Review of the Department of Electrical Engineering at IIT Bombay

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Introduction

The Review Committee met with the head of the department; faculty members of the department as a body; individual faculty members as members of research groups; and graduate students as well as undergraduate students, over a period of one and a half days. The Review Committee was also given a tour of the various lab facilities. The agenda of the meeting is shown in Appendix 1 and a link to the longer report prepared by the head of the department, Professor Abhay Karandikar is given in Appendix 2.

In general, the Institute and, in particular, the Department of Electrical Engineering is to be commended for the progress it has made in the last five years in its education and research program, faculty hiring, quality of its doctoral students and doctoral theses, honors and awards to faculty and contributions to technological innovation.

Some strengths based on our observations:

1. In recent times, the department has attracted some of the best faculty members.

2. The department has a good publication profile and sponsored research funding.

3. There is a steady growth in the number of graduate (masters and doctoral) students in the department.

4. The Microelectronics group stands out for its size, and quality, as well as its experimental research infrastructure.

5. Almost all research groups seem to be doing something that is connected to the needs of India.

6. Amongst the EE departments across IITs, this department has emerged as the undisputed number one destination for undergraduates entering IITs through the JEE.

7. The whole department enthusiastically participated in the review process.

Some weaknesses based on our observations:

1. Unlike the strong preference of UGs, the department is NOT the number one destination for graduate students entering the EE departments of IITs.

2. The faculty does not have a high opinion about the quality of its graduate students.

3. The UGs seem disconnected with the research carried out by the graduate students and the faculty.

4. The majority of UGs are not inspired to take up EE as a profession. In fact, most of them up are dropping out of engineering itself.

5. Despite the large Microelectronics group, department teaching seems weak in key areas like VLSI design and circuit design.

6. In view of the disproportionately large size (~25 out of 60) of the Microelectronics group, there is a possibility that the concerns as well as the visibility of the several other smaller research groups may be dwarfed.

7. The fraction of publications in tier one journals/conferences needs to increase.

Areas of concern for the institute administration:

1. The young faculty do not seem to appreciate the constraints of the administration. The institute administration does not seem to have an effective channel of keeping them informed about its plans.

2. The faculty assessment process is emphasizing quantitative measures. This is in sharp contrast to some of the best universities of the world

Recommendations

Our recommendations to the head of the Department and the Director of the Institute should be viewed as constructive suggestions to move the department to the next level of excellence. Moreover, it is our hope that the current review not be viewed as a one-time interaction of the department with the Review Committee. On the contrary, we hope that the department will continue to engage the members of the committee, individually and collectively, in realizing the educational and technological vision of the department as articulated by its faculty.

Summary of our Recommendations

Our *overarching recommendation* is the following:

The Department and the Institue have made substandial progress from being primarlily an excellent undergraduate institute to also being an excellent graduate education and research institution. Our recommendation is that the EE department and the Institute move towards the next level of excellence by making research, both at the B. Tech, M. Tech, and Ph.D. levels, an integral part of the education. Students should be able to proceed seamlessly from undergraduate education to doctoral research.

Our later recommendations are all related towards helping make this goal a reality.

Administrative Structure:

- Appoint an Associate Head to share administrative responsibilities.
- Appoint an Education Officer (Institute level consideration).
- Faculty Search Committee chaired by Head or Associate Head.

Education

- Freshman level: Review requirements. Less emphasis on Physics, Chemistry, and Mathematics. Exposure to frontiers of Science and Engineering (Department and Institute level considerations).
- Institute Undergraduate Research Program (MIT Model)
- Review and integrate Core Curriculum in EE

Graduate Education

- Institute culture of research seminars and attendance by graduate students
- Better interaction between graduate students, for example, by appropriate allocation of office space.
- Consider a single admission structure to M. Tech program and a single M. Tech graduate program. Considerable support from students.

Research

- Committee had inadequate time to make an assessment. All research groups should go through an exercise similar to the Microelectronics group and produce a "Vision" document.

Promotion and Tenure

- Current structure not transparent. Follow practice of major research universities in the world. Quantitative measures not useful.

Mentoring and Support of younger faculty

- Better communication bewteen Administration and Faculty.
- Eliminate constraints on spending start-up funds.
- No teaching of large classes in first 2 years.
- Encourage development of graduate courses in respective research specialities.

Entrepreneurship and Inventions to Ventures (Institute level)

- Study models such as Deshpande Center for Technological Innovation at MIT.

