Curriculum Vitae
of
Prof. S.S.KHARE

Name: **Shabd Sharan Khare**

Father's Name**:**   **Late Shri Fateh Bahadur Lal**

Permanent Address: **521, Meerapur Allahabad, U.P.**

Present Address: **Professor & Head, Mathematics Department, NEHU,
                               Shillong-793022, Meghalaya.**

Date of Birth**:**   **April 07, 1947**

Qualification: **M.Sc (Maths) in 1968 & Ph.D in Maths in 1977 from
                               Allahabad University**

Specialization: **Algebraic & Differential Topology**

Awards: **1. Fellow of National Academy of Sciences (1994)
                               2. Fulbright Fellowship (USA, 1986)
                               3. Commonwealth Academic Staff Fellowship (1987)
                               4. Gold Medalist in B.Sc & Silver Medalist in M.Sc
                                  From Allahabad University**

Visits Abroad**:**   **1. University of Virginia, USA in 1986 under Fulbright
                                   Fellowship
                               2. University of Manchester, UK in 1987 under
                                   Commonwealth Academic Staff Fellowship
                               3. University of California, USA in 1986
                               4. University of Edinburgh, UK in 1987
                               5. University of Duke, Durham, USA in 1992
                               6. London, U.K., January 2008.
                               7. Boston, U.S.A.., January, 2009
                               8. London, U.K., July, 2010
                               9. London, U.K., Jan, 2010 to Feb, 2011
                               10. Boston, U.S.A. June, July, 2011.**

Teaching: **A. Total teaching in different Universities: Approx. 43 years
                               B. Appointed as Professor in NEHU against open post in
                                  Dec. 1986
                               1. Lecturer, Allahabad University (Aug. 68-Dec. 71)
                               2. Lecturer, Gorakhpur University (Jan. 72-Nov. 75)
                               3. Lecturer, NEHU (Dec. 75- March 79)
                               4. Reader, NEHU (April 79- Nov. 86)**

Innovation in teaching mathematics:

Generally mathematics is an abstract subject considered as monotonous and hard nut to crack. During my vast teaching period of 40 years, I tried to make mathematics bit attractive, relevant and interesting. One of the efforts in this direction was to raise some of the following questions before introducing any concept.

(i).   Where form this concept has come?
(ii).   Why should we study this concept (other than the reason that it is in the syllabus)?
(iii).   What were the chain of thoughts or concepts or incidents which led to discovery of the concept?
(iv).   How is this concept relevant to some thing in our surrounding or to other disciplines?

Raising such questions and giving their suitable answers, wherever possible help in making the subject some what interesting. The students get to know some reasons or objective to study such concepts.

A good lively body language also helps in better teaching. Another way is to relate the concept at P.G. level to suitable concept at lower level where ever possible. Further, giving some geometric realisations of various concepts also helps in better understanding. As per my experience using these methods mathematics can be made much more interesting and lively. In fact, these methods helped significantly in making me a popular teacher in the department. During the last 35 years taught a variety of courses at P.G. level like: Real Analysis, Complex Analysis, Measure Theory, Topology. Linear Algebra, Abstract Algebra, Ring and Field Theory, Algebraic Topology, Statistics, Homology Theory Computer Programming and courses like Fibre Bundles, Characteristic classes, K-theory, Differentiable manifolds, Advanced Algebric Topology, Bordism Theory at M. Phil level.

Research Projects Under-taken from external funding agencies.

(i).   Research Project from National Board for Higher Mathematics during 1990-1993.
(ii).   Research project from D.S.T. (2000-2004), titled "Application of computer Techniques in Algebraic Topology: Functional Coding and Effective Homology" completed on 31.3.04.

Books:
(i)   Coauthor of "Abstract Algebra "by Zero", 1971.
(ii)   Coauthor of "Linear Algebra" by Zero, 1972.
(iii) Coauthor of "Basic Mathematics", 1986, NEHU Publication.
(iv)   Coauthor of NCERT book on Mathematics for Class XII, 2007.

Seminar, Conference, Workshop attended/participated:

(i).   Participated in the International Congress in Mathematics held at the University of Californian, Berkeley In 1986.

(ii).   Participated in the Seminar on "Algebraic Topology" in the University of Virginia in 1986.

(iii). Participate in the Annual Conference of British Mathematical Society in Edinburgh in 1987

(iv.)   Participated in the Series of Seminars on "Algebraic and Differential Topology" in the Department of Mathematics, University of Manchester, U.K. in 1987.

(v).   Participated in the First International Conference on "Fuzzy Theory & Technology" held at Duke University, Durhan, U.S.A. in 1992.

(vi).   Participated in the 42nd I.M.S. Annual Conference at Trivandrum in 1976.

(vii). Attended Summer School in "Semi-simple ring" at T.I.F.R in Bombay in 1969.

(viii). Attended Summer School in "Algebraic K-Theory" at Madurai University in 1971.

