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Research Article

Studies on Unrestrained and Commercializable Intellectual Property in Higher Educational Institutions

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ABSTRACT

The studies are related to aspects of scientific publications (Unrestrained Intellectual Property, UIP) as well as patents and technology transfer (Commercializable Intellectual Property, CIP) largely at the Indian Institute of Science (IISc). Data on the publication pattern of over hundred academic faculty in the disciplines of physical and mathematical sciences, mechanical sciences, electrical sciences, chemical sciences and biological sciences covering forty departments are collated and subjected to analysis on the patterns and differences between different disciplines in basic sciences and engineering sciences at IISc over a ten-year period. Addressing the question of whether the number of papers is a good indicator of quality or the word count of the publications is a better representation shows that even though there is a broad relationship, there is a factor 2 in the number of papers vis-à-vis number of words and so, the emphasis on number of papers can seriously undermine the perception on the influential nature of the individual's work. Even though some industry – academia interactions existed, but was limited and the primary reason was traced in questionnaire-based discussions that the role of CIP appears largely unattended by *inadequate institutional recognition to this venue as an intellectual pursuit*.

Keywords: Patents, CIP, UIP, Word count as a tool to quantify scientific output, Faculty promotion and evaluation.

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INTRODUCTION

The work of higher educational institutions depends on its research content and the infusion of knowledge into students in the pursuit of new knowledge is its concomitant aim. These are cooperative features because smarter and better trained students will contribute motivated hard work with significant contributions to research. Understandably, the motivation for research for any faculty member would be to uncover something grandly new, bring it to the attention of the scientific world first and others next and earn accolades, recognition, promotion, and awards. Promotion for outstanding work occupies an important position for a faculty member to be seen as a worthwhile colleague in the department or section within the institution and a worthwhile family member. Not all faculty members can be understood not to be always noble and wishing to reach the highest goals in very honorable and respected ways. Efforts to enhance visibility through shortcuts in terms of number of publications by making them suitably tailored with no substantive conceptual content are possible and cannot be easily argued against unless substantial time passes. The causes for these are many. There will be senior colleagues who have large number of "average" papers accepted for publication in reasonably good journals, the unjustifiable rejection of one's own papers in not the best of the journals, and petty jealousies that need to be factored into one's own life to make academic progress in an unblemished manner. Thus, academic life is many times as knotty as public life. The measurable academic output from an institution is a combination of these factors and one might find tracks of these in the variability of indices of performance. Some of these observations are not entirely new. These aspects have been discussed in earlier studies as well. Sonnert,[1] states "…Scientists have some control over the number of publications they generate from a given amount of research. On the extremes, 'mass producers' create a great volume of marginal material and 'perfectionists' produce a small number of extremely valuable publications" (Cole and Cole).[2] The idea of industry-academia interactions has also been a matter of debate and Leydesdorff and Etzkowitz[3] discuss the idea of academia – industry – government relations as a "triple helix" providing an important catch word for what is perceived as important for healthy growth of the institution and the country. The double helix of government – academia has been in practice for long in institutions of higher learning like IISc very significantly and the academia – industry relationship in a muted way over a time with attempts to enhance this relationship. In more recent times,

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Malele[4] has emphasized the importance of socio-economic development as an important component that should figure in the relationships. And also, arguments are advanced in which community engagement experience should be a component to assess a faculty member's academic promotion in a university. Greater emphasis of this class can perhaps be misused since engaging in socio-economic development relates to public relations and can dilute the true role of scientific creativity.

In view of (a) the appreciation obtained from the literature, (b) the fact that hardly has there been any rigorous study of performance of higher educational institutions vis-à-vis objectives with which such institutions are founded, and (c) Indian Institute of Science has always stood tall in the minds of the people of India and also overseas as a high quality educational institution for higher learning, the present work aims at a study of the academic performance of the institution as revealed through (i) the publication profile of a statistically significant size of the faculty, and (ii) its industrial and societal interactions identified as commercializable intellectual property through the centre for scientific and industrial consultancy. The former is rigorously treated using the publication data available from information in public domain as well those from within the Institute and the latter based on both data and interactions with faculty to determine their motivation to undertake basic research and development connected research. The rest of the paper is arranged in terms of sections involving discussions of the measures of performance, a description of sample source and methodology, journal and their features, analysis of journal publications, IISc and CIP, perceptions on Unrestrained Intellectual Property (UIP) vs CIP and a summary.

