabled services	27%	36%	36%	37%
Core	64%	45%	33%	40%
Startup	-	7%	17%	6%
PSU	-	4%	4%	3%
Education	9%	4%	3%	10%
Finance/Banking	-	5%	6%	3%
Number of students places	18/23	119/136	114/162	117/176

Placement is very much dependent on market conditions and the overall state of the economy. Also many students do get placed soon after graduation – these numbers are not taken in to account. Also, there are many students who opt for higher studies; these numbers are also not reflected in the above table.

e. *Adequacy of infrastructure teaching labs and equipment, for example by assessing average number of students per experiment in core courses*

On an average the number of students per experiment is 2 to 3.

f. *Adequacy of laboratory assistants*

At present most of the laboratory assistants at IITH are on contract. Every lab has at least one assistant. The recruitment for the permanent posts is underway. 20 posts are advertised to the post of technical superintendent, 9 posts for junior technician, and 2 posts for network administrator. Three junior technicians have already been hired by IITH. At present IITH manages its day-to-day activities with the help of project staff.

g. *Modernization of libraries: extent of electronic accessibility to library resources*

The library at IITH offers access to all major electronic resources and a few search databases. The resources available at IITH library are listed in Annex: Library Resources.

h. *Availability of students' workshops/ "tinkering" labs to students so that they may pursue their own ideas*

Every lab at IITH has a tinkering component. The one credit project introduced for the freshmen is also an initiative in this direction.

i. *Feedback from employers in science/ engineering sectors. The placement office should be mandated to obtain annual feedback from employers (industry/ R&D labs/ academic institutions) about the quality and performance of the Institute's students in key parameters. See also point 8 below.*

Annual feedback is not taken from the employers; however, feedback is taken from the employers right after the selection process.

j. *Internal assessment reports of departments and centers. These reports should have been discussed at length in institute's senate.*

Internal assessment of all individual departments is done at IITH. The assessment is done by experts from older IITs, IISc and industry. Various parameters measuring the quality of academics, research, infrastructure, interactions, and budget spending are considered for the review. In addition the review committee also interacted with the under graduate and postgraduate students before submitting their review report.

3. ***Research and Development***

a. *Range of research activities: (i) Volume, (ii) Breadth*

IITH has projects in all the areas that we deal with. The nature of project ranges from fundamental to the applied aspects.

b. *Publications per Faculty / Masters/ Ph.D student*

Please refer Annex: Publication and citation statistics

c. *Publications per Faculty / Masters/ Ph.D student in a list of top 10 journals in broad research fields as identified by the Institution's departments/ centers. This list of journals should be whetted appropriately by an independent group of peers/ experts and updated periodically every 5 or more years*

d. *Average number of citation per department/ center/ school*

Please refer Annex: Publication and citation statistics

e. *Number of papers with citations that are more than the average number of citations of the journal in which they are published.*

f. Other major research contributions: Technology developed/ technology transferred/ patents filed/ patents obtained/ etc.

Please refer Annex: Patents

g. *Recognitions &Awards (national and international) to faculty/ research staff/ post-graduate students*

Please refer Annex: Awards and recognition

4. **R&D environment**

a. *Average time that it takes a new faculty to set up lab*

Less than 1 year

b. *Retention of young faculty: What percentage of young faculty remains with institute for at least ten years? Base on data of previous decade.*

The attrition rate of faculty members is very low at IITH. Till date only 9 out of 130 faculty members have left IITH. Almost all of them moved to other institutes because of health reasons, two-body problem or family reasons.

c. *Consultancy and project money from non-internal sources.*

₹10 crore

d. *Research grants/ seed money from internal savings of the Institute to young faculty/ post-doctoral fellows/ Post graduate students*

Every faculty member gets 5 lakhs of seed grant on approval of a proposal. The seed grant is primarily to get the groundwork done on a research the faculty member wants to pursue. Additional money may be provided on need basis for procurement of equipment depending on the availability of internal. Research grant from external sources at IITH is to the tune of 125 crs.

e. *Collaborations internally and with other Institutes: number of papers/ projects/Ph.D students with collaborating authors/ mentors.*

Please refer Annex: Publication and citation statistics

f. *Adequacy of research infrastructure, labs and equipment*

IIT Hyderabad is very well equipped in terms of research infrastructure. However, need for maintenance support is required. Also, support is required to further enhance the research infrastructure – IITH has a long way to go till develops a world class research infrastructure.

g. *Adequacy (number and competence) of research and technical assistants/ officers/ engineers*

We have full complement of staff

h. *Number of large interdisciplinary research projects.*

- Information network for natural disaster mitigation and recovery (20 crs ~ USD 3.3 million)
- Cyber Physical Systems (₹17 crs ~ USD 2.9 million)
- IoT for smarter health care (₹4 crs ~ USD 667,000)
- Self powered wireless chipset for building to building communication (₹2 crs ~ USD 333,000)
- Cognitive radio (₹1.5 crs ~ USD 250,000)
- IUATC project (₹1.7 crs ~ USD 283,000)
- Green Sensor Networks for Air Quality Support (DEITY) (₹1 cr ~ 160,000 US$)
- Development of FRET enhanced quantum dot sensitized solar cells (₹1.33 crs ~ USD 220,000)

- Improving the efficiency of dense medium cyclone treating high NGM coal using GPU based CFD and PEPT techniques (₹2 crs ~ USD 333,000)
- Incremental sheet metal forming: Predicting modeling and validation (₹1.5 crs ~ USD 250,000)
- Evaluation of fly ash treated recycled asphalt pavement (RAP) for base/subbase construction (₹1 cr ~ USD 160,000)

i. *Work space for Ph.D. scholars, i.e., do they get their own desk/ computer?*

Yes. Each Ph.D. student is provided a lap top by the institute.

j. *Number of international conferences/ workshops attended by a Ph.D student (for exposure/ paper presentation)*