(ix).   Attended the Symposium on "K-theory" at NEHU, Shillong in 1977.

(x).   Participated in the "Topological group" session in the Annual Conference of Indian Science congress in 1979 held at Hyderabad.

(xi).   Participated in the Seminar on "Differentiable manifolds and Applications" held at Delhi in 1981.

(xii). Participated in the Annual I.M.S. Conference in 1982.

(xiii). Participated in the conference on "Topology and Functional analysis" held at Aligarh in 1983.

(xiv)   Participated in the Annual Conference of Indian Science Congress in 1985.

(xv).   Participated in the International Conference on Algebraic Topology held in Allahabad University in 1988.

(xvi). Participated in the Conference on Topology held at NEHU, Shillong in 1991.

(xvii). Participated in the ICOMIDC conference on "Geometry and its Applications" held at I.I.T. Delhi in 1992.

(xviii). Participated in the Annual conference of I.M.S. in 1995.

(xix). Participated in the International Conference on Algebraic and Differential Topology in Allahabad in 1996.

(xx). Participated in the International Conference on "Recent Development in Mathematical Analysis" at B.H.U. on 1998.

(xxi). Participated in the International Conference on "Topological Transformation Groups" in I.S.I. Calcutta in 1998.

(xxii). Participated in the Annual Conference of I.M.S. in December 1999.

(xxiii). Participated in the International Conference on "Low Dimensional Topology" in Allahabad in 2000.

(xxiv). Participated in the National Conference on "Algebraic and Geometric Topology" held in Delhi University in Jan. 2002.

(xxv). Participated in the International Workshop on "Topological Methods in Group Theory" held in the Institute of Mathematical Sciences, Chennai in July 2002.

(xxvi). Participated in the National conference on "Algebraic and Geometric Topology" held in Delhi University in Jan. 2002.

(xxvii). Participated in the Workshop on "Fractal Geometry" organized by the Department of Mathematics, University of Delhi in October 2004.

(xxviii). Participated in the Annual Conference of I.M.S. held in Jabalpur University in Dec., 2006.

(xxix). Participated in the "Symposium on some recent advances in Mathematics" organized by the Department of mathematics in April, 2007.

(xxx). Participated in the "International Workshop and Conference on Surface Mapping class groups and related topics" organized by the Department of Mathematics, NEHU, Shillong in June, 2008.

(xxxi) Organised Special Session on "Beauty of Mathematics" at St. Edmunds College, Shillong Sponsored by NASI, N.E. Local Chapter, Shillong in June 2008.

(xxxii) Participated in the Conference on Advances in Mathematics in September, 2008 at Gauhati University.

(xxxiii) Participated in "Training Programme on Content-cum-Methodology of Teaching Mathematics for High School Teachers", conducted by NERIE at Shillong College, Shillong in October, 2008.

(xxxiv) Organised a Special Session on "Workshop on Teaching of Mathematics for School Teachers" during Annual Conference of Indian Science Congress in NEHU, Shillong in January, 2009.

(xxxv) Participated in the Annual Conference of Indian Science Congress organized by NEHU, Shillong as Sectional Secretary of Mathematical Sciences in January, 2009.

Research Experience/ and papers:

   A. No. of M. Phil produced: 4.
       No. of Ph.D. produced: 4.

   B. Published 27 research papers in National & International Journals of repute and communicated 2 papers.

1. (Jointly with B.L.Sharma): "Characteristic numbers for un-oriented singular G-bordism", Proc. of A.M.S, vol.61, no.1, 1976, 149-152.

2. "Finite group action and equivariant bordism" Pacific J. of Math. vol.116, no.1 (1985), 39-44.

3. "Compact Lie group action and equivariant bordism" Proc. of A.M.S. vol.92, no.2 (1984), 297-300.

4. (Jointly with N.J.Dev): "Finite group action and vanishing of the group N (G, F)", Pacific J of Math. Vol.122, no.1 (1986), 57-71.

5. (Jointly with F.P.Choudhary & A.B.Chakraborty) "A note on Fuzzy sub groups and Fuzzy homomorphism" J. of Math. Analysis and its Application, vol.131, no.2 (1988), 537-553.

6. "Characteristic numbers for oriented singular G-bordism", Indian J of Pure & Applied Math., June (1982), 637-642.

7. "Stationary points set and G-bordism", Indian J of Pure & Applied Math. Jan. (1983), 1-4.

8. "(F, F')-free bordism, characteristic numbers & Stationary point set", Acta Mathematic Hungarica, 45, (1-2), (1985), 45-52.

9. "Reduction of equivariant bordism groups", Studia Sci. Math. Hungarica, 20, (1985), 213-216.

10. (Jointly with Ms. S.P.Choudhary): "A note on quotients of finitistic spaces", Indian J of Math. Vol. 28, no. 28 (1986), 107-115.

11. "On Dold manifolds", Topology and its Application, 33(1989) 297-307.

