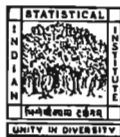


INDIAN STATISTICAL INSTITUTE



FIFTY-SECOND ANNUAL REPORT

April 1983–March 1984

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INDIAN STATISTICAL INSTITUTE

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Part I. Teaching, Training, Research, Projects and Publications

1. TEACHING AND TRAINING

1.1 Degree and Training Courses

During the period under review, 6406 candidates applied for admission and were called for written selection tests for the courses offered by the Institute viz. B. Stat. (Hons.), M.Stat., M.Tech., One year Post-Graduate Diploma in SQC and OR, 2-year part-time Post-Graduate Diploma in SQC and OR (Bombay and Madras), Research Fellowships in Mathematics and Economics, One-year Evening Course in Statistical Methods and Applications and the course on Operation of Data Processing Equipment. Admission tests were conducted at 12 centres all over the country and successful candidates were called for interview for final selection for admission to various courses during the academic year 1983-84.

1.1.2 There were three foreign applicants who had either been sponsored by the Government or who had applied directly for admission to our courses. The candidates were given special admission tests conducted through the Indian High Commission or Embassies at Bangladesh, Bahrain, Kenya and United Kingdom.

1.1.3 The annual examinations of the B.Stat. and M.Stat. courses were held in May-June 1983. The 1983-84 academic year commenced on 18 July 1983.

1.1.4 Seventy eight candidates received their degrees and Diplomas at the Eighteenth Convocation of the Institute held on 21 January 1984. Further, 93 candidates, who passed the various regular courses of one-year duration or less, received certificates during the period.

1.1.5 The number of candidates admitted to the different degree, diploma and certificate courses during 1982-83 and 1983-84 and the results of examinations held during the same period are given below.

Number of Students Admitted and Declared Successful in Different Courses

<i>Courses</i>	<i>number of students</i>		<i>number passed in annual examination in 1983</i>
	1982-83	1983-84	
1. Courses leading to a Degree in Statistics.			
1.1 Bachelor of Statistics with Honours			
B.Stat. (Hons.)			
1st year	23	25	14
2nd year	20	14	13
3rd year	11	13	11

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	<i>Courses</i>	<i>number of students</i>		<i>number passed in in 1983.</i>
		1982-83	1983-84	
4.2	Master of Statistics (M.Stat.)			
	1st year	41	19	28
	2nd year	25	26	25
1.3	Junior and Senior Research Fellows, Visiting Fellows	90	73	
2.	<i>Specialised Courses in Applied Statistics leading to Diplomas.</i>			
2.1	Statistical Quality Control and Operations Research (One-year)	15	16	10
3.	<i>Courses in Statistics for persons in Employment (Jointly with C.S.O.)</i>			
3.1	Junior Certificate Course in Statistics	13	10	10
3.2	Indian Statistical Service Probationers Training Course	38	33	33
4.	<i>Evening Courses</i>			
4.1	Statistical Methods and Applications			
	Calcutta	44	56	18
	Delhi	—	16	5
4.2	Two-year Post-Graduate Diploma in Statistical Quality Control and Operations Research (Bombay and Madras)			
	Bombay — 1st year	3	7	
	2nd year	3		2
	Madras — 1st year	14	23	6
	2nd year	11	6	9
4.3	Six-month Evening Course in Statisti- cal Quality Control (Bangalore and Hyderabad)			
	Bangalore — July-December 1982	27		
	January-June	20	18	14
	Hyderabad — July-December 1982	27		
	January-June	31	12	7

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<i>Courses</i>	<i>number of students</i>		<i>number passed in annual examination in 1983</i>
	1982-83	1983-84	
5. <i>Electronic Computer Courses</i>			
5.1 <i>M.Tech. in Computer Science</i>			
1st year	22	17	24
2nd year	8	24	7
5.2 <i>Intensive Course on Programming and applications</i>	39	39	39
5.3 <i>Course on Operations of Automatic Data Processing Equipment</i>	14	13	12
6. <i>Associateship in Documentation and Information Science</i>	8	8	
	547	468	287

1.2 *International Statistical Education Centre (ISEC), Calcutta*

The ISEC, started in 1950, is operated jointly by the International Statistical Institute and the Indian Statistical Institute, under the auspices of the UNESCO and the Government of India. The Centre functions under a joint Board of Directors. During the period under review, the Board consisted of : *Chairman* : Professor C. R. Rao, *Members* : E. Casado, J. M. Gani and E. Lunenberg (ex-officio members, representing the International Statistical Institute). *Secretary*, Department of Statistics, Govt. of India (representing the Government of India). B. P. Adhikari and N. Bhattacharya (Member-Secretary) (representing the Indian Statistical Institute).

During the year under review, the Centre conducted the Regular Course of the 37th Term with 27 trainees from 13 countries in South and South-East Asia, the Far East, and Commonwealth Africa. The Govt. of India awarded 14 fellowships for the foreign trainees—6 under the TCS of the Colombo Plan (SCAAP). Two foreign trainees were awarded CDTC fellowships. Eleven trainees—three from India, three from Brunei, three from Nigeria and two from Sri Lanka were financially supported by their respective Governments.

The ten-month Regular Course started on 4 June 1983. From June to September the trainees stayed at Calcutta and studied theory and applications of Statistics besides mathematics and economics. Most of the courses taught at this stage were compulsory for all trainees. During October-November, the trainees underwent six week programme of training in official statistical systems and procedures at New Delhi and other places. This part of the Regular Course was conducted by the CSO, Govt. of India.

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General Training in statistics was resumed at Calcutta around the middle of November and was completed by the end of January 1984. Most of the courses taught in this phase were optional and each trainee studied four or more courses chosen by them. Thereafter, the trainees entered the last phase of their training programme (February—March 1983) and each of them specialized in one area selected by him e.g. sample surveys and data processing, economic planning, demography and vital statistics, and SQC and OR. Examinations were held for each of the four phases of the training programme mentioned above. All the trainees were given certificates of merit in recognition of their satisfactory performance in the examinations. Since a proposal for awarding Diplomas instead of certificates was under consideration, these certificates were called 'provisional certificates of merit.

In addition to the above, three trainees attended Special Courses in different fields of applied statistics. Two of them had completed the ten-month Regular Course during the previous term, that is, during June 1982-March 1983. One of them was from Sierra Leone and he attended a six-month Special Course in "Labour and Price Statistics and Index Numbers with related Sample Surveys" during April—September 1983 with the support of a CFTC fellowship. The other from Uganda, studied National Accounts Statistics during April—June 1983 and was enjoying a SCAAP fellowship. The third trainee was a UN fellow from Afghanistan who had been admitted to a one-year Special Course in Demography and Sampling in August 1982 and completed it in July 1983. Some educational excursions were arranged for the trainees covering various places of interest in India.

Dr. Haruo Yanai of the Dept. of Psychology, Chiba University, Japan, stayed as visiting Professor during December 1983—March 1984.

Professor J. M. Gani, Chairman of the Statistical Education Committee of the International Statistical Institute and ex-officio Member of the Board of Directors of ISEC, visited the centre during 12-17 December 1983 and reviewed its activities with special reference to the recommendations made by the International Statistical Institute following Professor Gani's earlier visit to the centre in November 1979. Professor Gani held extensive discussions with the teachers and students of ISEC and submitted a report to the International Statistical Institute containing recommendations for further improvement of the functioning of ISEC.

1.3 Professional Examinations in Statistics

The holding of professional examinations in statistics for external candidates on an all-India basis has been an important activity of the Institute since 1938. These examinations are based on well organised syllabi to reach high professional standards and lead to Certificate and Diplomas.

During the year under report, the Statistical Assistantship Certificate, Junior Diploma in Statistics and Senior Diploma in Statistics Examinations were held at Bangalore, Bombay, Calcutta, Delhi, Hyderabad, Lucknow and Madras centres during April and October 1983 terms.

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The details on the number of candidates registered and appeared in examination and the results for both the terms of examinations are shown below :

<i>Examination</i>	<i>Number of candidates</i>					
	<i>Registered</i>		<i>Appeared</i>		<i>Passed*</i>	
	<i>April</i>	<i>October</i>	<i>April</i>	<i>October</i>	<i>April</i>	<i>October</i>
Statistical Assistantship Certificate	35	42	23	18	11	5
Junior Diploma in Statistics	36	44	19	21	5	8
Senior Diploma in Statistics	14	9	10	5	5	2

* In one or more papers only, not necessarily completed the examination.

The total number of candidates who have qualified for the award of Certificate and Diplomas in these professional examinations in statistics including the results of October 1983 term are 470 and 230 respectively.

Necessary arrangements were made for holding the above examinations for the term, April 1984.

2. RESEARCH WORK

A brief account of the progress of research in different divisions and units of the Institute is given below.

2.1 THEORETICAL STATISTICS AND MATHEMATICS

2.1.1 *Calcutta*

During the period, members of the Division have been engaged in research in the following areas : Stochastic Processes, Probability Theory, Probabilistic Number Theory, Asymptotic Theory, Multivariate Analysis, Decision Theory, Inference about Stochastic Processes, Sampling Theory, Design of Experiments, Combinatorial Mathematics and Graph Theory, Descriptive Set Theory and Mathematical Logic, Measure Theory, Harmonic Analysis, Functional Analysis, Algebraic Topology, General Topology, Topological Automata, Sediment Transport. The list of published papers and technical reports give a detailed idea of the work done in this Division in various disciplines of mathematics and statistics.

Among its other activities, the Division held a Summer School in Analysis and Probability at Mysore University from June 7 to July 10, 1983. The participants were lecturers, research scholars and postgraduate students from various universities. The

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subjects covered were Harmonic Analysis, Functional Analysis, Ergodic Theory and Wiener Integrals. Constant attempts were made to emphasize the interdependence of these subjects. Enough material was covered in these courses to bring the participants to the initial level of research fellows in these areas.

2.1.2 Delhi

Studies were carried out in the following fields : Algebraic and Differential Topology Operator Theory, Mathematical theory of Scattering, Stochastic Integration and its applications in Quantum Mechanics, Linear Algebra, Linear Models, Inference in Stochastic Process, Optimal Designs, Characterisation Problems, Game Theory.

2.1.3 Bangalore

A new result on large deviation probabilities for Markov Chains was obtained and shown to imply certain results in information theory. It is hoped that the methods used may lead to some more useful results in information theory.

Geometrical properties of Banach spaces are being studied using probabilistic methods and ideas.

2.2 APPLIED STATISTICS, SURVEYS AND COMPUTING

2.2.1 Research activities in the Division include both theoretical investigations into methodology and applications of known methods in the study of socially relevant real life problems. During the year under review research was conducted in the following broad areas :

(a) *Research activities in applied statistics* : The main areas of research were Design of Experiments, Sample Surveys, Multivariate Analysis, Linear Models and Combinatorics. New results were obtained in Optimality of experimental designs for assessment of mixed effects, Efficiency and optimality in various sampling strategies, Randomised response techniques, Invariant tests of independence of sets of normal variables, Classification with dependent samples Robustness with respect to specification errors in linear models and transition in graphs.

(b) *Projects* : The field work for the Survey of Foreign Tourists in India during 1982-83 was completed in March 1983 and a draft report was submitted to the Department of Tourism in September 1983. A report on Consumption of Public Services in West Bengal in 1976 was submitted to the Indian Council for Social Science Research. The voluminous historical data on earthquakes in North East India supplied by the North Eastern Council have been thoroughly scrutinised and put on magnetic tapes on which analysis will be carried out.

(c) *Bio-Statistics* : Research was carried out on problems of mapping of inherited ophthalmic disorders, Design of health surveys in a metropolitan area and

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Computer simulation of glucose homeostasis. Analysis of the data collected in the study on the epidemiology of malaria was completed.

(d) *Computer science* : Diagnostics of 'stuck at', 'bridging' 'short circuit' and 'intermittent' type faults were studied. New diagnostic models—some Information theoretic and some probabilistic were developed. Graph theoretic applications in digital circuit design and multivalued test outcomes were investigated. Work on development of computerised statistical data base management system is progressing rather slowly because of lack of manpower.

2.3 PHYSICAL AND EARTH SCIENCES

2.3.1 CHEMISTRY

Useful informations on the forms and level of humus in five broad soil types of West Bengal have been derived. Humus has been characterised by thirteen parameters and their variations among the soil groups could be explained on the basis of climatic factors, soil conditions and cultural practices. A classification of the soil organic matter has been suggested.

Colloid chemical properties of clays and humus acids have a strong bearing on most of the important soil reactions. Such properties, particularly the sorption behaviour of clays were studied previously. The scope has been extended to the humic and fulvic acids. Nature of sorption and description of zinc and cobalt ions by these acids has been studied during the period. Work on the sorption of basic and amphoteric antibiotics as well as ionic and non-ionic surfactants has been initiated.

2.3.2 ELECTRONICS

2.3.2.1 *Digital Electronics*

(1) Development of a multicomputer network : It is planned to link up all the different available micro computers via local-area network. The main emphasis is to share data and other resources, both software and hardware between the different systems. The hardware and software resources available with the systems that are to be incorporated with the network are briefly outlined below :

(a) A motorola M6800 based system : The system has 32K bytes of memory and is connected to a dual $5\frac{1}{4}$ " floppy disk drive unit. It is also connected to a number of other peripheral units such as (i) a paper tape punch (ii) a paper tape reader (iii) a PR40 mini 40 column matrix printer (iv) a letter quality 132 column Qume daisy-wheel printer and (v) a cassette type unit for extended backup storage. An A/D input subsystem and a D/A output subsystem have also been interfaced to the system to allow processing and control of analog parameters.

Currently the system has a single user disk based operating system and the various software utilities operating under the DOS are an assembler, a dis-assembler, a text

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editor, a text processor and a basic interpreter. Work is in progress, as detailed elsewhere to develop a multiuser DOS for the system.

(b) A Motorola M6809 based system : Currently the system has 32K bytes of memory but it can be easily expanded to 1M byte using the bank switching mechanism built into the system. The hardware necessary to support paged memory management is also built into the system. Two 8" double sided double-density floppy disk drives are connected to the system. Provisions for attaching a 5M byte Winchester drive and a cartridge streamer type drive is also provided on the disk controller card. This system has been connected to a 132 column letter quality printer.

Currently the system has a powerful disk operating system FLEX Ver. 1.9.1. This O.S. supports a number of high level programming languages such as PASCAL, C, FORTH etc. and also such utilities as an assembler, text editor, text processor.

(c) A Z80 based multiuser system : This system has 512 K bytes of main memory but can easily be extended to 2 M bytes by just plugging in the memory chips into the spare sockets provided for the purpose. It is connected to a 5 M byte Winchester drive and a 5 $\frac{1}{4}$ " double sided, double-density floppy disk drive. A 132 column daisy-wheel printer has also been interfaced to the system to obtain letter quality printouts. The system has a built in CRT controller that allows display in the 80 x 24 format. A full ASCII keyboard is also connected to the system. A 12", 15 MHZ CRT monitor connected to the system acts as the operator's console as well as a user terminal. A second user terminal has been connected to a serial I/O slot provided for the purpose.

The hard disk based multiuser operating system EUMEL is a very powerful one and supports a Basic interpreter (Microsoft compatible) and an ELAN compiler. ELAN is an extended version of standard PASCAL.

(d) A Z 80 based single user system : The hardware of this system is similar to that of the one described in (c). However, it has 256 K bytes of memory and is connected to two 5 $\frac{1}{4}$ " double sided double-density Micropolis floppy drives.

The operating system is the single user version of EUMEL and it supports a BASIC interpreter (microsoft compatible) and an ELAN compiler.

(e) An 8085A based system : This system is under development. Currently it has just 2 K bytes of main storage and 4 K bytes of video display RAM. A full ASCII keyboard is attached along with the system and it has a built in CRT controller. A 12", 25 MHZ monitor forms the console. Work is in progress to expand the memory to 48 K bytes and interface a 5 $\frac{1}{4}$ " Shugart disk drive.

(f) A 8085A based single board system : This system has 8 K bytes of onboard RAM and another 16 K bytes of onboard RAM. It has an onboard hex keyboard and display and a powerful monitor to allow user interaction. A cassette type has been interfaced to the system to allow program and data storage. A CRT terminal has also

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been connected to avoid the restrictions of the built-in hex keyboard. An EPROM programmer hooked up to the system allows firmware development. This system is mainly intended for m/c language program development.

(g) *A sixteen bit single board system based on Intel 8086* : This system has 8 K bytes of onboard RAM organized as 5K words. A built in hex keyboard and display along with a powerful monitor allows user interaction. The system also has a RS232C serial port that can be used to communicate with a terminal.

It will be necessary to modify and/or extend the existing software and also in some cases, the hardware of some of these systems to make them compatible to the proposed network. Some work has already been done and further work along this line is underway. As a first step the M6800 microcomputer detailed in (a) is being upgraded to a multiuser system. This is necessary since the system should be able to take care of the network protocols in the background and run user programs in the foreground. In fact it is intended to support more than one user locally at the system. The hardware necessary to support segmented memory management scheme and to generate timer interrupts for processor scheduling has already been developed. Some software associated with this has been developed, details of which are given under the heading 'Development of Software Packages'. A bidirectional serial link between this system and the 8085A based system described in (f) has also been developed. Currently communication is being done at 1200 bauds using a twisted pair, but it will be stepped up to 9600 bauds when the entire network becomes operational. Software associated with this is described later. Another serial link between the multiuser Z80 based systems detailed in (c) and (d) respectively is also developed. The single user system will, however, behave as an intelligent terminal (it will allow development and debugging of small ELAN programs locally) when hooked up to the network. Implementation of a serial link to connect the 8085 based system detailed in (e) and the M6800 based system (a) is also underway.

Initially to get the network up and running with minimum effort, the multidro architecture will be adopted with all the systems connected to a closed loop. A message sent by a particular system will be received in turn by all the systems connected to the loop. A system to which this message has not been addressed will simply retransmit it through the loop. A system for which the message is intended will make a copy in its own internal buffer and then retransmit it after writing a specified bit pattern (this is unique for each of the systems) in the header of the message. This will repeat until the message returns to the originating system which will remove it from the loop. The originating system can, by examining the header, determine if the message has been properly received by the intended system. In the event the transmitted message is not received back by the originating system within a specified period (determined by hardware timers built into each of the systems), it will be retransmitted. This will be repeated a number of times before the network is declared faulty.

To have a certain amount of fault-tolerance built into the system all links are bidirectional and they are actually built using two physically separate unidirectional links. This ensures that the network will remain operational in case of single link failures.

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(2) *Development of Software Packages* : A simple CAI package 'TUTOR' which allows the new user to interactively learn about the M6800 system has been developed. It runs on the M6800 system itself. A process scheduler module which will ultimately convert the M6800 microcomputer into a multiuser system, has been developed. The software necessary to support segmented memory management in a multiuser environment is being developed now. The software necessary to support communication between the M6800 system and the single board 8085 based system (1) using the serial link described in (1) is being developed. This includes the low level driver routines resident in M6800 and 8085 and also a complete disk based single user operating system resident in the 8085 system. A text processor with advanced features has been developed on the multiuser Z80 based system. It is written in ELAN. Work is underway to upgrade it to a mathematical typesetting system. A SPOOLer routine is also being developed for this system. This will allow a number of users to share the printer efficiently. A hardcopy graphics package is also being developed to allow generation of graphics on the Qume printer. Development of another software package which will digitize line drawings is also underway.

(3) *Theoretical Research on Computer Science* : Theoretical research works are currently under progress in the following areas.

(a) *Fault tolerant computing* : New methods for generating test sets for fault detection in combinational and sequential logic circuits have been developed. Special emphasis has been given to take care of sophisticated fault modeling like short circuit or bridging faults. Development of diagnosis schemes for modular digital systems and microprocessors is currently under-study.

