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LATE KING TRIBHUVAN'S MEMORIAL

&

DEMOCRACY DAY

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TABLE OF CONTENTS

PAGE

INTRODUCTION: - - 1

A Statement of Needs: - - 2

Articles:

1. Applications of Mathematics to the Social Sciences
   - Dr. Ram Man Shrestha - 3

2. A Glimpse of the History of Numeration Systems
   - Omkar Nath Pant - 8

3. On Age Structure of the Population of Nepal
   - Bhabani Shankar Rajbanshi - 11

4. New Math ? - Sushil Kumar Shrestha - 16

5. A New Inversion Operator for the Meijer-Bessel Transforms
   - Dr. Rameshwor Prakash Manandhar 20

Problems: - - 28

Announcements: - - 29

Introduction

The Seminar on the Mathematical Sciences was begun in the month of Aswin 2032. The participants have been Mathematical Sciences Faculty from the following places :

Institute of Education : Kirtipur, Kathmandu
Institute of Science : Kirtipur, Trichandra, Amrit, and Patan
Institute of Engineering : Patan, Thapathali, Balaju
Institute of Humanities : Kirtipur
Padma Kanya College
CEDA : Kirtipur
CDC - HMG : Harihar Bhawan, Pulchowk, Lalitpur

Meetings have been held each month since the beginning. Generally they are scheduled for the first Friday of each Nepali month.

The Seminar is devoted to the development of Mathematics and the Mathematical Sciences, to the improvement of the teaching of those subjects, and to the individual growth of mathematical scientists in the Kingdom.

This Report has been authorized by the Research Division of Tribhuvan University, Mr. Krishna Raj Pandey, Director. It is hoped that through it mathematicians and mathematical scientists in all of the kingdom will be able to benefit from and participate in the Seminar. In this way the country will be greatly aided in its development in the technical areas.

We warmly welcome your comments and your contributions.

The Coordinating Committee
Keshab Dev Bhattarai
Dr. Ram Man Shrestha
Mohan Bir Singh
Sushil Kumar Shrestha
Onkar Nath Pant

A Statement of Needs

This is a most auspicious occasion for the Mathematical Sciences, the issuance of the first Seminar Report. Through it now communication lines can be opened to benefit all persons in the country who are integrested in or use mathematics. In the end this will contribute greatly to the technical development of the nation and benefit all its citizens.

The kind of industry which ourcountry develops will depend on its production of skilled manpower and labor. This in turn depends in large measure on the quality of its programs in mathematics and the mathematical sciences. A mathematically literate public will help to bring about intelligent discussion of issues and necessary public support for the important technical decisions which must be made concerning them.

Thus there is need for mathematics and the mathematical sciences, both to gain technical competence for those who must use it in their work and to develop appreciation for it among the general public. The latter is so because mathematics does not belong only to professional people. It cuts across many fields and touches the lives of all.

Similarly there is a need for this report - to encourage writing in the mathematical sciences, to share ideas about the mathematical sciences, to reduce our isolation from each other, to reduce problems caused by lack of resource materials, to increase the number of potential text book writers and curriculum developers, and to increase awareness in us all to permit individual growth personally and professionally.

Our country is in the midst of a period of great growth and development. In our own way in our own area of activity we can all make a contribution to this effort. Through this report our collective ability to assist will be greatly enhanced. We need and ask your help in making it a success. It is we who are trained in this specific area who have the talent and the ability to provide the needed assistance. If we do not do the job, no one else will be able to do it. So let us all work together in this most important endeavor.

APPLICATION OF MATHEMATICS TO SOCIAL SCIENCES

R. M. SHRESTHA

' Make mathematics more meaningful - make it more useful. ' This has been a very popular slogan among the social scientists, biologists, management personnel and others during recent years. If this slogan, on one hand, reveals the fact that the basic principles and techniques of mathematics are gradually penetrating deeper and deeper into various branches of social sciences, biology, management science, etc., it also quietly sounds that mathematics have become less meaningful and less useful.

It is true that for more than half a century mathematical theories and techniques developed so fast that they remained almost inaccessible to the majority of the people in spite of their abundancy and high degree of perfection. It could do nothing more than earn an unfortunate nick-name - A DRY SUBJECT. It left most of the non-mathematics community completely uninterested and distracted from mathematics. This might possibly account for one of the reasons that gave rise to the above slogan. Instances of such theories which remained obscure for several decades or more not only to the common man but also to the most gifted mathematicians are not uncommon. Einstein's theory of relativity is one such example which remained almost meaningless and useless for several decades. Many branches of classical analysis which attained high degree of precision and perfection long back remained practically meaningless and useless even today.

Recent trends in curriculum development, text book preparation, training of teachers in the light of what is currently known as modern mathematics, claim to have made significant contributions in making mathematics easier to learn in less time than usual ; and in relating mathematics with real life situations in the simplest manner. This is how it raises serious questions as to the traditional mathematics programme.

This might be the second reason for the growth of the above opinion.