Measures of performance

Even though academic performance is measured in terms of number of publications, the overall contributions of a faculty member that would involve publications, consultancy, patents, developments of significance, teaching and administrative support would be assessed for their quality. This approach predates the idea of triple helix discussed in ref.[3] and the idea of socio-economic relevance discussed in ref.[4] Since quality is not an easy parameter to assess for an institution, it depends on a number of subject experts to provide their confidential assessment and then to base their judgments for promotions. When it concerns frontier research contributions, referees include many with some from overseas and the overall academic and administrative support related aspects are dealt with by the department. Formal communication of promotion or otherwise based on the responses from the experts are made available to the faculty member whose performance is assessed and these reach the rest of the community informally (excepting the chairman of the department). Thus, the number of publications is one measure of performance. As discussed in the earlier section, the word count was considered another valid parameter because some would write long and others short papers. The question of recognition of scientific work would be a parameter of significance. In general, in an academic environment, fellowship of academies was the parameter of significance. Since most institutions of significance pride in technology transfers as well, the output in the form of patents and technology transfer would be another appropriate measure. Since this aspect is not a widely nurtured and understood subject, its role in recognition is many times not even factored. The best way to assess this was to hold one-to-one meetings along with a questionnaire and obtain direct inputs from the faculty on what they thought as their appreciation of the role. This is the approach chosen for the current study.

Sample Source and the Methodology

A total of 102 faculty from IISc was considered for the study. There are five different faculty groups depending on their areas of work. At IISc, there are five divisions – Biological Sciences (BC), Chemical Sciences (CS), Electrical Sciences (ES), Mechanical Sciences (MS) and Physical and Mathematical Sciences (PMS). Each division has under its umbrella several departments. The largest of these divisions is Mechanical Sciences with each of its departments having multiple individual disciplines and the smallest is Physics and Mathematical Sciences. Even though cross division collaborations exist, they are not significant. In fact, efforts are being made to allow cross-division collaboration, but during the period of study, it was weak. Hence the present study is not affected because of this feature.

It was consciously decided to choose as many faculty for each of the divisions as possible to obtain a reasonable statistical measure of the performance. The details of the divisions, the departments and number of faculty considered are set out in Table 1.

The data of these faculty members was obtained with some effort. This was not entirely easy because at the time of this study, there was no central database for this purpose or demand that each faculty member place all his/her publications in an accessible manner on their web page. About 60% was obtained from the web sources. The rest was obtained directly through personal requests and from internet search through the library access. The sample population, as detailed in Table 1, belonged to a heterogeneous group – people having research and teaching experience (post Ph.D.) of 6 – 45 years.

Obtaining the number of publications was not such a difficult task. It was *very arduous* to determine word count. This is because it was necessary to obtain the number of words per page of each of the journals contained. There were issues of the first and the last page which would be different from the prime textual areas in terms of formatting, which in turn would have bearing on the number of words contained. The first page of the journals contained on average 38% fewer words than the second and

Table 1: Area-wise distribution of sample population (original).

Divisions	Departments	No. of faculty
Biological Sciences (BS)	Biochemistry, molecular and cell biology, molecular biophysics, genetics and ecological sciences.	19
Chemical Sciences (CS)	Inorganic and physical chemistry, organic chemistry, solid state and structural chemistry, materials.	18
Electrical Sciences (ES)	Electrical engineering, electronics design and technology, communication, computer sciences, bioinformatics, information sciences.	19
Mechanical Sciences (MS)	Aerospace, chemical, civil, mechanical, metallurgy, product design and manufacturing.	27
Physical and Mathematical Sciences (PMS)	Applied mathematics, cryogenics, high energy physics, instrumentation, and physics.	19
Total		102

Table 2: The number of journals used in each division or discipline (original).

Sl. No.	Discipline	No. of Journals	Publication pattern (No. of Researchers)
1	Biological Sciences	197	10.4 (19)
2	Chemical Sciences	139	7.7 (18)
3	Electrical Sciences	134	7.1 (19)
4	Mechanical Sciences	305	11.3 (27)
5	Physical and Mathematical Sciences	127	6.7 (19)

subsequent pages. The last page of the research paper contained references in most cases and in few cases acknowledgement and a profile of the author (s). About 85% of the last page of the articles analyzed in this study was less than a quarter page. For the purpose of computing the number of words, only the second or subsequent page is considered. The methodology adopted is to copy the PDF (Portable Document Format) text into a word file and using MS Word count tool. In cases (<15%) where the soft copy of the paper was not available, manual counting was used (admittedly very time consuming). The figures, graphs, tables, photographs, and images used in the research publication have been assigned a number of words based on the space they occupied. The text height and width were measured using scale either in the journal page or print version of PDF of journal article. A custom designed flexible scale containing font sizes in addition to centimeters and inches, was created and used. The magnitude of the effort is to be understood considering more than 900 journals were dissected for the information as above.