(b) *Design for testability in LSI/VLSI* : Testability considerations in LSI/VLSI circuits have been examined from a completely new angle. Research papers reflecting new design rules for inducing testability in LSI/VLSI circuits for detection of stuck-at and bridging faults have been published. Methods like random testing, syndrome testing, have been developed so that these can be used more efficiently for testing large digital logic circuits. The study of inadmissible class of faulty functions in logic circuits has been undertaken, the knowledge of which aids the design for testability. Testable design of CMOS/VLSI for detection of hard faults like 'stuck-open faults' has also been proposed.

(c) *Microprogramming* : Several results have been obtained in the area of control memory width minimization and the development of efficient address selection schemes in microprogrammed digital computers. An algorithm has been developed for verification of microprograms using the induction method of program verification.

(d) *Logic Design* : (i) An algorithm has been developed for failsafe realization of sequential machines using MOSFET networks. The states and inputs are coded using a restricted class of codes in such a way that each of the next state and output functions is realized by a two level MOS network and the realization is failsafe.

(ii) 2-assumability is a very important property in threshold logic and it has useful applications in the synthesis of threshold logic network. An iterative algorithm

has been developed for testing of 2-assumability of Boolean functions. The algorithm is well suited for machine computation. A FORTRAN program has been written based on this algorithm. Logic design with DSTL (Digital Summation Threshold Logic) arrays has been investigated.

(d) *Systems diagnosis* : Some studies have been made in the area of systems diagnosability e.g., techniques for designing optimal self-diagnosable system, etc.

(f) *Graph theory and combinatorics* : Several theoretical works on different problems of graph theory and combinatorics have been undertaken. In particular, the graph isomorphism problem, the forbidden clique problem, Pascal graphs, combinatorial problems involving Strilings number of the 2nd kind, Fibonacci numbers, and their engineering applications, have been worked out.

(g) *Heuristic search* : The recent techniques of heuristic search algorithms have been successfully implemented for solving some difficult problems of message routing in a distributed computing network environment. Many interesting properties of Mobius graphs, De-Bruijn graphs, have been explored regarding their suitability as computer networks. Admissible heuristic estimates can then be assigned to each processor node, which settle the optimal message routing problem in polynomial time complexity. Fault tolerance of these networks is currently under investigation.

(h) *Parallel architecture and parallel algorithms* : Parallel realizations of numeric and graph theoretic algorithms are currently under study. In particular, the numeric power evaluation problem, the sorting problem and the diameter evaluation problem in a symmetric graph, have already been implemented. Parallel architecture for improving the speed of a FFT processor has also been proposed.

2.3.2.2 Theoretical Physics

(1) *Particle Physics* : (a) In recent years multiparticle production phenomena in hadroninduced reactions are being studied from the viewpoint of the limited validity of the scale invariance hypothesis. A program has been undertaken to investigate various forms of scaling and their validity. Alongwith these, some very interesting features of the very high energy PP colliders are being studied in depth.

(b) Alternative to the standard grand unified theories is progressively being built up incorporating supersymmetry. Utilising the properties of conformal reflection supersymmetry and the generation of internal symmetry algebra are being probed. Also the role of random fields and stochastic quantisation in supersymmetry is being investigated. Attention is also being paid to the controversial magnetic monopole physics.

(2) *Cosmic Ray Physics* : The invariant distributions derived dynamically for the secondary particles like pions and kaons in high energy proton-proton scattering are utilised in deriving the muon-electron ratio observed in Cosmic Ray experiments and the shower size of the cosmic rays.

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(3) *Nuclear Physics* : From the view point of a strong interaction dynamics nucleon-nucleon potential has been derived earlier. Making use of this result, the problem of high density nucleons is being studied to apply this result to the neutron stars. Pions condensation for highly dense nuclear matter is also being investigated. Besides, baryon-baryon potential problems and the problems connected with the phase-shifts in nuclear physics are also being resolved.

(4) *Heavy Ion Reactions* : Relativistic heavy ion reactions are being studied utilising the results of proton-proton scattering in the high energy region. Plans have been chalked out to study the hadron-nuclei collision problems at both low and large values of transverse momenta and the Feynman variable.

(5) *Field Theory, Super conductivity and Phase transition* : A field theoretical study of the compositeness of protons at finite temperature has been undertaken and utilising this property of protons, the problems of Meissner effect, Cooper pair formation and super conductivity are being investigated. Very recently, Ising model and phase transition problems are being probed.

(6) *Stochastic space-time and foundations of Quantum Mechanics* : Using stochastic concept of space-time, potential problems both in classical and quantum mechanics are being studied. With some preliminary encouraging results in hand, and in depth and detailed mathematical analysis is taken up.

(7) *Plasma Physics* : In plasma physics we have been studying for the last few years three and four wave interactions. Most of the works has been completed and the results have been published. (A research scholar has submitted her thesis to the University of Calcutta on this subject). At present work on four wave interactions using numerical methods is in progress. A study of the effect of unequal linear damping on nonlinearly coupled waves using the methods used in the study of solitons has also been undertaken.

(8) *Supersymmetry and field theory* : In recent years supersymmetry seems to be playing an important role in elementary particle physics. We have studied the nature of vacuum of super symmetry models in various external field configurations. Interesting results have been obtained in case of external random sources. It has been shown that supersymmetry breaks spontaneously at the first order in the loop expansion. At present cosmological implications of this and also its relevance to the quark confinement problem is being investigated. A scheme to study the cosmological problems of SUSY GUT models has been taken up.

(9) *Quantum Mechanics and Dynamical symmetry group* : The role of dynamical group in the context of some important perturbation problems in atomic physics and particle physics is being studied. A recently developed operator method coupled with the properties of $O(2,1)$ group has been successfully applied to linear and spherical anharmonic oscillators. At present this group theoretic technique is being extended to relativistic cases, like Dirac equations with coulomb plus linear term.

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2.3.2.3 Fluid Mechanics

(1). (a) The work on two-phase flow problem with reference to separation of solid phase suspended in liquid phase in a hydrocyclone was continued.

(b) The work on flow analysis in an opposed jet in connection with the problem of flame stabilization by an opposed jet was continued. The analysis of the cold flow problem assuming it to be two dimensional and potential in nature is near completion.

(2) The problem in atmospheric turbulence in the case when the interaction of mean and turbulent fields of temperature and wind velocity is weak, has been worked out with the help of perturbation technique. The work on the similar type of problems that arise due to the generalization of some used model is in progress.

(3) In the field of Hydrodynamic stability it is desired to calculate the critical value of the parameter for certain problems. In the mean time a few problems viz. non-linear stability of the Ekman layer on a porous plate, non-linear stability of Buoyancy boundary layer in the presence of transverse magnetic field, existence of sub-critical thermal instability on a porous medium in the presence of rotation by spectral method have been investigated.

(4) Investigations of the theoretical problem of storm surge on a continental shelf are being done. This problem is found to happen on the coastal bed due to a disturbance, such as storm, generated in the deep sea. In this problem the coastal geometry consists of vertical straight wall extending to infinity in horizontal direction with sloping bottom. The linear model of the system of equations has been used here. The analytical expression for the sea surface elevation on the bed has been obtained for the case in which the effects of Coriolis parameter and bottom friction have been taken into account. The effect of Coriolis parameter, bottom friction and air/sea interaction on the sea surface elevation in the case where the slope of the bed is small, have been worked out. The study of the effects of all these factors to the case where the slope of the bottom is not small, is in progress.

2.3.3 ELECTRONICS & COMMUNICATION SCIENCES

Research activities in the unit include both theoretical investigation of methodology development and applications of the existing methods to the solution of practical real life problems. More than 40 research papers have been published this year in Indian and International Journals, Conferences Proceedings etc. by the research workers of the Unit. During the calendar year 1984, research was conducted in the following broad areas. The scientists participated in the M.Tech. (Comp.Sc.) and M.Stat. (ASDA) teaching programmes of the Institute.

1. Development of Methodologies for Image Analysis, Shape Analysis and Image Understanding System.

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B. Following new work in this area plan projects have been done—

- (a) A Generalised line segment code and a compression technique by the method of folding have been reported.
- (b) The methods of generation of digital circles, discs and rings are found and the geometric drawings in discrete grid are studied.
- (c) The shape of a set of points in 2-D plans are found by quadtree decomposition technique.
- (d) The technique of finding genus of a two-tone picture is being investigated.
- (e) Results of applying different transformation techniques such as Hoelling, Walsh-Hadamard, Discrete-Cosine, Haar and Slant have been reported in journals.
- (f) Some new methodologies for image restoration and enhancement applying cybernetic approach of human viernal system have been developed applied.
- (g) While investigating shape discrimination problems two new shape distance functions have been developed and reported.
- (h) Work on the development of a formal basis for digital plainmetry is in progress. The properties digitolines have been formalised and reported. Their behaviour under Euclidean motion and dialation are being studied.

2. Investigation on Pattern Recognition Technique : Further useful work in connection with symmetry analysis for open and closed curve has been completed and reported. Syntactic technique for recognition of handwritten connected numerals is in progress. A fuzzy syntactic inference grammar for skeletal maturity for X-ray images of bones have been developed and reported. Further work on estimation of Bayes error probability for noisy and imprecise measurement has been done. Fuzzy set theoretic approaches have been investigated and a new approach to estimation of fuzzy membership function has been published. Research on stochastic learning algorithm is in progress. Feature evaluation technique has been developed and reported using the concept of fuzzy entropy.

3. Theoretical and Experimental Investigation on Digital Communication technique : Investigation in this field is mainly carried on computer networking. A technique for avoidance of communication deadlock in a computer communication network has been suggested. Data compression techniques are investigated and work on the distributed communication systems using microcomputers is in progress. A collaborative project on statistical investigation on troposcatter characteristics has been undertaken with Institute of Radio Physics and Electronics and B.E. College, Howrah, and NPL, to be funded by DST.

4. Studies on Automatic Speech Recognition and Speech Processing : Works on phoneme structure of some Indian Languages and their application in ASR are

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under investigation. Syntactic approach in ASR is under investigation. Studies on the properties of large lexicon using Bengali Language have been undertaken. A new statistical discriminant function has been evolved which while cutting down the computation time appreciably provided recognition score better than the maximum likelihood methods. Research on clustering and stochastic learning of speech recognition system is in progress. The study of Acoustic phonetic structure of Bengali Language has been taken up. Studies on musical acoustics with particular emphasis on North Indian classical music is continued in collaboration with Sangeet Research Academy.

5. *Investigation on Biomedical Signal Processing* : The project includes the characterization of various biomedical signals such as ECG, EEF, EMG etc. for diagnosis by machine. Algorithms for ECG disease classification have been made and reported. ECG data compression technique has been reported. The unit successfully completed the Government of India project and developed a system which is capable of displaying noise free ECG signal in nonfading manner. It has other advantages over the existing available instruments. A second prototype model of the same equipment is under development. A fuzzy set approach for medical diagnosis of X-ray images has been taken up.

6. *Studies on Cybernetics and System Theory* : Research on application Fuzzy Set Theoretic Approach in Management Science and other socio economic system has been developed and reported. Further work is in progress. A new method has been developed applying fuzzy clustering method and branch and bound technique for management science application such as resource allocation problem. The work has been widely appreciated abroad. A work on Fuzzy linguistic for decoupling of a large multivariate system in reference to a power plant operation has been under consideration. Fuzzy correlation between membership functions has been defined and its application is being searched.

External Collaborative Projects :

1. During the year the unit continued to work for a project entitled "Development of 'continuous nonfading patient monitoring system'" sponsored by Electronics Commission, Govt. of India. The project has been completed and the final report is being prepared.

2. The next joint project entitled 'statistical studies on the tropospheric propagation for VHF/UHF and microwave link' has been sanctioned by Department of Science and Technology (DST) for 3 years and the work for this project is being planned.

3. The collaborative research project between ISI and Sangeet Research Academy (SRA) on Hindusthani Raga Sangeet and on Indian Stringed instruments is continued.

2.3.4 GEOLOGY

Programme of Geological research progressed in the following areas :

(i) *Stratigraphy and Palaeontology* : (a) Geology and palaeontology of the N.W. Pranhita-Godavari Valley ; (b) A new Triassic fish (Actinopterygii—Saurichthiformes)

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from the Yerrapalli Formation ; (c) Study of the Triassic Yerrapalli dicynodont fauna ; (d) Ceratodontid remain from the Upper Triassic Maleri Formation ; (e) Jurassic—Cretaceous fish remains from Godavari Valley ; (f) The sauropod dinosaur remains from the Inter-trappean beds in Central India ; (g) Study on Triassic reptiles from Tiki beds of the Son Mahanadi Valley ; (h) Fossil amphibians from Donwa beds of the Satpura Gondwana basin ; (i) A brachiopod labyrinthodont from the Upper Trassic Maleri Formation.

(ii) *Stratigraphy and Sedimentation* : (a) Stratigraphy and sedimentation of the Pakhal and Sullavai groups with special emphasis on the undeformed part of the sequence ; (b) Facies analysis and reconstruction of depositional environment of Maleri sediments ; (c) Studies on the 'lime-pellet' rock and associated red sediments of the Maleri Formation ; (d) Stratigraphy and sedimentology of the Albaka sequence and its comparison with the Pakhal sequence ; (e) Gondwana stratigraphy of the area north of Pranhita-Godavari confluence.

(iii) *Structural Geology* : Structural mapping of the area around Rajgarh, Ajmer dt., Rajasthan (completed).

(iv) *Trace Fossils* : (a) Studies in the Trace Fossils in the Maleri Formation ; (b) Trace fossils and stromatolites in the Kota Formation.

(v) *Special Projects* : (a) Analysis of seismological data (as part of ISI team and in collaboration with the North Eastern Council) ; (b) Study of the glaciogene Gondwana rocks India (in collaboration with University of Maine).

2.3.5 PHYSICS

1. *Teaching* : The Unit was engaged, during the period under reference, in teaching Physics to the B.Stat. (Hons.) second year students. The course contents included : thermodynamics, statistical mechanics and the atomic and nuclear physics.

2. *Research Activities : Project under plan activities* : The project 'Mechanical Properties of Human Biomaterials' started in 1979 with the object of determining the various mechanical characteristics of human anatomical materials, both external and internal, and the difference in these characteristics with age, sex, pathological conditions, locations etc. has been successfully completed this year (1983-84).

The important findings of the project have been published in the form of 14 papers in various journals/proceedings and presentations at a number of conferences both in the country and abroad. A monograph has also been published embodying the results of the entire project.

The new project that was undertaken in the year 1983-84— 'Heat and mass transport in skin' is in its initial stage of investigation. A device 'Thermosense' to measure the thermal sensory loss in skin conditions involving nerves has been just developed.

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Other research : The Unit was also engaged in : (i) theoretical studies on the control theory where methods for decoupling of linear invariant multivariable systems have been computerised and successfully applied to d.w.r. synchronous machine and 2-shaft gas-turbine ; design of non-interacting controller for non-linear systems is also completed, and (ii) studies on the interaction of physics and medicine.

2.3.6 FLUME PROJECT

Project A :

Data obtained from Flume experiments (conducted at Uppsala University, Sweden and Indian Statistical Institute, Calcutta) on size distributions of sediments deposited from suspension have been analysed and interpreted. Flume experiments show that all the grain sizes present in suspension are involved in the process of formation of a bed when the flow velocity is decreased. The size distribution deposited closely reflect the one present in suspension. This is contradictory to our common belief among sedimentologists that the coarsest grains are deposited from suspension first, resulting in a skewed distribution in the bed. The existing equation due to Rouse or Hunt tend to overestimate the depletion of the coarser grains from suspension. Two new methods based on the idea that this process of depletion is actually damped in nature, have been developed in this work. These methods give results which compare well (particularly for low velocities) with the observed values comprising the wide range of grain sizes.

Project B : Sediment Transport mechanism :

A two-dimensional theoretical model has been drawn up to explain the formation of solid body vortex in the laminar sublayer due to pressure fluctuations in the main floor. In the present work it was assumed that the pressure fluctuation was due to surface waves. A transducer has been developed at the River Research Institute at Harin-gata to measure fluctuations of pressure at the bed of a flume. It is envisaged to extend the model for three-dimensional pressure fluctuations and to carry out experiments in the flumes of River Research Institute.

2.4 BIOLOGICAL SCIENCES

2.4.1 Anthropometry and Human Genetics

(i) *Study of physical growth of Bengali Boys :* Data related to 25 anthropometric characters of one thousand school-going urban boys were collected and analysis was in progress.

(ii) *Pattern of fertility and reproductive wastages by parity and social class :* Incidence of low-weight babies in Calcutta was studied.

(iii) *Impact of altitude on human populations :* Anthropometric (adults and children), demographic, and haematological data were collected from a few Sherpa

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settlement in Kurseong and Darjeeling Sadar Subdivisions. Anthropometric (adults and children), demographic, haematological blood polymorphic, socioeconomic and intrafamilial food sharing data were collected from several Lepcha settlements in Kalimpong subdivisions.

(iv) *Study on the relationship between socioeconomic condition, nutrition and health* : Analysis of data and preparation of report continued. Demographic socio-economic and intrafamilial food sharing data were collected from the Oraon labourers of Jalpaiguri district and Mahishyas of Howrah district.

(v) *Biomedical study of the Portuguese descents of Mirpur villoge, Midnapore, West Bengal* : Collection of data continued.

(vi) *Genetic survey of some endogamous groups of Eastern India* : Data on biochemical genetic markers in ten population groups of West Bengal were under laboratory tests and the results were being statistically analysed.

(vii) *Indo-soviet collaborative anthropogenetic survey* : Data on biochemical genetic markers which were collected in South India from 16 population groups were under laboratory tests and the results were under statistical analysis.

(viii) *Bioanthropological study of migrant African group, the Siddhis of India* : Collection of biological data related to genetic markers was in progress.

(ix) *Bioanthropological studies among Nandiwalas and Dhangers* : On the basis of three new measures, analysis of dermatoglyphic data was in progress.

2.4.2 BIOCHEMISTRY

1. *Inorganic pyrophosphatase in plant leaf and seeds* : The spectrophotometric methods which accompany the oxidation of NADH have been standardised for the estimation of phosphoenolpyruvate (PEP) synthetase enzymes in the leaves of different C_3 and C_4 plants. These plants include *Oryza sativa*, *Bambusa arundinaceae*, *Triticum vulgare*, *Cynodon dactylon*, *Elusine indica*, *Saccharum officinarum*, *Zea mays* etc. The high level of alkaline inorganic pyrophosphatase in some of the above plant leaves was found to be directly correlated with the presence of PEP carboxylase and PEP synthetase in the same which were found to be the marker enzymes of C_4 pathway of photosynthesis. This chemotaxonomic importance which we have found was further proposed to be confirmed by in vitro study of PEP synthetase reaction.

Inorganic pyrophosphatase has also been studied during germination of *Oryza sativa* seed. Germination of the seed is associated with the increase of the level of this enzyme in both cotyledons and embryo suggesting that this enzyme is intimately associated with the synthesis of essential biomolecules-proteins, nucleic acids etc. required for germination. Synthesis of this enzyme has also been studied in presence of different inhibitors and activators of germination.

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2. *Correlation of cyanomethaemoglobin and oxyhaemoglobin levels in adult human beings* : To examine if any relationship exists between the technically complicated measurement of cyanomethaemoglobin and the simpler oxyhaemoglobin (and other haematological parameters).

About 400 blood samples collected by finger pricking, were examined in the field for oxyhaemoglobin and haematocrit values, while blood samples collected for cyanomethaemoglobin were brought in the laboratory (Biochemistry Unit) and estimated for cyanomethaemoglobin (spectrophotometrically). The above blood samples were also examined for differential leucocyte count and total serum protein as a part of another project (in collaboration with AHGU), to examine the nutritional status of the population (Lepcha). Further, the samples have been screened electrophoretically for abnormal haemoglobins. Statistical analyses on the total sample (about 1500) are in progress.

