

A BRIEF HISTORY OF THE DEPARTMENT OF MATHEMATICS I.I.T., BOMBAY, 1958-2007

The Indian Institute of Technology, Bombay was founded in 1958. The year 2007-08 marks its Golden Jubilee Year. As a part of the Golden Jubilee activities, a history of the Institute covering its fifty years of existence is being compiled. One of its chapters deals with the history of the Department of Mathematics of the Institute.

Preparation of this chapter was entrusted by the Department to a committee consisting of Prof. K. D. Joshi (Convener), Prof. B. V. Limaye, Prof. D. V. Pai and Prof. V. D. Sharma. The Committee met several times and also invited inputs from other members of the Department. Records from the Academic Office and the Administration of the Institute were also sought to gather the relevant data. The subsequent pages represent the outcome of the deliberations of the Committee.

Contents

The Initial Phase	2
Teaching of Mathematics in B. Tech. and M. Tech. Programmes	5
M. Sc. Programmes	10
Research and Ph. D. Program	14
International Conferences	16
Social and Outreach Activities	18
Heads of the Department	21
Concluding Remarks	22

The Initial Phase

The Department of Mathematics began as a small section comprising of two faculty members (both lecturers) from the time when IIT Bombay started functioning in the year 1958 from the premises of SASMIRA (Silk and Arts Silk Mills Research Association) Building in Worli, Mumbai. Subsequently, as the Institute progressively took steady strides to grow in size and stature, its mathematics section also gradually grew in size. As the Institute moved to its present campus in the year 1960, along with the other departments and sections, the mathematics section also moved to the campus which was then in a continuous stage of development. The faculty strength of this section had already grown to 15 in 1960 and it was further increased to 18 in 1962. It appears that the mathematics section became the Department of Mathematics in the year 1960. The Department was first housed on the top floor of the present Main Building. It was subsequently moved to the TCS Building (the present day Building of Estate Office) along with some other Departments.

In 1962, the newly constituted Senate of IIT Bombay met on the 19th December. Arising out of deliberations in this meeting, subsequently in its 6th Meeting held on 9.12.1963, the Senate approved a resolution on **Composition and Functions of the Academic Bodies of IIT Bombay**. According to this resolution, in addition to a *Senate Standing Committee*, each Department was required to constitute an *Academic Committee* for the Department with its Head/In-charge as the Chairperson of the Committee. Such a committee was required to have as many members as distinct fields of study in the Department as approved by the Senate. The members of the committee were to be selected by rotation on the basis of seniority. Moreover, the committee was required to have at least two members from other Departments duly nominated by the Senate. Also, Boards of Studies for a period of 3 years were to be constituted to consider, deliberate and make proposals to the Academic Committee on syllabi and curriculum. The main function of the Academic Committee, to quote from the minutes of this meeting, was, ‘to consider, deliberate and make proposals to the Standing Committee on all academic matters with specific reference to the Departments either such proposals as received from the Boards of Studies of the Department which are initiated by the committee or referred to by the Senate or its Standing Committee’. [sic]

In the same meeting of Senate, *Fields of Studies* in each Department were approved. For *Mathematics Department* the following Fields of Studies were approved:

1. Elasticity
2. Fluid mechanics
3. Statistics
4. Computation.

Soon thereafter in 1964, the first Academic committee was set up for the Department along with a Board of Studies. Two more Lecturers were inducted in the area of Statistics and Operations Research. In 1966, the first full-fledged Professor joined the Department along with one Lecturer and three Associate Lecturers. In 1967, one Assistant Professor and two Associate Lecturers joined the Department. Upto this point of time, the Department was mainly responsible for the teaching of mathematics and statistics courses in B.Tech and M.Tech programmes of the Institute. A number of faculty members were also involved in pursuing research for their doctoral degrees from the Institute. In its meeting held on 18.08.1967, the Senate of IIT Bombay accorded approval for the structure and the curriculum of the two year M.Sc. programme in Mathematics. The programme consisted of four courses each *Term* with an evaluation pattern consisting of 60 marks for Periodic Tests and Home Assignments and Term-end Examination consisting of 90 marks, in all 150 marks for each course. In the final term, three Elective courses were approved and also a Home Paper. The evaluation of the Home Paper carried 100 marks for a term-end examination. The M.Sc. programme in Mathematics was initiated by the Department in the year 1968-69.

The Department moved to the building where it is presently housed in the year 1966. Most parts of the ground floor and the entire first floor were available to the Department then. There was a round table conference room in the inner portion of the ground floor which was being used then for the meetings of the Senate and the Senate Standing Committee. The second floor of the building came up in the year 1977, and subsequently for some time a few offices on the ground floor, half of the first floor and the entire second floor were available to the Department.