Recommendations to the Department

1. Administrative Structure

The department has grown considerably in the last few years in terms of faculty size (approx. 60) and graduate students both in the B. Tech-M. Tech Program and doctoral program. In order to reach the next level of excellence, the administrative structure of the department needs to be rethought. We recommend that there be an Associate Head for the department. The division of responsibilities between the Head and Associate Head should be worked out through mutual consultation.
One of our recommendations (see later Education section) would be to appoint an Education Officer for the department. We would like to see that the department evolves towards an educational experience which seamlessly integrates Undergraduate Education, Graduate Education, and Research. Although committees currently exist for undergraduate and graduate education, their substantial revision and integration

requires an Education Officer. Teaching assignments should be supervised and approved by the Education Officer. The Education Officer should also make sure that new faculty at the Junior Faculty level not be asked to teach large Undergraduate courses during the first two years of their appointment. The Junior faculty should also be given the opportunity of teaching Graduate courses in their speciality during the early years of their career. We recognize that the appointment of an Education Officer is an Institute level issue.

There is a Faculty Search Committee. This committee should be chaired by one of the department heads (this might already be the current practice).

In general, we are recommending that there be more involvement on the part of the faculty in the administration of the department. In particular, the voices of the Junior faculty need to be heard in matters of curriculum development, research directions, selection of graduate student admissions (again, not to suggest that this is not already current practice).

Discussions with Younger Faculty

One of the most important parts of our review was our discussions with younger faculty. We include a summary of our discussions as prepared by a representative of the younger faculty (see Appendix 4). We consider that the implementation of these recommendations should be taken up as early as possible.

2. Education: Undergraduate and Graduate

In this meeting, we did not have the possibility of examining the undergraduate and graduate curricula of the department. Our main recommendation is that the department moves towards a research-oriented education, even at the undergraduate level (indeed, even in the freshman year). We recommend that a formal Undergraduate Research Opportunities Program (UROP) be instituted. The department might consider as a model the UROP program at MIT, adapted to IIT conditions. This would require the active participation of the various research groups in the department.

An integrated view of the undergraduate curriculum which shows the conceptual interconnections of different subjects is needed. A suggested model for such an exercise with the prerequisite structure clearly indicated is shown in Appendix 3. It may well be that basic courses such as Network Theory and Signals and Systems need to be rethought in light of current technological development.

On the interface of Undergraduate and Graduate Studies (Dual-Degree Program), a possible consideration would be to eliminate the specialization at the entry level for admission into areas: Microelectronics, Communications, Power Electronics and Power Systems, and Control and Optimization. The names of the specializations available for 2-year M. Techs are different from those available for Dual-Degree M. Techs. Also, the number of specializations available for Dual-Degree M. Techs is only two while those for M. Techs are five. This confusion should be avoided. Much of the intellectual action is on the interfaces. Furthermore, for work in industry, a subdivision of Electrical Engineering into sub-areas is not very useful. (For a detailed discussion of some of these issues with students, see Appendix 6.) There is overwhelming support for this from M. Tech students.

The undergraduate students entering IIT Bombay are clearly among the world's best. IIT Bombay therefore has the enviable opportunity of fashioning an innovative curriculum worthy of this student body, one that recognizes their special circumstances as well as the needs of the country.

The characteristics of the entering students are arguably special. IIT Bombay attracts the crème de la crème of India's high school students. Many however arrive after several years of coaching classes, consisting of thorough preparation for the highly competitive IIT JEE. As such they have been exposed to many years of repetitive and basic reinforcement of Physics, Chemistry and Mathematics.

These are also four or five very busy years of coaching classes on top of regular schooling, as a result of which there is often reduced opportunity for extra-curricular activities in high school. Many students are therefore not receptive to further continued emphasis on Physics, Chemistry and Mathematics in the first two years at IIT. Rather they are impatient to learn about electrical engineering. In fact, coupled with the attractions of the rich extra curricular activities they find at IIT, there is a loss of interest in the courses required to be taken by them in the first one to two years.

Yet another striking aspect is that few undergraduate students ever attend postgraduate school. Many students (ABOUT 71%?) go on to jobs in business "analytics," and not an advanced technical career. With the tremendous advances in science and engineering over the past few decades, the de facto "basic" technical degree has essentially become the Master's degree rather than the Bachelor's degree that it used to be in the past.

The production of advanced degree holders is especially important to India since there is a great need for the country to produce a much larger number of Ph.Ds. Just the need to staff all the colleges of the country would require an order of magnitude increase in the number of Ph.D.'s produced, let alone the research and development needs of industry. The number of Ph.D.'s produced in Electrical Engineering in 2012 was only a small number in comparison with the about six LAKH undergraduates produced each year.

As befits the leading program in electrical engineering in the country, and one with the world's best students, it is therefore appropriate to examine how one may ensure that a much larger percentage of students go on to pursue doctoral studies in electrical engineering. This requires the design of a curriculum that the nation's finest minds find attractive leading them to pursue further studies. This is especially so given the observations made above about a lack of interest in the courses currently taken by students in the first two years.