Previously statistical analysis on a small sample suggested that the oxy and cyanomethaemoglobin were highly correlated (male, $r = 0.92$).

3. As a part of another project in collaboration with AHGU 1500 blood samples were screened by paper electrophoresis for abnormal haemoglobins.

4. As a part of another project with in collaboration with AIGU about 200 blood slides collected earlier from Birpara area in North Bengal from tea garden labourers were examined for differential leucocyte count.

2.4.3 BOTANY

(i) During the agricultural year 1983-84 the *aman* rice varieties *Subarna*, developed by the Botany Research Unit from indigenous germ-plasm, and *Autkooli* and *Mulasail* collected respectively from West Bengal and Tripura states and selected for improvement by this unit were put to performance trial along with eight modern dwarf high yielding varieties (HYVs) at two levels of fertilizers, F_1 and F_2 at the ISI experimental farm in Giridih, *Subarna* out-yielded all but one HYV, IET 3257, both in grain and biological yields at both levels of fertilizers. The average grain, straw and biological yields (quintal/hectare) of *Subarna* were respectively 35.9, 46.0, 81.9 and those of IET 3257 were 36.3, 40.4, 77.7 in F_1 and those in F_2 for *Subarna* were 39.0, 42.0, 81.0 and for IET 3257 were 38.4, 49.3, 87.7 respectively.

In addition to these field experiments, multilocational field trials of *Subarna*, were conducted at the state farms of the Government of West Bengal as well as on the farmers' fields during the reference year under different agroclimatic conditions for an understanding of its adaptive plasticity. Although full reports of yields and other relevant data on performance of *Subarna* are not yet in hand, available information suggests its greater adaptive potential and higher possible acceptance over the exotic modern dwarf so-called high yielding varieties of rice.

While both the varieties are positively responsive to higher dose of fertilizers no inter-variatal response difference was observed in respect of grain yield. However, dis-

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line variation in the response behaviour of these two varieties was observed in respect of biological yield, which is the summation of grain and straw yields. It was found that straw yield of *Suharna* is negatively responsive while that of IET 3257 is positively responsive to higher nitrogen nutrition which are reflected in their biological yields.

(ii) *Intra-specific and inter-specific interactions in crop plants* : With an aim at generating a dependable data base on the performance of varieties and crop species in pure cultures and in mixtures, field experiments were conducted.

During 1983-84 three *aus/aman* and two *aman/aman* rice varietal combinations were studied. Land Equivalent Ratios (LERs) of grain yields were computed which clearly showed overall yield advantage in four combinations (total LERs ranging from 1.11 to 1.23) and insignificant disadvantage in one (total LER = 0.98) in alternate row mixture, while in intra-cluster mixture significant advantage was found in two combinations (total LERs ranging from 1.13 to 1.17), insignificant advantage in one combination (total LERs = 1.02) and clear disadvantage in two combinations (total LERs 0.84 and 0.92). In one combination 36BKBR7/498-2ARR8/two other mixture types, namely, seed mixture and culture in half-plots were also studied. The total LERs of seed mixtures and half-plots were 1.17 and 1.03 which indicate respectively a clear yield advantage in seed mixture and insignificant yield advantage in half plot mixture. Further, it is seen that in all three *aus/aman* combination the *aman* components showed grain yield advantage at the expense of *aus*.

Intercropping experiments with twelve cereal/legume and one cereal/cereal combinations were conducted with alternate rows, intra-rows, broadcast and half plot mixtures in twelve intercropping systems and the first three mixtures in one combination. Taking all cereal/legume intercropping systems together it is observed that with the exception of one, in all the other eleven combinations the yields of the cereal components were augmented in alternate rows, broadcast and intra-row mixtures. In six out of ten combinations the yield increments of the cereal component were appreciable while in the rest increments were positive but insignificant. The maize/cowpea intercropping system showed yield advantage in intra-row mixture (LER = 1.20) and disadvantage in the other three types of mixtures. The wheat/oat combination showed overall yield disadvantage in all types of mixtures.

The results show a scope for agricultural utilization of cereal/legume intercropping systems for augmenting of production per unit of cropped area.

(iii) *Behaviour and ecology of field rodent* : Several paddy fields were excavated for retrieval of hoarded rice car-heads from food chamber to determine the extent of pre-harvest losses of winter rice due to field rodent. Rodent rests were also retrieved from burrows. The nesting patterns, plant components and other behavioural studies are in progress.

(iv) *Deforestation : nature, cause and consequences* : The work is in progress.

2.4.4 CROP SCIENCE

Research was done in the following areas :

- (i) Comparative study of leaf epidermis between young and adult plants.
- (ii) Structure of vessel elements in roots of young palms.
- (iii) Anatomy of root, stem and leaves of seedlings of some palms.
- (iv) Relationship between foliar spirality, frequency and length of stomata and epidermal cells in *Areca catechu*.
- (v) Foliar spirality and its bearings on the fruit yield of *Areca catechu*.

2.4.5 EMBRYOLOGY

(a) *Biochemical Embryology*

(i) In connection with the research on cell cement that binds the embryonic cells of *Limnaea* (mollusc) it has now been further discovered that 1-2% Glycerol inhibits the biosynthesis of glycoproteins. Glycerol inhibits cell adhesion, is less toxic than tunicamycin, the well known antibiotic that has recently become a subject of keen interest, and unlike the latter, induces twinning. The inhibition of glycoproteins as evident from incorporation of labelled N-acetylglucosamine strengthens the suggestion that cell adhesion is at least partly due to glycoprotein molecules. A correlation of inhibition of glycoproteins, the positive cell cement has been found with the deadhesion and detachment of cells in early embryos of *Limnaea* due to glycerol and tunicamycin. Movie film records have also been made of the split of trochophores—an unusual effect of glycerol.

(ii) Cryogenic techniques have been tried to store the *Limnaea* embryos at -193° C. This is expected to be followed by other types of cells. The peculiarities of molluscan embryos present a formidable problem. So far it has not been possible to totally overcome this problem. Advanced embryos are destroyed either by slow or rapid thawing but a partial success has been indicated in the attempts with early embryos. This work is being carried out in collaboration with two teams at Indian Association for Cultivation of Science and Jadavpur University.

(iii) The data collected at Zimbabwe indicate that dispersal and germination of the large seeds of *Balanites maughami* are executed mostly by the elephants. These pachyderms are also an important factor in the dispersal of other species, such as *Cissus Quadrangularis*.

(b) *Biostatistics and Biomathematics*

Further investigations on mathematical and stochastic modelling of the cellular biology have been carried on. New methods for the analysis of stability aspects of the

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mathematical models have been explored. Attempts are now being made to extend the analysis to the study of carcinogenic process. A new methods for solving the probability distribution problems which arise in the applications of stochastic process in biology and populations growth has been established.

2.4.6 ENTOMOLOGY

Investigations on the breeding of *Anopheles spp* in two suburban localities (Baranagar and Dum Dum) : Samples of *Anopheles* larvae (all stages) were collected from 100 different sites of Dum Dum municipality (Patipukur, Motijheel, Cantonment area, South Subhashnagar, Matkol and Noapara etc.). No malaria-carrying species was found in these collections which contained *A. subpictus* only. Common larval sites were rain puddles, drains and pits made by Metro Railway Construction.

2.4.7 LEAF PROTEIN

1. Screening of nearly 20 hopeful plants was done to select promising species for Leaf Protein Yielding purposes. During screening their occurrence, growth habit, protein nitrogen extractability and other major physiological characteristics have been studied. The idea is to screen out few hopeful plants and carry out detailed biochemical and nutritional studies on them.

2. Extending our recently concluded detailed studies on by-product leaves of root crops, cole crops like cauliflower and knolkhol were studied. Preliminary results showed that root, succulence, PN extractability and protein contents of leaf protein concentrates were highly comparable to hopeful leaf protein yielding crops. Detailed agronomical and nutritional studies are contemplated to be carried out in the next year.

3. Varietal performances of winged-bean in ISI fields were carried out to select promising cultivars as (1) vegetable crop, (2) Cover crop and (3) Seed crop. Studies will be carried out in the next year also.

4. To study the microbiological aspects of leaf protein production different experiments were carried out to explore the possibilities of using deproteinized juice (whey) after leaf protein extraction as microbial growth media. Growth of fungi in the whey and their response to addition of different nutrients to the whey were carried out in details. Other important aspects like factors affecting production of penicillin and biomass are to be studied in the next phase.

5. Laboratory evaluation of the leaf protein concentrates of promising species was carried out. The studies covered different nutritional parameters and included crops like legumes, fodders, vegetables and water weeds.

2.5 SOCIAL SCIENCES

2.5.1 Demography Research

Population research activities in the institute have been revised from April, 1983. A number of population research projects have been taken up as part of this programme.

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(a) *Impact of family planning in fertility reduction in West Bengal* : Age specific fertility rates of rural West Bengal based on National Sample Survey and other regional surveys have been examined. The study showed that the fertility rate of rural West Bengal remained practically stationary over the last 20 years. Decline of ASFRs of higher ages due to sterilization programme has been offset by rise in ASFRs in earlier ages. The study highlights that overall fertility rate would have been much higher in the absence of family planning programme. Better results could have been obtained for control of population growth rate if the family planning education was directed to young couples more effectively.

(b) *Education growth disparities* : This study which was based on survey data in rural areas of Bengal, indicated that low rate of education or literacy growth among the females of educationally backward communities namely scheduled caste Hindus and Muslims was due to higher school enrolment age and low age at marriage. Drop-out rates may be lowered by simultaneous enforcement of Marriage Age Restraint Act of 1978 and motivating the rural couples to send their children to schools earlier.

(c) *Inter-state disparities of education growth* : This study is based on published census information of literacy rates. Five states namely Rajasthan, Jammu Kashmir, Bihar, Uttar Pradesh and Madhya Pradesh showed female literacy within 14.0 ± 2.5 percent in 1981. Among the 5 educationally backward states, Uttar Pradesh, Rajasthan and Bihar showed rising growth rate during 1951-61 to 1971-81. These three states showed poor level of sterilization programme effect.

Bihar, Jammu Kashmir and Madhya Pradesh showed comparable female literacy by all the measures considered but females of Madhya Pradesh showed higher drop-out rate before completing the primary stage of education. Decadal growth rate of Bihar during 1971-81 was lower than that of Madhya Pradesh inspite of much better record in the matter of sterilization acceptance.

(d) *Mobility of occupation in rural areas from Calcutta* : This study was taken up on the household survey data of Murshidabad, Nadia and Birbhum, 1980. The study showed a shift in occupation pattern from traditional agricultural to non-manual occupations. Non-manual occupation was found to be dominated by upper caste Hindus. Upward mobility was highest and immobility was lowest in the social group. Decreasing downward mobility was noticed among scheduled caste Hindus and other Hindus with advance of birth cohorts of sons. Lowest occupation mobility was exhibited by labourers. Labour services are contributed mainly by scheduled caste Hindus, Muslims and scheduled tribes.

(e) *Study of adolescent fertility* : Adolescent pregnancy and childbearing have demographic and health consequences and when they occur premaritally they have in addition legal, social and psychological implications.

In the present study the focus is on India where nearly 14 per cent of total births occur to mothers in the age group 15-19 years which is less in comparison with countries

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like USA or Jamaica. Fertility rate in every age group has declined but the decline has occurred much slowly in the adolescent age group particularly in the rural areas indicating little change in the marital pattern. The factors that may tend to influence adolescent fertility are briefly examined in the paper.

(f) *Estimating future student population in colleges of West Bengal, 1983-2001* : This study was taken up in July, 1983 at the request of the Commission for Planning of Higher Education, Government of West Bengal. It aims to project the college enrolment in the appropriate age range in 16 districts of the state during 80s and 90s and to provide a basis for action in the field of higher education by the Government.

Essentially the methods used in the study consist of (1) sub area (general) population projections in each of the sex-age groups and projection years ; (2) disaggregation of the projected population into single-year ages ; (3) estimating populations exposed to risk ; (4) estimating future college enrolment ratios, separately for males and females in each district ; and (5) estimating the volume of student population in colleges in different categories. The projections consider several alternative series such as 'high' 'low' and 'medium' estimates of fertility-mortality regimes. Evaluation of different estimates has been made to test the consistency so as to derive one series of estimates of student population.

(g) *Socio-economic survey on constraints to development* : A socioeconomic study on the present condition and development potential of the Basanti Police Station in the wider perspective of the Sundarbans, West Bengal, was initiated in May, 1981. The study is aimed at identifying the constraints to development and making policy prescription for regional development. Data collection has been completed. Preliminary results seem to indicate that despite scarcity of sweet water, cropping intensity has increased considerably in Sundarbans.

(h) *A female model working force table for developing nations* : Data on age specific activity rate of population is not available, and if available not adequate, for most of the developing nations. The table has got immense importance in constructing various working force models. With a view to solve this problem, a generalised model table for female working force has been constructed based on linear and non-linear regression equations, so that a crude rate could predict age specific activity rate more generally. A wide coverage of data with a large time reference from Demographic Year Book has been used to build up the model.

(i) *Socio-demographic characteristics of eligible couples in rural areas around Patna* : This is based on the data of 54 villages collected through the listing schedules of Education Development Survey (Plan) in rural Bihar. The project was taken up in 1981-82 to study the problems of educational backwardness of the rural population of Bihar. The data revealed that all the educationally backward social groups in Bihar are not improving their educational level to the extent desired. In comparison with 19.2% enrolment among eligible females, enrolment rates were 34.0%, 17.5%, 10.0%

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and 4.3% for upper caste Hindus, other Hindus, Muslims and schedule caste Hindus respectively in rural areas around Patna (1983). The corresponding enrolment rates in rural areas around Calcutta (1970) were 70.1%, 37.6%, 24.1% and 22.8% respectively. The drop out rate among rural females in West Bengal was much higher than that in rural areas around Patna in Bihar.

Socio-political environment for school enrolment in respect of the educationally backward social groups was found to be much superior in rural areas around Calcutta compared to that prevailing in rural areas around Patna. Poor state of female education among the weaker section of the rural population of Bihar was found from the survey. Higher percentages of sterilisation acceptors were found among scheduled caste Hindus and upper caste Hindus and the level of acceptance was lowest among the Muslims in rural areas around Patna. Only 6.1% acceptors were found in rural areas around Patna (1983) compared to 16.1% acceptors in rural areas around Calcutta (1978).

(j) *Education development survey in rural areas around Patna* : The project was taken up in 1981-82 to study the socio-demographic aspects of the rural population living around Patna. A similar study in respect of rural areas around Calcutta was completed in 1981. Detailed household survey of 60 villages has been completed during the year. One technical report based on the data from the listing schedule has been brought out during the year.

2.5.2 ECONOMIC RESEARCH

The main areas in which researches have been made during the current period are Economic Theory, Econometric Methods, National and Regional Planning, Applied Economics, and Poverty, Inequality, level of living and Income distribution.

A. Economic Theory : Research in economic theory continued on classical and post classical theories of value and distribution, nature and evolution of technology, analytical representation of productive process in various sectors and the associated process of investment, theory of rent, marketed surplus and agricultural pricing. Besides these, research in Social Choice theory and Game theory has also been undertaken and papers have been published.

B. Econometric Methods : Work in this area has been concerned mostly with the analysis of statistical problems in the estimation of single equation econometric models arising from (i) heteroscedastic disturbances (ii) transformation of variables (iii) errors in variables (iv) omission of regressors and misspecification of the equation, and (v) Bayesian Inference. Some work has also been done on the theory and methods of Index Number construction with particular reference to the International Comparison Project (ICP). Work on some theoretical and empirical problems of consumer behaviour and demand analysis has also continued.

C. National and Regional Planning : Work on national planning and collaboration with the Planning Commission, Government of India in this respect has progressed

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further during this period. The Planning Commission has recently assigned the Institute one short term and another long term project involving certain theoretical and practical problems of national planning. A group of workers in the unit is now engaged in this work and is also dealing with other theoretical and practical questions arising in macro/multisectoral planning at the national and regional levels. This group is expected to be strengthened in the near future.

Research on specific problems at the regional level is also being carried out. This includes (i) manufacturing, industrialisation and regional production, functional analysis (ii) monetization of agricultural products and regional surplus, deficit analysis (iii) spatial linkage growth centre analysis for the eastern region of India.

D. Applied Economics : The unit carried out a number of studies covering various aspects of the Indian economy during this period. These studies included problems of Indian Agriculture, Indian Industry, Labour, Energy etc. Particular mention may be made of the second phase of the rural survey undertaken by the unit. In this phase of the work a survey has been carried out in two clusters of villages in the Memari Block of the Burdwan district with a view to ascertaining the potentialities of development and the institutional and other constraints to development. This survey covered various aspects of the rural economy and is expected to throw light on the differences in the nature of problems between a relatively advanced area like Burdwan and a relatively backward region like Bankura where the first phase of the work was done.

Another survey project assigned by the Planning Commission/Joint Plant Committee of the Government of India and conducted jointly with the Applied Statistics Division intended to estimate the consumption of various types of iron and Steel in the small-scale manufacturing enterprises. This survey is being done simultaneously in the Calcutta Metropolitan District and the Delhi-Faridabad region. The field work has been completed and the processing of the data is in progress.

E. Poverty, Inequality, Level of Living and Income Distribution : As in earlier years, work on problems in this area has continued. Theoretical studies have been made on the measurement of poverty and inequality. Also empirical work on level of living has continued.

The project, sponsored by the International Labour Organization, Geneva, under the general title "Relative price of food and the rural poor—the case of India" has been completed during the period and the report which is now almost complete is expected to be submitted soon. In this report a comprehensive analysis of the movement of prices, absolute level of living, disparities in the level of living over time and for the general as well as for different sections of the rural population have been made at the all India level and also for some selected states.

2.5.3 PLANNING (DELHI)

The main areas of research carried out by the Economics—Group in the Delhi Centre are Economic Theory, Planning, Consumption and Inequality, and Applied Economics.

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Economic Theory : Research in Economic Theory includes work on the theory of decentralised resources allocation mechanism, non-linear input-output models, public goods, and incentive problems. Besides these some micro-economic models with special emphasis on credit have been constructed.

Planning : Work in this area has been concerned mostly with Planning at the Regional and District levels. A study on intra-state and inter-state disparities in Planning has been completed during this period. This study is based on empirical findings from the work of selected areas and regions carried out in the previous years. In another study micro-economic planning models have been constructed for India and at the District levels. Attempts are being made now to improve upon and enlarge these models. A study of environment, human settlement and social organisation with reference to the problem of development and disparities has been undertaken.

Consumption and Inequality : As in previous years, work on problems in this area has continued. A study has been made to examine the inter-state differential in household consumption pattern. The validity of Mahalanobis hypothesis that price rise in cereals leads to greater equality in distribution of expenditure on cereals accompanied by greater inequality in the distribution of cereals consumption in physical terms has been examined. A review of the present official estimates of private consumption expenditure is being made in a study in progress.

Applied Economics : A number of studies on various aspects of the Indian economy have been made during this period. In one study, the effect of price and distribution control in the Indian economy has been made. In another study category-wise demand for steel in the organised and unorganised sectors have been estimated. Work is also being carried out on estimating production function for manufacturing industries with special reference to capital-output ratios, their behaviour over time and reasons for such behaviour. Processing of the data collected for the project on "Women and Rice Cultivation" has almost been completed during this period.

The first phase of the project "Conflict Structure and Change", covering the Sili-guri sub-division of Darjeeling district has been completed. The last phase of the field work is nearing completion.

2.5.4 ECONOMIC ANALYSIS (BANGALORE)

During the period, studies on various aspects of the problems of regional demand patterns in India were continued. The list of published papers and technical reports give a detailed idea of the work done.

2.5.5 NATIONAL INCOME RESEARCH

The following gives a brief account of research activities carried out during 1983-84 including the projects approved under the plan budget.