In the initial phase, IIT Bombay had a significant collaboration with USSR under the UNESCO programme geared to the task of building up

the Institute. As far as the Department of Mathematics is concerned, it is worth mentioning here the visit of Prof. V. I. Gavrillov of Moscow State University to the Department in the year 1968-69. He gave two courses in *Complex Analysis* in the Department and also guided research of two faculty members working in the domain during that period. Mention may also be made of an *Analogue Computer* which was received from USSR for strengthening the efforts in the area of *Computation* during the period.

The above paragraphs only try to recapture the history of the initial phase of the Department. Over a period of time, thanks to the dedicated efforts of its faculty and students, the Department has steadily grown in size and stature. The areas of interest in mathematics and statistics that are being pursued in the Department today are vastly different from the ones which were being pursued in the formative period of the Department. Aside from contributing substantially to the teaching of core courses in mathematics in the B.Tech programme, the Department has been running two post B.Sc. master's programmes: M.Sc. (Mathematics) and M.Sc. (Applied Statistics and Informatics) which have been quite successful. It also contributes substantially by way of its social and outreach activities. More details are given in subsequent sections.

As is to be expected, the research activity of the Department was in its infancy, when the Department itself was in its infancy. This was due, primarily, to two factors. First, facilities such as a good library and a computational laboratory had to be developed. Secondly, most of the younger faculty members in the initial phase had only a master's degree and did their Ph. D. while working as lecturers here. Nowadays, a doctoral degree (preferably with some post-doctoral research experience) is a minimum qualification for an appointment as a faculty member. This was not so in the initial phase.

But the things picked up. The Ph.D. programme of the Department has contributed substantially to the training of specialized manpower so crucially required by the academic institutions and the R.& D. sector in the country. The publication profile of the faculty has also steadily risen to a higher pedestal over the years. Today, the Department is no doubt considered as one of the excellent advanced centres of teaching and research in mathematics and statistics in the country.

Teaching of Mathematics Courses in B.Tech and M.Tech Programmes

The B. Tech. programme of the Institute (and of all the IIT's) is, by far, the most coveted undergraduate degree programme in engineering in India, if not in the world. It is no exaggeration to say that a substantial portion of the prestige of the Institute is derived from its B.Tech. programme. Admission to it is through a highly competitive examination, the Joint Entrance Examination (JEE). Mathematics has been one of the subjects at this examination. In addition, all B. Tech. students have to undergo certain mathematics courses. The numbers and the contents of these have varied considerably over the years.

The present B.Tech programme started in 1958. Originally, it was a five year programme, but later in 1962 it became a four year programme. Subsequently, it became a five year programme upto 1978 when once again the new four year programme was initiated.

In the beginning, the number of *papers* in mathematics in B.Tech programme was six. The topics covered under these papers were roughly as follows:

Paper I: Coordinate Geometry and Solid Geometry

Paper II: Differential Calculus, Integral Calculus and Vector Calculus

Paper III: ODE & PDE

Paper IV: Statics & Dynamics

Paper V: Statistics

Paper VI: Numerical Analysis.

These papers were covered in the first three years of B.Tech programme. The instruction was organized in five divisions each consisting of about 60 students. Each division was assigned a teacher who took the lectures as well as the tutorial for that division. The evaluation in each paper was marks-based. It consisted of 40 marks for Periodic Tests and Home assignments and 60 marks for the Term-end Examination, in all 100 marks for each *paper*. A Coordinating Teacher was assigned for each paper and the Term-end question paper was common for all the divisions.

In July 1970, the Senate of IIT Bombay constituted a committee called the **Tendolkar Committee** for reviewing the UG curriculum existing then. Later in 1971, the Senate basically accepted the recommendations

in the report of this committee and constituted a committee called the **Mallik Committee** or the **Curriculum Committee** for framing a revised curriculum for B.Tech programme with a credit-based course structure. The recommendations of this committee were accepted by the Senate in 1971 and the credit-based course structure came into effect for the UG programme in the academic year 1972-73.

As a sequel to the Curriculum Committee recommendations, the following core courses in mathematics were made common to all branches of Five Year B.Tech/M.Sc. programme:

MA 101 Mathematics I 2-2-0-8

MA 102 Mathematics II 2-2-0-8

MA 201 Mathematics III 2-2-0-8

MA 202 Mathematics IV 2-1-0-6

MA 204 Mathematics V 2-1-0-6.

(The numbers given after the course name refer, respectively, to the Lecture hours, the Tutorial hours, the Practical hours and the Credits.)

In addition to the above courses, most of the Departments opted for the course

MA 301 Mathematics VI 2-2-0-8

in their 3rd Year, I Semester curriculum.

Together these courses covered calculus of one and several variables, matrix theory, ordinary differential equations, Fourier series and integrals, integral transforms, boundary value problems, complex analysis, partial differential equations, and probability and statistics. In addition to these courses, the students were allowed the choice of taking one of the following courses as an Elective in their second year second semester as a 2-1-0-6 course:

MA 206: Boolean Algebra

MA208: Linear and Quadratic Programming

MA222: Group Theory.

