Review of the Department of Mathematics-2008-2012: An executive summary

A committee consisting of six renowned mathematicians: Prof. Rajendra Bhatia (Indian Statistical Institute, Delhi), Prof. Arup Bose (Indian Statistical Institute, Kolkata), Prof. Carsten Carstensen (Humboldt University, Berlin), Prof. Ravindran Kannan (Microsoft Research Labs, Bangalore), Prof. Olivier Pironneau (l'Universit Pierre et Marie Curie, Paris) and Prof. V. Srinivas (TIFR, Mumbai) was appointed to review the activities of the Department of Mathematics in the years 2008-2012. The Academic Review of the Mathematics Department, Indian Institute of Technology Bombay was conducted in two phases: on January 6, 2014 and January 20-21, 2014. All the members of the Committee (except Profs. O. Pironneau and V. Srinivas) met at the IITB Campus on 6th January 2014, and had several meetings and discussions with members of the Department together and in various groups. Prof. V Srinivas was not in India during the review dates and joined the discussions on Skype. Prof. O. Pironneau visited IIT Bombay on January 20-21, 2014 and conducted an independent review.

The Committee was supplied with a comprehensive document entitled *Review of Academic Activities 2008-2012*. This report gives a detailed account of academic activities of the Department of Mathematics at the Indian Institute of Technology Bombay from January 1, 2008 to December 31, 2012.

The head of the department presented the status of the department on various aspects such as faculty strength and their research areas, growth in student numbers and academic programmes. The department has 36 regular faculty members, 1 emeritus fellow, 4 long term visiting faculty, 1 Raja Ramanna fellow, and 1 emeritus professor. Moreover, there are 180 students and 6 technical staff.

Academic Programmes: The department's doctoral programme has expanded dramatically in the period 2008 - 2012, doubling in strength to its current size of about sixty five research scholars. The department was the first in IIT Bombay to institute qualifying exams, a feature that has added considerable rigour to the training of our students. It is also among the few in the Institute to offer a large number of advanced *Topics* courses and seminars meant for research scholars in the second year and beyond.

The two Master's programmes which have around 120 students in total. The M.Sc. in Mathematics programmes has been quite successful in recent years with several students opting to pursue a doctorate, in premier institutions both in India and abroad, while others opting for a teaching career at various colleges and universities. The M.Sc. in Applied Statistics and Informatics programme produces applied statisticians armed with mathematical reasoning and programming skills. The graduates of this programme have been particularly successful in finding positions in industries across many sectors of the economy.

Research: The main research areas pursued by faculty members of the department include Algebra, Analysis, Combinatorics, Geometry, Number Theory, Numerical Analysis, Partial Differential Equations, Probability, Statistics, Theoretical Computer Science and Topology. During the review period, the department has accounted for 201 papers, many in reputed international journals, in addition to 7 research monographs and textbooks. It should be mentioned that over the years, members of our faculty have been responsible for no less than 31 books, many of which are now part of the standard undergraduate curriculum in many parts of the country. The faculty members have active ongoing collaborations with researchers at major Indian and international institutions and regularly participate in international conferences. The members of the department have also been involved in 20 sponsored projects and 2 consultancy projects between 2008 and 2012.

Undergraduate Teaching: The department offers six courses in the first two years of the B.Tech. degree, three of which are taken by all first year undergraduate students. Overall, mathematics courses account close to fifty percent of the common core classes, almost matching the contributions of all other departments combined in terms of course credits and hours of instruction. In addition to this, the department offers Minor programmes to undergraduates in Mathematics as well as Statistics, both of which have been very successful.

Outreach Activities: The faculty members of the department have been enthusiastically involved in various outreach activities most of which fall under the rubric of National Centre for Mathematics, National Programme for Differential Equations: Theory, Computation & Applications, and Technology and Innovation in Mathematics Education. The department has also contributed to distance learning programmes via CDEEP and NPTEL.