Please refer Annex: Publication and citation statistics

k. *Number of papers with Ph.D student as first author*

Please refer Annex: Publication and citation statistics

l. *How many M.Tech students were motivated into pursuing Ph.Ds? How many joined Ph.D programs at own/ sister institutes? Base on available data, for at least last five years.*

m. *Number of Ph.D graduates who pursued a career in academics, (abroad or IIT/ IISC/ TIFR/ CISR/ BARC/ R&D labs etc.). Base on available data, for at least last five years.*

IIT Hyderabad until now has graduated 8 Ph.D. students

n. *Number of post-doctoral scholars hired in the institute*

Nil

o. *Number of International students as Ph.Ds / post-doctoral scholars*

Nil

p. *Visiting researcher programs: Strength/ extent of engagement measured e.g., by*

(i) *Number of international visiting researchers who stay for at least a week.*

Approximately 15

(ii) *Number of courses/ workshops with international participation.*

q. *Internal assessment reports of departments and centers. These reports should have been discussed at length in institute's senate.*

(Please refer 2.j). These report is provide to the Panel.

5. ***External Stakeholder Engagement***

A. ***Industry Collaboration***

a. Number of Ph.D/ Masters theses directly linked to/ funded by industrial project

Please refer Annex: Publication and citation statistics

b. *Total income from Industry Sponsored Projects*

10 crs

c. *Technology transfer / adopted by labs, industry*

None at the moment

d. *IPR and patents. Please report patents obtained/ filed separately.*

Please refer Annex: Patents

e. *Curriculum development initiatives for Industry*

The Department of Mechanical and Aerospace Engineering is offering M.Tech for industry. Cyient Technology has sponsored 12 students to the program.

Executive M.Tech program for industry is one of the academic visions of IITH

B. ***Contributions to National Development Goals/priorities***

a. *Number of nationally relevant research projects, e.g., in sectors of defense, medicine, environment, energy, health, infrastructure, etc.*

Sl. No	Project Title	Sponsoring Agency
1	Non-Termal Plasma Assisted Direct Decompositied of Hydrogen Sulfide	MNRE
2	Degradation of Aqueous Organic Pollutants by Novel Advanced Oxidation Technology Combining Non-Thermal Plasma and Heterogeneous Catalysts	MOEF
3	Epoxy Nano Composites for Aerospace and Armor Applications	DRDO
4	Geogrid Reinformeed Granular Bed in lieu of Approach Slabs for Bridge Abutments'(Ministry's Research Scheme B-43)	MRTH
5	Isogeometric mesh fee analysis of Laminated composite plates	DRDO
6	A computational Damage Mechanics Approach for Muktiscale Failur Modeling of Composite Plates	DRDO
7	Cars project for design & Layout of low noise receiver frontend in 65nm rf cmos process technology	DRDO
8	Development of a Quadruped Robot With Flexible Body	DRDO
9	Development of magnetic pulse welding technology for joining dissimilar materials: stainless steel and aluminium alloys	DRDL
10	Non contact extensometry for localized strain measurement on welded specimens and evaluation of tensile properties	DRDO
11	Simulation Studies on Plume Analysis of Divert Thrusters of PDV Missile at High Altitude	DRDO

Sl. No	Project Title	Sponsoring Agency
12	Recrystalization Behavior and Evolution of Microstructure and Mechanical Properties in Bulk Nanostructured Duplex Steels Processed by severe Plastic Deformation	DRDO
13	Investigation of Magnetoelectric Coupling in lead Free Based Magnetoelectric Composites for Sensor Applications	DRDO

The aforementioned are projects sponsored by defense sector and ministries. In addition IITH is participating in a number of nationally relevant projects sponsored by other agencies. A few of them are listed below

- Digital India
- Project on smart city
- Cyber security
- Biofuels
- Smart health care

Faculty members from Civil Engineering were highly instrumental in preparing a user guide on hydrogeologic and water quality analysis in six Gram Panchayats in AP and Telangana, a project funded by European union and Bread for the world.

IITH has contributed to the high-altitude aerodynamic and propulsion analyses of PDV (long range interceptor missile) and K4 (submarine launched ballistic missile) projects. IITH contributions have helped DRDO laboratories to achieve successful maiden launches of both the missiles.

b. *Engagement/ help/ leadership provided to other technical institutes/ labs in areas of teaching and research, e.g., via programs such as TEQIP, or availability of specialized laboratories, etc.*

Knowledge Incubation for Technical Education (KITE) under TEQIP-II activities at IIT Hyderabad have started from August 2013 by conducting a conclave on Electrical and Computer Sciences (30-31 August 2013) and 56 participants from various TEQIP supported colleges have attended. The objective of KITE was to improve quality of technical education through institutional and systemic reforms and enhance efforts to prepare more post graduate students to reduce the shortage of qualified faculty and to produce more research and development in collaboration with other institutions and industry in 45 Institutes allotted by NPIU. Mechanical and Aerospace Engineering department of IITH conducted a two-day conclave during 7-8 March 2014 and 73 participants from various TEQIP colleges have participated. Faculty members from Chemical, Materials Science and Engineering and Biomedical Engineering have organized a two-day workshop on 'Fundamentals and Applications of Nanofibers' during 4-5 July 2014 and 43 participants have attended. A Two-day workshop on 'Additive/ Generative Manufacturing Technologies' for TEQIP college faculty is organized during 7-8 July 2014 at IITH with 16 participants from TEQIP

supported colleges. Several departments at IIT Hyderabad, by end of this year, have planned about 16 new TEQIP events.

c. *Policy Inputs/ Consultancies*

IITH faculty members are contributing to mineral processing, structural engineering, automotive engineering, communication and broadband technology, electronic manufacturing and cyber/information security.