Furthermore, many Departments had provided slots for the following courses under Elective I and Elective II in the fourth year and Elective V in the fifth year:

MA 401: Probability and Statistics

MA 402: Numerical Analysis

MA 404: Industrial Statistics

MA 501: Operations Research I.

In 1977, the Senate constituted a committee called the **Raman Committee** (and subsequently the **Raja Rao Committee** in 1978) for considering the change from Five Year B.Tech Programme to Four Year B.Tech Programme. The recommendations of the Raman committee were accepted and the new Four Year B.Tech Programme was started in 1978. In 1981, the Senate also constituted a committee called the **Hiralal Committee** to review the efficacy and the working of the UG programme as envisaged by the earlier Senate Committees on UG programmes. The committee laid great stress on the aspect of independent study by the student. To reflect the new philosophy, the credits for a 2-1-0 course was raised from 6 to 8.

In the Four Year B.Tech Programme, the number of core courses in Mathematics were reduced from 6 to 4 (with no significant reduction in the contents). This was possible because of the revised syllabus for the Joint Entrance Examination, which now included some calculus which was a part of MA 101 earlier. The courses were as follows (the fourth figure in the description of the course indicates the number of hours of independent study per week):

MA 4107 Mathematics I 2-1-0-5-8

MA 4108 Mathematics II 2-1-0-5-8

MA 4207 Mathematics III 2-1-0-5-8

MA 4208 Mathematics IV 2-1-0-5-8.

In 1996, the Senate once again constituted a committee called the **Narayanan Committee** to review the *Core UG Curriculum*. The committee made recommendations to the Senate in its first interim report in November 1996 and its second interim report in October 1997. The committee redefined the common core programme as that part of the curriculum, whether compulsory or elective, common to all departments which run a B.Tech, 5yr M.Sc. or 5yr Dual degree programme. It also emphasised (i) the flexibility in the choice of core courses for different specialization departments (ii) the creation of Departmental Options (DO) consisting of group of courses in place of some of the compulsory courses existing in the UG curriculum then.

Based on recommendations of the Narayanan Committee, the number of compulsory mathematics courses in the core UG curriculum was further

reduced from four to three. The courses were as follows:

Iyr Ist Semester: MA 103 Mathematics I 2-0-2-6

Iyr 2nd Semester: MA 104 Mathematics II 3-0-2-8

IIyr 1st Semester: MA 203 Mathematics III 3-0-2-8.

The course MA 103 consisted mainly of uni-variate and multi-variate calculus. The course MA 104 consisted mainly of vector calculus, the theorems of Green, Gauss and Stokes and their applications, elementary linear algebra with emphasis on matrix theory and introduction to numerical linear algebra. The course MA 203 consisted mainly of ODE's, systems of DE's, critical points and stability analysis, sequences and series, power series, solutions of ODE's using power series, Laplace transforms, Fourier series and integrals, transform techniques in DE's.

In addition to the compulsory courses above, most of the Departments, based on their requirements, prescribed to their students one of the following courses in the second year, second semester:

MA 204 Mathematics IV 2-1-0-6

MA 210 Introduction to Numerical Analysis 2-1-0-6

MA 212 Probability, Random Processes and statistical Inference
2-1-0-6.

The most recent revision of the B. Tech. mathematics courses has just come in, in the form of recommendations of the **Biswas Committee** constituted by the Senate in 2004. The major deviation from the past is the freedom given to the B. Tech. students to choose the level of their programme. Thus subject to certain requirements, the students can either opt for an (ordinary) B. Tech. degree (which has considerably less load than in the past) or go for a B. Tech. with honours in their respective branches. In addition, they may also select a minor outside their branches and complete a certain number of credits in the minor. One of the minors available is mathematics. As a result, there is now a greater freedom to choose the quantum of mathematics a B. Tech. student undergoes depending on his/her aptitude and interests. Thus all B. Tech. and Dual Degree students have to take the following three courses in Mathematics:

1) MA 105 - Calculus 3-1-0-8

2) MA 106 - Linear Algebra 3-1-0-4

3) MA 108 - Ordinary Differential Equations I 3-1-0-4

The first course is to run for one semester while the other two for half a semester each. In effect, this means that all B. Tech. students undergo two full common mathematics courses. In addition, the Department to which a student belongs may prescribe any one from a certain list of courses which includes the following three courses from Mathematics.

- 1) MA 205 - Complex Analysis 3-1-0-4
- 2) MA 207 - Differential Equations II 3-1-0-4
- 3) MA 214 - Introduction to Numerical Analysis 3-1-0-8

For those B. Tech./Dual Degree students who want to do a minor in Mathematics, the Mathematics Department lays down a minimum of 30 credits from the following courses:

- 1) All B. Tech. mathematics courses (other than the compulsory ones)
- 2) M. Sc. course MA 403 (Real Analysis) 3-1-0-8
- 3) M. Sc. course MA 405 (Basic Algebra) 3-1-0-8
- 4) M. Sc. course MA 406 (General Topology) 3-1-0-8
- 5) M. Sc. course SI 416 (Statistical Inference) 3-1-0-8
- 6) M. Sc. course SI 407 (Probability Theory) 3-1-0-8

It will thus be seen that a B. Tech. student with a genuine interest in Mathematics can now acquire a far stronger background in mathematics than was possible ever before. At the same time one has to admit that the number of B. Tech. mathematics courses which *every* B. Tech. student has to take has gone down from 6 two decades ago to just 2. This is perhaps a reflection of the changes in the perceived role of mathematics in engineering. Those who want to look at mathematics only as a tool can get by with the bare minimum. But those who hold that it has a deeper role have the provision to go deeper.