All the above observations appear to point to the need to take a fresh look at the curriculum. Perhaps students could be allowed to decompress from Physics, Chemistry and Mathematics in the first semester by taking courses in humanities, social science and fine arts. This will also give them the time and space to develop or pursue interests in extra-curricular activities. Nothing irredeemable is lost by technical courses beginning only after the first semester.

There is an exciting opportunity to design a curriculum that is top down and breadth first. Being as capable as they are, students could be immediately assigned exciting projects in the very first year where they are exposed to state-of-the-art technology or science issues, without necessarily having mastered all the prerequisites thoroughly in a bottom-

up manner. They can be assigned readings where they can fill in their knowledge, somewhat reminiscent of a case study approach.

After capturing student interest, the subsequent curriculum could thoroughly cover the material that students have already been stimulated by. The curriculum could also be made as breadth–first as much as possible, so that students can determine or discover what their passion is.

Courses can also be taught in an open-ended manner. Students are encouraged, even mandated, to attend a prescribed number of research seminars so that they understand where knowledge ends and research begins. The success of the undergraduate should be measured by how many go on to pursue post-graduate degrees.

Another possibility is to allow students to choose a Dual-Degree program even in their second or third year. This will allow a student whose interest in an advanced technical career to continue seamlessly into that, even though that may not have been their intention when they joined.

Given these potential opportunities, the review committee recommends that the department form a small group of faculty to actively pursue the possibility of designing such an innovative curriculum. Undergraduate students and alumni can be requested to provide their perspectives too. The committee can also examine how other institutions are addressing some of these issues, though they may not share the entire spectrum of special needs of an institution such as IIT Bombay. There is also the distinct possibility that such a curriculum could lead the rest of Asia, including countries such as Korea and Japan, where also there is intense competition among high school student for admission to the nation's leading universities.

3. Graduate Education

Our fundamental recommendations are for better interaction between Graduate students, much improved participation in seminars and less specialization at the M. Tech level. A possible solution is to mix office assigments between students from different research groups. The view that attendance at research seminars are a necessary part of research should be encouraged by the faculty.

It is also important that adequate resources for travel to international conferences be provided.

Perhaps a faculty committee could be formed to examine whether the current qualifying exam best serves the students and the department. One question worth examining is whether the qualifying exams unnecessarily repeats course material that the students have already been tested on.

The department could also re-examine the requirement for one journal paper as well as one conference paper for graduation. This requirement is not present at leading institutions. It can serve to make student and advisor goals more conservative, and also lead to publication in lesser non top-tier conferences.

Master's degrees could be made less compartmentalized. Perhaps just one Master's degree is all that is needed. The student and his/her advisor can decide what courses are best. The department need only stipulate a minimum number of courses at certain

levels. An open flexible approach is critical since research often breaks boundaries and straddles different fields and disciplines. Excessive labeling is not desirable. Furthermore for work in industry a sub-division of Electrical Engineering into sub-areas is not very useful.

The department should ensure that there is a smooth path from B. Tech. to M.Tech. to Ph.D. Excessive compartmentalization is harmful to this process. Students should be allowed to flexibly opt for the next step in the path at any time, of course conditioned on satisfactory performance, as measured by well designed qualifying exams.

The department or institution should somehow guarantee that a student or faculty member whose papers is accepted at a tier one conference is provided funding to attend it. This is a challenge that the institute leadership should focus on.

The department should examine whether there is an adequate number of advanced courses for Ph.D. students that capture the depth and rigour of fields. It may also be noted that offering an adequate number of such courses also allow younger faculty to develop and offer courses in their specialization. It is well recognized that such courses form the seeds of excellent Ph.D. theses.

Apparently there is a severe shortage of flats for married students. This needs to be expeditiously addressed by institute leadership. A related question that arises is this: Does the institute have a strategic planning committee that attempts to foresee problems in capacity expansion much before it becomes a reality?

For details of our discussion with students, see Appendix 5.

A rich culture of seminars
Every research group should aim to have a world-class weekly seminar series. This is standard best practice. The departmental seminar series is not a substitute for these. It is only a complement, in that it makes possible some broad talks. A strong seminar series in each research area is important to keep abreast of developments. In this regard, the seminars could even be made teleseminars, not requiring physical presence. An excellent example is the Fishbowl seminar series at Texas A&M University: https://cesg.tamu.edu/fish-bowl-seminar-series/

4. Research

We visited various research laboratories but we did not have the opportunity to examine the research contributions of the groups. Our general view is that the quality of research is high. The Microelectronics group would perhaps be singled out as unique in terms of its research as well as its experimental facilities.
For the future we would like to have the following information from each research group:

1) Unique capabilities of each research group (for example, experimental facilities.
2) Perspective of the research group in terms of strategic importance to global industry, India's needs, and connections to teaching.
3) Vision for the next 5-10 years.
4) What is needed to make the vision a reality.
5) Current constraints: Lab space, Operations and Safety, need for Technical and Support staff.
6) Interactions with the Institute, MHRD to realize this vision.