C. ***Social Responsibility***

a. *Community relevant projects, social outreach*

NSS chapter of IIT Hyderabad works with the motto 'NOT ME BUT YOU'. It is a body of students, guided by faculty and staff, who are driven by the spirit of social service, selflessly strive to improve the education, health and standard of living of the underprivileged. It is aimed at efforts to improve the social status of our nation. It encourages activities, which empower the society to respect the nature, education and nation. Plantation activity helps to promote awareness about the nature among the youth. Open day program initiated by NSS-IITH is aimed at inspiring the young generation to excel in the field of science and technology. In this program, large number of students from different schools of nearby villages participates. They interact with IITH students and explore the research laboratories and workshops where they are exposed to the latest technology. The volunteers undertake teaching activity at schools in village areas regularly to provide academic assistance to the students. Blood donation and cloth donation are actively taken up by the NSS. The scale of these activities is increasing every year by leaps and bounds. Innovative ideas are implemented every year by NSS like 'Each One Give One' where the students from various corporate schools in urban areas are encouraged to donate books which are distributed among the less privileged children. The NS Sites visit orphanages and old age homes and organize fun activities bringing smiles on the faces of many. By increasing the scale of these activities and undertaking novel projects, NSS-IITH works with a vision to make a huge difference to the society.

b. *Sensitiveness to on-campus labour/ environment/ energy/ water/ land etc. issues.*

Approximately 20 million man-hours of work on permanent campus has been completed till now and there was not a single untoward incident. IITH Received the GRIHA award for construction workers health and safety.

c. *Environment/ energy/ water/ land/ employment impact on local communities*

The master plan of IITH is designed not to have any adverse effect on land, water and energy on the local community. The permanent campus will be green with water treatment and rainwater harvesting, thereby reducing the dependency on ground water and municipal water supply. The new campus will have solar field exclusively to tap the solar energy using PV cells. These technologies will reduce IITHs dependency on grid power. The campus construction and the functioning of IITH will certainly provide employment for the local community, particularly considering the fact that the campus is designed for a population of 20,000.

D. ***Alumni Engagement***

a. *Contributions from Alumni*

b. *Engagement with alumni (academic/ publicity/ policy/ growth)*

The alumni association of IITH is relatively young. All graduates of IITH are provided with alumni card on convocation day. Recently the first batch of graduated students and some from the second batch convened at IITH for the first IITH alumni day

6. ***Vision for the future:***

Institute and its departments/ centers should spell out its strategic vision for next decade.

A Detailed Vision Plan for the next 5 years is under development and will be ready very shortly. Nevertheless the broad contours are:

Faculty, Students, Industry Interactions

- Recruiting world class faculty
  - Will be a major ongoing activity
  - Faculty empowerment
  - Faculty development
  - Faculty Leadership
- Scaling with quality
  - Reaching ~6000 students by 2018 Aug
- Strengthening and scaling the Ph.D. program – ~1200 Ph.D. students by 2018
- Enhancing Interaction with industry

Research, Innovations, Design, Incubation

- Creating a culture of
  - Research / Innovations
  - Multidisciplinarity
  - Entrepreneurship
- Making design as part of the IITH ecosystem
- Fine Arts, Performing Arts, as part of IITH Landscape
- Incubation
  - Already set in process. Section 25 company – IITH Technology Incubator is being formed
  - Submitted a proposal for Fabless Chip Companies Incubator to DEITY

Innovations in Academics

- Developing an innovative program that focusses on and encompasses:
  - Leadership
  - Entrepreneurship
  - Courage

- Executive Program at PG level
  - Will help enhance industry interactions
- Increase international collaboration
  - Start a program jointly with a leading international university

Corpus

- Building the corpus for IITH
  - Setting up an overseas (USA) heritage fund so that donations to IITH will be tax deductible
  - Already talked to a few people
  - Industrialist in Hyderabad ready to help
  - IITH already has a few alumni at Stanford and in Bay Area – plan to involve them in this activity

Some Multi-Disciplinary Thrust Areas

- Things 2 Bytes 2 Things (Digital Fabrication)
- Cyber Physical System / IoT (Smart Health Care Technologies, …)
- Cloud Converged Communication
- Sustainable Development (Smart Cities)
- Sensor Technologies
- Big Data Analytics
- Biomimetic
- Sustainable Mineral Processing & Utilization
- Automotive research center
- Part of Mega Physics Projects at KEK (High Energy Accelerator – Japan), Fermilab, CERN
- Center for Green Technologies

Some Projections …

- 6,000 students by 2018 and 9,000 by 2021
- 30 Post Docs by 2018 and 100 by 2021
- Approximately 400 faculty by 2018 and 600 by 2021
- Increase foreign students to 200 by year 2018
- Strong industry partnership
- About 500 crs of sanctioned research funding by 2018
- Executive M.Tech. program for industry
- Increase the outreach though program such as TEQIP, CEP courses and open house for neighbouring village schools

- A third of the faculty having an H-index of 20 or more in 8 to 10 years
- 50 patents filed in 8-10 years
- 15 INAE fellows in 10 years and 10 NASI, IAS or INSA Fellows
- 15 International Society Fellows (like IEEE, ASME, AIChE, ASCE, etc.)
- At least 10 international awards (like senior Humboldt, Humboldt professorship, JSPS, Elsevier Scopus young researcher, etc.) in 10 years
- 5 Swarnajayanti Awards in 5 years
- 2 Bhatnagar awards in 8 to 10 years
- Industry and Grant-in-Aid sponsored research worth 500 crs in 8 to 10 years
- Active participation in national development goals; health care, infrastructure, smart cities, digital India, interlinking of rivers, food security, Defense, Space, Atomic Energy, etc.
- Translational research: 10 technologies to be transferred (ToT) in 8-10 years
- Incubate / Nurture at least 20 companies in next 10 years
- Host at least 5 leading international conferences in next 10 years
- At least 2 IIT Director from IITH faculty in the next 5-10 years

7. ***Governance and Financial Resources***

   i. ***Management***

      a. *Adequacy of administrative support/ systems in relation to the level of activities envisaged?*

      b. *Responsiveness of the system to faculty, student needs*

      c. *Periodic feedback/ evaluation of administration from the institute's stakeholders (faculty/ research staff/ students/ etc.). Should include parameters gauging sensitivity/ efficiency and pro-activity/ transparency.*

      Since IITH is very young a composite answer to a, b, and c is given.