Journals and their features

The total number of journals in which researchers have published is about 950. The publications in each discipline occur over a much smaller number of journals. Table 2 provides the number of journals in each discipline and its publication pattern. The spread in the disciplines is reflected in the number of journals where the publications of the respective faculty appear. Mechanical sciences have the largest number of journals and physical sciences the smallest.

The last column indicates researchers' use of mean per capita journals. It can be seen that researchers in Mechanical Sciences discipline have published in large numbers of journals with an average per capita use of 11.3 journals and least usage is by researchers in Physical and Mathematical discipline indicating use of fewer journals for publications and so the per capita journal usage is 6.7.

It is not proper to strictly classify every journal into any particular discipline, as there are many journals, which cover all disciplines of science and technology like *Science*, *Nature*, *Current Science* and others who are quite discipline specific like *AIAA Aerospace Journal*, *Behavior*, *Biochemistry*, *Vaccine*, *J of Electron Spectroscopy and Rel. Phenomena* and so on. Hence this classification is based on general parameters; the discipline the author belongs to publishing the work. In the wake of the above facts, the classification is not very rigid in reality. Another phenomenon widely known and accepted is that as the knowledge progresses, the dividing lines between disciplines become very thin. Multi-disciplinary approach to tackle scientific problems, of late, is quite widespread.

Using the methodology mentioned in the previous section, journals used for this study were analyzed. Table 3 summarizes the characteristics of these journals.

The print area range is also large - 25 to 70 square inches with a mean of 54 square inches. More than 50% of the journals are in the range of 56-65 sq. inches.

Perhaps, for reasons of each journal wishing to be unique, their publishers use a special style of presenting the text, one such

Table 3: Print Area in Journals analyzed in this study (original).

Sl. No.	Print area in square inches	No. of journals and percentage in parenthesis
1.	25-30	24 (2.7)
2.	31-35	79 (8.5)
3.	35-40	81 (9.1)
3.	41-45	64 (7.2)
4.	46-50	64 (7.2)
5.	51-55	101 (10.9)
6	56-60	189 (21.3)
7	61-65	270 (30.0)
8	66-70	30 (2.9)

Table 4: No. of columns in Journals analyzed in this study (original).

No. columns	No. of Journals in the category	Mean ± σ words/page	Words/page Min, Max
One	251	581 ± 132	310, 1150
Two	642	949 ± 116	360, 1820
Three	9	943 ± 51	966, 1140

exclusive feature being the number of columns used. Table 4 classifies the journals analyzed; it can be seen that 71% journals use two columns and contain 360-1820 words/page. The range in the number of words/pages is very large.

The minimum to maximum height of print area in a typical page is 6 to 10.2 inches with a mean of 8.7 inches.

Figure 1 shows the data on the number of journals with words/pages. Each of the data points has a range of ± 25 on the values indicated. The distribution appears near normal with a wide spread in the words/page from about 400 to 1200. These data are

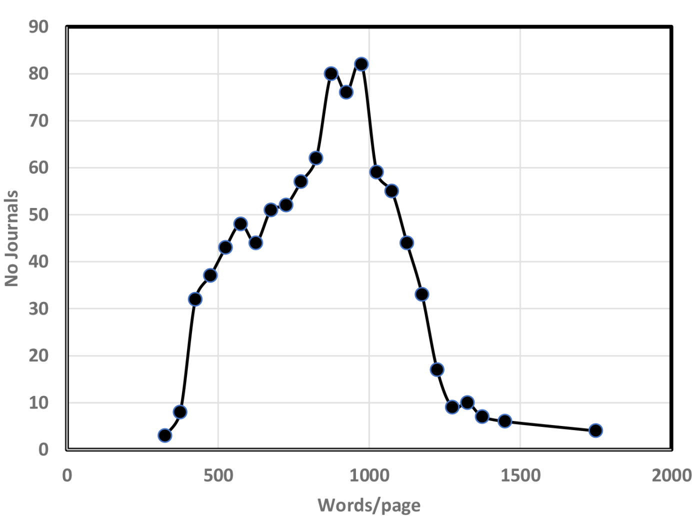

Figure 1: The distribution of the number of journals vs. words per page for a total of 902 journals. (original).