The most important part of a review such as ours is that it provides an opportunity for a critical self-examination of the department. In Appendix 7, we include a document showing the strategic plans of the Microelectronics Group.

5. Facilitating Junior Faculty and their careers

Junior faculty should be given every opportunity to develop their research program. Typically this involves launching special topics advanced postgraduate courses focused on their own research. Perhaps junior faculty should be given first preference in deciding which courses they would like to teach. Also, it is not best practice to assign junior faculty to teach courses not in their own area. Finally, since teaching large classes involves additional effort, perhaps senior faculty should be used preferentially for such courses. One challenge though is that even third or fourth year classes may be large at IIT Bombay. The recommended Education Officer can play an important role here. The cardinal principle is to maximally facilitate junior faculty in developing advanced courses around their area of research. The resulting passion, enthusiasm and expertise could be infectious to students.

All faculty should be provided adequate TA support, both in terms of quality as well as quantity (perhaps already in operation).

Conducting world-class research requires frequent “networking” with other world-class researchers. It is important to ensure that faculty are able to travel to international conferences. Perhaps a good goal to aspire to is to support each faculty member to travel to two international conferences each year. The current levels of support appear to support about two conferences every three years. This is generally inadequate. The committee recognizes the difficulties involved, since much government research support does not permit foreign travel. However, a solution, perhaps at the Institute level, is imperative. Administrative innovation or some high level funding strategies may be needed to meet this goal. This is a challenge that needs to be made a priority at the highest levels of the Institute.

The department or institution should somehow guarantee that a student or faculty member whose paper is accepted at a tier one conference is provided funding to attend it. This is a challenge that the institute leadership should focus on.

Better communication between the Administration and Junior Faculty is needed. One distinct complaint raised at several levels was that many administrative and bureaucratic processes involved were excessively cumbersome, highly inconvenient and time consuming. For example, there is a perception among faculty as well as Ph.D. Students that perhaps there are too many forms to be filled out in order to undertake foreign travel. Another broad complaint generally heard in the context of many processes was that many administrative approvals required forms that needed to be filled out in ink, and that further much information was repetitively required to be reported in several contexts. It would certainly be desirable if all necessary forms could be made web based. It would be good for a leading IIT such as IIT Bombay to lead the way by making innovative efforts to streamline all bureaucratic and administrative processes to meet or better best international practice. Perhaps an institute level committee can solicit input from younger faculty as well as Ph.D. students to minimize the forms, bureaucracy, legwork, and barriers involved in accomplishing all tasks. Obtaining faculty and student input into what barriers and inconveniences they faced is critical to improving user experience.

See Appendix 4 for disccusion for Junior Faculty.

6. Promotion and Tenure

The document on Self-assessment, Promotion and Tenure is far from transparent. We recommend that the Institute follow standard practice at most major universities in the USA.

A. First appointment usually Assistant Professor. Initial appointment, tenure track, for 3-4 years, renewable. Tenure has to be granted by the end of seven years or candidate needs to be notified at the end of the six year that tenure will not be granted. Some institutions, like MIT, promote at the end of 3-4 years to Associate Professor without tenure and then promotion to Associate Professor is considered at the end of the fifth year. Typically, 8 external letters requested. The candidate selects some references and the remainder selected by the head of the department with advice from Dept. Personnel Committee. 6 internal letters. No quantitative measures used. Main emphasis is on impact: teaching and research. The selection process involves three levels: Department (the most stringent examination), School, and finally, Academic Council.
B. Promotion to full Professor typically three years after tenure. Essentially same process.

7. Technological entrepreneurship and taking inventions to ventures

The Department and the Institute should consider how they can sponsor activities that promote entrepreneurship and take ideas from invention to venture. This is increasingly becoming the key to engineering impact and transformation of industries. To stay still is to fall behind other leading engineering institutions.

There are two separate strands of activities involved.