The role of mathematics courses in the M.Tech programme of the Institute has been relatively marginal. When this programme was initiated in the beginning of 1960's as a six semester programme, there used to be one compulsory course in mathematics and one optional course. This pattern continued for sometime even after the programme was reduced to four semesters. Subsequently, for several years the Departments preferred Electives (one or two) on topics in Mathematics and Statistics which were specially run for M.Tech programme. However, at present, it has not been possible to accommodate such courses.

M.Sc. Programmes

The Senate of IIT Bombay gave its approval for the very first M.Sc. (Mathematics) programme on 18 August 1967, and the programme started in July 1968. In each of the first 3 terms of this post-B.Sc. two-year programme, there were four compulsory courses in the following sequence: Real Analysis, Algebra, Complex Analysis, Ordinary Differential Equations, Abstract Analysis, Differential Geometry, Classical Mechanics, Algebra II / Partial Differential Equations, Theory of Probability, Numerical Analysis, Functional Analysis and Continuum Mechanics. In the 4th term, students took Potential Theory and Integral Equations, three elective courses and a Home Paper Project.

The above M.Sc. (Mathematics) programme continued (with minor modifications from time to time) till 1976-1977. The first time such a programme appeared in the Courses of Study Bulletin of the Institute seems to be in 1975-76. In this year, compulsory courses on Mechanics of Fluids, Mechanics of Solids, Topology, Computer Programming & Utilization, Statistics and Mathematical Methods show up. Also, the Home Paper Project was then spread over the third and the fourth semesters and carried 20 credits.

In the academic year 1977-78, a new M.Sc. programme called 'M.Sc. in Mathematics with Specialization in Computer Science' was introduced. It coexisted with the earlier M.Sc. (Mathematics) programme. The new programme had the following compulsory courses: Computer Programming & Utilization (EE), Introduction to Computing Systems (EE), Numerical Analysis & Algorithms (MA), Real Analysis (MA), Linear Algebra-Matrix Theory (MA), Introduction to Business Data Processing (EE), Digital Computer Programming (EE), Algebra including Boolean Algebra (MA), Finite Structures-Graph Theory, Combinatorics, Block Designs (MA), Differential Equations (MA), Numerical Solutions of ODE & PDE (MA), Complex Analysis (MA), Computer Methods in OR (MA)/Operations Research & Simulation (EE). In addition, there were two labs and a Home Paper Project spread over 2 semesters. This programme attracted a larger number of students and in some sense rejuvenated the M.Sc. level activities of the department.

Close on the heels of the specialization in Computer Science, the Department started another programme called 'M.Sc. in Mathematics with

Specialization in Statistics & Operations Research' in 1978-79. Apart from a selection of courses in the M.Sc. (Mathematics) programme, several new compulsory courses were floated for this specialization such as Operations Research I, II & III, Measure & Integration, Econometrics, Design & Analysis of Experiments and Multivariate Analysis. Many specialized electives were also on the offer.

In the academic year 1979-80, a major revision took place of the courses in all the three M.Sc. programmes run by the department. While a newly framed course called 'Principles of Mathematics' became a core course for all three, a course entitled 'Principles of Optimization' came in as a core course for the two specialized M.Sc. programmes. Also, a course on Statistical Inference was made compulsory for the specialization in Statistics & Operations Research, while Applied Algebra was made a core course for the specialization in Computer Science. In the year 1980-81, the regular M.Sc. (Mathematics) programme was interestingly christened as 'M.Sc. in General Mathematics without Specialization'! This modified structure of the three M.Sc. programmes essentially continued till the academic year 1984-85, when the regular M.Sc. (Mathematics) programme was split into two, one called 'M.Sc. in Mathematics with Specialization in Pure Mathematics' and the other called 'M.Sc. in Mathematics with Specialization in Applied Mathematics'. In this process, some of the earlier core courses were bifurcated and they remained compulsory for only one of the two split programmes. A new course called 'Topics in Modern Analysis' was meant only for the pure branch, while Fluid Mechanics I & II as well as Solid Mechanics I & II were meant only for the applied branch, for which Functional Analysis was no more required.