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A. Preparation of long-term series of capital formation and national income in India from 1857 to 1900 : No attempt has been made so far to estimate national income and capital formation for India during the pre-1900 period. The present study aims at filling this gap partially by estimating the two series for the period between 1857 and 1900. Estimation of capital formation at *current prices* in the public sector has been completed. The estimation of the corresponding series at *constant prices* is also nearly completed. The necessary data were collected during 1982-83 from the National Library and other libraries in Calcutta and from the National Archives in New Delhi. Some valuable documents were also located in the Nehru Memorial Library in New Delhi. It is expected to complete the estimation during 1984-85 on the basis of these materials.

B. Studies on size-distribution of income, occupational wage-differentials and related enquiries : The aim here is to employ available official data as well as data collected through small-scale sample surveys the disparities in income across earners with special reference to differentials among industry occupation categories.

One study on inter-temporal and inter-regional variation in the size-distribution of income in the public sector is in the reporting stage. This covers income-distribution of employees in Central and State Government Services.

A sample survey on 'Wage-earnings of employees in small-scale industrial unit' was carried out in the Calcutta Corporation area during February-May 1983 jointly by Dr. Bina Roy of NIRU and Prof. Robin Mukherjee of ERU. The survey covered a probability sample of industrial units drawn from the registers maintained by the Directors of Small-Scale Industries, Govt. of West Bengal. The Enterprise Schedule (Schedule A) was canvassed for 317 enterprises and the Worker Schedule (Schedule B), for 867 workers. The data on wage earnings and the items collected through the enquiry are being tabulated and the report should be completed by the end of current financial year (1984-85).

C. National accounting and other related studies on economic growth : Inter-regional disparities and imbalances in an economy like the Indian economy may be profitably studied by building up estimates of income and other aggregates at state, district and lower regional levels and then studying the time-trends in these estimates. In this background, the present study has estimated the time series of capital formation in West Bengal, at current as well as constant prices, for the period from 1960-61 to 1980-81. A paper on the associated problems of estimation was presented to the 14th General Conference of the IARNIW, held at ISI, Calcutta, on 7-9 November 1983. Another paper which has been completed estimates the financial resources for planning in West Bengal, corresponding to alternative rates of growth of state domestic product.

D. Estimation of generalized capital formation : A paper entitled "Variation of national income with components of generalized capital" was presented to the IARNIW Conference held in 7-9 November 1983 at ISI, Calcutta. A technical report on this paper is also ready for circulation. It is intended to develop a measure of human

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capital (stock and flow) and study it as a means of explaining income growth. Another study, "Inter-state variations in the human resources and economic development" examines the relationship between human capital and state domestic product utilising data for different states of India relating to two periods of time.

The sample survey on "Unaccounted components of human capital formation" in Howrah and Hooghly districts of West Bengal was started towards the end of the year. The field work is already completed. A random sample of 740 households in 30 blocks and 30 villages was covered for this survey. Tabulation of the material is now in progress.

E. Other studies : One paper presented to the IARNIW Conference held in November 1983 examined the 'Role of the tertiary sector in economic development with special reference to India'. This paper was partly based on cross section data for 102 countries and partly on time-series data for the Indian economy. Another paper entitled 'Changes in structures of the urbanisation of big cities in India—an inter-sectorial comparative analysis' was published during the year.

2.5.6 LINGUISTIC RESEARCH

The programme of research in fundamental and applied linguistics was continued in the Linguistic Research Unit under three main headings, as follows :

I. Studies on the phonetic structures of major Indian languages and application of the results in the areas of (a) speech pathology (b) second language acquisition and (c) cultivation of mother-tongue.

II. Studies on acquisition of language and bi-lingualism.

III. Application of statistics in linguistic problems.

1. Bengali Phonetics : Fundamental research is in progress on the suprasegmentals or prosodic elements of the Bengali language. Word stress, sentence melody and intonation patterns in Bengali will be studied with the help of modern equipment. Stress in monosyllabic disyllabic and polysyllabic words has been analysed and further research is in progress.

Speech Pathology : Surveys on norms of articulation and speech pathological deviations in school-going children have been carried out during 1980-81 to 1982-83. Analysis of the findings was completed during 1983-84. Publications are planned on the results of those studies during the current year. Further research has been initiated to study the articulatory norms of pre-school children of 2-4 years of age.

2. Hindi Phonetics : Fundamental research is in progress on the suprasegmentals or prosodic elements of the Hindi language. Data have been collected in Delhi from Hindi speakers on monosyllabic, disyllabic and polysyllabic words. The material

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has been recorded on magnetic tape and is being processed for analysis with modern instrumentation.

Speech Pathology : Preliminary studies are in progress to verify and finalize a methodology for habilitation of speech and language in children with Hindi as their mother-tongue. This is an adaptation for the Hindi language of the Kostic methodology for speech habilitation based on previous publications for Serbo-Croatian, English and Bengali. All projects on the Hindi language are being carried out with the collaboration of experts in the area, centred in Delhi, in particular with the N.C.E.R.T., Delhi University and Central Institute of Hindi.

3. *Telugu Phonetics* : Fundamental research is in progress on the suprasegmentals or prosodic elements of the Telugu language. Data have been collected in Hyderabad from Telugu speakers on monosyllabic disyllabic, and polysyllabic words as well as simple and complex sentences. The material has been recorded on magnetic tape and is being processed for analysis with modern instrumentation.

Speech Pathology : A collaborative project was initiated to write a methodology for speech and language habilitation of hearing-impaired children with Telugu as their mother-tongue. This is an adaptation for the Telugu language of the Kostic methodology for speech habilitation, based on previous publications for Serbo-Croatian, English and Bengali. The projects on the Telugu language are being carried out with the collaboration of experts in the area in Osmania University, Hyderabad.

4. *Oriya Phonetics* : Fundamental research is in progress on the articulatory and acoustic phonetic structure of the Oriya language. During 1983-84, further data have been collected on Oriya speech sounds and spectrographic recordings made of the same. Detailed discussions were held regarding further analysis and finalization of the material for publication.

II. Studies on Bilingualism and Acquisition of language : Studies are in progress on (a) acquisition of language and mother-tongue and (b) acquisition of bilingualism and factors involved in retention of mother-tongue. These studies are being carried out in (a) Calcutta and suburbs and (b) in Telugu speaking and Hindi speaking areas out-side Bengal.

III. Application of Statistics in Linguistic Problems.

1. *Serbo-croat* : Based on data provided by Visiting Professor Djordje Kostic, Belgrade, Yugoslavia, a number of studies are in progress on the vocabularies of leading Serbian poets of the 19th and 20th centuries. These studies will be taken as models for future research on the works of prominent authors in Bengali literature and subsequently for other Indian languages. Vocabularies of three Serbian poets are being processed with the help of the Computer Science Unit in this connection. Publications are expected during the current year.

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2. *Zuni* : Spectrographic data on an American Indian language, Zuni, was provided by Visiting Professor Djordje Kostic for statistical studies utilizing Mahalanobis D². Publications are expected during the current year.

3. *Bengali* : Data on the vocabularies of two prominent Bengali authors, Bankim Chandra Chatterjee and Rabindranath Tagore, are being prepared for statistical processing with a view to publish studies on the vocabularies of these two authors.

4. *Comparative studies* : A number of studies are planned, based on spectrographic data on the Bengali, Hindi, Telugu, Oriya and Punjabi languages as well as Serbo-Croat and English.

2.5.7 PRE-CENSUS POPULATION STUDIES

The main object of the Pre-Census Population Studies is to conduct research based on quantitative historical data.

(i) *Pre-Census Population Project of India* : The purpose of this project sponsored by the Registrar General and Census Commissioner of India and directed by the Head of the Pre-Census Population Studies Unit is the search, collection, compilation, editing, analysis, and publication of data on population and allied socio-economic variables from the past up to 1972 when the first census in India was initiated. Out of eight projected volumes, two have been published and another two volumes are getting ready for the press. The source materials used are massive volumes of historical records of the Survey of India, Revenue Survey, and other allied quantitative investigations. During the year under review, research of materials continued for the period 1831-1870 at different archives and libraries of India and abroad.

(ii) *Economic Changes in Rural India* : (a) Studies on Aligarh and Ballavpur villages : The purpose of the project is to study the socio-economic changes over time at micro-regional level using rare quantitative materials available since the early 19th century. Two studies—one on the 20 villages of Aligarh district in Uttar Pradesh and another on two villages Ballabhpur and Labhpur of the Birbhum district have been completed. (b) Studies on 200 villages of Bengal : Old records of Bengal Revenue Survey 1846-1878 has been discovered at the Record Room of the Director of Land Records and Survey, West Bengal. Data on population, houses stock and land use were compiled for about 1,000 villages. Some sample villages were selected for detailed study.

(iii) *Editing of the Manuscripts of Dr. Francis Buchanan* : Work now continues on manuscripts of Dinajpur and Rangpur districts.

2.5.8 PSYCHOMETRY

The scientific workers of the unit were engaged in different projects mentioned below :

(i) 'Development of a scale for measuring managerial skill' undertaken by S. Chatterji, M. Mukherjee and Anjali Ghosh.

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- (ii) 'Development of an intelligence test for deaf children' undertaken by S. Chatterji and M. Mukherjee.
- (iii) 'Rorschach psychogram through Computer Programming' undertaken by S. N. Banerjee.
- (iv) 'Popular views on mental health' undertaken by Tapan Basumallik and K. P. Bhattacharyya.

2.5.9 SOCIOLOGY

Main topics of research of Sociological Research Unit during the period were as follows :

(i) *Social ecology of Sundarban* : The objective of the study is to explore the possibilities and potentialities of the symbiotic relationship between the societal groups and their natural resources. An enquiry to explore the feasibility of the study on the basis of available materials has been completed and a report has already been prepared. In collaboration with a statistician of Stat-Math Division of ISI the sampling design has been prepared. The field survey is in progress.

(ii) *A study of group relations in Giridih and surrounding areas with special Reference to the development of the scheduled castes and tribes* : This is a study of group relations with special reference to the impact of development programme on the life and living of the scheduled castes and tribal groups. Exploratory enquiry and testing of the question schedules in the surrounding areas of Giridih has been completed. A report on the *Chamar* is under preparation and will be followed by the reports on other caste/groups in successive stages. On request from the Commissioner for Scheduled Castes and Tribes a brief note on this project has been sent for incorporation into Commissioner's report.

(iii) *Structure of social network and dimensions of change* : The project, undertaken in collaboration with the scientists of Stat-Math Division, ISI, has been completed. A technical report has been prepared and is available. Another paper has been written by a scientist of Stat-Math Division based on this project has been sent for publication.

(iv) *Caste, class, location and unequal exchange* : The report is under preparation.

(v) *Value systems and social change* : Field work in the two sample villages in Purulia has been completed. Exploratory survey in the southern region of the district is over. Professor Trevor Ling, Emeritus Professor, Manchester University, U.K. has been associated as collaborative Professor in the project. Draft report of the pre-pilot survey is underway. Data processing work is in progress.

(vi) *Village re-survey* : Field survey visualised could not be undertaken.

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(vi) *Problems of deforestation* : Collection of first phase of field data was completed. Data process is in progress. A draft report would be prepared shortly.

(viii) *Problems of social and economic adjustment of persons retiring from active workforce* : Processing and analysis of a part of data was done.

(ix) *The Hindu-Muslim relationship in Bengal during the 18th century with special reference to the Fakir and Sanyasi Rebellion* : The Hindu-Muslim relations, which have played an important role in Indian society, underwent significant changes after the introduction of British rule in Bengal. The objective of this project is to study these variations in the context of peasant rising which challenged the colonial rule from the middle of the 18th century onwards. In addition to the ongoing activities regarding collection and analysis of relevant archival data, a scientific paper has been published. A group discussion was also organised on methodology of appraising peasant movements in colonial India. A note has been prepared on the discussion.

(x) *The study of registry Marriage and the impact of legislation in West Bengal* : The objective is to study the changing character of marriage institution in West Bengal and the role played by the marriage legislation in effecting this change. It will identify the social groups favouring registry marriage, explore the social, economic, cultural and psychological forces behind accepting this and examine the nature and extent of their post-marital adjustments in society.

On the basis of earlier experiences through establishment of rapport with registered couples, preparation has been taken for detailed field work. A technical note prepared earlier, has been revised for publication.

(xi) *Politics of challenge and change* : Jayaprakash Narayan and concept of Total Revolution : Objective of the project is self-explanatory. A book based on the project is published.

(xii) *Conflict, structure and change* : Explorations in the analysis of agrarian social systems and directed social change : During this period we have collected certain basic information on agrarian structure in the rural areas of the Siliguri subdivision of North Bengal. At one level, the information collected is extensive and diffuse, cover by a 25% PPS, sample of the area. At another level, intensive survey of movement and non-movement areas covered by the sample has been undertaken with reference to labour, tenant and owner dimensions of the agrarian structure. Nearly 950 schedules completed between April and March 1983 are undergoing analysis. In addition to the rural revenue units, data have been collected from two tea plantations from the sample mouzas with a view to understand their structure and relationship with the agrarian social reality. Analysis of the data relating to two tea plantations is continuing.

The last phase of the work is in progress in which data from factors involved in the development of the peasant uprising of 1967 in the Naxalbari, Kharibari and Phansai-

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dewa areas of North Bengal Terai are being collected. Four research papers have been prepared on the basis of the data collected from the project.

2.6 STATISTICAL QUALITY CONTROL AND OPERATIONS RESEARCH

2.6.1 The Division continued with its objectives of promoting applications of Statistical Quality Control (SQC) and Operations Research (OR) methods, training and education of executives, inspectors, trainees, operators consultative services of industrial establishments and research in SQC & OR and allied methods. The activities of the Division are organised through comprehensive programme under the broad classification of (i) promotion, (ii) training, (iii) plant services and (iv) research.

2.6.2 Promotional activities were continued in public and private sectors. Inplant training of technologists, trainers, inspectors and operatives including the training programme in local languages and services continued to have support from a number of public and private sector organisations. The units of Bharat Heavy Electricals Ltd. Hyderabad, Hardwar, Bhopal and Jhansi etc. continued as servicing plants of the division besides a number of other plants both in public and private sectors. Several organisations were added to the list of servicing plants during the period including all the plants under Steel Authority of India Ltd. (SAIL) for which a quality survey was completed and report submitted.

2.6.3 The Division undertook new project assignment during the period apart from rendering consultative services to factories already in its rolls. The Division has so far produced about 800 specialists and about 650 research papers, technical literatures, manuals etc.

2.6.4 The Division continued liason with various academic and technical institutions, productivity councils, societies and several other national and international bodies by way of its academic technical and promotional activities.

2.6.5 *Service* : During the period under review 13 plants joined the SQC service scheme. 129 technical reports were sent to factories and 6 factories discontinued. A total of 63 factories are taking consultative services as in March 1984.

2.6.6 Social demonstrative studies involving applications of SQC and OR methods were taken up in a number of areas. Some of them are : reliability evaluation of newly designed windmill and solar collector for developing energy, evaluation of vendor performance, reducing the incidence of rejection due to shrinkage in aluminium casting and a compressor shop, influence of blade characteristics of LP blade frequency, control of functional and assembly problems in overspeed governors ; evaluation of process capability at SRM 100 lathe machine in pump shop in respect of drilling of a wheel roter blades ; copy planning of LP moving blades and at slitting for 5" lamination, control of variation of dimension of drive turbine after grinding, study of induction hardening of gear wheels, control of resistance imbalance of PLJF cables, improvement of conformance of PLJF cables to water penetration test, control of distortion of parted

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rings during heat treatment, control of ground bore ovality, control of size variation at superfinishing, control of weight and quality of medicines, evaluation of working performance of GTV spinners.

Education and Training : In plant training programmes at various factories continued. A series of training programmes for senior executives of Bharat Heavy Electricals Ltd., continued on regular basis besides regular inplant programme for executives at various levels. One-year special programme for executives at fairly advanced level blended with practical applications continued for fourth and fifth batches of trainees at Madras. Several short term specially designed training programmes were also conducted at different units of the Division for select group of executives from organisations in India and abroad.

2.6.7 During the period under review 3869 managers and technologists were trained in various inplants, general and other courses, 493 trainees underwent professional training in SQC & OR at a post-graduate level and in part-time courses in Calcutta, Bombay, Delhi, Madras, Bangalore and Hyderabad.

2.6.8 The Division organised a Summer Institute on Mathematical Programming at Mysore University. Twentyfive participants including university teachers and SQC-OR specialists of the division attended the programme. Besides SQC-OR specialists from the division some external experts in the area served as faculty for the programme.

2.6.9 *Research :* During the period under review 11 papers were published, 17 sent for publication, 9 manuals and technical reports, etc. prepared by the specialists of the Division.

2.7 LIBRARY, DOCUMENTATION AND INFORMATION SCIENCES

2.7.1 *Central Library :*

(i) With the addition of 2,168 books and 1,794 bound volumes of journals to the stock the total collection of the Library rose to 1,75,855 volumes.

(ii) *Acquisition Unit :* The Unit accessioned 2,168 titles during the period under report, out of which 1,880 were purchased and 595 were received as gift. 7 titles were also acquired on exchange basis. It also acquired 619 titles for the Circulating Library.

(iii) *Periodicals Unit :* The Unit received 2,404 periodicals out of which 685 were received against subscription, 1,400 on complimentary basis and 619 on exchange arrangement with national and international organisations. The Library also acquired 168 back volumes of journals. It accessioned 1,794 bound volumes of journals and completed the technical processing of 1,700 journal titles.

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(iv) *Circulation Stack Maintenance Unit* : The Unit issued 42,323 books and journals to the users on loan and on reference. The total membership of the library rose to 4,276 which includes NSSO staff, ISI staff, Research Scholars and Project Assistants, B.Stat. and M.Stat. students, ISEC trainees etc. as well as outside students and institute members. 549 readers were given special permission to use the library for a short period. 36 books and journals were borrowed from other libraries and 15 books and journals were loaned to other libraries under the Inter-Library Loan Arrangements.

Q. C. Circle : A documentation list of current journals on quality control and operations research was prepared during this period.

(v) *Reports and Records Unit* : The Unit accessioned 347 titles and processed 751 titles. 2,026 titles were issued to borrowers during this period.

(vi) *Translation Unit* : The Unit translated the book 'A quality control text : off-line quality control relating to technical and design departments' by G. Taguchi (1981) and has taken up a project to translate 'Population increase in mainland China and its implication for China's economic development—a research memoir' published by the Asian Economy Research Institute'.

Shri Sunit Bose, Translator is giving a regular course in Russian to the B.Stat. students.

(vii) *Special Materials Unit* : The Unit accessioned 180 micro-documents and 185 Russian books.

(viii) *Circulating Library* : The Workers' Circulating Library acquired 619 new titles bringing the total collection to 32,107. It issued 34,104 books to the members.

(ix) *Technical Precessing Unit* : The Unit classified and catalogued 2,546 books and other documents.

(x) *Reprography and Photography Unit* : The Unit provided 2,66,046 xerox prints for the users during the period under report. 546 frames of photographs of different occasions, 6,009 prints of bromide enlargements, 3,777 frames of microfilming from drawing books, charts, journals etc., 913 copies of photoprints, 7 copies of photostat from big maps and 685 slides for lecture were made during the period under report.

(xi) *Workshop* : A six-day workshop on Information Management Technology in collaboration with IASLIC was conducted in the Institute from 28 November to 3 December 1983. There were twenty participants from all over the country.

(xii) *Documentation Unit* : The Unit is compiling the following bibliographies and expect to release them shortly. (i) Bibliography on Statistical Quality Control ;

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(ii) Bibliography on Energy ; (iii) A Select Bibliography on Rural Reconstructions and Development ; and (iv) A Comprehensive Bibliography on Statistics and Mathematics.