One effort consists of designating one faculty member, preferably one with start-up experience, to lead efforts that capture student attention and develop their interest in entrepreneurship. The goal to aspire to is that graduating students should regard starting a technological company as one of the attractive options. Towards this end, business plan contests can be organized. These could be based on projects that the students are working on in their final year or earlier. World famous entrepreneurs, perhaps IIT Bombay alumni, could be invited to serve as judges of contests, or even to provide funding for the contest that could be named after them. Leading entrepreneurs can also be invited to give lectures to a wide audience. The end goal is to create an awareness of entrepreneurship and to think of technology as a path to that. The Illinois Technology Entrepreneur Center (http://www.tec.illinois.edu) is good model for this. Joint programs, either at the Bachelor's or Master's level could be developed with the business school.

At the same time, a separate effort should also be made to convert ideas, particularly the excellent research being conducted by faculty members, into venture. Retired CEOs and CTOs can serve as "catalysts" in converting research accomplishments into practice. An excellent model is the Desponded Center for Technological Innovation at MIT (http://deshpande.mit.edu).

APPENDICES

Appendix 1: Agenda of the Review Committee Meeting

Appendix 2: Longer report prepared by the head of the department

Appendix 3: Model for conceptual interconnections of different subjects

Appendix 4: Discussion with younger faculty

Appendix 5: Discussions with undergraduate and Dual-Degree students

Appendix 6: Undergraduate exposure to research and more elective courses (M-Tech Program)

Appendix 7: The strategic plans of the Microelectronics Group

Appendix 8: List of vitae items

APPENDIX 1

REVIEW COMMITTEE AGENDA

Monday, 6th January, 2014

915 am - 945 am Meeting with Director
9.45 a.m. - 10 a.m. Introduction of all faculty members

10 a.m. - 11.30 a.m.	Presentation on Department by Head (assisted by other faculty colleagues)
11.30 a.m. - 11.40 a.m.	Tea Break
11.45 a.m. - 12.45 p.m.	Interactions with Young Faculty members (all those who joined in the last 5 years)
1.00 p.m. - 2.00 p.m.	Lunch
3.00 p.m. - 4.00 p.m.	Interactions with all faculty members
4.00 p.m. - 5.00 p.m.	Interactions with Graduate students (about 50-60 Masters and PhD students will join)
5.00 p.m. - 6.00 p.m.	Interactions with Undergraduate students (about 50-60 students will join)
	(*Department General Secretary will moderate these interactions with students.)*

Tuesday, 7th January, 2014

9.30 a.m. - 11.30 a.m.	Visit to various labs and facilities.
11.30 a.m. - 1.00 p.m.	Review Committee Meeting (to meet closed door)
1.00 p.m. - 2.30 p.m.	Lunch with Head and DPC members- Wrapping up.

APPENDIX 2

The department has compiled a report on various activities. Due to the large file size (309 pages), the report is available at the following link--

http://www.ee.iitb.ac.in/deptreview/EE-IITB-2014-REPORT.pdf

Appendix 3: Model for conceptual interconnections of different subjects

An overview of the EECS Curriculum at MIT as a possible model for a development of a similar overview at IIT.

The report (in two parts) can be downloaded here:

http://web.mit.edu/mitter/Public/IIT_Bombay/

Appendix 4: Discussion with younger faculty

(9 page insert)

EE Departmental Review

Discussion points for ‘young’ faculty

Outline

- Academics
- Administrative infrastructure
- Research infrastructure
- Support infrastructure

Academics

- Teaching load for new and young faculty
  - New faculty should be able to select courses before others, or start new expertise-centric courses
  - New faculty should not have to teach large undergrad class
  - Overall focus should be to enable new faculty to set up productive research programs quickly
  - Faculty assessment for promotion should not give weightage to teaching large class
  - Load allocation and faculty assessment must take into account time spent on service to common facilities, may be handled at group level

Academics

- TA support in terms of quality, quantity
  - TA training should be instituted
  - TA performance tracking should be done, student evaluations may be included there, good performance should be recognized
  - Best senior TAs may be used for TA training
  - Faculty and TAs must have clear idea of TA responsibilities: grading, tutorial, HW etc.

Academics

- Class size
  - (Can one break up large classes without increasing average teaching load?)
- Faculty assessment
  - (Forms to be shared with the committee)
- Recognition of Master's level research
  - Awards may be instituted for the best dual-degree and M.Tech. projects

Administrative Infrastructure

- New faculty – joining, relocation
  - (Is it possible to increase faculty compensation within the existing constraints?)
- Paperwork, red-tape, non-academic workload
  - Administrative processes need to be improved
  - Support staff should be provided to ease non-academic load on faculty
  - Staff performance evaluation and rewards should be instituted
  - Professional management staff needed for managing large lab infrastructure
- Student stipend level
  - May be enhanced to reduce graduate study 'penalty'

Administrative Infrastructure

- Faculty international travel
  - At present CPDA allows 2-3 international conferences in 3 years, depending on location
  - 2 international conferences every year must be enabled
  - MHRD, government funding agencies, Institute should all ease restrictions on use of travel funding for international conferences, itemized caps etc.