The four specializations in Computer Science, Statistics & OR, Pure Mathematics and Applied Mathematics were run by the department from 1984-85 to 1994-95. In the subsequent academic year, a structural change took place. On one hand, it seemed appropriate to combine the specializations in Pure mathematics and in Applied mathematics to create a balanced and sound programme in Mathematics, and on the other hand, a strong need was felt to combine the specializations in Computer Science and in Statistics & OR to formulate an industry-oriented programme. Thus in place of the earlier four specializations, a so-called scholastic stream 'M.Sc. (Mathematics)' and a so-called utilitarian stream 'M.Sc. (Applied Statistics & Informatics)' were introduced. A great deal of flex-

ibility was offered in the scholastic stream by making all courses in the 2nd, 3rd and 4th semesters as electives in Group A (Pure Mathematics), Group B (Applied Mathematics) and Group C (Statistics). Only the first semester courses Linear Algebra, Real Analysis I, Complex Analysis, Numerical Analysis I and Differential Equations I were compulsory. The utilitarian stream was aimed at creating professional academicians who can manage and analyze large statistical data with tools of the computer science. It had the following course structure. Semester I: Computer Programming & Utilization (CS), Discrete Structures (CS), Applied Linear Algebra (SI), Mathematical Modeling (SI), Mathematical Systems Theory (SI), Applied Probability & Statistics; Semester II: Data Structures & Algorithms (CS), Programming Lab (CS), Business Information Systems (CS), Numerical Methods (SI), Optimization (SI), Applied Stochastic Processes (SI); Semester III: Discrete Algorithms (SI), Finite Difference and Finite Element Methods (SI), Categorical Data Analysis & Regression (SI), Electives I & II; Semester IV: Stochastic Programming Applications (SI), Experimental Design (SI), Electives III & IV. In addition, a Work Visit of 4 weeks duration during the vacation months was a requirement. Over the years, some courses and labs offered by the Computer Science & Engineering department were replaced by redesigned courses and labs offered by the Mathematics Department.

Major revisions in the two M.Sc. programmes in Mathematics and in Applied Statistic & Informatics took place in the years 2001-2002 and 2006-2007. In the first revision, the totally elective nature of all courses in the 2nd, 3rd and 4th semesters of the M.Sc. (Mathematics) programme was changed by introducing certain compulsory courses, and the elective courses were restricted to 2 in the 3rd semester and 3 in the 4th semester. Also, three Principal Streams were introduced: (i) Pure Mathematics, (ii) Applied Mathematics & Scientific Computing and (iii) Statistics. By taking 4 of the 5 electives as well as the Home paper Project in a particular Principal Stream, a student could earn a mention of that stream in his/her degree certificate. For the M.Sc. (Applied Statistics & Informatics) programme, a course on Database and Information System offered by the Computer Science & Engineering Department was included as a core course, and a realignment of the elective courses was made by creating two groups : (i) Applied Statistics, (ii) Informatics and Scientific Computing.

In the second revision, the theoretical statistics component of the M.Sc.

(Mathematics) programme was shifted to the M.Sc. (Applied Statistics & Informatics) programme, and the computer science part of this programme was made more theoretical and more self-reliant. Further, the concept of a restricted elective was introduced by giving a bifurcated choice of courses such as Algebra II / Numerical Analysis, Algebraic Topology / Mathematical Methods for the M.Sc. (Mathematics) programme, and O.D.E. / Multivariate Analysis, Network Models / Nonparametric Statistics for the M.Sc. (Applied Statistics & Informatics) programme. For both the programmes, the curriculum was made somewhat lighter; also the credits for the Home Paper Project were reduced from 20 to 12 in order to correctly reflect its weightage in the curriculum. Also, the requirement of a work visit for the M.Sc. (Applied Statistics & Informatics) programme was dropped.

The class strength of the M.Sc. (Mathematics) programme has always been moderate. While it had dwindled to less than 10 in the mid-seventies, it has stabilized to around 15. In contrast, the class strength of the M.Sc. (Applied Statistics & Informatics programme) has always been between 20 to 25. Every year both programmes attract a select band of very good students. Till the academic year 2003-2004, the department used to conduct its own entrance test for admission to its M.Sc. programmes. Since the academic year 2004-05, the admission is through a national examination called JAM (Joint Admission to M.Sc.) which is conducted jointly by all the seven IITs.

In addition to the post-B.Sc. programmes at the Master's level described above, the Department ran a five-year Integrated M.Sc. programme in Mathematics during the seventies. The intake for this programme was through JEE (Joint Entrance Examination) which was then conducted by all the five IITs mainly for admission to the B.Tech. degree. Soon after the initial break-in period, the class strength of this programme became so low that the Senate of the Institute decided to hold it in abeyance. It was occasionally revived (in 1996 and in 1999) to induct a small number of highly motivated and exceptionally talented B.Tech. students of IIT Bombay who wanted to shift to Mathematics from Engineering.

Presently, a collaboration is on the anvil for the Institute to take over the M.Sc. courses at the renowned Institute of Science, Mumbai, run by the Government of Maharashtra. The details are being worked out.