Last but not the least is the fact that the existing theories and techniques of mathematics are necessary but not sufficient for a proper mathematical explanation of the vast body of data that has been collected over the years or obtained through experiments. Situations of this type are the most challenging to the mathematics community as these testify the incompetence of the existing mathematical theories and techniques ; and, in fact, quest for answers to such problems lead to the creation or discovery of new theory or theories in mathematics. So, for mathematicians interested in fundamental research such problems are of crucial importance.

Problems of this nature are very common even in our everyday life. Describing a class of situations that led recently to the creation of a new theory - the theory of Catastrophe, the Warwick Professor, E. C. Zeeman makes the following remarks (The Geometry of Catastrophe, Times Literary Supplement, 10 December 1971) :

> Throughout nature we observe continuous changes giving rise to discontinuous jumps : for example a continuous rise in temperature will cause water to boil suddenly, which is a sudden jump in density. In economics a gradual relaxation after a squeeze may cause inflation explosion. Gradual changes in environment may cause sudden evolutionary changes or sudden cultural advances or sudden change of opinions. People suddenly change their minds, and suddenly lose their temper, and suddenly burst into tears. Nations suddenly go to war. The smoothly growing embryo suddenly begin to fold. Electrical circuit suddenly flip into a new oscillation. Bridges suddenly break and trees suddenly tumble. "

The fact that a gradual change in control can cause a sudden catastrophic change in behaviour is the fundamental characteristic of each of the above situations. This fundamental feature is the basic idea embedded in the French topologist Rene Thom's theory of catastrophe.

This theory of catastrophe was further developed by E. C. Zeeman and others, and is known to have applications to problems covering a wide range of fields, from science and engineering to social sciences. But it is to be remembered that there are methods and techniques other than the catastrophe theory which are often used to treat discontinuities. Thom's theory adds a new and probably more useful tool to this collection, but it is to be understood that this theory is yet far from being a universal theory of discontinuities. As to the problem of applications of mathematics to social sciences, it will be sufficient to mention here that the mathematical background necessary for a social scientist vary from elementary level mathematics to the advanced one depending upon the nature of the problems concerned and the person dealing with them. Some of the important branches of mathematics & statistic which are increasingly used in social sciences are

(a) Classical and modern analysis (b) Linear Algebra
(c) Analytic geometry (d) Theory of games
(e) Differential and difference equations
(f) Graph theory (g) Markov chain
(h) Combinatorics
(i) Computer science and computer programming etc. etc.

Most of these, viewing from our national context, fall into the category of advanced undergraduate or graduate level mathematics / statistics programme ; and are generally beyond the reach of the most of the social scientists in our country. Below this we have the beginning undergraduate and school level mathematics / statistics programme involving the basic tools of arithmetic, algebra, geometry, calculus, statistics, etc. If we try to make a very crude estimate of the number of social scientists equipped with the above mentioned undergraduate or school level mathematical background or mathematicians with inclination towards social sciences, it will not be incorrect to say that they can be counted with the help of the fingers of our two hands only.

But it does not imply that the mathematicians, statisticians, social scientists in Nepal have remained silent in this directions. Instances are plenty in numbers, where mathematicians, statistcians and social scientists have tried to improve the situations by changing curriculum, orienting the teachers, motivating the students. Individual and institutional attempts are still continuing to create or develope school and University level mathematics programme accessible to the non-mathematics community and suitable for the current situation. It may be worth mentioning an instance in which a mathematics teacher under the direction of the Dean of the Institute of Science tried to motivate certificate level students with economics major but having very little mathematical background and create some interest in mathematics.

He started with words such as ' Aggregate ', ' price ', ' demand ' supply ', ' elasticity ', ' equilibrium ', etc., which are the basic terms in the principles of economics and are generally known to them. To relate these to the basic notions of the analytic geometry of two dimensions, he took the help of the following phrases from economics : ' Aggregate of demands, aggregates of goods, collection of revenue, a class of business men, etc. and gave the heuristic introductions to the concepts of a set and set-membership, aggregates such as - aggregate of prices, aggregate of goods demanded, the relation or function existing between them, another basic concept of mathematics, waseasily constructed. This, in turn, gave rise to the notion of ordered pairs. The aggregates of prices or goods demanded and the relations existing between them were then represented by points on number lines and coordinates planes respectively. Such representations have not only been the visual aids for the students but also empirical means of constructing graphs exhibiting various relations between the aggregates. In doing so, situations which have close link with the basic ideas of economics were exposed to help them understand the section formulae. Similar attempts to motivate the students of social sciences in studying algebra, calculus, statistics, advanced level mathematics and their uses in social sciences are known to have been made by mathematics and social science teachers at different levels.

Response to such attempts to popularize a mathematically oriented social science programme are in no way unfavourable. However it does not imply that we have been able to make any appreciable progress in this direction. It is at an embryonic stage. To develope this embryo we need a good mathematically oriented social science programme suitable for students poor in elementary mathematics, social science teachers with adequate mathematical background, mathematicians with interest in the applications of mathematics to social sciences. We may possibly have to encounter the bitter opposition from a handful of so-called social scientists of our country who have or have developed allergy towards mathematics and also from some mathematicians who takes mathematics for mathematics itself only. Leaving this small group of social scientists and mathematicians aside it is now universally accepted by all that a mathematically oriented social science programme is a MUST for our national development.