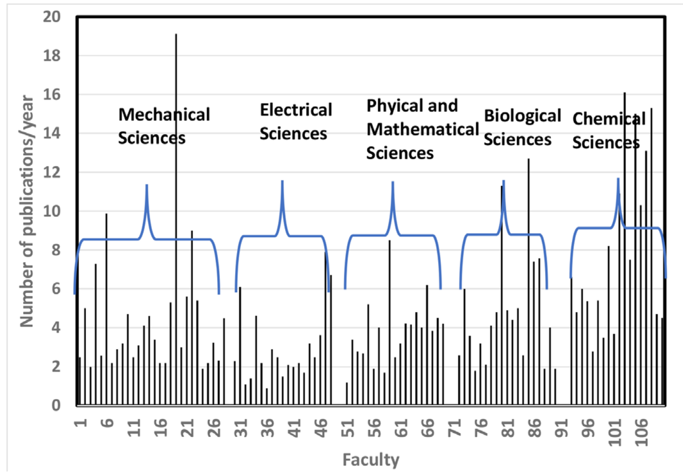

Figure 2: The number of publications/years averaged over 10 years of the 102 faculty from the five divisions (original).

used to obtain the total words that a faculty member wrote in his/her publications over 10 years.

Analysis of journal publications (Unrestrained Intellectual Property -UIP)

As a measure of the performance of the faculty in different disciplines, the data on the number of publications per year averaged over the 10-year period for the faculty is shown in Figure 2.

It must be remembered that Mechanical and electrical sciences belong to the engineering discipline and the three other basic sciences. The data is very revealing. The different divisions seem to reflect very different tendencies. The lowest performance is in Electrical sciences and the highest in Chemical sciences. The faculty from Chemical sciences publish a much larger number of papers than others. If we keep apart about a dozen faculty with a very high number of publications, most other faculty publish between 2 to 5 papers a year. It is important to examine the faculty with the largest number of publications. For instance, publications of 19/year – a paper every three weeks - may imply that a large content of the papers is about similar (like experimental tools, procedures or mathematical approaches) and the new content does not need intensive thinking or rationalization with findings of literature. It actually implied in specific cases that there is a battery of research students (the fraction of post-doctoral fellows was not large at IISc as the students would look for post-doctoral opportunities overseas) who would write the papers with guidance from senior students and the papers are briefly scrutinized before being cleared by the supervisor for submission. Those, whose publication records showed a 2 to 4 publications per year had between 2 to 4 Ph. D. students.

Discussion with several of the faculty (to be discussed later on intellectual property related aspects) revealed that it would take a couple of months for ideas to crystallize, conflicts in data

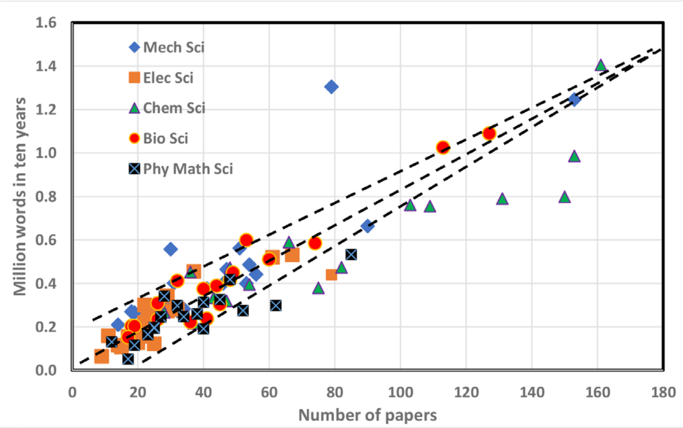

Figure 3: Academic output in terms of number of words vs number of papers by the faculty in various divisions. (original).

and calculation aspects resolved and to put together material of significance would be such that publishing four papers of intellectual significance, year after year would be stupendous. It is also possible that a breakthrough in the experimental or computational study might inspire a spate of publications. But this cannot last too long unless repetitive work is performed.