Index to statistical literature : An index of articles on statistical theory methods and applications published in current journals will be brought out shortly. The index will be published quarterly.

2.7.2 Delhi Centre Library :

The Centre accessioned 778 books and 661 bound periodicals. During the period, 277 periodicals were received of which 10 were complimentary and 3 were on exchange basis. A total of 13,768 publications were circulated. About 125 inter-library loan transactions were handled. The Centre provided 3541 xerox prints for the users during the period under report. Two bibliographies were prepared during the period. They are (i) Adam Smit : Critical Assessment and (ii) Maynard Keynes : Critical Assessment. With the addition of 1,439 books and bound volumes, the total collection rose to 22,810. Assistant Librarian attended XIV IASLIC Conference from 26-29 December 1983 which was held at Delhi.

2.7.3 Bangalore Centre Library :

The centre accessioned 558 books out of which 6 were received as gift. During the period, 241 periodicals were received of which 30 were complimentary. It accessioned 405 bound volumes of journals. About 450 books were classified during the year while 500 were catalogued. A total of 4,000 books and 3,000 periodicals were circulated. About 300 inter-library loan transactions were handled. With the addition of 558 books, the total book collection came to 7,655 and stock of bound volumes rose to 1,844 with the addition of 405 volumes.

2.7.4 Documentation Research and Training Centre (DRTC), Bangalore.

(i) *Objectives and programmes of DRTC* : The objectives of DRTC are as follows : (a) To contribute to the development of the different branches of information science including documentation and library science by doing, guiding, and supporting research and development in the concerned field. The aim is to develop expertise and excellence in different areas of information science. (b) To help development of information centres including libraries, documentation centres, data centres and information analysis and consolidation centres by offering advisory services in designing specific development plans, tools, and techniques required for this purpose. (c) To disseminate results of research, information analysis and consolidation and of advisory services in different areas of information sciences including documentation and library science. (d) To develop man-power with appropriate professional skills and understanding that is capable of participating efficiently and effectively in the management (that is, design, development, organisation, implementation, operation, control, and evaluation) of information service systems, centres, and programmes and in the advanced teaching and research programmes in information sciences, and to help this manpower in finding

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appropriate job opportunities. (e) To ensure the development of the man-power engaged in professional activities. (f) To ensure the development of the member of the member of the DRTC faculty.

To achieve these objectives, the activities of DRTC have been organised into the following programmes :

(1) Research Programme (2) Advisory Service Programme (3) Extension Programme (4) Publication Programme (5) Training Programme (6) Employment Information Programme (7) Continuing Education Programme (8) Faculty Development Programme.

The following is the report of activities of DRTC during 1 April 1983 to 31 March 1984.

(ii) *Training* : The 1983-84 session of the DRTC course leading to the award of "Associateship in Documentation and Information Science" commenced on 1 August 1983. On the basis of an admission test and interview 8 candidates were selected for admission to the course. There were 3 deputed candidates. Two of the candidates joined the course on study leave.

Due to ill health one of the candidates discontinued the course after one month. All the other candidates will be appearing for their final examination during the period 14-25 May 1984, after completing the formal residential part of the course. After this, each of them has to complete an approved research project and to submit the dissertation pertaining to it. The results of their course performance will be declared only after the valuation of their dissertation.

Research : The main topics of research in which the different members of the DRTC faculty have been engaged during the period are furnished below :

G. Bhattacharyya : (1) Refinement of the methodology of designing a vocabulary control device called Classaurus. (2) Formulation of rules for specific purpose-oriented Postulate based Permuted Subject Indexing (POPSI—specific). (3) Study of the evolution of subject indexing languages. (4) Analysis of the development of education for library and information science in India. (5) Survey of Indian information sources and services in science and technology. (6) Survey of the landmarks in the development of Library automation. (7) Perspectives of information science. (8) Relevance of Ranganathan's ideas in the context of modern developments in library and information science.

M. A. Gopinath : (1) Facet analysis of inter-disciplinary subject. (2) Systems approach to the recognition of Ranganathan's Fundamental Categories. (3) Analysis of Ranganathan's contributions to library classification. (4) Media selection for information service products. (5) Identification of areas and programmes for continuing education for librarians in India. (6) Financial norms for collection development in libraries. (7) Analysis of Phase Relations in the natural and social sciences.

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S. Seetharama : (1) Analysis of the classification schemes for medical sciences for the purpose of identifying compatibility between general and special schemes on the subjects concerned. (2) Design and development of depth classification in the field of medical sciences. (3) Planning and management of information systems and services. (4) Methodology for information analysis and consolidation.

K. Ravichandra Rao : (1) Computerization of library activities from the view point of developing automated systems for certain library functions and information retrieval. (2) Bibliometric studies from the view point of developing measures for determining effectiveness of library services and determining the adequacy of library collection. (3) Library education from the view point of developing curriculum for computer applications to library and information science and quantitative librarianship.

F. J. Devadason : (1) Establishment of Postulate based permuted subject indexing (POPSI) language as a meta language for computer aided generation of information retrieval thesaurus. (2) On-line construction of alphabetical classaurus based on Deep Structure of subject indexing languages. (3) Computer generation of different types of subject index entries based on the Deep Structure of subject indexing languages. (4) Query profile construction for computer searching of bibliographic data bases.

3. CONFERENCES, SEMINARS AND SYMPOSIA

Among different conferences, symposia, seminars and workshops organised by the Indian Statistical Institute mention may be made of the following :

(i) A data analysis workshop for the life sciences was organised in Calcutta by Dr. T. Krishnan during 16 January, 1984—4 February, 1984. This workshop is the first of its kind in India. Scientists actively working in life sciences were selected to participate in this workshop. The most distinguishing feature of the workshop is that the scientists and statisticians were both equally involved, problems were explained and formulated, analysis carried out and interpretations made all as a part of the workshop.

(ii) UGC workshop on Teaching of Quantitative Economics organised by the Economic Analysis Unit in collaboration with Department of Economics, University of Mysore. The workshop made a number of useful recommendations on the syllabus for the teaching of Quantitative Economics in university courses. (Convener : Dr.N.S. Iyengar) July 11-16, 1983.

(iii) The sixty-sixth All-India Economic Conference was organised by the Economic Analysis Unit in collaboration with the Department of Industrial Management, Indian Institute of Science, and Indian Institute of Management, Bangalore. Over 500 delegates participated in the deliberations. Dr. N. S. Iyengar was the Honorary Secretary of the Organising Committee of the Conference. Dec. 28-30, 1983.

(iv) The twenty-second Indian Econometric Conference was organised by the Economic Analysis Unit in collaboration with the Indian Institute of Management, and the Indian Econometric Society. About 110 delegates participated in discussions over the issues arising out of the nearly 70 papers submitted for the conference. The conference papers were published in two volumes.

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(v) The 14th General Conference of the Indian Association for Research in National Income and Wealth was jointly organised by the Institute (National Income Research Unit) and the Bureau of Applied Economics and Statistics, Government of West Bengal and was held at ISI on 7-9 November 1983. The Conference was inaugurated by Shri Jyoti Basu, Chief Minister of West Bengal. A number of papers were contributed by Dr. Bina Ray, Dr. Krishna Mazumdar and other members.

The following seminars were organised by the Economic Research Unit during the year :

(a) Prof. R. M. Sundrum, Centre for Development Studies, Trivandrum, Land, Labour and Capital, A Dynamic multi-sectoral model, 7.4.83.

(b) Dr. Dipak Roy Basu, Institute of Agricultural Economics, University of Oxford, Stochastic optimal control of a monetary model for India, 19.4.83.

(c) Dr. W. T. N. Roberts, Consultant to the United States, Methods of energy accounting, 21.11.83.

(d) Dr. D. P. Sharma, Institute of Economic Growth, Delhi, Tetanus epidemiology and control in selected rural and urban areas of India, construction of a computer simulation model, 7.12.83.

(e) Tamal Datta Chowdhury, Department of Economics, Calcutta University, A macroeconomic framework for a dual economy, 15.12.83.

(f) Dr. Abhirup Sarkar, A model of trade in intermediate goods, 23.12.83.

(g) Prof. Zvi Griliches, Department of Economics, Harvard University, USA, Issues in the measurement of the contribution of research, 30.12.83.

(h) Prof. L. R. Klein, Nobel Laureate in Economics, University of Pennsylvania, USA, Estimation and evaluation of large sized economy—wide econometric models, 11.1.84.

The following seminars were organised by Planning Unit (Delhi) :

(a) Dr. V. K. Chetty : Seminar on "Dual pricing in production and distribution" on 24th November 1983 at Delhi School of Economics.

(b) Dr. S. Gangopadhyay : Seminar on "Some aspects of land reforms" on 30th November, 1983 at J.N.U.

The seminars organised by DRTC, Bangalore are :

(a) Seminar on 'Development of library science and library profession during the last four decades'. Bangalore, 6 May 1983. The leading presentation was made by Prof. P. N. Kulkarni, Head of the Department of Library Science, Banaras Hindu University, Varanasi.

(b) Seminar on "National information system for science and technology". Bangalore, 21 May 1983. The leading presentation was made by Maj. R. Thiagarajan, Director, Information and Documentation, DST, New Delhi.

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(c) Seminar on "Anglo-American Cataloguing Rules, Edition 2." Bangalore 10-11 June 1983. The leading presentations were made by Ms. Mary Jo Furgal, Program Officer, American Center, Madras and Dr. K. Subramaniam, Cataloging Coordinator, US Library of Congress Office, New Delhi.

(d) Seminar on "Library and Information Science : Yesterday, Today and Tomorrow". Bangalore 12 August 1983. Presentations on the various aspects of the theme were made by the following : (1) Dr. G. Bhattacharyya, (2) Dr. M. A. Gopinath, (3) Shri S. Seetharama, (4) Dr. I. K. Ravichandra Rao (5) Shri M. N. Seetharaman, Information Officer, National Aeronautical Laboratory, Bangalore.

(e) Seminar on "Current trends in reference and information services". Bangalore 27 September 1983. The leading presentation was made by Ms. R. Sugra Begum, Head, Department of Library Science, Polytechnic for Women, Bangalore.

(f) Seminar on "Micro-processor revolution in libraries". Bangalore, 15 September 1983. The leading presentation was made by Dr. K. Subramanyam, University of Drexel, Philadelphia, USA.

(g) Seminar on "Information technology : Some recent developments". Bangalore, 20 October 1983. The leading presentation was made by Dr. V. Kanath Retired Chief of Information Division, BARC, Bombay.

(h) DRTC refresher seminar on "Library automation". Bangalore, 14-16 November 1983. The leading presentation was made by Dr. I. K. Ravichandra Rao, DRTC, Bangalore.

(i) Seminar on "Education for library and information science in the United Kingdom". Bangalore, 3 December 1983. The leading presentation was made by Mr. P. M. Whiteman, Head, Department of Social Management Studies, College of Librarianship, Wales, U. K.;

(j) Workshop on "Technology and the information age : Information resources and services in economics and business, social science and science and technology". Bangalore, 12-14 December 1983. Leading presentations were made by the following : (1) Dr. Miles Jackson, Professor, Library Studies, University of Hawaii ; (2) Shri A. K. Das Gupta, Librarian, Administrative Staff College of India, Hyderabad ; (3) Dr. G. Bhattacharyya, Head, DRTC Bangalore.

(k) Seminar on "Technical information as a commodity". Bangalore, 3 March 1984. The leading presentations were made by Dr. Jozsef Kadar, Director, National Technical Information Centre and Library (OMIKK) Budapest, Hungary and Mr. Tibor Bazso, Advisor, State Office of Technical Development, Budapest, Hungary.

(l) DRTC annual seminar on "Perspectives of information science". Bangalore, 12-14 March 1984. Twenty three papers on various aspects of the theme contributed by the information scientists from different parts of India were presented.

(m) Seminar on "Energy information system in India". Bangalore, 16 March 1984. The leading presentation was made by Mr. N. K. Gopalkrishnan, Director, Energy Documentation Centre, TERI, Bombay.

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(n) Seminar on "PGI programme on computer applications". Bangalore, 24 March 1984. The leading presentation was made by Dr. John B. Rose, Programme Specialist, PGI, UNESCO, Paris.

(o) Seminar on "Information analysis and consolidation : An efficient and effective learning technique". Bangalore, 18 February 1984. The leading presentation was made by Ms Christina Louis, and other DRTC students.

(p) Seminar on "Measures for Library Evaluation". Bangalore, 29 March 1984. The leading presentation was made by Mr. Arup Ray Chaudhury and other DRTC Students.

4. PUBLICATIONS

The following publications were brought out during the period April 1983—March 1984 :

(i) *Sankhyā* : The Indian Journal of Statistics, the official organ of the Indian Statistical Institute.

Series A : Vol. 45, Part 2, 3

Series A : Vol. 46, Part 1

Series B : Vol. 45, Parts 1, 2, 3

(ii) *Proceedings* : The following seven Golden Jubilee proceedings are going through the press for printing.

(1) Proceedings of the Golden Jubilee Conference on Statistics : Applications and New Directions.

(2) Proceedings of the Golden Jubilee Conference on Review of the Indian Planning Processes.

(3) Proceedings of the Golden Jubilee Conference on Advances in Information Sciences and Technology.

Vol. 1 : Pattern Recognition and Image Analysis and Digital Communications ;

Vol. 2 : Information Storage, Retrieval and Processing ;

Vol. 3 : Microprocessor-based Computer Architecture.

(4) Proceedings of the Golden Jubilee Conference on Human Genetics and Adaptation.

Vol. 1 : Human Adaptation

Vol. 2 : Human Genetics.

(5) Proceedings of the Golden Jubilee Conference on Frontiers of Research in Agriculture.

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- (6) Proceedings of the Seminar on Combinatorics and Applications in Honour of Professor S. S. Shrikhande.
- (7) Proceedings of the Golden Jubilee Conference on Women, Work and Society.
- (iii) *Technical Reports* : Thirty three technical reports from the Statistics-Mathematics group have been issued during the period.

5. LIST OF SCIENTIFIC PAPERS AND PUBLICATIONS

5.1 *List of Papers Published*

A. Theoretical Statistics and Mathematics

1. Babu, G. J. (1983) : On the law of iterated logarithm for occupation measures of empirical processes. *Zeitschrift für Wahrscheinlichkeitstheorie und verwandte Gebiete*, 65, 73-81.
2. — (with Singh, Kesar) (1983) : Inference on means using the bootstrap. *The Annals of Statistics*, 11, No. 3, 999-1003.
3. — (1984) : Bootstrapping statistics with linear combinations of chi-squares as weak limit. *Sankhyas, A* (46), pt. 1, 85-93.
4. Bose, Arup (1984) : The Bernstein-von Mises theorem for a certain class of diffusion processes. *Sankhyas, A* (45), pt. 2, 150-160.
5. Huda, S (1983) : Two third-order rotatable designs in four dimensions. *Jour. State. Planning and Inference*, 8, 241-243.
6. Maitra, A. (1983) : Selectors for Borel sets with large sections. *Proc. Amer. Math. Soc.*, 89, 705-708.
7. Mazumder, B. S. (with Dandapath, B. S.) (1984) : Unsteady free and forced convective diffusion. *Int. Jour. Engng. Sci.* 22, 247-252.
8. Nag, Subhashis (1984) : On the holomorphy of maps from a complex to a real manifold. *Pacific J. Math.*, 110, 191-201.
9. Rao, S. B. (with Ghosh, S. and Singhi, N. M.) (1983) : On a robustness property of PB1BD. *J. Statistical Planning and Inference*, 8, 355-363.
10. Rao, T. J. (1983) : Horvitz-Thompson strategy vs. stratified random sampling strategy. *Jour. Stat. Plan. & Inf.*, 8, 43-50.
11. — (1983) : Some aspects of random permutation models in finite population sampling theory. *Metrika* 4.

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12. — (1984) : On Brewer's class of robust sampling designs for large scale survey. *Métri'a.*
13. — (1984) : Allocation of sample size to strata and related problems. *Biometrical Journal* 5.
14. Sarma, Y. R. (with Rao, J. S.) (1983) : A measure of association for circular data *Proc. 44th Session of ISI 1983*, vol. 2, 571-574.
15. Saha, G. M. (with Raktoe, B. L. and Pesotan, H.) (1982) : On the problem of augmented fractional factorial designs. *Communications in Statistics, Theor. & Math.*, 11 (23), 2731-2745.
16. — (with Kageyama, S.) (1983) : Bounds on the number of blocks in binary designs. *Bulletin, Faculty of School Education, Hiroshima University*, 6 (2), 61-63.
17. Sinha, B. K. (with Saha Ray, Rita) (1983) : Optimal weighing designs with a string property, *Jour. Stat. Planning & Inference*, 8, 365-374.
18. Dapat, N. B. (1983) : "Doubly Stochastic Matrices with Equal Subpermanents", *Linear Alg. and Appl.* Vol. 51, 1-8.
19. — (1984) : "A Matrix of permanents", *Linear Alg. and Appl.* Vol. 56, 57-62.
20. Bhattacharya, C. G. (1983) : "Use of Modified Estimators in Recovery of Inter-Block Information", *Sankhya B*, 45, Pt. 3, 466-470.
21. — (1983) : "On a Fundamental Result of Least Squares", *Gujarat Statistical Review*, Vol. 10, No. 1, 85-86.
22. — (1984) : "A Characterization of an Orthogonal Matrix with an Application", *Gujarat Statistical Review*, Vol. 11, No. 1, 39-40.
23. Mathew, Thomas. (1983) : "Linear Estimation with an Incorrect Dispersion Matrix in Linear Models with a Common Linear Part", *Journal of the American Statistical Association*, Vol. 78, No. 382, 468-471.
24. — (with Bhimasankaram, P.) (1983) : "On the Robustness of the LRT with respect to Specification Errors in a Linear Model", *Sankhya, Ser. A.*, Vol. 45, No. 2, 212-225.
25. — (with Bhimasankaram, P.) (1983) : "Optimality of BLUE's in a General Linear Model with Incorrect Design Matrix", *Journal of Statistical Planning and Inference*, Vol. 8, No. 3, 315-320.

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26. — (with Bhimasankaram, P.) (1983) : "On the Robustness of LRT in Singular Linear Models", Sankhya Series A., Vol. 45. No. 3, 301-312.
27. Mitra, S. K. (1983) : "On Estimability in Linear Models", Gujarat Statistical Review 10, 45-47.
28. — (with Puri, M. L.) (1983) : "The Fundamental Bordered Matrix of Linear Estimation and the Duffin-Morley General Linear Electro-Mechanical Systems", Applicable Analysis 14.
29. Mukherjee, K. K. (with Bhatia, R.) (1983): "On the Space of Unordered Triples of Complex Numbers, J. Lin. Alg. and its Appl.,
30. Parthasarathy, K. R. (with Karandikar, R. L. and Hudson, R. L.) (1983) : "Towards a theory of Non-Commutative Semimartingales Adapted to Brownian Motion and a Quantum Ito's formula", Springer 49.
31. Parthasarathy, K. R. (with Hudson, R. L.) (1983) : "Quantum Diffusions", Springer, 49.
32. — (with Sinha, K. B.) (1983) : "On the Stochastic Dyson Series", Springer 49.
33. Parthasarathy, T. (with Ramamurthy, K. G.) (1983) : "A Note on Factorization of Simple Games", OPSEARCH, 20, 170-174.
34. Rao Prakasa, B. L. S. (1983) : "Characterization of Stochastic Processes by Stochastic Integrals", Adv. Appl. Prob. 15, 81-89.
35. — (1983) : "Asymptotic theory for non-linear least square estimators for diffusion processes", Math. Operations forch Statist. Ser. Statistics, 14.
36. Sunder, V. S. (1983) : "A spectrum modulo operators of rank less than n " Mathematics Today, 1, 81-88.