12. "Action of k-torus & vanishing of the group N (G, F)", National Acad. Science Letters, vol.12, no. 11, (1989), 383-386.

13. (Jointly with A.K.Das): "Cobcat and singular bordism", Pacific J of Maths. vol. 155, no. 2, (1992), 215-227.

14. (Jointly with A.B.Chakraborty): "Fuzzy homomorphism & Algebraic Structures", Fuzzy Sets & System, (North Holland) 59(1993), 211-221

15. (Jointly with N.J.Dev): "Compact Abelian Lie group action and vanishing of the group N (G, F)", Studia Sci. Math. Hungarica 30 (1995), 189-195.

16. (Jointly with A.K.Das): "On Milnor's Theorem and G-bordism", J of I.M.S., vol.61 nos. 3-4 (1995), 229-240.

17. (Jointly with A.K.Das): "A product formula for cobcat and some calculations", Indian J of Pure & Applied Math. 25(4), 1994, 405-10.

18. (Jointly with A.B.Chakraborty): "Fuzzy homomorphism t-level f-fuzzy subgroups generated by a fuzzy subset", Fuzzy Sets & Systems (North Holland), vol. 74 (1995) 259-268.

19. "Bordism, group action & fixed points set", Progress of Math., vol.32, no.2, (1998), 135-149.

20. (Jointly with A.K.Das): "Which Milnor manifolds bound", Indian J of Pure & Applied Math. 31(11), 1503-1513, Nov. 2000.

21. (Jointly with Sanghita Dutta): "Independence of bordism classes of Milnor manifolds", J of I.M.S., vol. 16 (2001), 1-16.

22. (Jointly with Sanghita Dutta): "On second Stiefel Whitney class of Grassmann manifolds & cuplength", J of I.M.S., 69(2002), 237-51.

23. "On bounding and independence of Wall Manifolds", Accepted in J of I.M.S. in Feb. 2004.

24. (Jointly with Dr. A.K. Das) : "On Conjecture of H. Singh" Accepted in the volume dedicated to Prof. H.C. Khare for The Mathematics Students, 2007.

25. "Span of Milnor Manifolds", Journal of the Indian Mathematical Society, Vol. 75, Nos. 1,2,3 (2008), 47-57.

26. "Fractional Differintegration and its Applications", Proceedings of the National Conference on Advances in Mathematics, Sept. 2008, p. 1-14, Gauhati University.

27. (Jointly with Ms. Sanghita Dutta) "Cobcat of Milnor manifolds", Communicated.

28. (Jointly with A.K. Das) : "Bordism of odd dimensional singular manifolds in BO with small cobcat", Communicated.

29. "Span of Wall Manifolds", accepted in J of I.M.S.

Salient features of Research work:

A.   Given a closed smooth manifold M^n with free action of a group G, a G space X, an equivariant map f: $M^n \longrightarrow$ X, characteristic numbers of the Map f: $M^n \longrightarrow$ X has been defined. We proved that f: $M^n \longrightarrow$ X bounds i.e. there exists a compact smooth manifold W^{n+1} with action of G with an equivariant map F: $W^{n+1} \longrightarrow$ X such that boundary of W^{n+1} is M^n and F restricted to M^n is f if and only if all characteristic nos. of f: $M^n \longrightarrow$ X are zero [1]. This was further extended for oriented manifolds in [6] and for non-free action in [8].

B.   Stong in 1971 proved that if M is closed smooth manifold with free action of $\mathbf{Z_2}$ then M must be $\mathbf{Z_2}$-boundary. We considered action of any finite group G with centre C of even order. Let G(C, 2) be the subgroup of C consisting of all elements of order 2. Let M be a closed smooth manifold with action of G and F be the fixed point set of M under G. We proved that M is a G-boundary if either F is empty or F has trivial equivariant normal bundle in M [2], [7]. Extension of this result for compact Lie group has been studied in [3]. Thus, the significant observation made in such study is that for the problem of G-boundary for a group G, only elements of order 2 in the centre of G play key role.

Fixed points set of a smooth G-manifold plays an important role in determining G-bordism. According to one of the important results proved by us, if (M^n, T) is a closed involution then one of the followings is true.

a.   n = 2r and (M^n, T) is bordant to (IRP^{2r}, id)
b.   n = 4r and (M^n, T) is bordant to $(IRP^{2r} \times IRP^{2r}, twist)$.
c.   n = 2r + 2 and (M^n, T) is bordant of (IRP^{2r+2}, t), where
       t $[x_o, x_1, \ldots, x_{2r+2}] = [-x_o, -x_1, x_2, \ldots, x_{2r+2}]$

C.   Our next step was to study G-bordism using G-slice types. Kosniowski proved in 1978 that some equivariant bordism theories vanish by constructing one such for any finite abelian group. We extended his result first for any finite group [4] and then for any compact abelian Lie group [12], [15].