Our attempts so far have been scattered and disorganised. What we have to do immediately is leave such sporadic attempts and develope an integrated mathematically oriented social science programme which will encompass within its ambit various disciplines of social sciences. To make such programme a practical one, curriculum has got to be revised or developed, text-books prepared, teachers trained and facilities provided. Only thus we shall be able to make mathematics more meaningful and more useful as far as social sciences are concerned.

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A Glimpse of the History of Numeration Systems.

——— Onkar Nath Pant

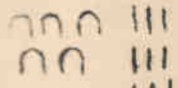
As the civilization began men learned to settle peaceably into groups or communities in river valleys because of the advantage of getting water. These were mainly along the river Nile in Egypt, the Tigris and Euphrates on Mesopotemia, along the Indus and, later the Ganges in India and the Hwanho and the Yangtse in China. There were other places where the settlement occurred but the places mentioned above are the most important as regards the development of mathematics.

In those days no body knew the idea of numbers. People learned to tame the animals such as sheep, cows etc. As they needed to count them they counted them into groups of 5 or 10 by matching the fingers on the hand. By the use of fingers on both hands collections containing up to ten elements could be represented. By combining fingers and toes one could count up to twenty. When the man used such scheme of representation he piled the stones into the groups of five because he could observe the hand and foot against the piled up stones.

Later on as people became more and more civilized they felt the need for trade with neighbouring communities. Then much larger numbers were found to be necessary in counting as well as in recording numbers. They were placed into a large group and given a different symbol so that they could be written down more quickly. Let us first discuss how Sumerians and Babylonians recorded and dealt with numbers.

The people who settled in the region between the Tigris and Euphrates rivers at the entrance to the Persian Gulf around 4000 Po. C were called Sumerians. Just as thousands of years before in the stone age, the people had bartered their possessions using amber or flint as means of exchange, so Sumerians could now barter their goods with food as means of exchange. For example, a bow and some arrows worth four measures of barley could be exchanged for a goat which was considered as worth 4 measures of barley. Later the precious metals such as gold and silver were discovered. Pieces of silver weighing $\frac{1}{60}$ of a pound called shekels were introduced and gold was considered as worth four times that of the silver.

As the trade grew more and more it was necessary to keep the records of transaction. This was done in clay. The clay was flattened out into tablets and a reed or bone called stylus which was just like a pencil but circular at one end and shaped to a triangle at the other was used to write on clay tablets. The tablets were allowed to dry in the sun. During earlier days of Sumerian civilization the end of the stylus was pressed into the clay vertically to represent ten units and a smaller stylus was pressed obliquely to represent a unit. Similarly an oblique impression with the larger stylus indicated sixty units and a vertical impression indicated 3600 units. Combinations of these were used to represent the intermediate numbers. Babylonians proceeded along the same line as did the Egyptians with repetitions of the symbol for units and tens. Egyptians wrote



for fiftynine. Mesopotamians could represent the same number on the clay tablet as

Beyond the number fifty nine the Egyptian and Babylonian systems were different. Babylonians were aware that their two symbols for units and tens were sufficient for the representation of any integer It seemed that Babylonians had no clear way to indicate " zero ". They some times lft a space where a zero was necessary. Due to the lack of zero symbol it was inconvenient to distinguish between 55 and 505. By about the time of Alexander, a special sign consisting of two small wedges placed obliquely was invented to serve as a place holder where a numeral was missing. The Babylonian zero symbol seemed to have been used for intermediate empty positions only. There are no extant tablets in which a zero sign appears in the terminal position of the number.

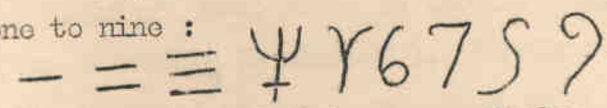
Greeks had used their alphabetic letters to represent the numbers. Since the classical greek alphabet contains only twenty four letters, use was made of an older alphabet which included three additional symbols. With the advent of small letters in Greece the association of letters and numbers were as follows :

α	β	γ	δ	ε	ϛ	ζ	η	θ	ι	κ	λ	μ	ν
1	2	3	4	5	6	7	8	9	10	20	30	40	50
ξ	ο	π	ϙ	ρ	σ	τ	υ	φ	χ	ψ	ω	ϡ	
60	70	80	90	100	200	300	400	500	600	700	800	900	

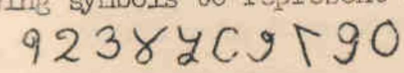
For thousands a bar was placed to the left of the letters. For example, /α would mean 1,000. Though this system counted decimally, there was no decimal place system because "ιβ" or "βι" would always be 12. The Romans represented the numerals through the letters, I, V, X, L, C, D, M. The letters V and X are said to be originated by either of the two ways. One of them from hands and the other ten striking off the strokes. By opening the hand with fingers close together and the thumb out to the side the shape of V is formed. Two hands putting upside down as fixed above forms X. Another way the V and X originated is believed to be by writing ten single strokes and crossing them off like this

so that V would be the top part of X.