B. Applied Statistics, Surveys & Computing

1. Bandyopadhyay, Shibdas : Admissibility of likelihood ratio rules in covariate classification using dependent samples, Australian Journal of Statistics, No. 3.
2. Bhimasankaram, P. (with Mathew, T.) : On the robustness of the LRT with respect to specification errors in a linear model, Sankhya Ser. A, 45, 212-225.
3. Chaudhuri, A. (with Adhikari, Arun K.) : On optimality of double sampling strategies with varying probabilities, Journal of Statistical Planning and Inference, 8, 257-265

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4. — On the relative efficiencies of several strategies for estimating a finite population mean, *Biometrica*, 70, 689-693.
5. Gupta, Bidyut (1983) : Anomalous properties of stuck-at fault in combinational logic circuit, *Proceedings of the IEEE*, Vol. 71, No. 6, 779-780.
6. — : Syndrome testable design of combinational network for detecting stuck-at and bridging faults, *Proc. Int. Test Conf.*, Cherry Hill, 83, USA, 446-452.
7. Maitra, T. : Some distributional aspects of public services in national consumption, *Journal of Income and Wealth*, Vol. 6.
8. Majumder, Partha Pratim : Application of Isozymes to the mapping of inherited ophthalmic disorders, *Isozymes*, II : 121-135.
9. — : A note on positive identification of paternity by using genetic markers, *Human Heredity*, 33, 29-35.
10. — : Relative risks of diseases in the presence of incomplete penetrance and sporadics, *Statistics in Medicine*, 2, 13-24.
11. Pal Chowdhury, P. : Information Theoretic Model of a $p-t$ diagnosable system, *Proceedings of IEEE International Symposium on Circuits and Systems*, Los Angeles, USA, 1306-1309.
12. Sen, Arunabha : Interpolation Merge-Case for a new Merge Algorithm (Invited Paper), *Proceedings of the Annual Convention of Computer Society of India*, Ahmedabad.
13. — : On System Diagnosis with Multivalued Test Outcomes, *Proceedings of the 13th International Symposium on Multiple valued Logic*, Kyoto, Japan.

C. Physical and Earth Sciences

1. Digital Electronics

1. Bhattacharya, B. B. (with Gupta, B.) (1983) : "Anomalous effect of a stuck-at fault in a combinatorial logic circuit", *Proc. IEEE* Vol. 71, No. 6, 779.
2. — (1983) : "Syndrome testable design of combinational networks for detecting stuck-at and bridging faults", *Proc. IEEE 1983, International Test Conference*, Philadelphia, 446-452.

2. Theoretical Physics

1. Bandyopadhyay, P. (with Sarkar, H. and Bhattacharya, B.) (1983) : Finite quantum field theory and neutrindynamics, *International Journal of Theoretical Physics (USA)*, 22, 617.

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2. — (with Roy, S.) (1984) : Half-orbital angular momentum and Loventz invariance in anisotropic space, *Hadronic Journal (USA)*, 7.
3. Basu, S. (with Roy Chowdhury, R. K.) (1983) : Nonlinear Coupling of Two three wave systems in Plasma, *J. Plasma Physics (UK)*, 30, 345.
4. Bhattacharyya, B. (with Bhattacharyya, Sikha, and Roy Choudhury, R. K.) (1984) : The operator method and eigenvalues of Quartic and Sextic Anharmonic Oscillators, *FIZIKA*, 16 (2), 161, (Yugoslavia).
5. Bhattacharyya, D. P. (with Roy Choudhury, R. K.) (1984) : Photo-nucleon cross section of High Energy Muons, *Fizika (Yugoslavia)* 16.
6. Bhattacharyya, S. (1983) : Secondaries in $P\bar{P}$ Colliders at SPS energies and a multiple production model, *Fizika (Yugoslavia)*, 15(3), 299.
7. Roy, Pinaki. (1984) : On supersymmetry breaking in a strong magnetic field. *J. Phys. (UK)*, G 10, 417.
8. — (1984) : Comment on the effect of a strong magnetic field and high temperature on spontaneously broken gauge theories, *Phys. Rev. (USA)*, D. 29, 1857.
9. — (with Roy Choudhury, R. K.) (1984) : On Super-symmetry and Random sources, *J. Phys. (UK)*, G. 10, L. 51.
10. Roy, S. (1984) : Stochastic Space-time, Quantum theory and constancy of the speed of light. *Hadronic Journal (USA)*, 7.
11. Roy Choudhury, R. K. (with Ghosh, Barnana) (1984) : Borel summation method and first order Perturbation Formula for the potential $V(r) = F/r^2 + H/(r + z^2)$, *Z. Naturf (West Germany)*, 39A (2), 142.
12. — (1984) : Quark Confinement Potential and Regge Trajectory, *Fizika (Yugoslavia)* 16, 79.
13. Sidhanta, J. (with Roy Choudhury, R. K. and Bhattacharyya, D. P.) (1983) : Rigorous saddle Point Method for Cosmic Ray Integral, *Phys. Rev. (USA)*, D28, 1113.

3. *Fluid Mechanics*

1. Dandapat, B. S. (1983) : On the non-linear stability of the Ekman layer on a porous plate, *Proceedings of the Second Asian Congress of Fluid Mechanics, Beijing, China*, 202-207.

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2. — (with Gupta, A. S.) (1978) : Global Stability of Hartman flow between two parallel plates, Recent Adv. Applied Maths. and its Applications, 1-7.
3. — (with Mazumdar, B. S.) (1984) : Unsteady free and forced convective diffusion through a Channel, Int. J. Engg. Sci. 22. 247-252.
4. Ghosh, A. (1983) : Study of flow field in a hydrocyclone, Proceedings of the Second Asian Congress of Fluid Mechanics, Beijing, China, 518-522.
5. — (with Deb Nath, K. D. and Majumdar, A. K.) (1983) : On the flow in a rectangular cavity, Indian Journal of Pure and Applied Mathematics, 14(5), 646-660.
6. — (with Dawn, C. S. and Modak, G. C.) (1983) : A simple procedure for determination of antenatal foetal weight, The Journal of Obstetrics and Gynaecology of India, Vol. 33, No. 1, 133-137.
7. Mazumdar, H. P. (with Chakraborty, A. K. and Bhattacharyya P.) (1983) : On Kovasznay's theory of homogeneous and isotropic turbulence, River Behaviour and Control, Vol. XV, 12-18.

4. Geology

1. Jain, S. L. (with Sabni, Ashok) (1983) : Some Upper Cretaceous vertebrates from Central India and their palaeo-geographic implications. In, Cretaceous of India : Palaeoecology, Palaeogeography and Time boundaries (ED. H. K. Maheswari), Indian Association of Palynostratigraphers, Lucknow, 66-83.
2. — (1983) : Spirally coiled 'coprolites' from the Upper Triassic Maleri Formation, India. Palaeontology (London), Vol. 26, Pt. 4, 813-829.
3. — (1984) : A review of the genus *Lepidotes* (Actinopterygii : Semionotiformes) with special reference to species from Kota Formation (Lower Jurassic), India. Journal of the Palaeontological Society of India, Vol. 28. Plates I-V, 7-42.
4. Sen Gupta, Sugata. (1984) : A reinterpretation of the stratigraphy of the Delhi Supergroup of Central Rajasthan between Rajosi and Chowadasya, Ajmer dt. Rajasthan. India Journal of Earth Sciences, Vol. 11, No. 1, Figs. 1-13, 38-49.

5. Flume Project

1. Mazumdar, B. S. (with Dandapat, B. S.) (1984) : Unsteady free and forced convective diffusion, Int. Jour. Engg. Science, USA, Vol. 22, 247-252.
2. — (with Ghosh, J. K. and Sengupta, S.) (1984) : Deposition from suspension : Experimental Theoretical Studies, Accepted in 4th Int. Symp. on Stochastic Hydraulic Dept., of Civil Engineering, University of Illinois, Urbana, USA.

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6. *Physics*

1. Ganguly, S. (with Mukherjee, T. K.) (1983) : Design of non-interacting controller for d.w.r. synchronous machine, *Journal of the Institute of Engineers (India)*, 63, Pt. El. G. 256-258.
2. — (1983) : Design of non-interacting controller for 2-shaft gas-turbine, *Journal of the Institute of Electronics & Telecommunication Engineers*, 29, No. 11, 559-561.
3. Gupta, A. B. (with Ghosh, K. G.) (1983) : Tensile properties of Human scalp hair in diffuse alopecia (Abstract), IV International Symposium on Bioengineering and the Skin, Besancon, France, 43.
4. — (with Ghosh, S. N.) : Hardness of human nails : normal and pathological. IV International Symposium on Bioengineering and the Skin, Besancon, France, 34.

7. *Chemistry*

1. Das, T. (with Ghosal, D. N.) : Chemistry of Soil Organic Matter in West Bengal Soils. *Acta Agrochemica*.

8. *Electronics and Communication Science*

1. Chanda, B. (with Chaudhuri, B. B. and Dutta Majumder, D.) (1984) : 'A modified technique for image segmentation and edge detection', *Proc. Int. Conf. Cyber, Soc., India*, 777-781.
2. Chaudhuri, B. B. (with Kundu, M. K.) (1984) : 'Digital line segment coding : A new efficient contour coding scheme', *Proc. IEEE, Part-1*.
3. Datta, A. K. (1984) : 'On some properties of digital lines', *Proc. IEEE Int. Conf. SMC, India, Vol. 1*, 156-160.
4. — (with Ganguli, N. R., Mukherjee, B., Dutta Majumder, D., Banerjee, B. M., Sengupta, S. and Nag, D.) (1983) : 'Spectral characteristics of vowels sung in Hindusthani Shastriya Sangeet', *Jour. SRA, Vol. 4*, 62-69.
5. — (with Ganguli, N. R. and Dutta Majumder, D.) (1983) : 'Speech and Music—A review on quantitative studies', *Jour. Sangeet Research Academy, Vol. 4*, 77-91.
6. — (with Ganguli, N. R.) (1984) : 'Machine recognition of plosive sounds using VC contextual information', *Proc. IEEE Int. Conf. SMC, Vol. 1*, 336-339.

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7. Dutta Majumder, D. (1983) : 'Fuzzy sets and systems—Theory and some applications', Journal of Indian Society for Cybernetics, Informations Sci. and Management Applications (SCIMA), Vol. 12, No. 2 & 3, CSIR, New Delhi.
8. — 'A scientific approach on the art of music', Jour. SRA, Vol. 4, No. 1, 70-72.
9. Kundu, M. K. (with Chaudhuri, B. B. and Dutta Majumder, D.) (1984) : 'Digital line segment coding : A generalization to contour run length coding', Proc. Int. Conf. SMC, Vol. II, 903-907, Delhi.
10. Pal, S. K. (with Deravi, F.) (1983) : 'Grey level thresholding using second order statistics', Pattern Recognition Letters, Vol. 1, 417-422.
— (with Pathak, A. and King, R. A.) (1984) : 'Syntactic recognition of skeletal maturity', Pattern Recognition Letters, Vol. 2, 193-197.
12. — (with Guha, M.) (1983) : 'A comparative study of some edge detection techniques', Proc. IEEE SMC, Delhi, 1230-1234.
13. Parui, S. K. (with Dutta Majumder, D.) (1983) : 'Two methods for quantification of shape distance between open curves', Proc. IEEE Int. Conf. SMC, Bombay-Delhi, 581-585.
14. Ray, K. S. (with Dutta Majumder, D.) (1983) : Guidelines for measurement of combustion inside the furnace of a steam generation Unit', IETE, Vol. 20, No. 10.
15. ——— (1984) : 'Application of circle criteria for stability analysis of linear SISO and MIMO systems associated with fuzzy logic controller', IEEE System Man. Cybern., Vol. 14, No. 2.
16. — (with Kuoraritakis, B. A.) (1984) : 'An extension of characteristic sequences method to the case of repeated roots', IEEE Automatic Control, Vol. 24, No. 9.
17. — (with Dutta Majumder, D.) (1984) : 'Simulation of a nonlinear steam generating unit', Proc. IEEE Int. Conf. SMC, Vol. 1.
18. Roy, Anuradha (with Dutta, A. K.) (1984) : 'A statistical recognition of vowel in connected speech', Proc. IEEE Int. Conf. SMC, India, Vol. 1, 336-339.

D. Biological Sciences

1. Anthropometry and Human Genetics

1. Mukherjee, B. N. (with Reddy, A. P., Ramchandriah, T. and Murthy, M. S. R.) (1983) : Red cell glucose-6-phosphate dehydrogenase deficiency in five endogamous groups of Andhra Pradesh. Comparative Physiology & Ecology, 107-108.

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2. — (with Baxi, A. J., Joshi, S. H., Malhotra, K. C. and Kate, S. L.) (1983) : Incidence of Hepatitis B (Australia). Antigen among three communities in Malarial Western Maharashtra, India. *Human Heredity* (Denmark), 33, 231-236.
3. — (with Reddy, A. P., Malhotra, K. C., Das, S. K. and Ramchandriah, T.) (1982) : A serological and biochemical genetic study among the coastal and plateau Yanadis : A tribal population of Andhra Pradesh. *HOMO* (W. Germany), 33, 174-183.
4. — (with Reddy, A. P.) (1983) : Wide spread distribution of LDH variants in various ethnic groups of India, *SAP*, 5, 1-12.
5. — (with Sauber, P., Walter, H. and Malhotra, K. C.) (1982) : Isoelectric focusing in the detection of extended polymorphism of PGM₁ in ten endogamous groups of West Bengal and Orissa, India, *Proc. Int. Symp. Recent. Trend. Immunohaematology* (ICMR) Bombay. 182-188.
6. — (with Reddy A. P., Kumar, Vijaya, M. and Malhotra, K. C.) (1983) : Genetic relationship between the chenchu, Irula and Yanadi : A Reassment. *Indian. Jour. Anthrop. Soc.* 18, 31-34.

2. Biochemistry

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29. Mukherjee, B. N. : Computerised method for analysis of covariance structures. (Behaviourometrica Vol. 14).
30. — Redundancy analysis in the singular case. (Psychometrica).
31. Mukherjee, B. N. (with Yani, H.) : Image analysis from a singular correlation matrix. (Psychometrica).
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33. — : Generalised algorithm for Computer Graphic objects like polygons. (JIETE).

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35. — : On system diagnosis algorithm with adaptive testing. (IEEE FTCS-14).
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37. Sen Arunabha. : On system diagnosis in presence of intermittent faults. (IEEE Trans. on Computers).
38. — : On the completeness of diagnosis of intermittent faults (IEEE trans. on Computers).

C. Physical and Earth Sciences

1. *Digital Electronics*

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2. — : "Logical modeling of physical failures and their inherent syndrome testability in MOS/VLSI", Communicated to IEEE 1984 Int. Test Conference, Philadelphia, U.S.A.
3. — : "Optimal interconnection in digital systems satisfying concurrency constraints", Int. J. of Systems Science, (To Appear).
4. — : "A graph theoretic approach to optimal design of static-logic hazard free combinational circuits", Proc. IEEE 1984. International Symposium on Circuits and Systems (ISCAS), Montreal, May 1984, (To Appear).
5. — : "Optimal design of hazard-free easily testable logic networks", Int. J. Systems Science, (To Appear).
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7. — (with Gupta, B. Sarkar, S. and Choudhury, A. K.) : 'Design of EX-OR SUM-OF-PRODUCT networks with universal tests for detecting stuck-at and bridging faults', Computers and Electrical Engg. (Pergamon Press). (To appear)
8. — : 'Design of easily testable RMC network for detecting bridging fault', Communicated to Proc. IEEE.

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10. ----- : 'A heuristic search approach to optimal routing and some related properties in trivalent processor network graphs'. Communicated to IEEE-ICCSP 1984.
11. ----- : 'A new diagnosis algorithm for general self diagnosable systems'. Communicated to IEEE-ICCSP 1984.
12. ----- : 'A paralel algorithm to compute the diameter of a symmetric graph', Communicated to IEEE-ICCSP 1984.
13. Pal, A. (with Bhattacharya, B. B).. 'Syndrome testable logic design with DSTL arrays for detecting stuck-at and bridging faults'. Proceedings of IEEE, (To appear).
14. Sinha, B. P. (with Dattagupta, J. and Sen, Asish). 'Improved FFT algorithm using memory segmentation technique'. Signal Processing, (To appear).
15. -- (with Bhattacharya, B. B.) : 'On the numerical complexity of short circuit faults in logic networks'. IEEE Trans. Comput. (To appear).

2. Theoretical Physics

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2. ----- : Possible resolution of the likesign dimuon puzzle in neutrino-induced high energy interactions. (To appear in Hadronic Journal, USA).
3. Roy, Pinaki : On supersymmetry and Random sources—Z. Fur Phys. C. (West Germany).
4. -- : Supersymmetry under the influence of a strong magnetic field and high temperature—Z. Fur Phys. C. (West Germany).
5. --- : Supersymmetry in non-simply connected space time—Gzech. J. Phys. B.
6. --- : Supersymmetry and Magnetic fields—Czech. J. Phys. B.

3. Fluid Mechanics

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3. Haldar, K. : Study of storm surge problem on a continental shelf with sloping bottom. Mausam.
4. Mazumdar, H. P. : On the fluctuations of total pressure associated with a general type of hydromagnetic turbulence. Archeves Mechanics (accepted for publication).

4. *Electronics and Communication Science*

1. Biswas, S. N. (with Chaudhuri, B. B.) : 'On the generation of discrete circular objects and their properties'. Computer Vision Graphics and Image Processing.
2. Chakraborty, B. (with Mukherjee, B. and Dutta Majumder, D.) : 'Automatic accuracy detection of vocal notes in North Indian Classical Music'. Tor. Sangeet Research Academy.
3. Chanda, B. (with Chaudhuri, B. B. and Dutta Majumder, D.) : 'A hybrid edge detector and its properties'. Inter. J. Syst. Science, (1984).
4. ————— : 'A differentiation/enhancement edge detector and its properties'. IEEE Trans. SMC.
5. ————— : 'An efficient least-square biomedical image restoration using image-noise correlation criterion', JIETE.
6. ————— : 'Noise removing image segmentation through grey level histogram sharpening. IEEE. Trans. SMC.
7. Das, J. : 'On the compression of Biomedical signals'. JIETE.
8. Datta, A. K. (with Ganguli, N. R.) : 'Behaviour of terminal frequencies in VC combination'. Acustica.
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11. Kundu, M. K. (with Chaudhuri, B. B. and Dutta Majumder, D.) : 'A generalized digital contour coding scheme'. Computer Vision, Graphics and Image Processing Tor. (Academic Press).
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14. ——— (with Murthy, C. A. and Dutta Majumder, D.) : 'Correlation between two fuzzy membership function'. Fuzzy Sets and Systems.
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17. ——— (with Pethak, A.) : 'Fuzzy grammars in syntactic recognition of skeletal maturity from X-rays'. IEEE Trans. SMC.
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19. Ray, K. S. : "Application of fuzzy logic controller to a block decoupled nonlinear steam generating unit (210 MW)." IEEE Trans. Automatic Control.
20. ——— (with Ghosh, A. M. and Dutta Majumder, D.) : ' L_2 -stability and related design concept for SISO linear system associated with fuzzy logic controller', IEEE Tr. SMC.
21. ——— (with Dutta Majumder, D.) : 'Fuzzy logic control of a nonlinear multivariate steam generating unit (200 MW) using developing theory'. IEEE Trans. SMC.

5. *Geology*

1. Chaudhuri, A. : Stratigraphy of the Purana supergroup around Ramgundam, Andhra Pradesh : Journal of the Geological Society of India, (Accepted).
2. ——— (with Howard, J. D.) : Ramagundam sandstone : a Middle Proterozoic Shoal bar sequence : Journal of Sedimentary Petrology.
3. Jain, S. L. : A new triassic fish (Actinopterygii : Saurichthiformes) from the Yerrapalli Formation, Pranbitha-Godavari Valley, India. Journal of the Geological Society of India, (Accepted).
4. ——— : Variability of dermal bones and other parameters in *Amia calva*. Zoological Journal of the Linnean Society, London, (Accepted).