Research and Ph. D. Program

The Department of Mathematics at IIT Bombay, since its inception to date, has maintained a continued tradition of high quality education and research. In spite of depleted faculty strength at times, and increased teaching and administrative responsibilities, the Department has been able to keep both its teaching and research interactions at a sustained high level, along with a regular output of high quality research in the areas of Pure Mathematics, Applied Mathematics and Statistics.

The period during late sixties to mid seventies would be remembered in the annals of history of the Department of Mathematics at IIT Bombay because in this period it acquired the name and fame of being one of the best Applied Mathematics Departments in the country, in terms of research output. During this period, the Department had a large number of research scholars, and most of them worked in continuum mechanics with statistics being a second major area of interest; the Department produced 40 Ph.Ds and published more than 100 papers in internationally cited journals.

During mid seventies and eighties, induction of several outstanding faculty in different areas of pure mathematics made the Department not only strong and balanced but really vibrant through their serious teaching and research endeavours towards making the Department globally competitive in terms of quality education, research and a major resource centre for the country. Since then we had a flurry of research activities in several areas of pure mathematics, applied mathematics, and statistics, and our department is now considered a centre of excellence in mathematical research - highly sought after by prospective Ph.D. students. Most of our graduate students of that period are occupying high positions in IIT's, universities and other research establishments.

Currently, the Department consists of 30 faculty members, 2 adjunct faculty, 1 distinguished Professor, 3 post-doctoral fellows and 35 research scholars. Besides having a strong Ph.D. programme, the Department offers two Master's degree programmes, which attract a large number of students every year, and so far more than 1000 M.Sc and 250 Ph.D students have passed out from the Department. Faculty members are actively engaged in quality research, and have continued to maintain excellence in terms of research output and citations. Over the fifty years the Depart-

mental faculty members have been conferred many honours including the Bhatnagar Award and the Young Scientists Award and election to the Fellowship of the Indian National Science Academy. The linkage with the R&D organisations in the industries is continuously growing as a number of industrial/consultancy projects are ongoing. There is a close faculty-student interaction in the Department even at the master's degree level in the sense that the students are supposed to work for their projects under the guidance of faculty members; some of these projects are sponsored by industries and R&D organisations which provide both the student and faculty an opportunity to work on real life problems. Indeed, some of these students are initiated into research when they work for their project during the second year of the master's degree programme.

In recent years the Department, with a view to promote collaborative research, has strengthened its visitor's programme by inviting several distinguished mathematicians from other institutions in the country and abroad as visiting fellows to give quality input to the education and training imparted to the students. Currently, the Department enjoys a unique and prominent place amongst the premier Mathematics Departments in the country that are engaged in education, training and research in Mathematical Sciences.

Besides pursuing their own research and guiding research scholars, many faculty members of the Department have attended research conferences in India and abroad, including the International Mathematics Congress held every four years. Some of them have given invited addresses. Many faculty members have refereed and reviewed articles for a number of mathematical journals. In fact, several of them have served or are serving on editorial committees of several prestigious mathematical journals and also on the advisory boards and the R&D Committees of several universities and other academic institutions.

It would be in order here to cite the names of faculty members who have contributed significantly to research, along with a brief description of such contributions. But there is such a wide spectrum of contributions of comparable excellence, that it would be unfair to single out a few of them, while listing them all is precluded by space considerations especially so because in many cases it would be difficult to appreciate the significance of a contribution without some technical elaboration. Interested readers can learn more about them by visiting the Departmental website.

International Conferences

Several international conferences were held under the auspices of the Department of Mathematics of IIT Bombay covering a wide range of research areas in which the faculty members of the department have been making significant contributions. The details of these conferences are given below in chronological order.

1. (i) Dates: 20-22 December, 1977
(ii) Title : Optimizing Methods in Statistics
(iii) Organizers : J. S. Rustagi (Ohio State University), P.C. Jain
(iv) Proceedings : Published by Academic Press in 1979.
2. (i) Dates: 16-20 December, 1985
(ii) Title : Methods of Functional Analysis in Approximation Theory
(iii) Organizers : C.A. Micchelli (IBM, New York), D.V. Pai, B.V. Limaye
(iv) Proceedings : Published by Birkhauser, Boston/Stuttgart in 1986.
3. (i) Dates : 15-17 December, 1986
(ii) Title : Optimization, Design of Experiments and Graph Theory
(iii) Organizers : M.N. Gopalan, G.A. Patwardhan
(iv) Proceedings : Published by IIT Bombay in 1987
(v) Special Aspect : In honour of Prof. M.N. Vartak (IIT Bombay) who superannuated in 1986.
4. (i) Dates: 10-15 December, 1990
(ii) Title : Mathematical Theory of Control
(iii) Organizers : M.C. Joshi, A.V. Balakrishnan (UCLA, California)
(iv) Proceedings : Published by Marcel Dekker, New York in 1993.
5. (i) Dates: 13-15 January, 2000
(ii) Title : Trends in Commutative Algebra