      The administration at IITH responds very promptly to the needs of faculty and students. Permanent recruits are very few, however, the numbers are increasing steadily. The review of administration staff will be conducted very soon.

   ii. ***Financial Resource Management***

      a. ***Fund mobilization (besides MHRD)***

         i. *Internal Revenue Generation as percentage of Non-Plan expenditure*

         Presently IITH has no non-plan budget. 4.42 crs is the internal revenue (Student fee + overheads) for FY 2013-14.

         ii. Corpus Fund

         50 lakhs

b. ***Cost Efficiency***

i. *Cost per student*

7 lakhs per student (this is slightly on the higher side since IITH is a young institute and there is a huge spending on building the research infrastructure)

ii. *Fee per student per annum/ Non-Plan Expenditure per student*

Please refer Annex: Fee Structure

There is no non-plan expenditure since IITH are in project mode

iii. *Total fee paid by student (discounted)/ Per annum average salary*

Please refer Annex: Fee Structure

iii. ***Transparency:***

Mechanism of transparency in place by the Institute as steps that have been taken for internal quality assurance

a. *Transparent decision making processes*

Decisions are made by committees following the rules of Govt. of India / rules laid down by the BoG. The decisions are communicated to the stakeholders by email.

b. *Academic issues, research grants, systems for recognition/ awards etc.*

All academic issues are discussed in the senate of the institute. Research grants, system of recognition, award etc. are in compliance with the Govt/institute norms and no discretion is exercised.

c. *Procurement processes*

As per Govt/Institute norms. Tenders and other information are hosted on the website.

d. *Infrastructure development, right from requirement to planning to execution.*

As per Govt. of India norms following tender procedure

e. *Proactive disclosure on all critical issues (As per RTI)*

Being undertaken and will be completed in due course

f. *Placing information in public domain: website*

As per the Govt. of India norms (Selections, tender, details of procurement etc are placed on the website)

iv. ***Infrastructure:*** Is the support infrastructure (IT, Hostels, Faculty/ Staff housing, sports facilities) adequate? And how sensitive and eco-friendly it is to the campus and surrounding environment (land/ water/ energy/ greenery).

The new campus is under construction and the required infrastructure has been planned. The campus is planned to be totally green campus.

8. ***Stakeholders Survey***
   a. *Internal Stakeholders*
      i. *Students*
      ii. *Faculty*
      iii. *Non-faculty*
   b. *External Stakeholders*
      i. *Industry*
      ii. *Alumni*
      iii. *Community leadership*
      iv. *Government*

   The panel will be able to meet the students, faculty, and staff independently and make an assessment. The alumni are not very large at present. However, IITH had started establishing mechanism to be in touch with the Alumni continuously. Mechanism will be put in place to take feedback from the alumni once IITH does have a sizable number of alumni.

9. ***Diversity***

   What is the current status of diversity (gender/ international) on campus? Does the Institute have programs to promote diversity among students, staff and faculty? Does the Institute have adequate mechanisms to deal with issues related with discrimination and harassment? Reports of such cases and action taken should be made available.

   The gender diversity is reasonably good at IITH. For the 2014-2015 academic year, the overall girl student population is 21%. The incoming batch of 2014 B.Tech students has 24% girl students. Internal compliance committee is established to deal with sexual harassment of women at workplace. IITH is in the process of establishing a grievance cell. If the faculty pleases, he/she can approach the director directly or the Head of the Department or Dean of Faculty.

Process of External Review

(a) *The Peer Review of each Institute would be carried out on a periodic basis, once in every five years. For the new IITs, similar exercise be carried out on completion of five years.*

(b) *The Review Committee will consist of five eminent persons from Industry and Academia, to be selected by the Chairman of the Council of IITs, from a panel of 10 names proposed by the Board of Governors of respective Institutes. The report of the Review Committee will be placed before the IIT Council for its consideration.*

(c) Besides periodic review of the institution, each IIT w similarly undertake, an in-house, department-wise review before any external Peer Review is carried out. The report will be considered by the concerned BOG of IIT and the recommendations made therein would be pursued at appropriate level i.e. at the Institute level, Board level and the IIT Council, if necessary.

Annex: Library Resources

Tools	Details
End Note	A note placed at the end of an article, chapter, or book that comments on or cites a reference for a designated part of the text.
Turnitin	Turnitin is the global leader in evaluating student work. The company's cloud-based service for originality checking, online grading and peer review saves instructors time and provides rich feedback to students.
ChemDraw Pro	ChemDraw is the drawing tool of choice for chemists to create publication-ready, scientifically intelligent drawings for use in ELNs, databases and publications and for querying chemical databases.
Database	**Details**
Academic Search Complete	Academic Search Complete is a multi-disciplinary database, with more than 6,100 full-text periodicals, including more than 5,100 peer-reviewed journals
Reaxys Direct CWA	Reaxys is a web-based chemical search, analysis and workflow tool. Reaxys provides links to Scopus for all matching articles. Reaxys is a newer and more advanced product than an earlier offering from Elsevier, Crossfire Commander. As of 2011, "Reaxys has completely replaced the Crossfire Databases."
Scopus	Abstracting and Indexing database
Proquest dissertation and thesis	entire collection of PQDT
ASTM	Standards entire collection
Journals	**Details**
ACS Legacy Archive + ACS Web	26 Journals
ECS (Subscription renewal notice)	7 Journals:The Electrochemical Society is a learned society based in the United States that supports scientific inquiry in the field of electrochemistry and solid-state science and technology. It was founded in 1902 as the American Electrochemical Society. ECS currently has over 8,000 members in 70 countries.
RSC-Online Package A+ RSC-Nano Scale	34 Journals
Journal of Fluid Mecahnics	1 Journals
ProQuest Bundle	1. Dissertations & Theses complete 3 Million Dissertations/Theses with 80,000 New Theses added every Year. 1600 Titles
Thieme	5 Journals
MathSciNet	approximately 550 journals
AIP	36 Journals
APS	Its consits 2290 journals
Project Muse	approximately 321,087 articles
JSTORE	JSTOR currently includes more than 2,000 academic journals
IEL Online	It includes 3,769,403 items
ACM	1000 journals
ASCE Online	CEDB is a free bibliographic database offering over 200,000 records of all publications by American Society of Civil Engineers
Science Direct	Science Direct is a leading full-text scientific database offering journal articles and book chapters from nearly 2,500 journals
Springer	Near about 1700
SIAM	16 Journals
IEEE	Full set