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6. Rudra, D. K. (with Bandyopadhyay, S.) : The Upper Gondwana Stratigraphy north of the Pranhita-Godavari confluence : Journal of the Geological Society of India.

6. *Physics*

1. Ghosh, K. G. (with Ghosh, S. N. and Gupta, A. B.) : Tensile Properties of human umbilical cord. Indian Journal of Medical Research.
2. Gupta, A. B. (with Ghosh, S. N.) : Hardness-thickness correlation of human finger nails. Indian Journal of Medical Research.

7. *Chemistry*

1. Das, T. (with Ghosal, D. N.) : Distribution and Forms of Organic Matter in Soils of West Bengal. I. Himalayan and Sub-Himalayan Soils. J. Indian. Soc. Soil Sci.
2. ———— : Distribution and Chemistry of Organic Matter in Soils of West Bengal. II. Alluvial and Lateritic Soils. J. Indian Soc. Soil Sci.
3. ———— : Physico-Chemical Characteristics of Saline Soils. Journal of the Indian Society of Coastal Agricultural Research.

D. Biological Sciences

1. *Anthropometry and Human Genetics*

1. Basu, S. (with Gupta, R.) : Comment on the paper entitled "High altitude hypoxia, culture and human fecundity/fertility : a comparative study". by M. C. Goldstein, P. Tsarong and C. M. Beall. American Anthropologist, Washington, 1983.
2. Mukherjee, B. N. : Biochemical Markers : Its distribution in Indian Tribes. South Asian Anthropologist.
3. ——— : Genetic heterogeneity in the Tribal population of South Western India. *Proced. International Symposium on genetic Micro-differentiation in Human and other population 1983.*
4. ——— : Human Placenta for population Genetic study : Special reference to Alkaline phosphatase isozymes in Indian populations. Indian Jour. Phys. Anthropol. Hum. Genet.

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5. ——— (with Reddy, A. P.) : Gene diversity among the tribes of South and Western India : Distance analysis in ten tribal groups. *Indian J. Anthropol. Soc.*
6. ——— (with Das, S. R.) : Haptoglobin : Genetic and variation in Indian population. *Institute of Ethnography, USSR.*
7. ——— (with Reddy, A. P., Malhotra, K. C. and Sauber Peter and Walter, H.) : Transferrin polymorphism by Isoelectric focusing in three endogamous of Midnapur & Coochbehar, West Bengal. *Zeitsch. Morph. Anthropol. West Germany.*
8. ——— (with Malhotra, K. C., Das, Raj Kumar, Bandyopadhyay, S. and Kate, S. L.) (1982) : Spatial and social variation in Sickle cell trait, G-6-PD deficiency and Malarial incidence in North Maharashtra : A preliminary Report. *Proc. International Conf. Hum. Genet. Adapt. ISI. Golden Jubilee.*
9. ——— (with Kate, S. L., Phadke, M. A. and Sainani, J. S.) : Study of plasma Enzyme cholinesterase variants amongst different population groups of Maharashtra India. *Proc. International Conf. Hum. Genet., Adapt. ISI Golden Jubilee.*
10. ——— (with Malhotra, K. C.) : Incidence of Red Green colour Blindness in population groups of North West India. *Institute of Ethnography, Soviet Academy of Sciences, USSR.*
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12. ——— (with Reddy, A. P. and Basu, Ahabinda) : Glyoxalase polymorphism among three tribes of Eastern India : *Indian J. Anthropol. Soc.*
13. Pakrasi, Kanti. : Marriage System and its Impact on Family Formation and Family Planning. *The Proceedings of the New Delhi Conference on Recent Population Trend in South Asia.*
14. ——— : Control of Expanding Family : Indian Experiences. *Journal of the Indian Anthropological Society, Calcutta.*
15. ——— (with Basumallick, T., Chowdhury, S. and Chakraborty, M.) : The Mentally Retarded children of Eastern India. *Social Biology, USA.*
16. ——— (with Bandyopadhyay, S., Sil, S., Banerjee, J. and Banerjee, A. R.) : Motor Development of Bengali Infants by Nutritional Status in the First Year of Life. *Anthropological Kozlemeneyck, Hungary.*

2. Biochemistry

1. Bhattacharya, S. K. (with Bharati, P., Mukhopadhyay, B. and Maitra, N.) : Intestinal parasitic prevalences in relation to economic status in a village population of Howrah district, West Bengal, *In* : *Indian Journal of Public Health.*

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2. ——— (with Das, S. K., Gupta, R., Roy, D. and Basu, A.) : Variation in differential leucocyte count in relation to age and body build in a rural population of West Bengal, India. *In* : Canadian Review of Physical Anthropology.

3. *Crop Science*

1. Ghosh, M. : Vessel elements in roots of young Palms. Principles, USA.
2. ——— : The anatomy of roots in young palms. Journal of Indian Botanical Society.
3. ——— (with Jobri, B. M. and Davis, T. A.) : On the frequency of stomata in leaves of young and adult palms. Phytomorphology.

4. *Leaf Protein*

1. Banerjee, Anjana : Nutritional potential of the winged bean. Indian Jour. Nutrition & Duthis.
2. ——— (with Bagchi, D. K. and Si. Lohit) : Studies on the potentialities of winged bean as a multipurpose legume cover crop in tropical regions. Experimental Agriculture, London, U.K.
3. ——— (with Bagchi, D. K. and Matai, S.) : Edible protein from a common weed, *Allmania nodiflora* R. Br. Current Science.
4. Bagchi, D. K. (with Banerjee, A., Chakraborty, S. and Bhattacharya, B.) : Performance of turnip as root and leaf protein yielding crop under different lamb of nitrogen, boron and molybdenum. Jour. of Horticultural Science, U.K.
5. ——— (with Banerjee, A. and Bhattacharya, B.) : Effect of nitrogen, boron and molybdenum on root and extracted protein yield of radis. Indian Journal of Agric. Sci., I.C.A.R. New Delhi.

5. *Embryology*

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2. ——— : Twinning and Cellular Deadhesion, in *Limnaea* Embryos Induced by Glycerol and Tunicamycin.
3. ——— (with Dutta, J.) : Characterisation of Leopard Pheromones.
4. Tapaswi, P. K. (with Roychowdhuri, R. K.) : A Stochastic Model of Gene Activation and RNA Synthesis during Embryogenesis.

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5. ----- : A New Approach to the Distribution Problems Arising in the Study of Population Growth of Sexes.

E. Social Science

1. *National Income Research*

1. Ghosh, Buddhadev (with Gupta, Swagata) : Regional Bias in Secondary Sector Activity : The case of West Bengal. *Business Standard*.
2. Roy, Bina (with Datta, Pranati) : Estimation of the stock of some consumer durable goods in India in 1980 from time series production data. *Journal of Income and Wealth*, Vol. 6, No. 2, July 1982.
3. --- (with Saha, Somesh and Mukherjee, M.) : Certain observations on the share of cash expenditures in total consumption by states. *Journal of Income and Wealth*, Vol. 6, No. 2, July 1982.
4. --- (with Choudhuri, Bharati) : Comparative study of growth between different regions in India. *Journal of Income and Wealth*, India.

2. *Pre-Census Population Studies*

1. Bhattacharya, Durgaprasad. : On Sociological Writings in Bengali 1800-1850. *Bulletin of the Socio-Economic Research Institute*.
2. ----- (with Deb Roy, Rama) : Data base of a Quantitative Socio-Economic History of India. *Proceedings of the Indian Historical Records Commission*, Vol. 49.
3. ----- : Glimpses of Land Records in Bengal, 1750-1850. *Proceedings of the Indian Historical Records Commission*, Vol. 49.
4. ----- : On some Source Materials of the 19th Century Economic History. *Bulletin of the Socio-Economic Research Institute*.
5. Chatterpadhyay, Kunal : Human Resources and its Role in Tourism Development. *Socialist Perspective*.

3. *Economic Analysts*

1. Iyengar, N. S. : "An analysis of economic size distributions with illustrations from National Sample Survey data". *Journal of Quantitative Economics*.
2. Nayak, Vijay (with Prasad, Shailaja) : "On the levels of living of the Scheduled Castes/Scheduled Tribes". *Economic and Political Weekly*.

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3. Suryanarayana, M. H. : "Living Levels in Karnataka". *Economic and Political Weekly*.

4. *Sociology*

1. Chakraborty, Aniruddha : "Accumulation Process of economic and political Supremacy of Brahman : A case study in Palamau District, Bihar". *Journal of Indian Anthropological Society, Calcutta*.
2. Chakraborti, Prafulla : "Some aspects of 'Complex' families in Calcutta. *Journal of Comparative Family Studies, Canada*.
3. Chattopadhyay, Manabendu : "Labour, tenure and farm efficiency". *Labour Capital and Society (McGill University, Montreal, Canada)*.
4. ----- : "Transformation of labour use in Indian Agriculture". *Cambridge Journal of Economics, Cambridge, U.K.*
5. ----- (with Haldar, S.) : "Labour and Modes of Production". *Society and Change, Calcutta*.
6. ----- (with Chatterjee, Arun Kr.) : "Agrarian relations in a North Bengal peasant movement belt : Historical evolutions and contemporary situations". *Indian Economic and Social History Review (School of Economics, Delhi)*.
7. ----- (with Ghosh, Sumit Kr.) : "Poorer among the poor". *Social Scientists, Trivandrum*.

5. *Psychometry*

1. Ghosh, Anjali : Self-Drawing as a measure of Intellectual Maturity in a group of Hearing-impaired Children. *Journal of Social and Economic Studies*.
2. --- (with Gupta, Patralekha) : A study of intellectual maturity in a group of hearing impaired children using two different non-verbal tests of intelligence. *ISPT Journal of Research*.
3. Mukherjee, M. (with Chatterji, S.) : Effectiveness of Merit as Promotion Criterion. *Productivity*.
4. ----- : Personality Pattern and Success. *Japanese Journal of Psychological Research*.

6. *Economic Research*

1. Bhattacharya, N. (with Chatterjee, G. S. and Pal, Padmaja) On variation in level of living across regions and social groups in rural India during 1983-84 and 1973-74. *Rural poverty in South Asia*.

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2. Chattopadhyay, M. : Agrarian relations in a North Bengal peasant movement belt : Historical evolution and contemporary situation. *Man and Development*.
3. ——— : Transformations of labour use in Indian agriculture. *Cambridge Journal of Economics*.
4. ——— ; Class differentiation within the peasantry. *Economic and Political Weekly*.
5. ——— : Conditions of labours in Indian agriculture. K. P. Bagchi and Company.
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7. ——— (with Majumdar, A.) : A system of demand equations, based on price independent generalised linearity. *International Economic Review*.
8. Dutta, Bhaskar : Effectivity functions and acceptable game forms. *Econometrica*.
9. ——— : Non Cooperative implementation and surplus sharing methods of public project selection. *Journal of Public Economics*.
10. ——— (with Barbera, Salvador) : General, direct and self implimentability. *Journal of Mathematical Economics*.
11. ——— (with Gevers, Lewis) : On majority rules, veto rights and "Perfect equilibrium allocation of a shrinking cake". *Review of Economic Studies*.
12. Pal, Padmaja : Variation in the level of living across social groups in India during 1973-74. *Economic and Political Weekly*.
13. Panda, M. K. (with Majumder, K. C.) : Intertemporal consistency and Sixth plan model of India. *Economic and Political Weekly*.
14. Sengupta, A. K. : Import substitution in Govt. consumption and its economic repercussion. *Lokudyog*.

7. *Planning* (Delhi)

4. Bhat, L. S. : "Market town and production centres in India". Proceedings of the conference on recent population trends in South Asia, East-West Centre, University of Hawaii, Honolulu.
2. Chander Prakash : "Surplus sharing rules and incentives in planning procedures for public goods". *Econometrica*.

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3. --- (with Kundu, T. R.) : "On the multiple basis exchange algorithm". Naval Research Logistics Quarterly.
4. --- (with Dubey Pradeep) : "Input-Output prizes with endogeneous demand" in the Review of Economics and Statistics.
5. Chetty, V. K. : "Fenchel duality theorem and the dual in non-linear programming. Journal of Quantitative Economics.
6. --- (with Jha Sikha) : "Dual price equilibrium : Existence and efficiency. Econometrica.
7. ----- : "Micro-Economics of rationing and licensing. Journal of Quantitative Economics.
8. ----- : "Dual pricing and supply behaviour : A partial equilibrium analysis", Economics and Political Weekly.
9. Gangopadhyay, S. : "In submission with or without surplus labour" Oxford Economics Paper.
10. --- : "Change of Technics". Economic Development and Change.

F. Statistical Quality Control

1. Ghosh, D. T. : 'An investigation on the effect of inspection error on AOQ of a Single Sampling Plan acceptance-rectification system'. 'Sankhya'.
2. Iyer, Narayan. V. : 'Popularising defect prevention approaches in industries through operative training programme'. QR Journal of Indian Association for Quality & Reliability.
3. Majumdar, S. K. : 'Effect of Processing Variables on the superplastic behaviour of Zn-22% Al Alloy'. Journal of Japan Institute of Metals.
4. --- : 'Role of iron on the superplastic behaviour of aluminium bronze'. Scandinavian Journal of Metallurgy.
5. Rajendra Prasad, V. : 'Stochastic scheduling on two non-identical parallel processes'. OPESEARCH.
6. --- : 'Scheduling on a single processor subject to interruptions in processing'. OPESEARCH.
7. Ramamurthy, K. G. (with Mohan, S. R.) : 'Non-negativity of principal minor Po-matrices'. 'Linear Algebra and its Applications'.

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8. --- (with Parthasarathy, T.) : 'Probabilistic implications of the assumption of homogeneity'. OPSEARCH.
9. --- (with Parthasarathy, T.) : 'Contraction of simple games and its applications'. OPSEARCH.
10. --- (with Parthasarathy, T.) : 'Matroidal games'. International Journal on Game Theory.
11. Tijs, S. H. (with Parthasarathy, T., Potters, J. A. M. and Rajendra Prasad, V.) : 'Permutation games: Another class of totally balanced games'. 'OR Spektrum'.

G. Documentation Research and Training

1. Bhattacharya, G. : Analysis of the structures of outstanding subject indexing languages in the light of the general theory. Journal of Library and Information Science.
2. --- : User education and user orientation : Some basic considerations. Library Herald.
3. Devadason, F. J. : On-line construction of alphabetic classaurus : A vocabulary control and indexing tool. Information Processing and Management (USA).
4. Gopinath, M. A. : Development of library and information professional. Library Herald.
5. --- : Impact of bibliographic data base services on citation in technical papers. Journal of Librarianship.
6. --- : 'Multi disciplinary subjects : Their emergence, structure, development and classification. Library Science with a slant to Documentation.

5.3 PAPERS READ AT CONFERENCES AND OR TO BE PUBLISHED IN CONFERENCE PROCEEDINGS

A. Theoretical Statistics and Mathematics

1. Bapat, R. B. (with Sunder, V. S.) : "On Majorization and Schur Products". Presented at the Regional Conference on Statistics and Probability, December 12-14, 1983, Indian Statistical Institute, New Delhi.
2. Mathew, Thomas : "Admissible linear estimation in singular linear models". Regional Conference on Statistics and Probability, December 12-14, 1983, Indian Statistical Institute, New Delhi.

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3. Parthasarathy, K. R. : "Quantum Ito's formula and Stochastic Evolutions" Presented at the Regional Conference on Statistics and Probability, December 12-14, 1983, Indian Statistical Institute, New Delhi.
4. ——— (with Hudson, R. L.): "Construction of quantum diffusions in Quantum Probability and Applications to the Quantum Theory of Irreversible Processes". Ed. L. Accardi, Springer L. N. M.
5. Parthasarathy, T. (with Ramamurthy, K. G.) : "Probabilistic implications of the assumption of homogeneity", Regional Conference on Statistics and Probability, December 12-14, 1983, Indian Statistical Institute, New Delhi.
6. Prakasa Rao, B. L. S. "The rate of convergence of the least squares estimator in non-linear regression model for dependent errors". East Asian and Pacific Regional Conference on Statistics and Probability, Indian Statistical Institute, New Delhi, December 12-14, 1983.
7. ——— : "On some applications of the non-parametric statistical analysis for counting processes" in the Symposium on "Statistical Methods for Stochastic Processes" held during the 71st Session of Indian Science Congress at Ranchi on January 5, 1984 (invited talk).
8. Ramachandran, B. (with Prakasa Rao, B. L. S.) : "On the equation $f(x) = \int_{-\infty}^{+\infty} f(x+y) d\mu(y)$ ". Regional Conference on Statistics and Probability, December 12-14, 1983, Indian Statistical Institute, New Delhi.
9. Ramamurthy, K. (with Rajput, B. S.) : "Properties of semi-stable probability measures on R^m ". Presented by B. S. Rajput in the Third Poland Conference on "Probability Theory on Vector Spaces". To appear in Springer Verlag Lecture Notes.
10. Sunder, V. S. (with Bapat, R. B.) : "On majorisation and Schur Products", Regional Conference on Statistics and Probability, December 12-14, 1983. Indian Statistical Institute, New Delhi.

B. Applied Statistics, Surveys & Computing

1. Bandyopadhyay, Shibdas : Use of hospital data for population health policy making. Presented at the National Symposium on Statistics in Medicine Thansi, November 10-12, 1983 (to appear in the book entitled 'Statistics and Medicine').
2. ——— : 'Calcutta Housing' : Presented at the Seminar on Calcutta Beyond 2000 AD, Calcutta, February 15-17, 1984 (To appear in Science and Culture).
3. ——— (with Roy, J. and Raja Rao, S.) : Design of surveys for planning of health service in a metropolitan area. Presented at the National Symposium

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on Statistics in Medicine, Thansi, November 10-12, 1983. (To appear in the Book entitled 'Statistics and Medicine').

4. Basu, Anirban : A paper on the "performance of multiprocessor system" was presented in the Annual Convention of Computer Society of India, Ahmedabad.
5. Basu, T. K. : 'Computer Simulation of Glucose Homostasis'. Presented in the Ninth CASAMCU National Symposium held in the Department of Applied Mathematics, Calcutta University.
6. Chaudhuri, Arijit : An application of randomized response technique in estimating production functions using agricultural data. Presented in a symposium in crop estimation and crop forecasting held in the Department of Statistics, Calcutta University in September 1983.
7. ——— : Use of the attribute sampling plans in reliability estimation. Presented at National Conference on quality, reliability in electricity and electronics held at Jadavpur University.
8. Gupta, Sanjib : 'Influence of smoking on coronary heart disease'. Presented in the Indian Physiological Society Symposium, Science College, Calcutta, May 1983.
9. ——— : 'Role of diets and the biosynthesis of cholesterol'. Presented in the Physiology Section of ISCA held at Ranchi in July 1984.
10. Krishnan. T. : A paper on Analysis of Thyroid Cancer data was presented at Data Analysis Workshop, Brussels Belgium in April, 1983.
11. Mājumder, Partha Pratim : Comparison of ascertainment—bias correction schemes for multiply—ascertained pedigrees. Presented in the XV International Congress of Genetics, New Delhi, December, 1983.
12. Mukherjee, B. N. (with Mukhopadhyay, B.) : A comparative study of certain indices of digit preference. Presented at the 9th Annual Conference of India Association of the Study of Population held at Jaipur during December 22-26, 1983.
13. Roy J. : Computers in Medicare. Presented in the National Symposium on Statistics in Medicine, Jhansi, November, 10-20, 1983.
14. ——— (with Raja Rao, S. and Bandyopadhyay, Shibdas). Design of statistical surveys for planning of health services in a metropolitan area. Presented in the National Symposium on Statistics in Medicine, Jhansi, November 10-20, 1983.