- Student travel
  - MHRD, government agencies, Institute should ease restrictions on conference travel for students, both domestic (train only), and international (overly restrictive itemized caps)
  - Full support should be provided for students at all levels (not only Ph.D.) for presenting papers in international conferences

Research Infrastructure

- Start-up grants
  - Should be minimally restrictive, e.g. in terms of international conference travel
  - Institute should be liberal in terms of matching grants and other schemes to enable new faculty to set up new facilities, especially for experimental research
- Lab space, student office space
  - Institute/Department needs to project needs, plan ahead
- Difficulty of getting larger (` 1crore +) funding
  - Senior faculty may help by joining proposals as co-PI

Support Infrastructure

- Medical coverage limitations
  - The Institute may be liberal in providing amenities like comprehensive medical coverage to faculty
- Faculty, student, staff housing
  - Institute needs to project needs, plan ahead

Appendix 5: Discussion with undergraduate and Dual-Degree students

(4 page insert)

The discussion was around the following four themes:

1) Academics
2) Courses and curriculum structure
3) Infrastructure
4) Student-faculty interaction

Main points of discussion are as below:

1. The specialization in the Dual Degree Programme: is the label required?

Students - Changing area of specialization from microelectronics (Micro) to Communications and Signal Processing (CSP) and vice-versa very easy.

-Curriculum very flexible. All courses from fourth year are electives - courses allowed to be taken include not only Elec courses, but also courses from other departments (Math/Statistics/...)

-Minor program of Elec is also extremely flexible, and is one of the best and most sought after.

-Honour program for the B.Tech students allows students to choose from a wide range of courses including relevant ones from other departments.

Suggestion from Panel - Alternative approach is to not use labels (like Micro and CSP), but suggest courses for each stream, and leave it to the student to decide for him/herself to follow the suggested path or try out another. Just have the degree as M.Tech in Electrical Engineering, which is apparently quite common in other colleges.

Students - Some core courses meant to give a basic understanding of electrical engineering in the initial years, after which switching of specialization is possible and facilitated.

Electives may be freely chosen - no courses that must be necessarily taken.

The label is meant to give direction to the dual degree project.

Suggestion from student - Area of specialization may be chosen after the third year, and not at the time of entering IIT, because switching is not as easy as it is made out to be and depends on the academic standing of the student, and there is an inertial tendency on the part of the students to go with their default degree.

Comment from panel - Label might make the area of specialization sound narrow to recruiters or universities.

Students - Generally, no distinction is made between the two areas of specialization by the recruiting firms

Comments by students - Labels are primarily to fill the seats and are often do not describe the true nature of the area of specialization well (for instance, Micro has many sub-disciplines), which perhaps might be misleading to a recruiter or university unless they look into the transcripts in detail.

2. Labs and Practicals

a. Curriculum and structure of labs

Students - Labs are not in sync with theory. Often, labs test us on concepts that haven't been introduced in the corresponding theory courses.

Situation is particularly aggravated for students who have changed their branch to Elec (such an option exists for students in other departments with a good academic standing right after the first year), as they haven't even done some prerequisite courses (for Devices lab, in particular)

On this, faculty say:

- Theoretical concepts always precede the practical aspects of most courses, so this is inevitable while they both run in the same semester
- When lab is run in the next sem however, students tend not to retain the concepts they have learnt in the theory course the previous sem.

b. Lab infrastructure

Students - Lack of infrastructure (labs are run in slots so that infrastructure is shared, and spoilt apparatus worsens the situation) - problem is mainly for control and power lab courses. Getting better infrastructure should help as students actually each get to use the equipment for a reasonable duration

Also, TAs and RAs can and should be better trained so that they can lend a helping hand to students facing problems in labs

3. What can the department do to ensure more UGs stay back (in the department/institute/academia)? India has a PhD crunch and it is up to the students to address it.

Students - Many courses do not expose students to recent trends. This should be changed.

- Most courses are not open-ended. Reading courses and other courses that allow greater insights into current topics in the field are few. (for instance, a basic course on power systems does not tackle smart grids, energy trading etc)

Grades can be scored by studying 1 day before exams, and they are the only motivating factor for students to study.

- Applying for internships is a very painful procedure. Collaboration between academia and industry, and between IIT Bombay and other schools should be increased.

Panel

- Students can take initiative, and start a student conference of sorts that has a high visibility (like in MIT).
- Student participation in seminar series and department-wide colloquia (not very theme-centric) should be increased.
- More seminars for each discipline/lab in the department should be conducted so that students can get to know recent trends and research in their niches as well.
- Employees of MNCs like IBM etc can be invited, and this can help resurrect the lecture series.