D.   One of my Ph.D student expressed keen interest in fuzzy theory. Till 1987, no study was made for multivalued fuzzy homomorphism. We made a systemic study of multivalued fuzzy homomorphism in [5], [14] and [18].

E.   Next my effort was to study Dold manifolds P (m, n), Milnor manifolds H (m, n), Grassmann manifolds G (m + n, n) and Wall manifolds Q (m, n). We studied two basic questions about these manifolds.

1. For what values of m and n do these manifolds bound?
2. For a given positive integer d, is the set of bordism classes of all non-bounding Dold/Milnor/Grassmann/Wall manifolds of dim d independent in the bordism group N_d over $\mathbf{Z}_2$?

We completely settled both these questions for Dold/Milnor/Grassmann/Wall manifolds in [11], [20], [21], [23]. Answer to the second question has been proved to be affirmative. The result answering question 1 are as follows.

(i).   Dold manifold P (m, odd) bounds, $\forall$ m
           and P (m, 2r) bounds if and only if m > 2r
           and 2^a divides $m - 2r - 1$ for some a with $2^a > 2r$.

(ii).   A Milnor manifold H (m, n) with m ≤ n bounds
           if and only if at least one of the following is true
           (a). m = n   (b). m = 1   (c). mn ≅ 1 (mod 2)
           (d). n ≅ 2 (mod 4) and $m + 1 < 2^{\nu(n+2)}$, where $\nu(n)$ is the highest power of 2 dividing n.

(iii).   Wall manifold Q (m, n) bounds if and only if n is odd or n is zero with odd m.

        The bounding and independence problem of Milnor manifolds proved to be much more difficult than corresponding problem of Dold manifold which was settled in 1989. Keeping this in view, we decided to develop Computer Programme to calculate the Stiefel – Whitney numbers of Milnor manifolds H(m, n) for given m & n. Using this programme for different values of m and n, we got a pattern which helped in guessing the class of values of m & n for which H (m, n) bounds. Then we gave mathematical proof for the same. Similarly, for independence problem, it was very difficult to associate a suitable monomial M (m, n) of Stiefel-Whitney classes for each non-bounding Milnor manifold H (m, n) of a given dimension d such that the Stiefel-Whitney number of H_i (m, n) for the monomial M_j (m, n) is δ_{ij}. For this also, we used the programme and got a pattern, which helped in choosing such suitable monomial. After this a mathematical proof was given for independence problem. In the same way, computer programme was developed to calculate Stiefel-Whitney classes of universal bundles on Grassmannians, which gave a pattern helping us to prove independence problem of Grassmann manifolds and in calculating the height of second Stiefel-Whitney class W_2. The result proved about the height of second Stiefel-Whitney class W_2 is as follows:

Results.   (1)   In $G_{n+2, 2}$ with $2^s < n + 2 \leq 2^{s+1}$, ht $(W_2) = n$.

(2).   In $G_{n+3,3}$ with $2^s + 1 < n + 3 \leq 2^{s+1}$

$$ht(W_2) = \begin{cases} 2^s, & \text{if } n + 3 = 2^s + 2. \\ 2^s + 2^{p+1} - 2, & \text{if } n + 3 = 2^s + 2^p + 1, p \geq 2. \\ 2^s + 2^{p+1} - 1, & \text{if } n + 3 = 2^s + 2^p + t + 1, 1 \leq t \leq 2^p - 1, \\ & p \geq 2. \end{cases}$$

(3).   In $G_{2^s + 3, 4}$, $ht(W_2) = 2^{s+1} - 4$.

(4)   In $G_{2^s + 4, 4}$, $ht(W_2) = 2^{s+1} - 1$.

(5)   In $G_{n+4, 4}$, with $2^s + 1 < n + 4 \leq 2^{s+1}$,

   $ht(W_2) = 2^{s+1} - 4$, if $n + 4 = 2^s + 2$ or $2^s + 3$.

   $= 2^{s+1} - 1$, otherwise.

(6)   In $G_{n+k, k}$ with $k \geq 5$, and $2^s + 1 < n + k \leq 2^{s+1}$,

   $ht(W_2) = 2^{s+1} - 1$.

(7)   In $G_{2^s + 1, k}$ with $k \geq 3$, $ht(W_2) = 2^s - 1$.

The application of computer techniques in solving problems in Algebraic Topology is first attempt in the country.

F.   Next, we studied cobcat, singular bordism and its equivariant analogue in [13], [16], [17], [24], [25], and [26].

Using the programme for the cobcat of Milnor manifolds, we found some patterns which helped in calculating cobcat of significant class of Milnor manifolds mathematically, which is given as follows:

Results:

(1).   Let $2s = 2^b(2B + 1)$, $b > 1$. Then cobcat $(H(2r + 1, 2s)) = 2r + 2B + 2$.

(2).   Let $B + 1 = 2^c(2C + 1)$ and $r \geq 2^{c+1} - 1$. Then

   cobcat $(H(2r + 1, 2(2B + 1))) = 2r + 2^{c+2}.C + 1$.