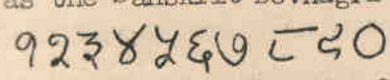
In earlier stages Hindus had used the following symbols to represent from one to nine :



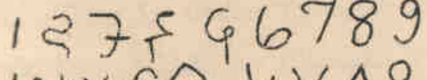
With advent of the symbol for zero, Hindus started to write the following symbols to represent one to nine and zero:



where as the Sanskrit Devnagri script is



In west and east Arabia, the following symbols had been used.



and,

Later on Hindu numberals based on decimal system have been used much in practice, and the concept of negative numbers has been started. In the mean time the systems were transfered to Arabia and the western people learned them from the Arabs. This system is called the Hindu - Arabic numerals which are written as follows, 1,2,3,4,5,6,7,8,9,0.

This is also called the decimal position system. It is an improvement in earlier method. It has allowed the science of mathematics to grow what it is today.

On Age Structure of the Population of Nepal

by Bhabani Shankar Rajbanshi

Inspite of many sources of error in age-reporting, in reporting of births, the data available for the three censuses of Nepal viz of 1952/54, 1961 and 1971 have revealed the constancy of age-structure during these decades. See tables I and II. Such a constancy of age structure is one of the properties of the so-called stable populations. A mathematical theory of stable populations was developed by Alfred J. Lotka as early as 1939 in " Theorie analytique disassociations biologiques," deuxieme partie (Paris, Hermann, 1939). According to his theory, the stability of age structure is the result of a constant fertility and mortality schedule operating for an indefinite period of time in a closed population. The population of Nepal is not completely closed to migration, but since the net-migration i. e. In-minus-out migration is negligible in comparison to total population (of the order of about 20 to 25 thousands p. a. from an average total population of nearly 10 million). Family planning was first introduced officially in Nepal in 1950, and would take some decades of concentrated and persistent efforts to make any visibleimpact on the fertility behaviour. As far as mortality is concerned, there might have been some appreciable changes in the death rates in the recent decades. Nevertheless, it could be shown that the effect of a slightly or gradually declining mortality schedule is not as outstanding as the effects of changes in fertility schedule. Thus if these remarks were correct, the stable population theory can be applied to explain the stability of Nepalese age structure.

Lotka hypothesized that constantly operating mortality and fertility schedules can be mathematically represented by a survivorship function $p(x)$ and a maternity function $i(x)$,

where $p(x)$ = probability of survival of an individual to age x

$i(x)$ = probability that an individual of age x will beget a baby.

Thus it is more convenient and meaningful to use functions $p(x)$ and $i(x)$ as applying to female populations alone.

Let $P(t)$ = total number of females living at time t

= proportion of persons, out of the total of $P(t)$ living within the age interval from x to $x + dx$

so that $\int_0^{\omega} c(x,t)\,dx = 1$ where ω = upper limit of age in life.

(ω may also be replaced by ∞ since $c(x,t) = 0$ beyond $x = \omega$)

$B(t)$ = total female births per annum at time t

$b(t) = B(t)/p(t)$ = birth rate per head p. a., at time t

r = intrinsic rate of increase per head p. a. i.e. natural rate of increase

$p(x)$ = probability of surviving from birth to age x = lx/lo where lo = number of births at $t = 0$ and lx = number of those in lo who survive to age x

$i(x)$ = births per head per annum at age x, counting daughters only.

Then the number of persons at ages x to $x + dx$ is $P(t)c(x,t)\,dx$ and these are obviously survivors of births x years previously so that

$$P(t)\ c(x,t)\ dx = B(t-x)\ p(x)\ dx. \quad\ldots\ldots\ldots\ldots(1)$$

Multiplying by $i(x)$,

$$P(t)\ c(x,t)\ i(x)\ dx = B(t-x)\ p(x)\ i(x)dx \quad\ldots(2)$$

The total number of births per annum at time t is

$$B(t) = \int_0^{w_2} B(t-x)\ p(x)\ i(x)\ dx \quad\ldots\ldots\ldots\ldots\ldots(3)$$

Where w_2 is the highest value of x for which $i(x)$ has a non-zero value. Here also w_2 may be replaced by ∞ without affecting the integral. Given $p(x)$ and $i(x)$ which for human populations is everywhere non-negative, the problem is to determine the form of the curve for $B(t)$ in (3)

Let the trial solution be $B(t) = \sum_{n=1}^{\infty} Q_n e^{r_n t}$

so we get $\sum_{n=1}^{\infty} Q_n e^{r_n t} = \int_0^{\infty} \sum_{n=1}^{\infty} Q_n e^{r_n(t-x)} p(x)\, i(x)\, dx = \sum_{n=1}^{\infty} Q_n e^{r_n t} \int_0^{\infty} e^{-r_n x} p(x) i(x)\, dx$ (5)

Equ (5) is satisfied when

$$\int_0^{\infty} e^{-r_n x} p(x)\, i(x)\, dx = 1 \qquad (6)$$

With the product $p(x)\ i(x)$ everywhere non-negative between 0 and ∞ the fundamental equ. (6) for r_n yields one real root and infinitely many complex roots. The coefficients Q_n and the root r_n in (4) generallygives for $B(t)$ a curve with damped oscillations. In the ultimate state where t is very large the oscillations are negligible and the curve $B(t)$ depends almost wholly on the real root r. At that stage

$$B(t) = Qe^{rt} = Qe^{r(t-x)}\ e^{rx} = B(t-x)e^{rx} \ldots\ldots\ldots\ldots (7)$$