The number of words vs. the papers is set out in Figure 3. While a fair amount of data falls along a linear relationship, implying larger number of papers also meaning a proportional number of words, there are deviations even allowing for scatter in the expectations (covered by the two outer dotted lines), it appears that about 10% faculty publish with lower number of words for every paper they publish. And an exception or two who publish a lot both in terms of number of papers and words. Most of the faculty who publish a larger number of papers with lesser content of words per paper belong to the chemical sciences division – with many chemical compounds to study or synthesize and conduct characterization studies (this could be an over-simplification, but not far from the truth). Most importantly, even in the band of variation the number of words written in a paper varies by a factor of 1.5 to 2.5 in the 20 to 40 papers (for ten years) range. To put this differently, faculty members who write 40 papers in ten years, would have put in 20000 to 40000 words in their papers. If those who write 40000 words could split the contents into different publications (of course, may not always be possible), they would have got nearly twice the number of publications. This is such a wide range that perception of faculty in the department and the senior faculty involved in promotions and awards would get a very different picture depending on the approach chosen for publications (The details of the publications of individual faculty members are set out in the Appendices Table A1 to A5).

The mean parameters are listed in Table 5 for all the divisions. The number of faculty that has more than 25 publications in 10 years (2.5 per year) shows that all in chemical sciences and most in bio sciences have this accomplishment. Electrical sciences division seems to lag behind with mechanical sciences as well as physical and mathematical sciences in a respectable range (75% faculty meet the expectation stated here). The difference in the variation of the number of publications per year over different faculties being such a large number implies that one needs to be extremely cautious in treating the number of publications as an indicator of intellectual productivity of the faculty.

Going further, the number of words per paper is the lowest for physics and mathematical sciences division as well as chemical sciences division. That the largest number of words and words/paper belongs to the Mechanical sciences division is not also easily explainable. That these are significant averages and show up distinct features implies that these are to be taken valid for what they are. The only factor is that an extraordinary performance of some faculty leads to these aberrations cannot be ruled out.

IISc and Commercializable Intellectual Property (CIP)

Indian Institute of Science is a premier institute of higher learning in India that celebrated its centenary in 2009 and has on an average of about 2500 students out of this about 1500 Ph.D. students and rest Masters with an intake of about 700 students per annum. It offers about 400 courses at PG level and 80 courses at research level. IISc has about thirty-five departments and centres in many branches of science and engineering. It produces on average 2000 research publications annually. The set objectives of the Institute are "to provide for advanced instruction and to conduct original investigations in all branches of knowledge *as are likely to promote the material and industrial welfare of India*".

In the background of the last statement, much discussion went on in the late sixties and early seventies (IISc docs).[5] Consequent upon these, the Centre for Scientific and Industrial Consultancy (CSIC) came into being on March 3, 1975 as the industrial window allowing consultancy activities to be undertaken by faculty in a formal way ensuring institutional support. This was the starting point for activities related to CIP.

Initial phase saw a lot of proactive measures to encourage faculty members to undertake consultancy. CSIC successfully dealt with 3800 projects, about 120 projects per year on the average by about 100 faculty in most branches of science, engineering and management from 1975 to 2008. The projects undertaken varied in themes and clientele – individual, proprietary firms to multinational to government agencies, cost ranging from a few thousands to millions and project duration of a few weeks to a few years. Those of a few weeks refer to an important calculation for immediate use or suggestions for an early resolution of a field problem. Projects operating from 1 to 2 years are about product development and associated performance testing. There have been consultancy projects involving periodic institutional advice lasting several years. A few examples of successful projects are cited here.

Table 5: Statistics of the publications and words/paper (original).

Division	No. Faculty	No. Faculty > 25 Pap	Av. No. Pap/yr	Av. Words /year	Av Words /pap
Mech. Sciences	27	18	4.5	42601	9471
Elec. Sciences	19	9	3.0	27095	8961
Phy, Math Sciences	19	15	3.8	27184	7073
Bio. Sciences	19	15	4.8	43214	8937
Chem. Sciences	18	18	8.0	57735	7228
Weighted mean			4.8	39527	8756
(Max - min)			5.0	32432	2398

There was a problem solving situation that got posed to CSIC in 1984, when it was reported that there was a heavy landslide due to incessant monsoon rains and the penstock pipe of a major hydroelectric power station (Sharavathi power station, Karnataka producing a thousand MWe under full discharge conditions) had been damaged and the secretary to a relevant department of the Government of Karnataka who had close links with several faculty at IISc reached out to Chairman, CSIC soon after and enquired if IISc would help out in the restoration of the penstock indicating a timeline. The point was that the reputation of IISc would be at stake if IISc failed and so the Chairman wanted the responsibility to be distributed so that when a crisis situation arose inputs from many could be obtained. A team of eight people from four departments were put together to be the consultants. A step-by-step procedure was evolved to understand the precise technical issues and ways of overcoming. The problem was resolved after about eight months within the timeline provided to them. This was one of the problems that got solved due to the participation of faculty from several departments.