(3).   Let $m = 2^a(2A + 1)$, $n = 2^b(2B + 1)$, $b > 1$. Let

   $t = [(n - m)/2^b]$, when $a < b$ and $t = [(n - m)/2^b] - 1$,

   when $a \geq b$. Then cobcat $(H(m, n)) = m + t + 1$.

(4).   Cobcat $(H(2^a, 2 + 2^a)) = 2^a$.

In many other cases, where we could not calculate exact cobcat, we calculated the lower bound of cobcat.

H. Singh has made three conjectures for manifolds with cobcat at most 4 in 1988.

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Conjecture 1: If $o(n) \geq 4$, then M^n is a boundary, where $o(n)$ denotes the number of nonzero terms in the diadic expansion of n.

Conjecture 2: If $o(n) = 3$, then any two n – dimensional non-bounding manifolds are bordant to each other.

Conjecture 3: If $n = 2^s + 1$, $s \geq 0$, then cobcat $(M^n) \leq 3$.

The first conjecture was solved by F.P. Paterson in 1989. We solved conjecture 3 completely and conjecture 2 partially by proving that the conjecture 2 is true if $n = 2^r + 2^{r-1} + 1$ or $2^r + 2 + 1$. and the number of non-bounding manifolds, up to bordism, with cobcat at most 4 is 0, 1 or 3, if $n = 2^r + 2^s + 1$ with $r - 1 > s > 1$.

In 2004, we settled the bounding problem of wall manifolds. Recently we calculated Span of Milnor Manifolds, Dold manifolds and Wall manifolds for many cases. However, some cases are still unexplored.

Research Plans during the next 5 years:

In the coming 5 years, we may be working on some of the following problems.

a. Span of Dold, Milnor, Grassmann and Wall manifolds.
b. Cobcat of Dold, Milnor, Grassmann and Wall manifolds.
c. Embedding problem for Dold, Milnor, Grassmann and Wall manifolds.
d. To study for general group action some results available for involution.
e. To study bordism classification of smooth manifolds with given cobcat.
f. To study bordism classification of smooth manifolds having additional structures on it like manifolds whose k-times tangent boundle is stable trivial.
g. To develop fuzzy continuity for a multivalued fuzzy map between two topological spaces.

Invited talks.

(i) A talk on "Dold manifolds" in International congress in Mathematics held at University of California in 1986.

(ii) A talk on "Milnor manifolds" in the University of Edinburgh in 1987 during the Annual conference of B.M.S.

(iii) Two talks on 'Fuzzy Homomorphisms" in the first International Conference on "Fuzzy Theory & Technology" held at Duke University, U.S.A. on 1992.

(iv) A talk on "On coincidence of mutually commutative differentable periodic map" in the Topological group session in the Annual Indian Science Congress Conference in 1979 at Hyderabad.

(v) A talk on "(F, F^1) – free bordism & stationary points set" in the Seminar on "Differentiable manifolds and applications" held at Delhi in 1981.

(vi) A talk on "G-bordism, characteristic numbers and stationary points set" in the conference on Topology and Functional analysis held in Aligarh in January 1983.

(vii) A talk in I.M.S. Conference in 1982 on "Compact Lie group action and equivariant bordism".

(viii) A talk in the Annual Conference of Indian Science Congress in 1985 on "Reduction of equivariant bordism group".

(ix) Four talks in the conference on Algebraic Topology held at Allahabad in 1988.

(x) Two talks in the National Topology Conference held at NEHU in 1991.

(xi) A talk in ICOMIDC conference on Geometry and its Application at I.I.T., Delhi in 1992.

(xii) A talk at the Annual Conference of I.M.S. in 1995 on "Cobcat and Singular bordism".

(xiii) Three talks in the International Conference on Algebric and Differential Topology at Allahabad University in 1996.

(xiv) A talk in the International conference on Recent Developments in mathematical Analysis at B.H.U. in 1998 on "Bordism group action and fixed points set".

(xv) Three talks at I.S.I. Calcutta in the International Conference on "Topological transformation groups" in 1998.

(xvi) A talk at Annual Conference of I.M.S. in 1999 on "G-bordism and Stationary Points".

(xvii) Two talks at Allahabad University in 2000 on "Vector Fields on manifolds"

(xviii) Two talks at Tezpur University on "Geometry and Topology" in 2001

(xix) A talk on "Algebraic Topology through Geometry" at Guwahati University in 2002.

(xx) A talk on "Grassmannians and height of its second Stiefel-Whitney class "in the National Conference on "Algebraic and Geometric Topology" held in Delhi University in Jan 2002.

(xxi) Series of five talks on "Computer techniques in Algebraic Topology" at Jabalpur University in 2003 under DRS (SAP) programme.

(xxii) Series of four talks on "Computer Techniques for bounding and independence problems of Dold, Milnor and Grassmann Manifolds" at Delhi University in January, 2004 under DRS (SAP) Programme.