Annex: Publication and citation statistics

S. No.	Dept	No. of Faculty	Total number of publications	Citations	h Indiex	Citation/ Faculty	publications/ faculty
1	BioTech	5	1	13	1	2.6	0.2
2	BioMed	4	6	18	2	4.5	1.5
3	Chemical	14	53	161	7	11.5	3.8
4	Chemistry	9	142	532	13	59.1	15.8
5	Civil	12	22	47	4	3.9	1.8
6	CSE	10	22	4	1	0.4	2.2
7	Electrical	18	114	81	5	4.5	6.3
8	LA	10	4	1	1	0.1	0.4
9	MSME	8	22	22	2	2.8	2.8
10	Maths	9	29	37	3	4.1	3.2
11	MAE	16	42	93	6	5.8	2.6
12	Physics	11	66	151	6	13.7	6.0

Publication Record	Physics	LA	BM	EE	MSME	MAE	CY	ChE	BT	MA	CSE	CE
Number of publications with Masters student as co-author	5	3	2	56	19	28	21	14	0	4	7	27
Number of publications with Ph.D students as co-author	17	4	9	81	13	38	100	26	2	17	28	16
Number of papers with collaborators as co-authors	62	13	13	55	20	11	29	55	2	47	9	37
Number of projects with collaborators	6	1	0	17	4	7	4	4	4	2	3	22
Number of publications with Ph.D student as first author	19	2	8	46	10	51	97	23	1	15	19	10
Number of international conferences/workshops attended by Ph.D students	31	0	0	21	12	12	8	27	4	5	17	7
Number of students per experiment in core labs	1	0	1 to 2	4	2 to 3	3	15	3 to 4	2	0	NA	3 to 4
Number of internal students as Ph.Ds	0	8	2	9	19	10	2	20	3	0	2	10
Number of Ph.D/Masters theses directly linked to funded industrial projects	0	0	0	16	1	5	0	1	0	0	10	13
Number of publications per master student	NA	0.4	0.1	0.4	1.2	0.3	NA	0.4	0.0	NA	0.2	0.5
Number of publications per Ph.D student	0.6	0.2	0.6	1.0	0.4	0.8	1.9	0.8	0.1	1.3	1.0	0.4

Annex: Patents

1. K Kuchi et al., Interference Management for a Distributed Spatial Network, PCT/IN2012/000339, Filed on 9 May 2012.
2. KS Karthik, K Kuchi, R Bhaskar, 'An ordered reduced set successive detector for low complexity, quasi-ML MIMO detection', PCT application, 18 January 2013, U.S. Application Serial No. 13/745,018
3. Vamshi Krishna K, Bheemarjuna Reddy Tamma, Manoj Kumar M and Nitesh Shah, Systems and Methods for Dynamic Wideband Channel Selection, filed for U.S. patent in January 2014.
4. Kathik K.S, Kiran Kuchi, B. Ramamurthi, An ordered reduced set successive detector for low-complexity, quasi-ML MIMO detection, PCT application was filed on January 18, 2013 as U.S. Application Serial No. 13/745,018.
5. Kiran Kuchi, Shariar Emami, A method and apparatus for a cluster specific CSI Feedback, Provisional patent application, filed on 2/11/2014.
6. Kiran Kuchi, Opportunistic Scheduling and Interference Alignment in Multiple Antenna Systems, provisional application 2161/CHE/2013 filed on 16/05/2013.
7. Kiran Kuchi, Interference Suppression in HetNets through Coordinated SIMO/MIMO Interference Codes, PCT application PCT/IN2014/000332,16/05/2014.
8. AP Rajalakshmi et al, A high speed and low complex beam-former system to transmit signals and method thereof, Appln. No. 1249/CHE/2014, 11 March 2014, Provisional patent filed.
9. Tamal Ghosh, Siva Rama krishana, Asudeb Dutta, Shiv Govind Singh, Sub 100°C thermo-compression metal - metal direct bonding, File no. 1846/CHE/2014
10. Chandrashekar Sharma, High aspect ratio hierarchical superhydrophobic and anti-reflective polymeric surfaces fabricated by biomimicking Canna Indica plant, Indian Patent Application No.: 2507/CHE/2014, May 17, 2014