Two groups have been active in substantive industry relevant projects. One from the cryogenic center of the physics department where a special cryo-oxygen container as a breathing apparatus for the indigenous light combat aircraft was built to some critical specifications.

Another group engaged in biomass gasification for power generation developed the technologies for biomass based distributed power generation from 5 to 1000 kWe and the technologies were transferred to several private industries both in India and overseas bringing larger revenues in terms of first-time fees and royalties over a fifteen-year period. In the early stages, these efforts were converted into a separate operation under a Society under the Institute for the specific purpose to allow greater freedom for its faculty participants to operate all the transactions under the overall guidance of a board for which the IISc director was the Chairman. There were some other spin offs that did not start right, but allowed to grow separately outside the ambit of IISc.

Perceptions on UIP and or vs CIP

It was found that the perceptions of CIP-Commercializable Intellectual Property was somewhat alien to IISc culture of fundamental research and questions of whether we should even be engaged in it were debated hotly. A questionnaire-based on interview was undertaken with a substantial fraction of the faculty at IISc as also from University of Mysore and University of Agricultural Sciences, Bangalore (Narahari).[6] The broad summary is that the senior academic management does not consider these aspects to be as important and, in some cases, not even needed. Even though many statements are made about the relevance in public forums, the approaches used in promotion and owning up technology development and outstanding consultancy is very weak. The expectation of the senior management is that such consultancy and technology development *even if it is science based* is not on par with journal publications. A paper in *Nature* or *Science* is more widely positively discussed across the campus and science-based technology development rarely figures in the discussions. One of the reasons is that the colonial hangover is not overcome. Technology development can largely be appreciated only within the country, whereas scientific publications have international reach that allows for international recognition and personal visibility, features that are widely perceived as a worthwhile approach. The institutional culture therefore is seriously amiss on these aspects. Though over time, there have been changes, but the senior management does not feel strong enough to help create a change in a substantive manner, *because these questions are not even debated formally*. The Governments may want the change, but much larger scale internal debates are needed to ensure ownership of the culture both by individual academics and the institution because it is important that front ranking science is not sacrificed due to induction of new ideas of industrially and socially relevant research and development. Such debates did not take place during the period of this study and do not seem to have taken place afterwards either.

CONCLUSION

This paper has discussed the aspects related to intellectual property of Indian Institute of Science – via publications (unrestrained) and science-based consultancy/technology development. Widely held view on the number of publications is shown to be a weak measure of intellectual performance of faculty. Institutional efforts at showcasing *outstanding science-based consultancy and technology development* are almost absent or very weak in IISc and perhaps true in many other institutions. Unless true intellectualism is respected whether it appears as scientific publication or science-based consultancy, the progress of the institutions of higher learning becoming leading lights for societal change will be difficult to achieve.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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APPENDICES

The data on faculty publications

The data collection was constrained by the availability. Due to the fact that some faculty had joined later, and the data access was difficult, the publication period in some cases is less than 10 years. The division, the department, the number of years over which the data has been collected, the actual period of collection of data, the total number of papers during this period, the average over the period of the papers and the number of words is all set out in the table for all the divisions.

Table A1: Mechanical Sciences (MS) division (original).