(xxiii) Gave a series of 5 lectures on "Fractal Geometry and its Application" in the workshop on Fractal Geometry organized by the Department of Mathematics, University of Delhi in October 2004.

(xxiv) Delivered the key note address as Chief Guest on "Prospects of Milk and Indigenous Dairy Products and Dairy Development in North Eastern Region" in the Valedictory Function of the Winter School on "Advances in Indigenous Dairy Products" organized by the Department of Animal Husbandry and Dairying, BHU, in Dec. 2004.

(xxv) Delivered the Inaugural address as Chief Guest on "Integrated Approach to Sustainable Dairy Development with Special Reference to NE Region" in the Inaugural Function of the Summer School on "Strategies for Production, Processing and Marketing of Milk and Milk Products" organized by the Department of Animal Husbandry and Dairying, BHU, in June, 2005.

(xxvi) Give an invited one hour talk on "Span of Milnor Manifolds" in a special session of Algebraic Topology conducted during Annual Conference of Indian Mathematical Society held at Jabalpur University in December 2006.

(xxvii) Give an invited one hour talk in "Symposium on some Recent Advancements in Mathematics" organized by the Department of Mathematics, NEHU in April, 2007. The title of the talk was "Bounding of manifolds and group actions".

(xxviii)Gave two invited talks on "New role of mathematics teachers at plus two level" in the Workshop on Mathematics Text Books for Class XII in June 2007 organised by NERIE, Shillong.

(xxix) Gave two invited talk on "Mathematics can be fun" at the "Orientation of Master Trainers in Mathematics" organised by North East Regional Institute of Education, NCERT, Shillong in August 2007.

(xxx) Gave one hour talk on "Fractional calculus" in the University of Manchester, U.K in January, 2008.

(xxxi) Was invited as Chief Guest at the "Orientation Programme for Master Resource Persons of N.E. States on teaching of Science and mathematics" organised by North East Regional Institute of Education, NCERT, Shillong in June, 2008. Delivered four lectures on "How to make mathematics interesting in the class room".

(xxxii) Gave an invited one hour talk on "Fractal Geometry and its Applications" in the "International Workshop and Conference on Surface Mapping Class Groups and Related Topics" organised by the Department of Mathematics, NEHU, Shillong in June 2008.

(xxxiii) Organised Special Session on "beauty of Mathematics at St. Edmunds College, Shillong, Sponsored by National Academy of Sciences India, N.E. Local Chapter, Shillong on 25th June, 2008 and gave a talk on "Mathematics can be fun".

(xxxiv) Conducted an interactive session with faculty of Mathematics Department, Manipur University on "How to Communicate mathematics effectively in the class room" in September, 2008.

(xxxv) Gave one hour invited talk on "Differintegration and its Applications" in Gauhati University in September 2008.

(xxxvi) Gave 4 lectures in the "Workshop on Training of Mathematics Secondary School Teachers" conducted by NERIE, Shillong in September, 2008.

(xxxvii) Was invited as Guest of Honour in "Training Programme on content cum methodology of teaching mathematics for Higher School Teachers" conducted by NERIE at Shillong College, Shillong in October, 2008 and gave an hour talk on "How to remove Math phobia".

(xxxviii) Was invited as Chief Guest in the Inauguration of Refresher Course in Mathematics in December, 2008 conducted by Mathematics Department, NEHU, Shillong and gave an invited talk on "Some essential aspects of mathematics teaching at plus two level and graduate level".

(xxxix) Organised a Special session on "Teaching of Mathematics for School Teachers" during Annual Conference of Indian Science Congress, 2009 held at Shillong from June 3 to June 7, 2009 and gave two talks in the Special Session.

(xxxx). Gave an hour talk on "Bounding of Specific Manifolds" in Boston University in January, 2009.

(xxxxi) Gave Key Note Address on "Taxi-cab geometry" in the National Seminar in Mathematics organized at Gauhati University on 12.9.09.

(xxxxii) Gave Prof. J.N. Kapur Memorial lecture on "Fractal calculus" in the Department of Mathematics, Dr. B.R. Ambedkar University, Agra on 5.10.09.

(xxxxiii) Gave a talk on "Span of specific manifolds" in the University of
          of Manchester in July,2010

(xxxxiv) Gave an invited talk on "Span of   Dold and Wall manifolds" in the
          Topology Meet organized in the Department of Mathematics, University
          of Manchester, in Jan. 2011 sponsored by British Mathematical Society.

(xxxxv) Gave a special talk titled " On Abel Prize 2011 to John Willard Milnor :
          A brief description if his significant work " in the Advanced Instructional
          School in Algebraic Topology organized by Depeartment of Mathematics,
          NEHU, Shillong on 13th June, 2011.