Annex: Awards and recognition

1. Sudhakara Reddy Yenumala received Ambuja's Young Researcher's Awards for 2011 for guiding thesis titled 'Reforming of Vegetable Oil for the Production of Synthesis Gas; Thermodynamic Analysis and Flow Sheet Design'.
2. Ch Subrahmanyam received Royal Society International Travel Grant to visit the University of Manchester, UK.
3. Faiz Ahmed Khan has been awarded Fellow at the National Academy of Sciences (2011) and Indian Academy of Sciences (2012)
4. Remya Narayanan won the Best Poster Award in the Sciences, on IIST Research Scholar's Day held at IIST Thiruvananthapuram, on 16-17 December 2011.
5. Subhash Ranjan Dey has been invited as 'Alexander von Humboldt Guest Scientist' at Institute for Structure Physics, Technical University Dresden, Germany, and also an Invited Professor at University Paul-Verlaine Metz, France.
6. Chandra S. Sharma received the INAE Innovative Student's Project Award 2011 for his Ph.D. thesis.
7. V Kanchana Received the Young Scientist Award 2011 from Andhra Pradesh Academy of Sciences.
8. Swetarekha Ram received Best Poster Award at National Conference Organised by Advanced Materials Research Group of Computational Nano Science and Technology Lab (NCMAT-2012), ABV-IITM, Gwalior (M.P.) India.
9. KP Prabheesh was selected as Young Economist to participate in the 4th Nobel Laureate Meeting in Economic Sciences, held in Germany on 23-27 August 2011.
10. Kolluru VL Subarhmanyam, Life Member, Indian Concrete Institute.
11. S Sireesh has been nominated for Best Paper Award for his paper titled 'Assessment of Recycled / Secondary Materials as Pavement Bases', ICE Journals, Thomas Telford, 2011 and ASCE Middle Brook Best Paper Award for the paper titled 'Experimental and Modeling Studies of Permanent Strains of Subgrade Soils', published in ASCE Journal of Geotechnical and Geoenvironmental Engineering, 2011.
12. Mr Pankaj Sahlot and Mr Sajin George Sajan received First Prize in Poster Presentation Friction Stir Welding at 'Design and Development of Materials for Advanced Technologies' (DMAT-2012) from 23-24 January 2012 at IT Banaras Hindu University.
13. Mr Sreekanth Mandati received the Best Poster Presentation Prize at 3rd EICOON SCHOOL on 'Science and Technology of Renewable and Clean Energy Sources' held in Kolkata on 30 April - 1 May 2012.

14. Dr Thenmalarchelvi Rathinavelan, Young Innovative Biotechnologist Award-2012, DBT – Government of India.
15. Dr Kirti Sahu, National Academy of Sciences India (NASI) - Young Scientist Platinum Jubilee Award (2012).
16. Dr Kirti Sahu, Indian Academy of Sciences (IAS) - Young Associate (2012-2015).
17. Dr Sireesh Sirade, Elected as Editorial Board Member for Institution of Civil Engineers (UK) Proceedings of ICE Journal Ground Improvement (2012-2015).
18. Dr Suriya Prakash, Ramanujan Fellowship, Department of Science and Technology.
19. Dr Shashidhar T, Received fellowship under the research excellence program USC-India (PEIN) to visit University of Santiago De Compostela, Spain.
20. Dr Suhash Ranjan Dey was invited as Alexander von Humboldt Guest Scientist at Materials Science and Engineering, Ruhr-University Bochum, Germany, May-July 2012 for 2 months.
21. V Kanchana: Elected as Associate Fellow of Andhra Pradesh Academy of Sciences (AFA PASc) in 2012.
22. Best paper Award: Narendra Patel and Renu John, Intra-retinal layer segmentation of OCT image, International Conference on Photonics, VLSI and Signal Processing-ICPVS 2014, KU College of Engineering & Technology, Kakatiya University, Warangal, 28-29 March 2014.
23. Rajakumara Eerappa, Ramalingaswami, DBT Re-entry Fellowship (2014).
24. Kirti Chandra Sahu, Indian National Science Academy (INSA) - Medal for Young Scientist (2013).
25. G. Prabusankar, Alexander von Humboldt Fellowship, Germany
26. G. Prabusankar, IIT Bombay Research Paper Award
27. S. Suriya Prakash, Prestigious Ramanujan Fellowship, Department of Science and Technology.
28. Asif Qureshi, Prestigious INSPIRE Faculty Award, Department of Science & Technology, India, 2013
29. Ramakrishna Upadrasta, above POPL paper is recipient of a European Network of Excellence on High Performance and Embedded Architecture and Compilation (HiPEAC) paper award for 2013.
30. Dr. P Rajalakshmi, Awarded as an INDIA's Most Inspiring Women Engineer/Scientist for the year 2014 by Engineering Watch
31. Dr. M.Deepa, Awarded as an INDIA's Most Inspiring Women Engineer/Scientist for the year 2014 by Engineering Watch

32. Dr. Pradeep Kumar Yemula, POSOCO Power System Award (PPSA) 2013, Selected among the top 15 candiates in doctoral category. Award conferred by Foundation for Innovation and Technology Transfer (FITT) IIT Delhi along with Power system Operation Corporation of India (POSOCO).

33. Dr. Suhash R. Dey, IEI Young Engineers Award 2013- 14 from the Institution of Engineers (INDIA) in Metallurgical & Materials engineering discipline. The award consists of INR 10,000/- and a Citation.

34. Dr. Suhash R. Dey, Bhaskara Advanced Solar Energy (BASE) Fellowship 2014 from Department of Science and Technology (DST), India and the Indo-U.S. Science and Technology Forum (IUSSTF) - to spend some time at Dr. David Ginley's laboratory at National Renewable Laboratory (NREL), USA.