Comments by the Committee:
The Committee broadly agrees with this self-assessment of the Department. It is happy that in recent years the Department has made special efforts to broaden its areas of research, and now has high caliber researchers in several areas of pure and applied mathematics. This has raised the profile of the Department and given it its present strength. For the Department to grow further, it would need to recruit several outstanding young

persons in all areas of mathematics and to motivate them to stay active in research. Two of the reviewers felt that some younger faculty are not very active in research and have suggested a five year tenure track system or to make the promotion system harder as a solution.

Ph.D. programme: The committee pointed out that Ph.D. program would need to be ambitious with more high quality dissertations coming out. The committee felt that that often the training in the undergraduate and masters programs in the country has left several deficiencies, and because of this many good students are not prepared to get into research soon after entering the Ph.D. program. They recommend that the tenure of the research fellowship should take into account this problem. The progress of every student should be judged by a committee of the Department, and if it is satisfactory, then a research fellowship should be provided for a period of up to six years. It is also difficult to find money to send Ph.D. students to training programs abroad. For Ph. D. students, two publications accepted while submission of thesis may be relaxed to two papers submitted for publication, with a letter from the advisor guaranteeing the quality of the research.

M.Sc. programmes: The Committee is happy to note that the Department is running two masters programs that are of good quality, and are successful in their objectives. In an interaction with students they were happy to see that several students in the mathematics program had an ambition to go for doctoral studies, and almost all students in the Applied Statistics and Informatics (ASI) program were finding jobs in the industry. Minor revisions and flexibilty in the curriculum suggested to suit the requirements by the students may be considered.

General facilities: The Committee was dismayed by the state of the building that houses the Mathematics Department. Though there has been a genuine and time-consuming effort to renovate the facilities with the effect that most professors have decent offices with all modern facilities, internet access etc, the entire building has an unkempt look, the corridors are littered, the toilets not functioning, etc. There is still a clear shortage of office space and the PhD students suffer, as a big number of them have no assigned place to sit and work. There is a remark on uneven level of the technical staff, some being hopelessly inefficient and others overworked and too few. The computing facilities of the department are managed by a single engineer, efficient yet over worked. But the flip side of his efficiency is that if he leaves or falls sick the department will be immediately in a very difficult situation. The institute is urged to pay attention to these aspects.

Publications: Taken globally, the committee felt that the publication record of the department is excellent. Some of the committee members felt that at the individual level, some members fall below the generally accepted standard: at least 4 publications in 4 years though there are notable exceptions. It was noted that the rules for travelling abroad forbid visits for research collaboration unless done on the side of a conference.

Action plan:

1. The department plans to continue recruiting outstanding young faculty in all areas of Mathematics. An emphasis will be on hiring and attracting those who are truly exceptional and have strong potential to be leaders in the field. Possibilities for extending the the tenure of contract from 3 years to up to 5 years will also be explored. Recruitment of promising young Ph.D.'s as postdoctoral fellows will be promoted.

2. The Department would further encourage collaborative research by facilitating visits by fellow researchers and also by working with the Institute to enable the faculty get funds through CPDA and other sources for a research visit abroad and not just for participation in international conferences.

3. Following a proposal recenty approved by the BoG, the Department will intiate a scheme of a comprehensive and meaningful self-assessment to be done annually by each faculty. Moreover, it plans to conduct a 2-day symposium at least once each year to showcase some of the major research activities of the faculty and research scholars in the preceding year.

4. Steps towards strenghtening the Ph.D. programme are already intiated by revising the admission criteria and the qualifying examination requirements. Efforts will be made to fund participation in international conferences or workshops at least twice during the tenure of each Ph.D. student. Also participation in relevant national conferences/workshops will be encouraged.

5. Revision in M.Sc. (Mathematics) programme has been done in 2013 allowing more flexibility in terms of the choices of courses for the students. A revision of the M.Sc. (ASI) programme taking into account some of the feedback from present and past students, is expected soon.

6. Renovation of various facilities is currently underway and the department expects to have more space available (entire buliding) in the near future and will work with the institute to upgrade the infrastructure.