(xxxxvi) Gave a talk on " Vector fields on specific manifolds " in the University of
          Boston in July, 2011

(xxxxvii) Gave an invited talk on " Fibonacci numbers and their occurrence in
          Nature " in a Seminar in Union Christian College, Umiam, Shillong,
          Sept. 2011.

Administrative Posts: 1. Headship in Maths. Deptt. NEHU from 1981 to 1984.
                           2. Chief Proctor in 1999 – 2000.
                           3. Deanship from March 1998 to March 2001.
                           4. Pro-Vice Chancellorship from April 2001 to 4th October,2010
                           5. Head, Department of Mathematics, NEHU.from 4.3.2011

Administrative and Educational Management:

(i).   When I took over as head of the Department in 1981, there was absolute scarcity of research scholar in the department. I went to colleges and tried to motivate bright college teachers to come forward for research. These efforts resulted in attracting 3 college teachers for research. The first Ph.D. from the department was a college teacher under my supervision.

(ii).   My another effort was to develop a good school of Algebraic Topologists in the department. In the beginning, I was alone in this branch. It is heartening to note that now there are 5 active teachers in the department in the field of Algebraic Topology.

(iii).   Till 1982, our syllabus did not have any component of computer programming. Sensing the trend, I made a special effort to introduce 2 semester courses in computer programming, which helped significantly in inculcating computer culture among students. It also helped in attracting more students in Mathematics, as it helped in fetching job.

(iv).   Appointed as a member of "Curriculum Development Committee in mathematics" by U.G.C. in Jan. 2001 and contributed significantly in

development of U.G and P.G. courses in mathematics. Our report was submitted to U.G.C.

(v).   Appointed as a member of "Committee for Academic and Administration Audit" for Tezpur University in 2001.

(vi).   I joined as Pro-Vice-Chancellor of NEHU, Tura Campus in April 2001. Within few months, we prepared a Vision Document for Tura Campus till 2020. The basic philosophy of the Vision document was to have least duplication with the departments available in NEHU, Shillong and to have disciplines which are relevant to this region and are job/entrepreneurship oriented or application oriented. Keeping this in view we incorporated disciplines like Rural Development and Agricultural Production, Forestry, Rural Economy and Micro Financing, Tourism, Mass Communication, Information Technology, Ancient History and Archaeology, Industrial Chemistry, Electronic, Industrial Mathematics, Bio-technology etc. During the last couple of years we opened two new Post-Graduate departments in Tura Campus including Rural Development and Agricultural Production which is a new experiment in the country. The syllabus deals with Rural Development through Agriculture, Horticulture, Animal Production including Dairy, Poultry, Fishery, Piggery, Gottery, Bee Keeping, Sericulture, Silviculture Aromatic and Medicinal crops etc. Through these courses, the students will be exposed to various aspects of rural development and will get an opportunity to choose item of their choice for self employment. The result seems to be encouraging as many students of the first batch are likely to go for self employment in dairy/poultry/piggery/mushroom cultivation. We have opened a demonstration dairy unit about 5 years back and at present we have 15 Jersey and Holstein Friesian cows and 20 calves on self sustained basis. The objective is to create awareness amongst students and local people about dairy and to spread the culture of raising high breed cattle instead of indigenous ones. We plan to start demonstration units of piggery, poultry, nursery, mushroom cultivation, sericulture, fishery, bee-keeping and duckery etc culminating to an integrated composite farm. If this experiment is successful, it will significantly contribute to the economic and social development of this area. The signs at present are positive. With concerted effort, we have been successful in organizing campus placement interview in Tura Campus for Semester IV students of Rural Development and Agricultural Production (This is for the first time in the 30 years history of NEHU) in April 2005. Eighty per cent students were selected for job and they have already joined from August 2005 after 3 weeks training in Delhi. Since then every year campus placement in RDAP has been conducted successfully.

         The UGC has sanctioned the Faculty of management in Tura Campus in 2005. We started the Department of Management from August, 2006. We arranged placement opportunities for the first batch of Semester IV students in 2008 and we were successful in providing 100% placement in leading companies like Dabur, ICICI, HDFC, Pradan, Nestle, DRDA etc. We have also proposed the Department of Corporate Communication, Department of Forestry and Forest Management, Department of Ancient History and Archeology, Department of Rural Economic and Micro-Financing and Department of Computer Science.