- (iii) Organizers : V.D. Sharma, A.R. Shastri, J.K. Verma, S.R. Ghorpade, M.K. Srinivasan, M.A. Sohoni, R.C. Cowsik (Mumbai University), B. Singh (TIFR, Mumbai) and R.A. Rao (TIFR, Mumbai)
6. (i) Dates: 19-21 December, 2000
 - (ii) Title : Statistics, Combinatorics and Related Areas
 - (iii) Organizers : Satya Mishra (University of South Alabama), S.V. Sabnis
 - (iv) Proceedings : Published as a special issue of 'American Journal of Mathematical and Management Science' Vol.22, No.3 & 4 in 2002.
 7. (i) Dates: 7-9 December, 2002
 - (ii) Title : Industrial Mathematics
 - (iii) Organizers : M.C. Joshi, A.K. Pani, S.V. Sabnis
 - (iv) Proceedings : Published by Narosa Publishing House, New Delhi in 2006.
 8. (i) Dates: 11-13 December, 2004
 - (ii) Title : Recent Trends in Nonlinear Analysis and its Applications
 - (iii) Organizers : N. Nataraj, A.K. Pani
 - (iv) Special Aspect : In honour of Prof. D.V. Pai (IIT Bombay) and Prof. M.C. Joshi (IIT Bombay) who superannuated in 2003 and 2004 respectively.
 9. (i) Dates: 7-9 December, 2005
 - (ii) Title : Topics in Functional and Numerical Analysis
 - (iii) Organizers : R.P. Kulkarni, A.K. Pani
 - (iv) Proceedings : Being published as a Special issue of Journal of Analysis
 - (v) Special Aspect : In honour of Prof. B.V. Limaye (IIT Bombay) who completed 61 years in 2005.

Social and Outreach Activities

The popular image of a mathematics department is an ivory tower and it is further accentuated when the department happens to be a part of some exalted institution like IITs.

The Department of Mathematics of I.I.T. Bombay is a pleasant exception to this image thanks to its various social and outreach activities. The Mathematics Association of the Department has for its members all faculty and students of the Department. It is managed mostly by the M. Sc. students under the supervision of some faculty member. It caters to social functions such as welcome and farewell to the incoming and outgoing batches of students. It also has its own teams for various sporting events such as football and chess. In some years it has organised picnics where faculty members can take along their families, thereby providing a charming contrast to the supposedly stern perception of mathematicians.

The Mathematics Association has also undertaken academic activities where persons from outside the Department, and indeed, persons from outside the Institute as well can participate. Academically, the most significant such activity is the Popular Lecture Series, where speakers give expository talks accessible to anybody with a general interest in mathematics. The topics have varied from space curvatures and number theory to cryptography and ancient Indian mathematics.

But probably the most popular activity of the Mathematics Association has been the annual Mathematics Olympiads. This is a quiz competition in mathematics (not akin to the National or International Mathematics Olympiads) open to all college students. Many colleges send their teams and prizes are given for the teams and also for individual performance. Separate prizes are given for two categories of students, the junior and the senior. There is, in fact, also a third category open to laymen who may have left mathematics a long time ago, but who have a nostalgic interest in it. This is often accompanied by an essay writing contest on subjects related to mathematics. Souvenirs containing short mathematical articles of general interest, along with prize winning essays from the contest, are published. The organisation is done by students and brings out the best in their managerial skills. The first Olympiad was held in 1979 and the tradition continued uninterrupted for over two decades. Because of some operational difficulties, it could not be held for a few years.

But it is revived from 2007.

The Department also has activities where it interacts with people in the academic community at large. These include :

- (i) **Industrial Mathematics Group:** Devoted especially to problems from the industries where mathematics can be applied.
- (ii) **Statistics-Study Group:** Devoted to discuss both the research articles in statistics and its applied aspects.
- (iii) **Workshops in Mathematics:** An yearly activity aimed to motivate and encourage final year B.A./B.Sc. students to take up higher studies in mathematics. Started in 1994, it is sponsored since 1997 by the Department of Science and Technology. This gives the departmental faculty a chance to directly interact with students pursuing a Bachelor's degree in Mathematics, which is especially significant because the Department has no programme of its own leading to a Bachelor's degree in Mathematics. (A B.Tech. programme in Mathematics and Computing is, however, in the offing.)
- (iv) **TIME Seminars:** The national seminar in 'Technology and Innovation in Mathematics Education gives a platform to teachers to interact and share their experiences.
- (v) **Math for ECM:** Program emphasising the role of Mathematics in Economics, Commerce and Management studies.

There are also activities where the Department has helped other bodies in organising their mathematics related activities. The most prominent among these is the MTTS (Mathematics Teaching and Talent Search) program of the NBHM (National Board for Higher Mathematics). Started in 1993, the Department played a crucial role in the conception of this annual activity and also hosted it for the first three years. It has also hosted some ATM (Advanced Training in Mathematics) programs of the NBHM.