- Students should be more proactive. They can start reading courses on their own, and just ask some faculty to supervise or moderate paper discussions or reviews.

4. How to enthuse students from the freshmen year itself towards research and the department? (asked by panel)

Panel: Students get burnt out during preparation for JEE. This might be a reason for declining motivation.

Show of hands indicates that only ~20-30% believe that the environment is intellectually vibrant.

Suggestion by Students -

- Allotment to departments based merely on JEE rank (except for certain branch-change students whose academic standing allows them to switch branches at the end of first year). Instead, branch should be allotted after a year of study. However, a lot of societal pressures as well as perception around better jobs etc has created a pecking order among the branches which would probably still be followed even after 1 year.

- Younger professors not experienced enough in teaching. Interaction with more senior profs should be encouraged.

- Electives may be introduced after the second year, rather than wait for the fourth year, so that flexibility is introduced.

Suggestion of panel -

Decompress after JEE? Take more humanities courses, and less of math, physics and chemistry.

Suggestion of Students

- Reduce exposure to physics, maths and chemistry (all done heavily preparing for JEE) and rather focus on exposure to all the engineering disciplines
- Department Introductory Course (DIC) may be conducted in a better way. Industrial visits should be increased, and theory decreased. DIC should be a purview of electrical engineering, and should not be overly theoretical. Right now it acts more as a precursor to some specific courses later in the curriculum and does not really inform students of the breadth in electrical department or what research goes on right now (DIC can be taught by multiple faculty members, again with the aim of increasing flexibility and widening scope)
- EE & CS may be clubbed as in many schools abroad.
- Excellence in academics and research should be recognized better, on a par with achievements in sports and cultural activities
- Freshmen may be given projects in the department under faculty members, not too technical but which gives them skills like paper reading and thinking about open problems.
- B.Techs have a B.Tech project that accounts only for 6 credits - equivalent to a regular theory course, and it therefore degenerates to a mere literature survey. Credits for the B.Tech project may be increased to ensure it becomes a rigorous research project.

5. Weak academic performances and the department academic mentorship programme

- Currently there is availability of a faculty advisor (FacAd) to each student for consultation. Earlier, 1 FacAd/50 students. Now, 1 FacAd/10 students, making it much more effective.

- Also, the Department Academic Mentorship Program exists to mentor students with unsatisfactory academic performance, and lend them a helping hand.

Panel - Why do students perform badly?
One reason for performance flagging may be because of the grading system (relative grading). A solution could be to not have grades in the first year.

Students-
- While there is certainly an unhealthy grade obsession on campus, no grading would mean no motivation for students to study, and many more might drift towards extracurricular activities.

- Another reason for poor performers is that students are from various social backgrounds. Some have inferiority complex because of reservation etc, and get easily demotivated. Some entrants give JEE in Hindi, and encounter severe issues with the classes, as the medium of instruction at IIT is English

- One of the major reasons for dropouts however is over involvement in extracurricular activities. Students feel the only way to counter this is to increase motivation and excitement in academics and research. Make academics more 'glamorous'.

Suggestion by Students (freshmen) -
Separate Seminar Series for freshmen and sophomores
However, the current lecture series and seminars witness very low attendance, so might not be a foolproof mechanism

Final summary of discussion
Suggested ways to restructure the courses and increase academic motivation right from the start in summary:
- Better DICs and massive reexamination of first-year curriculum, perhaps removing physics maths and chemistry courses altogether
-Top down approach to curriculum
- Elective choices earlier on
- More open-ended and reading courses
- Research-oriented curriculum
- More department seminars which are not so technical as to be completely inaccessible to freshmen and sophomores
- Delayed branch (or specialization) selection

Appendix 6: Undergraduate exposure to research and more elective courses (M-Tech Program)

(1 page insert)