From equation (6) Lotka developed a quadratic to solve for r.,

$$\tfrac{1}{2}\beta r^2 + \alpha r - \log_e R_0 = 0 \qquad \ldots\ldots\ldots (8)$$

Where $\quad R_j = \int_0^{\infty} x^j\, p(x)\, i(x)\, dx$

and $\quad \alpha = R_1/R_0, \quad \beta = (R_1/R_0)^2 - R_2/R_0$

$R_0 = \int_0^{\infty} p(x)\, i(x)\, dx$ clearly represents the so-called net reproduction rate

First approximation from (8) gives $r = \frac{1}{\alpha}\log_e R_0$ ....(9)

So the intrinsic rate of natural increase will be $r \leq 0, > 0$ according as $R_0 \leq 1$ or > 1.

Thus $B(t-x) = B(t)e^{-rx}$ from Equation (7).

From (1), $c(x,t) = \frac{B(t)}{P(t)} e^{-rx} p(x) = b(t) e^{-rx} p(x) \ \ldots \quad (10)$

Therefore $\int_0^{\infty} c(x,t)\, dx = 1$, and we have

$$1 = \int_0^{\infty} b(t)\, e^{-rx} p(x)\, dx.$$

Thus $b(t) = \frac{1}{\int_0^{\infty} e^{-rt} p(x) dx} = b$ which is independent of time t.

This is called the intrinsic birth rate.

Then equ (10) also may be written as

$$C(x.t) = be^{-rx} p(x),$$

$$\text{or } C(x) = be^{-rx} p(x).$$

This represents the intrinsic age distribution which shows a constancy of age structure over time.

The subject can further be pursued to derive interesting results.

Table I. Age Distribution of Female Population of Nepal (Percent)

		Year	
Age (Yrs.)	1952/54	1961	1971
All ages	100.0	100.0	100.0
0 - 4	13.12	14.18	14.68
5 - 9	13.46	13.98	14.94
10-14	10.45	10.39	10.36
15-19	9.38	8.37	8.71
20-24	9.26	8.85	8.78
25-29	9.04	8.94	8.26
30-34	7.53	7.77	7.42
35-39	6.00	6.00	6.25
40-44	5.56	5.22	5.36
45-49	5.08	4.00	3.76
50-54	3.84	3.88	3.42
55-59	2.27	2.37	2.17
60-64	2.58	2.69	2.71
75-69	1.11	1.16	1.24
70 +	1.75	1.74	1.93
Unknown	0.57	0.46	x

Table II Age Structure of Total Population of Nepal, 1952-1971 (Percent)

Age / Year	1952 / 54	1961	1971
All ages	100.0	100.0	100.0
0- 4	13.2	14.2	14.1
5- 9	13.9	14.4	15.1
10-14	11.3	11.3	11.2
15-19	9.6	8.6	9.1
20-24	8.8	8.4	8.4
25-29	8.7	8.6	8.1
30-34	7.2	7.5	7.0
35-39	6.1	6.2	6.5
40-44	5.4	5.0	5.3
45-49	4.2	4.1	4.0
50-54	3.8	3.8	3.5
55-59	2.3	2.4	2.2
60-64	2.3	2.5	2.5
65-69	1.1	1.1	1.2
70 +	1.6	1.6	1.8
Age unstated	.5	.3	0

New Math ?

Sushil Kumar Shrestha

The use of the term " New Math " in the school math program is quite misleading. The author has often come across people who have the conception that really new kinds of mathematics so far non-existent in the mathematical history have been created and incorporated in the school math program. But it is not true. Because of this lack of knowledge among the public at large, there are unwarranted criticisms against the new math program. They claim that the children coming out of schools, to-day, do not know even simple computations and talk a lot about sex (confused with the term 'set'). There is, again, another group who think that nothing new has really been done except in the sense of " old wine in new bottle,". The author's main objective in writing this humbly short article is to introduce the Nepalese readers, especially those keeping an interest in the development of the mathematics instruction in the schools of Nepal, with answers to " why, how and what New Math is about ? ".

Only upto the beginning of the fifties of this century, mathematics programs in schools in most of the countries in the West did not differ much from what it used to be a century back. The objectives of mathematics instruction in the schools were influenced by the demands for a steady supply of clerks, engineers, and navigators but not mathematicians. Classroom instructional practice was nothing more than tedious drill. Psychologically, the pupils were treated as calculating machines where facts and informations can be stored and asked to repeat routine calcu[illegible] but not as living beings capable of thinking and discovering new ideas. It was the rare child who could go off and discover mathematical principles on his own and thus enjoy mathematics. During all these periods, [illegible] were made, from time to time, to bring about changes in school math, but not with much effect.