35. Saket Asthana, Best Poster Award in MagMa 2013, IIT Guwahati, India

36. Jammalamadaka Suryanarayana, IIT-DAAD exchange guest scientist award (2014)

37. Jyoti Ranjan Mohanty, IIT-DAAD Guest scientist award 2014

Annex: Fee Structure

Program	Fee (₹)	Fee / per annum avg salary (₹)
B.Tech	100800	1.47
M.Sc	20800	0.30
M.Tech (regular)	20800	0.30
M.Tech (sponsored)	60800	0.89
M.Des	20800	0.30
M.Phil	20800	0.30
Ph.D (regular)	15800	0.23
Ph.D (sponsored)	45800	0.67

Appendix I: Schedule of External Review Panel Meetings

Program for External Review of IITH, 10-12 August 2014

Sunday, 10 August 2014

Time	Venue	Activity	People
20:00 - 21:30		Dinner at Hyatt	Panel, Deans

Monday, 11 August 2014

Time	Venue	Activity	People
09:00 AM		Leave Hotel	Panel
09:45 AM		Arrive at IITH	Panel
10:00 - 10:45	LH 3	Presentation UB Desai on: (A) Progress in relation to previous projections	Panel, All Faculty
10:45 - 11.:30	LH 3	Presentation UB Desai on: (B) Plans for the Future Coffee / Tea	Panel, All Faculty
11:30		Coffee / Tea	Faculty
11:30 - 12:00	206	Measures Adopted Towards A and B (Coffee / Tea served during discussion)	Panel, Director, Deans
12:00 - 13:00		Panel Visits Selected Labs	
13:00 - 14:00		Lunch	Panel, Director, Deans, Heads of Department
14:00 - 15:00	LH 3	Meeting Faculty	Panel, Faculty: Interested Faculty have 3 mins for oral presentation or ask questions
15:00 - 16:30		Visit Permanent Campus: Visit Labs, Presentation by Dean Planning, Visit Construction Site	Panel, Director, Deans
16:30 - 17-15		From Permanent Campus to Hotel	Panel
17:15 - 19:30		Rest	
19:30		Buffet Dinner at Hyatt	Panel, All Faculty

Tuesday, 12 August 2014

Time	Venue	Activity	People
09:00 AM		Leave Hotel	Panel
9:45 AM		Arrive IITH	Panel
10:00 - 10:30	LH 1	Meeting Staff	Panel, All Permanent Staff
10:30 - 10:50	LH 1	R and D at IITH, Presentation by Dean Academic Program	Panel, All Faculty
10:50 - 11:10	LH 1	Academics at IITH, Presentation by Dean Academic Program	
11:10 - 11:30		Coffee / Tea	Deans and HoDs
11:30 - 12:15	LH 1	Meeting Students	Panel, Students
12:15 - 12:45	206	Meeting Director	Panel, Director
13:00 - 14:00		Lunch	Panel, Director, Deans
14:00 - 16:00		Panel only Meet	Panel
16:00 - 16:30		Closing Meeting with Director and Deans	Panel, Director, Deans
16:30		To Hotel or Airport	Panel

Appendix II: Short Profiles of External Review Panel Members

Professor Suresh V. Garimella

Professor Suresh V. Garimella is Purdue University's Executive Vice President for Research and Partnerships, and the Goodson Distinguished Professor of Mechanical Engineering. He is also Director of the National Science Foundation Cooling Technologies Research Center. He previously served as Chief Global Affairs Officer, and as Associate Vice President for Engagement. He received his Ph.D from the University of California at Berkeley in 1989, his MS from The Ohio State University in 1986, and his Bachelor's degree from the Indian Institute of Technology Madras in 1985. His areas of expertise include *micro- and nano-scale transport phenomena, thermal management and energy efficiency in electronics systems, renewable and sustainable energy systems technology and policy, and global academic-public-private partnerships.* Garimella has supervised over 80 Ph.D and MS students, and co-authored 500 refereed journal/conference publications and 19 patents and patent applications. Seventeen alumni from his research group are now faculty members in prestigious universities around the world. Garimella has held honorary faculty positions at the Technical University of Darmstadt in Germany, Xi'an JiaoTong University in China, and the University of New South Wales in Australia. He serves on the Board of Directors of Modine Manufacturing Company.

Garimella served as Jefferson Science Fellow at the U.S. Department of State from 2010 to 2011, in the International Energy Office. Most recently, he was reappointed Senior Fellow of the State Department's Energy and Climate Partnership of the Americas (ECPA), a regional partnership announced by President Obama at the April 2009 Summit of the Americas to promote clean energy, advance energy security, fight energy poverty, reduce greenhouse gas emissions, support strategies for sustainable landscapes and build capacity for climate change adaptation.

Garimella serves in editorial roles with several leading energy-related journals. He is Fellow of the American Association for the Advancement of Science (AAAS) and the American Society of Mechanical Engineers (ASME). His efforts in research and engineering education have been recognized with the 2014 ASME Charles Russ Richards Memorial Award, 2011 NSF Alexander Schwarzkopf Prize for Technological Innovation, 2010 ASME Heat Transfer Memorial Award, 2010 Distinguished Alumnus Award from IIT Madras, 2009 ASME Allan Kraus Thermal Management Award, 2004 ASME Gustus L. Larson Memorial Award, 2012 Provost's Award for Outstanding Graduate Mentor, 1995 Graduate School/UWM Foundation Research Award for Outstanding Research and Creative Activity, 1997 UWM Distinguished Teaching Award, and the 1992 Society of Automotive Engineers' Ralph R. Teetor Educational Award, among others.

Professor Jun Murai

Professor Jun Murai is Professor and Dean of Faculty of Environment and Information Studies, Keio University. He received his Ph.D. in Computer Science, Keio University in 1987, specializing in Computer Science, Computer Networks and Computer Communication. He developed the Japan University UNIX Network (JUNET) in 1984 and established WIDE Project in 1988. He is currently the Founder, research and development of computer networks. He served as a member of the 20th Science Council of Japan. He is a member of the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters), chairs and serves on many other governmental committees, and is active in numerous international scientific associations.

From 1993 to1995, he was a member of Internet Architecture Board (IAB). From 1997 to 2000, he served on the Board of Trustees of Internet Society (ISOC). From 1998 to 2000, he served on the Board of Director of the Internet Corporation for Assigned Names and Numbers (ICANN).