No	Faculty	Dep	Yrs	Period	ΣPap	Av P/y	Av Words/yr
1	Debashis Ghose	AE	10	1996-05	25	2.5	30525
2	Debiprosad Mahapatra	AE	6	2000-05	30	5.0	55743
3	Joseph Mathew	AE	8	1995-04	14	2.0	13699
4	Ranjan Ganguli	AE	10	1998-07	51	7.3	56208
5	Kartik Venkataraman	AE	7	2001-07	18	2.6	27030
6	Gopalakrishnan S	AE	8	2000-07	79	9.9	130473
7	Mahapatra PR	AE	10	1983-92	22	2.2	19524
8	Mukunda HS	AE	10	1988-97	29	2.9	32396
9	J Srinivasan	CAOS	10	1995-04	32	3.2	27281
10	SK Satheesh	CAOS	10	1996-05	47	4.7	46464
11	Mujumdar PP	Civil	10	1997-06	25	2.5	27223
12	Manohar CS	Civil	10	1998-07	31	3.1	40127
13	D Nagesh Kumar	Civil	10	1998-07	41	4.1	37585
14	TG Sitharam	Civil	10	1996-05	46	4.6	39887
15	Kumar Jayant	Civil	10	1997-06	34	3.4	28191
16	Anantha Ramaswamy	Civil	10	1998-07	22	2.2	21753
17	Sudhakar Rao M	Civil	10	1998-07	22	2.2	15415
18	Jayant M Modak	ChE	10	1998-07	53	5.3	39984
19	Giridhar Madras	ChE	8	2000-07	153	19.1	155727
20	Ayappa KG	ChE	9	1997-05	27	3.0	32047
21	Vikram Jayaram	Met	10	1998-07	56	5.6	44078
22	Ranganathan S	Met	10	1994-03	90	9.0	66302
23	Pradip Dutta	ME	10	1997-06	54	5.4	48539
24	Ghoshal A	ME	10	1997-06	19	1.9	26556
25	Rudra Pratap	ME	10	1998-07	22	2.2	19649
26	Munjal ML	ME	8	1999-06	26	3.3	32978
27	Venkat R Sonti	ME	6	2001-06	14	2.3	34836
	Weighted Mean					4.5	42601

(AE = Aerospace Engineering, CAOS = Centre for Atmospheric and Oceanic Sciences, ChE = Chemical Engineering, Met = Metallurgical Engineering, ME = Mechanical Engineering).

Table A2: Electrical Sciences (ES) division (original).

No	Faculty	Dep	Yrs	Period	∑Pap	Av P/y	Av Words/yr
1	Y Narahari	CSA	10	1997-06	23	2.3	28649
2	Patnaik LM	CSA	10	1992-01	61	6.1	51938
3	Joy Kuri	CEDT	10	1998-07	11	1.1	15847
4	L Umanand	CEDT	10	1996-05	14	1.4	11567
5	Gopakumar K	CEDT	8	2000-07	37	4.6	56869
6	Anurag Kumar	ECE	10	1998-07	22	2.2	30118
7	KVS Hari	ECE	10	1997-06	9	0.9	6369
8	Viijaya Kumar P	ECE	10	1998-07	29	2.9	27242
9	Navakanta Bhat	ECE	10	1997-06	25	2.5	12080
10	Khincha HP	EE	10	1984-93	15	1.5	10636
11	Rajanikanth BS	EE	10	1998-07	21	2.1	15620
12	Ramakrishnan AG	EE	10	1998-07	20	2.0	12800
13	Ranganathan VT	EE	10	1998-07	22	2.2	22086
14	Ramanarayanan V	EE	10	1998-07	17	1.7	15555
15	Thukaram D	EE	10	1998-07	32	3.2	28030
16	Debanath Pal	SERC	10	1998-07	25	2.5	29698
17	Govindarajan R	SERC	8	2000-07	29	3.6	42726
18	Sekar K	SERC	10	1998-07	79	7.9	43855
19	Jayant R Haritsa	SERC	10	1997-06	67	6.7	53119
	Weighted mean					3.0	27095

(CSA = Computer Science and Automation, CEDT = Centre for Electronic Design and Technology, ECE = Electronic and Communication Engineering, EE = Electrical Engineering, SERC = Supercomputer Engineering and Research Centre).

Table A3: Physical and Mathematical Sciences (PS) division (original).

No	Faculty	Dep	Yrs	Period	∑Pap	Av P/y	Av Words/yr
1	Basudeb Dutta	AM	10	1996-05	12	1.2	13044
2	Rangarajan G	AM	10	1995-04	34	3.4	24599
3	Mrinal K Ghosh	AM	10	1990-99	28	2.8	34146
4	S Thangavelu	AM	10	1995-04	27	2.7	24489
5	Asokan S	ISU	10	1994-03	52	5.2	27371
6	Rajanna K	ISU	10	1996-05	19	1.9	11451
7	C Mohan Rao	ISU	10	1994-03	40	4.0	19026
8	Shivaprakash NC	ISU	10	1995-04	17	1.7	5169
9	AK Sood	Phy	10	1996-05	85	8.5	53232
10	Arnab Rai Choudhuri	Phy	10	1995-04	25	2.5	19466
11	Rahul Pandit	Phy	10	1990-09	32	3.2	29720
12	Reghu Menon	Phy	9	1993-01	38	4.2	28710
13	Vasanth Natarajan	Phy	6	2001-06	25	4.2	32869
14	Anil Kumar	Phy	10	1996-07	48	4.8	41848
15	Sriram Ramaswamy	Phy	10	1998-07	40	4.0	31359
16	Subramanyam SV	Phy	10	1993-02	62	6.2	29787
17	Subash Jacob	CCT	6	2000-05	23	3.8	27347
18	Diptiman Sen	CHEP	10	1995-04	45	4.5	32597
19	Apoorva Patel	CHEP	10	1983-92	42	4.2	30265
	Weighted mean					3.8	27184