However, with the Russian's Sputnik in 1957, the Westerners, especially the Americans, were hard hit with the thought of lagging behind in the space race. The Americans realised that the root cause to this lagging behind was due to poor math and science programs in schools. Consequently, millions of federal and Foundation money were flooded to improve existing math and science programs with the realisation that the urgent need is no longer for the people who could do routine work but for men who could describe scientific findings accurately who could understand machine languages and write programs to give proper directions to do complicated mathematical calculations, who could use mathematical knowledge in many other subjects and above all, who could cope with the ever changing needs of the present day world. Many experimental projects were undertaken and researches harnessed to exolore on how children learn mathematics, what appropriate topics can be profitably introduced in different grades, how children should be taught, etc. Thus a revolution in school math programs swept almost all over the developed countries since the day of the first Russian Sputnik into space. The revolution is still continuing. Out of this revolution came the terms much used in school math education to day, such as: New Math, Mathematical Psychology, Discovery Method of Teaching, etc.

As we see now it is hard to pin down what New Math actually is. New Math means many things. However, to continue discussion, it is convenient to categorize/ many aspects of New Math into two specific categories: (1) Subject-Matter Content Aspects (2) Instructional Aspects.

If we go through the School Math Curriculum of some of the Western countries, we shall be surprised to find such formidable topics as sets, mappings, topology, transformation geometry, probability, clock arithmetic, etc., being introduced in grades as low as primary level. Groups, rings, vectors, matrices, coordinate geometry, topology, calculus, computers, etc., are taught at the secondary level. These are the topics introduced only at the college level in old programs. The inclusion of these topics at the school level has been justified by many experimental

researches conducted on what mathematics children are able to learn at a particular developmental stage and how these mathematics topics are to be taught most effectively. Of course, attention was also paid to what mathematical equipment the children of today may need as adults of tomorrow to understand the world in the right perspective. Most of the advocates of modern math believe that the type of mathematics included in the old program is not mathematics at all. They are even proposing that Euclidean geometry should be removed from the school math curriculum.

Another term that arises quite often in the discussion of New Math is ' discovery ' method of teaching. This method requires the teachers to encourage children to find out for themselves how to perform a routine operation like multiplication or to solve simple problems or what really a particular theory is all about. Researchers have shown that the pupils learn quickly and retain longer what they have learnt by themselves. Also it was found that both the teachers and the students are markedly motivated to teach and learn math. Another great innovation in the procedure of classroom instruction in New Math came as a result of findings of prominent psychologists such as J. Piaget and Z. P. Dienes. They found out the children upto the age of 11 or 12 always think in terms of concrete situations. As a result abundant use of concrete materials are used to make the mathematical ideas seem meaningful to the children, and most of the modern schools have facilities called mathematics laboratories, where children play with concrete mathrials, make concrete models to explain mathematical ideas and thus understand mathematical principles which make sense to them.

It is known to all that with the coming of NESP , there have been some changes made in our math program. However, personally the author feels these changes are not enough. Drastic revisions should be made of our school math curriculum, too, so that the future generatio is not deprived of mathematical competencies to continue to live smartly enough in this world which is getting more complicated day by day. Of course, there will arise many problems and it is our (whether we are engaged either in the teaching of math or in the improvement of mathematic instruction) paramount duty to identify problems and suggest remedies. There should be a medium to keep the dialogue going among the concerned people and interested parties.. The author hopes the present publication will help to fulfill that purpose.

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A NEW INVERSION OPERATOR FOR THE MEIJER-BESSEL TRANSFORMS

R. P. Manandhar

1. Introduction. If the Meijer-Bessel transform is given by

$$(1.1) \qquad f(s) = (2/\pi)^{1/2} \int_0^\infty (st)^{\lambda + 1/2} K_\nu(st)\, \phi(t)\, dt \quad s > 0,$$

where K_ν denotes the modified Bessel function of the second kind, we define an inversion operator $L_{k,x}\left[f(s)\right]$ for the transform (1.1) by

$$(1.2) \qquad L_{k,x}\left[f(s)\right] = \left(\frac{c}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)}{\Gamma(2k+1)\sqrt{(2\pi x)}}\, s^{k+(1+\nu+\lambda)/2}\, D^k \left[s^{k-\nu} D^k\, s^{\frac{\nu}{2}-\frac{\lambda}{2}-\frac{1}{4}} f(\sqrt{s})\right]_{s=\left(\frac{2k}{x}\right)},$$

where $\left(\frac{c}{k}\right)^k \sim \sqrt{2}\, c_k = \sqrt{2}\, \frac{4^k\, k!}{(2k)!} \quad (k \to \infty)$

and $D \equiv \frac{d}{dx}$, $\quad D^{-1}(x^a) = \int_x^\infty s^a\, ds \quad$ if $Re(a+1) < 0$

$$= \int_0^x s^a\, ds \quad \text{if } Re(a+1) > 0 .$$

Then we shall show that under certain conditions

$$\lim_{k \to \infty} L_{k,x}\left[f(s)\right] = \phi(x)$$

for all $x > 0$ in the Lebesgue set for $\phi(x)$.