- M.Tech RA Programme:
  - Unique programme giving exposure to lab setup and lab management skills.
- Conversion from M.Tech to M.Tech+PhD Dual Degree programme
  - Students can make informed and secure decision regarding their PhD career and Faculty gets to know his student well before beginning a PhD venture.
- Teaching assistantship
  - TA'ship with some faculty expects good level of involvement with the course. This gives good experience to the TA's, however this is not true with all the faculty.
  - Students are also involved in M.Tech / PhD selection process for paper setting and paper correction.
- Interaction
  - Interaction is poor among PhD scholars
  - Suggested action 1 : Geographic co-location of students was suggested to improve interaction among students
  - Suggested action 2 : Students colloquium organized by students should be held, for which department should fund for inviting dignitaries.
  - Suggested action 3 : Weekly student presentations should be conducted and this information should be updated on an activities web page.
- Courses and Research area
  - Course selection is flexible across departments.
  - Students have freedom in selection of advisor and work area.
  - Number of specialized courses at various rigor levels should be made available.
  - General fundamental courses (mathematics etc) should be introduced and should be taught rigorously. For example a student had cited a course titled 'BJT' offered in some other institute.
  - Strict action against cheating cases in courses (especially in assignments) should be enforced.
- Funding
  - Scholarship for PhD students should be increased. Financial support duration of 4 years should be increased.
  - Funding for conference travel should be increased and made available for at least two international conferences. Currently there is a condition of a 3 year gap between travel grants.
  - Refund process should be made easy (Currently the paper work is time consuming).
- Internship and Industry collaboration
  - Should be encouraged and opportunities should be increased
- Qualifier
  - Qualifier process should be more of a take home exam rather than a spot impromptu viva.
- Infrastructure
  - Research scholars rooms have been setup. More are underway.
  - Some research labs are not equipped well enough.
  - Accommodation for married students is seriously short. HRA is also hardly sufficient for off campus stay.

Appendix 7: The strategic plans of the Microelectronics Group

(8 page insert)

EE Departmental Review

Microelectronics Group Vision

Outline

- MicroE Group features
- Faculty
- Students
- IITBNF

The MicroE Group

- Largest group in EE
  - Close to 30 faculty members, including visiting faculty (not exclusive, may be affiliated to other groups too)
  - Runs one of the two B.Tech.+M.Tech. dual degree programs in the EE Department
  - Covers both circuits/VLSI design as well as semiconductor devices/technology
  - Runs the IITB Nanofabrication Facility (IITBNF) funded by the Centre of Excellence in Nanoelectronics and other projects
  - Runs national-level outreach program, viz. the Indian Nanoelectronics Users Programme

MicroE Faculty

- Faculty strength gap in certain areas
  - Digital system design
  - Embedded system design
  - Optoelectronics, photonics
  - MEMS/NEMS/MOEMS
  - Microfluidic/nano-bio devices
  - Atomistic simulation
  - Power semiconductor devices
  - Novel architectures: quantum-information, neuromorphic

MicroE Faculty

- Need strategy for hiring & developing faculty
  - Mentoring fresh PhD's and attracting experienced professionals to join IITB especially in major gap areas
  - Visiting faculty positions (has been well-staffed in the devices area)
  - Enable faculty travel to international conferences
  - Mentoring and promoting of junior faculty by seniors
  - Mechanism for larger start-up funding for significant new experimental capability building
  - More flexibility for new faculty to offer courses in their research area, not teach large classes in the beginning

MicroE Students

- Even undergrads should get hands-on research opportunity
- Provide broad exposure in Microelectronics to undergrads
- Infrastructure should be developed for creating and enhancing experimental and modeling labs
- Conference travel must be enabled for undergrads, DDs, M.Tech's, enhanced for PhD students
- Internship/co-op opportunity for PhD students may be formalized

IITB Nanofabrication Facility

- Enabling facility for more than 50% of MicroE faculty (those in device/technology areas)
  - Almost unique in India in terms of comprehensive design-fab-test capability, industry interaction, open access
  - Critical for manpower training, specialized technology development for national needs
  - Has grown organically so far through projects by initiative from faculty

IITB Nanofabrication Facility

- Need to remain state-of-the-art and be sustainable
- Institute needs to support with
  - Space
  - Skilled staff
  - Streamlined procedures
  - Utilities
  - Safety & emergency response

Appendix 8: List of vitae items

Suggested Format for Faculty CVs

Current Position
Personal Data
Education
Experience in Higher Education (prior positions, visiting positions, etc)
Awards and Honors
Plenary/Keynote Talks
Invited Talks (seminars, invited conference presentation, etc)
Service Activities (committee memberships, etc)
Editorial Activities
Conference and Other Committees (TPCs, etc)
Tutorials and Short Course Activities (courses offered outside campus to other audiences)
Technology Transfer (deployment of research at companies, etc)
University Service (various committees in department, institute, etc)
Teaching Honors
Doctoral Theses Supervised
Masters Theses Supervised
Present Students (just names)
Projects (Name, Source, Total Funding, Faculty member's role (e.g., principal), Duration)
Courses Taught (show course name, enrollment, and the results of any teaching evaluation)
Patents (filed, granted)
Publications/Submissions (In the following indicate with an asterisk next to the name of the paper if peer reviewed.)
Books
Monographs
Books Edited
Book Chapters
Articles in Journals
Articles in Conference Proceedings