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15. Vijayan, K. S. : A paper on "Transitivity in graphs" was presented at the Annual Day Seminar at the Mehta Research Institute of Mathematics on 19th July, 1983.

C. Physical and Earth Sciences

1. *Electronics and Communication Sciences*

1. Biswas, S. N. (with Dutta Majumder, D.) : 'A new method for 2-D shape dilation'. Proc. Inter. Conf. on Pattern Recogn. Montreal, Canada, 1984 (to be published).
2. ——— (with Chaudhuri, B. B.) : 'Computer graphics generation of discrete circular objects and some associated properties'. IEEE Inter. Conf. Computer, Systems and Signal Processing, Bangalore.
3. Chanda, B. (with Chaudhuri, B. B. and Dutta Majumder, D.) : 'A modified technique for image segmentation and edge detection'. Proc. Inter Conf. Cyber. Soc. India, January 1983, pp. 777-781.
4. Chaudhuri, B. B. (with Kundu, M. K.) : 'Digital line segment coding : A new efficient contour coding scheme'. Proc. IEEE, Part-1, (1984).
5. Das, J. : 'Communication deadlocks and its minimization'. Proc. IEEE Conf. on computers in Communication and Control, Brighton, U.K. (1984).
6. Datta, A. K. : 'On some properties of digital lines'. Proc. IEEE Inter Conf. SMC, India, (1984), Vol. 1, pp. 156-160
7. ——— : 'A statistical recognition of vowel in connected speech', Proc. IEEE Inter. Conf. SMC, India, (1984) Vol. 1, pp. 336-339.
8. ——— (with Ganguli, N. R.) 'Machine recognition of plosive sounds using VC contextual information', Proc. IEEE Inter. Conf. SMC, Vol. 1, pp. 336-339.
9. De, A. K. (with Das, J. and Dutta Majumder, D.) : 'Development of a microprocessor based monitoring system'. First Asian Congress on Management Science Cybernetics and General System, Delhi, 19-21 January, 1984.
10. Kundu, M. K. (with Chaudhuri, B. B. and Dutta Majumder, D.) : 'Digital line segment coding : A generalization to contour run length coding'. Proc. Inter. Conf. SMC, Delhi, (1984) Vol. II, pp. 903-907.
11. Pal, S. K. (with Chakraborty, B. and Dutta Majumder, D.) : 'Feature evaluation through measures of fuzziness'. Proc. Seminar on Sig. Process., Cochine, November 1983.

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12. --- (with Pathak, A.) : 'Syntactic recognition of X-ray images'. Proc. Seminar on Sig. Process., Cochine, November 1983.
13. --- (with Guha, M.) : 'A comparative study of some edge detection techniques'. Proc. IEEE SMC, Delhi, December 1983, pp. 1230-1234.
14. Parui, S. K. (with Dutta Majumder, D.) : 'Two methods for quantification of shape distance between open curves'. Proc. IEEE Int. Conf. SMC, Bombay, Delhi, December 1983, pp. 581-585.
15. ----- : 'How to qualify shape distance for 2-dimensional regions'. Proc. 7th Inter. Conf. on Pattern Recog. Montreal, Canada, 1984 (to be published).
16. Ray, K. S. (with Dutta Majumder, D.) : 'Simulation of a nonlinear steam generating unit'. Proc. IEEE Inter. Conf. S. M. C. Vol. 1.
17. Ray, K. S. (with Dutta Majumder, D.) : 'Image contrast enhancement using concept of visual nonlinearity'. IEEE Inter. Conf. SMC, 1984
18. --- (with Ghosh A. M. and Dutta Majumder, D.) : 'Dominant sequences method and pattern directed inference : An approach towards artificial intelligence for unknown multivariable system'. IEEE Inter. Conf. Comp. Syst. and Sign. Process, 1984.

2. Theoretical Physics

1. Bandyopadhyay, P. (with Sinha, Malabika) : Electron Muon ratio at Ultra high energies Cosmic Rays. Proceedings of the 18th International Cosmic Ray Conference held in Bangalore, India, 1983.
2. Bhattacharyya, S. : Cosmic ray data and accelerator data for particle production at very high energies : Concurrences and contradiction. Proceedings of the 18th International Cosmic Ray Conference Vol. 5, 202 held in Bangalore, India, 1983.
3. --- : Physics at ISR and Collider energies : A comparison and some comments. International Colloquium in multiparticle dynamics Lake Tahoe, California, 1983 Other details not yet received.
4. Roy Chowdhury, R. K. (with Bhattacharyya, D. P.) : Calculation of photo nuclear energy loss term for Muon. 18th I.C.R.C. Bangalore, 7, (1983) 86.
5. --- (with Ghosh, Baruana) : Group theoretic approach to spherical anharmonic oscillator. XII International Colloquium on Theoretical Methods in Physics, held in Trieste, 1983.

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6. Sidhanta, J. (with Roy Chowdhury, R. K., Bhattacharyya, D. P. and Pal, P.) : Intensity depth relations of high energy electrons and photons. 18th I. C. R. C. Bangalore 5, (1983), 372.
7. ----- : Inelastic Effects in E. A. S. Nucleon Number—An Analytical Solution, 18th I.C.R.C. Bangalore 5, (1983) 368.

3. Fluid Mechanics

1. Dandapat, B. S. : Finite amplitude analysis of rotating fluid layer in a porous medium heated from below. 28th Congress of Indian Society of Theoretical and Applied Mechanics, Waltair, December 26-29, 1983.
2. Haldar, K. : Study of storm surge on a sloping bed. 28th Congress of Indian Society of Theoretical and Applied Mechanics, Waltair, December 26-29, 1983.
3. Mazumder, H. R. (with Chakrabarti, B. K.) : A note on the correlation functions in homogeneous and isotropic turbulence. 28th Congress of Indian Society of Theoretical and Applied Mechanics, Waltair, December 26-29, 1983.

4. Physics

1. Ganguly, S. (with Mukherjee, T. K.) : Design of non-interacting controller for d.w.r. synchronous machine. Annual Paper Meeting, Institution of Engineers (India), April. 8-9, 1983, Jabalpur.
2. Gupta, A. B. (with Ghosh, S. N.) : *In Vitro* hardness of human finger nails. XIIth National Conference of the Indian Association of Dermatologists, January 19-22, 1984, Aurangabad.

5. Chemistry

1. Ghosal, D. N. (with Bhattacharyya, S. K.) : Adsorption of surface Active Cations on Organic and Inorganic Soil colloids. National Symposium on Surfactants, Emulsions and Bio-colloids, October 27-29, 1983, held at Jadavpur University.

D. Biological Sciences

1. Anthropometry and Human Genetics

1. Basu, A. (with Gupta, R., Bharati, P., Mukhopadhyay, B. and Roy, S.) : Physical environmental, sociocultural and ethnic correlates of human biology in some populations of West Bengal, India : Mortality differentials. Presented at Pre-Congress session of the XIth International Conference of Anthropological and Ethnological Sciences, 18-19 August, 1983, Victoria, Canada.

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2. Forsius, H. (with Mukhopadhyay, B., Basu, A., Gupta, R., Majumder, V. and Bhattacharya, S. K.) : Ethnic differences and Ophthalmological traits in three populations of Kalimpong subdivision, Darjeeling District, West Bengal, India. Presented at the XIth International Congress of Anthropological and Ethnological Sciences, 20-25 August, 1983, Vancouver, Canada.
3. Mukherjee, B. N. : Glyoxalase polymorphism among three tribes of Eastern India. International Conference on Man and Environment, held in Calcutta, 6-9, 1983. This paper was presented by Dr. A. P. Reddy.
4. ——— : Isoelectric focusing for genetic polymorphism of PGM₁ in five population groups of Karnatak, Kerala and Andhra Pradesh. X Annual Conference of the Indian Society of Human Genetics, held at Waltair, 7-9 December, 1983.
5. ——— : A variant in Transferrin 'C' sub typing in a Bagdi population of West Bengal, India. XV International Congress of Genetics, Held in New Delhi, 12-21 December, 1983.
6. Roy, B. (with Bharati, P., Ganguli, P., Pal, N., Biswas, P., Roy, P. C., Roy, R. N., Roychudhuri, S. K., Ganguli, S., Mitra, P., Gupta, R., Manna, D. and Basu, A.) : Physical environmental and sociocultural correlates of human biology in some populations of West Bengal, India : morbidity patterns. Presented at the XIth International Congress of Anthropological and Ethnological Sciences, 20-25, August, 1983, Vancouver, Canada.

2. Botany

1. Roy, S. K. : The strategy for breeding cultivated edible fungi : Problems and prospects (Lead paper). Silver Jubilee Celebration, International Conference on "Science and Cultivation Technology of Edible Fungi". Regional Research Laboratory (CSIR), Jammu and Kashmir, Srinagar, September 9-11, 1983.

3. Crop Science

1. Ghose, M. : The anatomy of the seedlings of some *phoenix* species. 71st Indian Science Congress, Ranchi, 3-8 January 1984, (Abs. No. 247, pp. 113-114).

4. Leaf Protein

1. Matai, S. : "Leaf Protein Technology : Broad lines of studies of the art and its perspective and problems". G. B. Pant University of Agriculture & Technology, Pantnagar, 19 August, 1983, (Invited lecture).

E. Social Sciences

1. Demography

1. Das, C. R. : Study on Cohort Data on Primary Education and Their Social Indicators. Read at the Ninth Annual Conference of IASP held at Rajasthan University, Jaipur during 22-26 December, 1983.

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2. Datta, Pranati (Miss.) : Occupation Distribution and Mobility in Rural Areas of Bengal. Read at the Eighth Social Science Congress by the Indian Academy of Social Sciences, 9-12 July, 1983, Hyderabad.
3. Dutta, S. K. : A pilot study on the Effect of Child Mortality on Fertility. Read at the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
4. Ghosal, A. K. : Impact of Family Planning on Fertility Reduction in West Bengal. Read at the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
5. Guha Roy, S. : Parameterizing Indian Fertility Experience by Gompertz Function. Read at the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
6. Malaker, C. R. : Modelling of Indian Nuptiality. Read at the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
7. --- : Calcutta's Population beyond 2000 AD. Read at the Seminar on Calcutta Beyond 2000 AD. Organised by Indian Science Association, Calcutta during February 15-17, 1984.
8. Mukhopadhyay, B. K. : A comparative Study of Certain Indices of Digit Preference in the Census Single Year Age Returns of Developed and Developing Countries. Read at the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
9. Saha, A. K. : On Acceptance of Rural Health Services. Read at the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
10. Sarkar, B. N. : Indian Demographic Dimensions : Problems and Prospects. Presented at the Seminar on Population Crisis and National Development, Kanpur University, 24-25 April, 1983.
11. --- : Enrolment Age and Measurement of Literacy. Read at the Eight Social Science Congress by the Indian Academy of Social Sciences, 9-12 July, 1983, Hyderabad
12. --- : Inter-state Disparities of Education. Presented at the Fourth Annual Conference of the Society for the Study of Regional Disparities, 25-26 November 1983, Patna.

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13. ——— : Data Base for Education Studies. Presented in the Ninth Annual Conference of IASP held at the Rajasthan University, Jaipur during 22-26 December, 1983.
14. ——— : Population Welfare Planning in Rural Areas of Bengal. Presented in the 71st Session of the Indian Science Congress Association, 3-8 January, 1984, Ranchi.

2. National Income Research

1. Majumdar, K. C. (with Mazumdar, Krishna and Paul, Manabendra) : Variation of national income with components of generalized capital. Presented to 14th General Conference of the IARNIW, ISI, Calcutta 7-9 November, 1983.
2. Mazumdar, Krishna (with Paul, Manabendra) : Role of tertiary sector in economic development with special reference to India. Presented to the 14th General Conference of the IARNIW, ISI, Calcutta, 7-9 November, 1983.
3. Roy, Bina (with Gupta, Swagata) : Capital Formation in West Bengal : Related Problems of Estimation. Presented to the 14th General Conference of the IARNIW, ISI, Calcutta, 7-9 November, 1983.
4. ——— (with Majumdar, K. C. and Datta, Pranati). A Study on the Estimation of different Macro-Economic Aggregates and the growth of the economy in West Bengal. Presented to the 14th General Conference of the IARNIW, ISI, Calcutta, 7-9 November, 1983.

3. Pre-Census Population Studies

1. Bhattacharya, Durgaprasad (with Deb Roy, Rama). A note on Calcutta and Industrial Region, 1951-2000. Seminar on Calcutta beyond 2001. Indian Science News Association, Calcutta, February 15-17, 1984.

4. Economic Analysts (Bangalore)

1. Iyengar, N. S. (with Suryanarayan, M. H.) : "An Analysis of Economic Size Distributions with illustrations from National Sample Survey data". The Twenty-second Indian Econometric Conference, Bangalore, January, 2-4, 1984.
2. Narayana, N.S.S. (with Parikh, K. S. and Srinivasan, T. N.) : "Indian Agricultural Policy Model : Preliminary results of an analysis of redistributive policies". The Twenty-Second Indian Econometric Conference, Bangalore, January 2-4, 1984.
3. Shailaja Prasad (with Iyengar, N. S.) : "A note on the effect of grouping on inequality measures". The Twenty-Second Indian Econometric Conference, Bangalore, January, 2-4, 1984.

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4. Swamy, P. A. V. B. (with Mehta, J. S., Thurman, S. S. and Iyengar, N. S.) : "A generalized multicollinearity index for regression analysis". The Twenty-Second Indian Econometric Conference, Bangalore, January, 2-4, 1984.

5. *Planning* (Delhi)

1. Bhat, L. S. : "Spatial perspectives in Socio-economic Development from national and regional angles" 4th Indo-British Seminar on Rapid Social and Economic change in a regional framework held at Birmingham and Lampeter in U.K. during September 14-28, 1983.
2. Chetty, V. K. : Delivered an invited lecture on "Price and Distribution Controls in the Indian Economy" conference held in Bangalore during 3-5 January, 1984.
3. Saluja, M. R. (with Gupta S. P.) : "Preparation of Macro-Economic model for South Asia" was presented at the IXth conference of the CSCD from 12-17 March, 1984.
4. Saradmoni, K. (with Mencher, Joan) : "The Invisible Hand behind Agriculture : Land owning, Women in Supervision and Management" in the session Women and Development : Agriculture at the XI ICAES, Vancouver on August, 23, 1983.
5. --- (with Mencher Joan) : "Landless Agricultural Labour Women in three Rice Regions of India : Work and Income".
6. --- : "Agrarian Struggles and the end of Matriliney : from common property rights to individual ownership and the sub-ordination of Women".
7. --- : "Declining Employment for the Labour : Increasing involvement by land owning Women".
8. --- : "Women's Studies in India" at the symposium on Women's Studies.

6. *Sociology*

1. Bandyopadhyay, S. (with Eschen Von Donald) : "Cooperatives and rural development". International Congress of Anthropological and Ethnological Sciences, sponsored by International Development Research Centre, Canadian International Development Agency, Social Sciences and Humanities Research Council of Canada, McGill University, Canada, August, 11-13, 1983, at Val-Morin, Quebec, Canada.
2. Biswas, S. K. : "Peasantisation of Hill Economy in North East India". Seminar on Planning in North East India, Shillong, 21-23, April, 1983, organised by North-East India Council for Social Science Research.
3. --- : "Dependency and family care of the aged in village India—A case study", Symposium on Ageing and Society, St. Xaviers College, Calcutta, 14 February, 1984.

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4. Bhattacharjya, Debasish : "Impact of communication on a tribal village—A case study of Dumdumi village". Presented at International Conference on 'Man and Environment', at Ashutosh Centenary Hall, Indian Museum, Calcutta during 6-9 December, 1983, organised by Indian Anthropological Society, Calcutta (with Indian Statistical Institute ; Anthropological Survey of India and International Association of Human Biologists, England).
5. Chakrabarty, Aniruddha : "In search of roots of occupational differentiation among some tribals—A case study in Palamau district, Bihar". Presented at International Conference on 'Man and Environment ; at Ashutosh Centenary Hall, Indian Museum, Calcutta, during 6-9 December, 1983, organised by Indian Anthropological Society, Calcutta (with Indian Statistical Institute ; Anthropological Survey of India and International Association of Human Biologists, England).
6. Chatterjee, Arun Kr. : "Problems of ethnic identity : Some observations in a changing socio-economic context". Presented at International Conference on 'Man and Environment' at Ashutosh Centenary Hall, Indian Museum, Calcutta, during 6-9 December, 1983, organised by Indian Anthropological Society, Calcutta (with Indian Statistical Institute ; Anthropological Survey of India and International Association of Human Biologists, England).
7. Ghosh, Bhola Nath : "A case study among the Koras in Md. Bazar in the district of Birbhum". Presented at International Conference on 'Man and Environment' at Ashutosh Centenary Hall, Indian Museum, Calcutta during 6-9 December, 1983, organised by Indian Anthropological Society, Calcutta (with Indian Statistical Institute ; Anthropological Survey of India and International Association of Human Biologists, England).
8. Mukhopadhyay, Shyamal : "Unusual business in a border village : A case study of how does the young generations acquire an economic footing ?". Presented at International Conference on 'Man and Environment' at Ashutosh Centenary Hall, Indian Museum, Calcutta, during 6-9 December, 1983, organised by Indian Anthropological Society, Calcutta (with Indian Statistical Institute ; Anthropological Survey of India and International Association of Human Biologists, England).

7. *Psychometry*

4. Chatterji, S. : "Some Aspects of Performance Appraisal"—Seminar organised by Institute of Management in Government, Trivandrum on 8th July 1983.
2. ——— : "Communication in Organisation"—in Management Development Programme, organised by National Aluminium Co. at Puri from 30th June to 1st July, 1983.
3. ——— : "Selection by Objective Method"—in Bharat Heavy Plate and Vessels, Visakhapatnam, on 3rd September, 1983.

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4. Mukherjee, M : "Accuracy of Self Assessment"—in a Seminar organised by Institute of Management in Government, Trivandrum, on 8th July 1983.
5. ——— : "Group Dynamics and Team Building"—in Management Development Programme, organised by National Aluminium Co. at Puri, from 30th June to 1st July 1983.
6. ——— : "How to improve accuracy of Mental Measurement"—in Bharat Heavy Plate & Vessels, Visakhapatnam, on 3rd September, 1983.

F. Documentation Research and Training

1. Bhattacharyya, G. Socio-economic change and information. Presented at the Seminar on Library Service towards Socio-economic Change, Bangalore, 11 April, 1983.
2. ——— : Some landmarks in the development of library automation. Presented at the DRTC Refresher Seminar -14, 14-16 November, 1983. (Published in DRTC Refresher Seminar).
3. ——— : Evolution of subject indexing languages. Presented at the 29th All India Library Conference, Mysore, 5-9 December, 1983. (Published in "Fifty years of librarianship in India : Past, present and Future". p. 377-390).
4. ——— : Indian information sources and services in science and technology. Paper presented at the Workshop on "Technology and the Information Age", Bangalore, 12-14 December, 1983.
5. ——— : Perspectives of information science : An introduction. DRTC Annual Seminar, 21 ; 1984 ; paper AA.
6. ——— : Methodology of studying subjects for information work and service. DRTC Annual Seminar, 21 ; 1984 ; paper AA.
7. Devadason, F. J. : Knowledge of searching bibliographic data bases : An essential component of information science. DRTC Annual Seminar, 21 ; 1984 ; paper EF.
8. Gopinath, M. A. : Library as a learning centre. Presented at the Seminar on Library Services Towards Socio-economic changes, Bangalore, 11 April, 1983.
9. ——— : Ranganathan's contribution to library classification. Presented at the 29th All India Library Conference, Mysore, 5-9 December, 1983. (Published in "Fifty years of librarianship).
10. ——— : Information support system for advertising. Presented at the IASLIC Conference 19, New Delhi. 1983.