The inversion operator defined by (1.2) bears a close similarity to that obtained by Hirschman and Widder (3: ch.3, p. 75) for the Meijer transform

$$(1.3) \qquad f(s) = \sqrt{(2/\pi)} \int_0^\infty \sqrt{st}\, K_0(st)\, \phi(t)\, dt$$

but differs from that originally obtained by Boas [1: p. 21] for the other Meijer transform

$$(1.4) \qquad f(s) = \sqrt{(2/\pi)} \int_0^\infty \sqrt{st}\, K_\nu(st)\, \phi(t)\, dt .$$

It is the purpose of this paper to establish a set of necessary and sufficient conditions that a function $f(s)$, defined for all real $s > 0$, admits representation as Meijer-Bessel transform defined by (1. 1) .

2. <u>Inversion theory</u>. In this section we give inversion theory for the transform (1.1) . For this we require the following lemma .

<u>Lemma 2.1</u> If

$$h(st) = (2/\pi)^{1/2} (st)^{\lambda+1/2} K_{\nu}(st) \text{, then}$$

$$L_{k,x}\left[f(s)\right] = \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1- \quad)}{\pi\Gamma(2k+1)\ \sqrt{(2k)}} \left(\frac{2k}{x}\right)^{2k+3/2+\lambda} t^{\lambda+2k+1/2} K_{\nu}\left(\frac{2kt}{x}\right) . \tag{2.1}$$

<u>Proof</u>. We have

$$s^{\frac{\nu}{2}-\frac{\lambda}{2}-\frac{1}{4}} h(t\sqrt{s}) = (2/\pi)^{1/2}\ t^{\lambda+1/2-\nu} (t\sqrt{s})\ K_{\nu}(t\sqrt{s}) .$$

Using the result of Erdelyi [2: p. 79]

$$\left(\frac{d}{zdz}\right)^{n} \left[z^{\nu} K_{\nu}(z)\right] = (-1)^{n}\ z^{\nu-n}\ K_{\nu-n}(z)$$

we obtain $s^{k-\nu} D^{k} \left[s^{\frac{\nu}{2}-\frac{\lambda}{2}-\frac{1}{4}} h(t\sqrt{s}) = (2/\pi^{1/2} (-1)^{n} 2^{-k}\right.$

$$t^{\lambda+1/2-\nu} (t\sqrt{s})^{k-\nu} K_{\nu-k}(t\sqrt{s}) .$$

The use of another resultof Erdelyi (2: p. 79

$$\left(\frac{d}{zdz}\right)^{n} \left[z^{-\nu} K_{\nu}(z)\right] = (-1)^{n}\ z^{-\nu-n} K_{\nu+n}(z)$$

Completes the proof of the lemma.

<u>Theorem 2.1</u>. If $\phi(t) \in L$ in $0 \leq t \leq R$ for every positive R, and if the integral (1.1) converges, then $L_{k,x}\left[f(s)\right]$ exists and

$$\lim_{k\to\infty} L_{k,x}\left[f(s)\right] = \phi(x)$$

for all $x > 0$ in the Lebesgue set for $\phi(x)$.

<u>Proof</u>. Under the hypothesis of the theorem the integral (1.1) converges absolutely for $s > 0$ and $\lambda+3/2-\nu > 0$, $\lambda \geq 0$, and therefore converges uniformly. Hence we may evaluate the derivatives of $f(s)$ by differentiation under the integral sign. Therefore by use of lemma (2.1) we have

$$(2.2) \qquad L_{k\lambda,x}\left[f(s)\right] = \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)}{\pi\Gamma(2k+1)\sqrt{(2k)}} \int_0^\infty \left(\frac{2k}{x}\right)^{2k+1/2+\lambda} t^{2k+1/2+\lambda} K_\nu\left(\frac{2kt}{x}\right)\phi(t)\, dt .$$

Now it is easy to see that the integral on the right of (2.2) converges under the same conditions for which the integral (1.1) converges. Hence $L_{k,x}\left[f(s)\right]$ exists.

Using the following asymptotic estimates [4: p. 136 & 5: p. 73]

$$K_\nu(z) \sim \left(\frac{\pi}{2z}\right)^{1/2} e^{-z} \qquad (z\to\infty)$$

$$\frac{(2k)!}{\sqrt{4\pi k}} \left(\frac{e}{2k}\right)^{2k} \longrightarrow 1 \qquad (k\to\infty)$$

we have

$$\lim_{k\to\infty} L_{k,x}\left[f(s)\right] = \lim_{k\to\infty} \frac{\Gamma(k+1-\lambda)}{k!\,k!} \left(\frac{k}{x}\right)^{k+1+\lambda} \int_0^\infty t^{k+\lambda} e^{-\frac{kt}{x}} \phi(t)\, dt$$

If $\lambda = 0$, the above integral reduces to the singular integral for Laplace transform. Hence we may follow Widder [5: ch. 7, p. 280 - 283] to get

$$\lim_{k\to\infty} \frac{\Gamma(k+1-\lambda)}{k!\,k!} \left(\frac{k}{x}\right)^{k+1+\lambda} \int_0^\infty t^{k+\lambda} e^{-\frac{kt}{x}} \phi(t)\, dt = \phi(x)$$