(AM = Applied Mathematics, ISU = Instrumentation and Services Unit, Phy = Physics, CCT = Centre for Cryogenic Technologies, CHEP = Centre for High Energy Physics).

Table A4: Biological Sciences (BS) division (original).

No	Faculty	Dep	Yrs	Period	∑Pap	Av P/y	Av Words/yr
1	Anjali A Karande	BC	10	1997-06	26	2.6	23416
2	Savithri HS	BC	10	1997-06	60	6.0	51067
3	PN Rangarajan	BC	10	1997-06	36	3.6	22170
4	Dipankar Nandi	BC	10	1997-06	18	1.8	20253
5	K Muniyappa	BC	10	1997-06	32	3.2	41124
6	Ramrajasekaran	BC	9	1999-07	19	2.1	22592
7	Raghavendra Gadagkar	CES	10	1996-05	41	4.1	23761
8	Sukumar R	CES	10	1996-05	48	4.8	41598
9	Balaram P	MBU	10	1998-07	113	11.3	102505
10	Murthy MRN	MBU	10	1998-07	49	4.9	44867
11	Varadarajan R	MBU	10	1996-05	44	4.4	38865
12	Dipankar Chatterji	MBU	9	1999-07	45	5.0	33707
13	Manju Bansal	MBU	10	1995-04	26	2.6	30765
14	Surolia A	MBU	10	1997-06	127	12.7	109047
15	Vijayan M	MBU	10	1997-06	74	7.4	58451
16	Shaila MS	MCB	7	2001-07	53	7.6	85422
17	Rajan Dighe	MRDG	9	1999-07	17	1.9	16930
18	Sandhya Visweswariah	MRDG	10	1997-06	40	4.0	37550
19	Seshagiri PB	MRDG	10	1998-07	19	1.9	16987
	Weighted mean					4.8	43214

(BC = Biochemistry, CES = Centre for Ecological Sciences, Phy = Physics, CCT = Centre for Cryogenic Technologies, CHEP = Centre for High Energy Physics).

Table A5: Chemical Sciences (CS) division (original).

No	Faculty	Dep	Yrs	Period	∑Pap	Av P/y	Av Words/yr
1	ED Jemmis	IPC	10	1998-07	66	6.6	58904
2	Mugesh G	IPC	10	1998-07	48	4.8	47251
3	Umapathy S	IPC	6	1997-02	36	6.0	75231
4	Sampath S	IPC	8	2000-07	43	5.4	41621
5	Arunan E	IPC	10	1996-05	28	2.8	26632
6	Ramakrishnan S	IPC	10	1996-05	54	5.4	39545
7	Sebastian KL	IPC	10	1997-06	35	3.5	25086
8	Varma KBR	MRC	10	1996-05	82	8.2	47377
9	Nanda KK	MRC	10	1997-06	37	3.7	21604
10	Chattopadhyay K	MRC	10	1996-05	109	10.9	75501
11	Biman Bagchi	SSCU	10	1998-07	161	16.1	140572
12	Gopalakrishnan J	SSCU	10	1995-04	75	7.5	37885
13	Guru Row TN	SSCU	10	1998-07	150	15.0	79753
14	Rao KJ	SSCU	10	1989-98	103	10.3	76101
15	Sarma DD	SSCU	10	1998-07	131	13.1	78954
16	Mehta G	OC	10	1995-04	153	15.3	98568
17	Uday Maitra	OC	10	1998-07	47	4.7	31986
18	Ramanathan KV	NMR	8	2000-07	36	4.5	36655
	Weighted mean					8.0	57735

(IPC = Inorganic and Physical Chemistry, MRC = Materials Research Centre, SSCU = Solid State Structural Chemistry unit, OC = Organic Chemistry).