Immediately after joining as Pro-Vice-Chancellor, I went all out to get a land from the Government of Meghalaya for our Campus. It is heartening to note that the effort was successful and finally we have been formally handed over 326 acres of land in January 2004. We are developing Agriculture, Horticulture and Animal Production Farms in the Campus for demonstration to students and people of this area. Contour Survey has been prepared by Survey of India and Master Plan including electrification, water supply and sewage system for the Permanent Campus has also been prepared from a famous Architect of Calcutta. A proposal with an estimate of Rs. 30 crores has also been submitted to U. G. C., M. H. R. D. and other possible funding agencies including DoNER. On the basis of our proposal, about 4 months back we have been sanctioned Rs 10 crores as first phase for the development of infrastructure in Tura Campus from MHRD through UGC with an understanding to sanction second and third installments in second and third phase after proper utilization of the first phase amount. We selected M/S Kothari Associates Ltd., from New Delhi as our Consultant. We started seven projects namely 2.4 km. internal road, 5.65 km pakka fencing, Academic block of 4 teaching department, Management block, boys hostel, girls hostel and library block in 2006. All the projects are at the verge of completion and the Campus is to be shifted to the permenant site in Feb. 2010. UGC has sanctioned last month a sum of Rs 40 crores for infrastructure and new departments and Rs 8 crores for Management in addition to general grant of Rs 5 crores in XI plan. Till date construction worth more than 20 crores is already over & by January, 2010 construction (which is in progress) of another 5 crores will be over. From Feb. 2010 onwards, the construction of Administrative Block, teaching & non-teaching staff quarters, Guest House, Health Clinic, two more hostels will start which should be finished by 2012. Four new departments (Computer Applications, Agri-Business Management & Food Technology, Horticulture, History & Archeology) & additional teaching and non-teaching posts are in the pipeline for approval within sanctioned amount of Rs.48 crores With this amount, one will be able to develop decent infrastructure within 2012 and will be able to open 4 new job oriented departments. This will significantly help in bringing a vibrant academic atmosphere in the Campus, where teachers, research scholars and students can get proper facilities to work till late hours and to have interaction through frequent interdisciplinary seminars, conferences, workshops and symposium etc.

After coming here, I tried to motivate teachers to have a Fortnight Seminar Series Forum which may prove to be a platform for various intellectuals, social workers, educators from Tura to interact with each other and air their opinion and thought about various aspects specially those relevant to social, economical and educational development of the people of this region. This Fortnight Seminar Series Forum started about four years back. The speakers and audience are invited from colleges, other concerned institutions and also from public life. The speakers so far include Ex-Governor of Meghalaya, our Ex-Vice Chancellor, erstwhile Speaker P.A. Sangma, Principal of Don Bosco College and many other distinguished scholars.

I also tried to motivate teachers to conduct frequent seminars and conference at Regional and National level. With these efforts there has been a sea

change in the academic atmosphere of the Campus. The Campus has become academically lively with frequent seminars/workshop, in which students also take active part. This has resulted in many research students joining in all the departments. At present there are more than forty of research scholars working in different departments as against nil six years back. Campus has also produced 6 Ph. D students till date. We have also started publication of Annual Campus Magazine from 2007 mentioning various academic activities of the Campus. This also includes poetries, essays, plays etc. from students and survey articles, review articles etc from teachers. This has proved to be an academic mirror of the Campus. The Department of English has started publishing a research journal titled "Protocol: Journal for Translation, Creative and Critical Writings" from 2007.

My objective was to turn Tura Campus into a vibrant academic institution which may fulfill the requirement and aspiration of people of this region and contribute significantly to academic, social and economical growth of this area. I happened to be successful in my mission in the last nine and half years.

Contributions during the last 10-years:

a. Produced two Ph.D students.
b. Published 6 research papers and communicated 2 research papers.
c. Participated in 9 National and 4 International Conference/Workshop.
d. Gave 28 invited talks in different Universities and conferences.
e. Awarded a Research project titled "Applications of Computer Techniques in Algebraic Topology: Functional coding and Effective Homology" in July 2000 which was completed in March 2004. Dr. A.K. Das was co-investigator.

   Under this project a totally new computer aided technique was developed and used to apply the problems in Algebraic Topology like bounding problems, independence problem, and calculation of cobcat. This is the first effort of its kind in the country. This technique can also be applied for calculation of Span, settling immersion and embedding problems etc. During this project, I produced 5 research papers which includes one paper titled 'On independence of Grassmannians" by Dr. A.K. Das, the co-investigator.

f. Appointed as a member of "Curriculum Development Committee in Mathematics" by U.G.C, on Jan. 2001 and contributed significantly in developing U.G. and P.G. syllabus. The report of the committee was submitted in may 2001.

g. Nominated as a member of Committee for Academic and Administrative Audit for Tezpur University in 2001.

h. Appointed as Pro-Vice-Chancellor, North-Eastern Hill University, Tura Campus. The contribution towards academic development and Campus development is given under the heading Administrative and Educational Management (item no. (vi).

9. Appointed as Secretary, National Academy of Sciences, N.E. Region, Local Chapter, Shillong in 2004 and am continuing till date.

10. Appointed in Book Writing Advisory Committee of NCERT for class XII book in Mathematics in March, 2006. The book finally came out in March 2007.

11. Was chosen as Sectional Secretary of Mathematical Sciences for Annual Conference of Indian Science Congress, Jan, 09 and organized a special session on "How to make mathematics interesting" in the Annual conference of Indian Science Congress. This was the first and very successful attempt in the history of Indian Science Congress.

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