Apart from the colloquia and invited addresses before professional audiences all over India and a few countries abroad, the faculty members of the Department have also participated in refresher courses in Mathematics ranging from those for school teachers to those for university teachers. They have also helped some mathematics departments in their formative

stages in various colleges and universities, by giving contributory lectures in areas where the necessary expertise was lacking. These activities are too numerous to be listed. Suffice it to say that the faculty members of the Department are among the most sought after speakers.

These activities are complemented by another which has an even wider and a more permanent impact. Many of the faculty members of the Department have written books on mathematics which have been published by reputed publishers, both in India and abroad. The nature, the topics and the level show considerable variety. Some are meant for undergraduate students, some for graduate students and some for the professionals in an area. The topics covered include analysis, topology, differential equations, discrete mathematics and so on. Most of these books are well received by the academic community and some of them have been prescribed as texts/references at many educational institutions. Several faculty members have also written popular articles on mathematics, sometimes in regional languages.

Heads of the Department

The Department of Mathematics formally came into being in 1960. Till 1966 it had no (full) professor. So the persons who headed it till then were called in-charge. Dr. C. R. Marathe was the first in-charge while Dr. M. N. Vartak was the last one in 1966. Apparently, Dr. M. N. L. Narasimhan took over as the in-charge in 1964 but was again taken over by Dr. Marathe who continued till 1966 and then by Dr. Vartak who was the in-charge for only a couple of months. But no authentic record is available of the dates of these changes of hand.

From 1966 onwards, the Departmental headship was by rotation (with a normal term of three years at a time). Also the heads had to be professors. The following is a chronological list of those who headed the Department from 1966 till present.

Name	Year in	Year out
P. C. Jain	1966	1969
R. D. Bhargava	1969	1971
P. C. Jain	1971	1973
M. N. Vartak	1973	1977
P. C. Jain	1977	1978
M. P. Ranga Rao	1978	1981
B. S. R. Rao	1981	1984
D. V. Pai	1984	1987
G. A. Patwardhan	1987	1990
M. V. Deshpande	1990	1993
B. V. Limaye	1993	1996
V. D. Sharma	1996	2000
M. C. Joshi	2000	2003
V. D. Sharma	2003	2006
J. K. Verma	2006	—

Concluding Remarks

Fifty years is a duration with certain peculiarities. It is a small period from the point of view of global history. But in terms of human life expectancy, it is a long period. In fact, it is the longest period within live memory with any ceremonial value. When the Diamond Jubilee of the Institute will be celebrated in 2033, it is unlikely that anybody alive at that time will have had a first hand experience of the days the Institute was founded. Fortunately, in this year of the Golden Jubilee celebrations there are persons, who, even though now retired, have served the Institute right from its inception. There are also some faculty members who were students at this Institute in its very early years and recount fond memories of that era. The campus was quieter with lots of vacant spaces and greenery. The facilities available were skeletal in today's comparison, what with no xerox machines and no computers, and telephones being the privilege of a few! Notices were cyclostyled on brownish yellow paper rather than sent on e-mails. Still, it was a happy, peaceful life.

In recording the history of the Mathematics Department for the last fifty years, we wish we could have done some justice to this human aspect. But space considerations have prevented us. The various facets of the Department could barely be covered in the space and time allocated. Some of the data from the past was not available despite our best efforts, because in the administration there was a systematic removal of files that are older than forty years. So in some cases we had to rely on memory, either of our own or of some colleagues. We apologise for any consequent deviations from the facts.

Another place where we had to resort to some unpleasant restraint was in giving the names of the individuals. We have mentioned most of the noteworthy achievements of the Department. Obviously, these achievements were possible only because of the efforts put in by some individual faculty members. But in many cases, these efforts were collective and it would be unfair to selectively credit only the individuals who headed them. Even in the case of significant research contributions, we have, after considerable thought, desisted from naming the researchers individually. The idea here was certainly not to deny the credit. But the fact is that there is such a wide spectrum of such achievements of comparable quality that it would be difficult to list them selectively and listing them all is

precluded by space considerations. The only exception we have made is to list the names of the organisers of International Conferences held under the auspices of the Department. These, we believe, are sufficiently distinguished both in terms of status and rarity. We have also given a chronological list of the persons who headed the Department right from its inception till date.

Even though the research achievements have not been listed with names, a saving feature (albeit only partly) is that the contributions of individual faculty members at present are easily available from their personal home pages on the departmental website, <http://www.math.iitb.ac.in>. We also refer the interested reader to this site for more details of some of the activities which we could cover only sketchily.

In conclusion, the Committee to prepare the history of the Department apologises for any omissions or errors that may have occurred inadvertently. It also thanks all the colleagues within the Department and persons in the Institute administration. Without their valuable inputs and help, the Committee's task would have been next to impossible. The Committee hopes that although only a brief record of the fifty years, this humble effort will serve as an inspiration for the future.

(K. D. Joshi)
Convener

(B. V. Limaye)

(D. V. Pai)

(V. D. Sharma)