He received the Jonathan B.Postel Service Award in 2005 and IEEE Internet Award in 2011. He was inducted into Internet Hall of Fame in 2013.

Professor Raj Reddy

Professor Raj Reddy (Panel Chair) is the Moza Bint Nasser University Professor of Computer Science and Robotics in the School of Computer Science at Carnegie Mellon University. He is one of the early pioneers of Artificial Intelligence, has served on the faculty of Stanford and Carnegie Mellon University for over 40 years and was the Founding Director of the Robotics Institute at CMU (more at www.rr.cs.cmu.edu).

Reddy received the ACM Turing Award in 1994 for his contributions to Artificial Intelligence. He was awarded the Legion of Honor by President Mitterrand of France in 1984 and the Padma Bhushan by the President of India in 2001. He was awarded the Okawa Prize in 2004, the Honda Prize in 2005, and the Vannevar Bush Award in 2006.

He served as co-chair of the President's Information Technology Advisory Committee (PITAC) from 1999 to 2001. He has been awarded eleven Doctor Honoris Causa including from Universities of Henri-Poincare, New South Wales, Massachusetts, Warwick, and HKUST.

Dr. Kumar Sivarajan

Dr. Kumar Sivarajan is the co-founder and Chief Technology Officer of Tejas Networks, a telecommunications product company based in Bangalore. Prior to Tejas Networks, Kumar was an Associate Professor in the Electrical Communication Engineering Department, at the Indian Institute of Science, Bangalore. Earlier he has worked with the IBM Thomas J. Watson Research Center, Yorktown Heights, New York.

Kumar is co-author of the textbook `Optical Networks: A Practical Perspective' first published in February 1998. He is a Fellow of the Indian National Academy of Engineering, an Associate of the Indian Academy of Sciences and a recipient of the Swarnajayanti Fellowship from the Department of Science & Technology. He is also a recipient of the IEEE Fortescue Fellowship and the IEEE Baker Prize Paper Award.

Kumar holds a Bachelor's Degree in Technology in Electrical Engineering from the Indian Institute of Technology (IIT), Madras and a Doctorate from the California Institute of Technology. He is a distinguished alumnus of IIT, Madras.

Professor P. R. Kumar

Professor P. R. Kumar obtained his B. Tech degree in Electrical Engineering(Electronics) from IIT Madras in 1973, and the M.S. and D.Sc. degrees in Systems Science and Mathematics from Washington University, St. Louis, in 1975 and 1977, respectively. From 1977-84 he was a faculty member in the Department of Mathematics at the University of Maryland Baltimore County. From 1985-2011 he was a faculty member in the Department of Electrical and Computer Engineering and the Coordinated Science Laboratory at the University of Illinois. Currently he is at Texas A&M University, where he holds the College of Engineering Chair in Computer Engineering.

Kumar has worked on problems in game theory, adaptive control, stochastic systems, simulated annealing, neural networks, machine learning, queueing networks, manufacturing systems, scheduling, wafer fabrication plants and information theory. His research is currently focused on energy systems, wireless networks, secure networking, automated transportation, and cyberphysical systems.

Kumar is a member of the National Academy of Engineering of the USA, and a Fellow of The World Academy of Sciences. He was awarded an honorary doctorate by the Swiss Federal Institute of Technology (Eidgenossische Technische Hochschule) in Zurich. He received the Outstanding Contribution Award of ACM SIGMOBILE, the IEEE Field Award for Control Systems, the Donald P. Eckman Award of the American Automatic Control Council, and the Fred W. Ellersick Prize of the IEEE Communications Society. He is an ACM Fellow and a Fellow of IEEE. He was a Guest Chair Professor and Leader of the Guest Chair Professor Group on Wireless Communication and Networking at Tsinghua University, Beijing, China. He is an Honorary Professor at IIT Hyderabad. He is a D. J. Gandhi Distinguished Visiting Professor at IIT Bombay. He was awarded the Distinguished Alumnus Award from IIT Madras, the Alumni Achievement Award from Washington University in St. Louis, and the Daniel C. Drucker Eminent Faculty Award from the College of Engineering at the University of Illinois.

Professor Surendra P. Shah

Professor Surendra P. Shah is Walter P. Murphy Emeritus Professor of Civil Engineering and was the founding director of the pioneering National Science Foundation Science and Technology Center for Advanced Cement-Based Materials. His current research interests include: fracture, fiber reinforced composites, nondestructive evaluation, transport properties, processing, rheology, nanotechnology, and use of solid waste materials. He has co-authored two books: Fiber Reinforced Cement Based Composites and Fracture Mechanics of Concrete. He has published more than 500 journal articles and edited more than 20 books. He is past editor of RILEM's journal, Materials and Structures.

Professor Shah is a member of the US National Academy of Engineering. He is also a foreign member of the Chinese Academy of Engineering and the Indian Academy of Engineering. He is the only civil engineer who is a member of these three academies. He has received many awards, including the Swedish Concrete Award, American Concrete Institute's Anderson Award, RILEM Gold Medal, ASTM Thompson Award, American Society of Civil Engineers' Charles Pankow Award, and Engineering News Record News Maker Award. He was named one of the ten most influential people in concrete by Concrete Construction Magazine. Recently, he spent time at the Indian Institute of Technology, Madras as an Honorary Professor under the auspices of a Fulbright grant. He is an honorary member of American Concrete Institute and RILEM (based in Paris).

Besides teaching at Northwestern, Professor Shah has taught at the University of Illinois,

Chicago and served as a visiting professor at MIT, University of Sydney, Denmark Technical

University, University of Singapore, Darmstadt University, and Laboratoire Central des Ponts etChaussees, Paris. Currently, he is a member of the Institute of Advanced Studies at Hong Kong University of Science and Technology. He is also honorary professor at Hong Kong Polytechnic University, Dalian Maritime University, Nanjing Technical University, and South East University.

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