Therefore

$$\lim_{k\to\infty} L_{k,x}\left[f(s)\right] = \phi(x)$$

Now it remains to show that conditions of the theorem 3c [5: p. 283] are satisfied. We observe that $\phi(t) \in L$ in $0\leq t\leq R$ for every positive R and r of that theorem may be taken to be zero. Also c may be taken to be greater than s_0 since the integral $\int_0^\infty e^{-cx}\phi(x)\, dx$ converges. The Lebesgue set for $\phi(x)$ is the set of numbers t_0 such that

$$\int_{t_0}^{t} |\phi(x) - \phi(t_0)|\, dx = o(|t-t_0|) \quad (t\to t_0+) .$$

$$(2.2) \qquad L_{k,x}\left[f(s)\right] = \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)}{\pi\Gamma(2k+1)\sqrt{(2k)}} \int_0^\infty \left(\frac{2k}{x}\right)^{2k+1/2+\lambda} t^{2k+1/2+\lambda} K_\nu\left(\frac{2kt}{x}\right) \phi(t)\, dt .$$

Now it is easy to see that the integral on the right of (2.2) converges under the same conditions for which the integral (1.1) converges. Hence $L_{k,x}\left[f(s)\right]$ exists.

Using the following asymptotic estimates [4: p. 136 & 5: p. 73]

$$K_\nu(z) \sim \left(\frac{\pi}{2z}\right)^{1/2} e^{-z} \qquad (z \to \infty)$$

$$\frac{(2k)!}{\sqrt{4\pi k}} \left(\frac{e}{2k}\right)^{2k} \longrightarrow 1 \qquad (k \to \infty)$$

we have

$$\lim_{k\to\infty} L_{k,x}\left[f(s)\right] = \lim_{k\to\infty} \frac{\Gamma(k+1-\lambda)}{k!\,k!} \left(\frac{k}{x}\right)^{k+1+\lambda} \int_0^\infty t^{k+\lambda} e^{-\frac{kt}{x}} \phi(t)\, dt .$$

If $\lambda = 0$, the above integral reduces to the singular integral for Laplace transform. Hence we may follow Widder [5: ch. 7, p. 280 - 283] to get

$$\lim_{k\to\infty} \frac{\Gamma(k+1-\lambda)}{k!\,k!} \left(\frac{k}{x}\right)^{k+1+\lambda} \int_0^\infty t^{k+\lambda} e^{-\frac{kt}{x}} \phi(t)\, dt = \phi(x) .$$

Therefore

$$\lim_{k\to\infty} L_{k,x}\left[f(s)\right] = \phi(x)$$

Now it remains to show that conditions of the theorem 3c [5: p. 283] are satisfied. We observe that $\phi(t) \in L$ in $0 \leq t \leq R$ for every positive R and r of that theorem may be taken to be zero. Also c may be taken to be greater than s_0 since the integral $\int_0^\infty e^{-cx}\phi(x)\, dx$ converges. The Lebesgue set for $\phi(x)$ is the set of numbers t_0 such that

$$\int_{t_0}^{t} |\phi(x) - \phi(t_0)|\, dx = o(|t-t_0|) \quad (t \to t_0+)$$

For such set of numbers the hypothesis (iv) of the theorem is satisfied. This completes the proof.

3. Representation theory. The following theorem is fundamental to the representation theory.

Theorem 3.1. If for each positive integer k

$$\int_0^x L_{k,t}\left[f(s)\right]\,dt = O(x) \qquad (x\to\infty),$$

then $f(\infty)$ exists and

$$\lim_{k\to\infty}(2/\pi)^{1/2}\int_0^\infty (xt)^{1/2+\lambda}K_\nu(xt)\,L_{k,t}\left[f(s)\right]\,dt$$

$$= f(x) - f(\infty) \qquad 0<x<\infty .$$

Proof. By the definition of the operator (1.2) we see that the hypothesis is equivalent to

$$(3.1)\quad \int_{x^{-1}}^{\infty} y^{2k+\nu+\lambda-3/2}\,D^k\left[y^{2k-2\nu}D^k\,y^{\nu-\lambda-1/2}\,f(y)\right]dy = O(x) \qquad (x\to\infty,\ k=0,1,2,\ldots)$$

The proof of the theorem 7b [5: ch. 7, p. 295] clearly shows that the existence of these integrals implies the existence of $f(\infty)$ and that

$$\left[f(x)-f(\infty)\right]^{(k)} = o(x^{-k}) \quad (x\to\infty,\ k=0,1,2,\ldots.$$

Also writing $\theta(y) = y^{2k-2\nu}D^k\,y^{\nu-\lambda-1/2}\,f(y)$ in (3.1) and integrating by parts we get

$$\int_{x^{-1}}^{\infty} y^{2k+\nu+\lambda+1/2}\,D^{k+1}\left[\theta(y)\right]dy$$

$$= -x^{-2k-\nu-1/2-\lambda}\,D^k\left[\theta(x^{-1})\right] - (2k+\nu+\lambda+1/2)\int_{x^{-1}}^{\infty} y^{2k+\nu}\,D^k\left[\theta(y)\right]dy.$$

Since both these integrals are $O(x)$ as x becomes infinite the same is true for

$$x^{-2k-\nu-\lambda-1/2}\,D^k\left[\theta(x^{-1})\right].$$

Hence $\quad \theta^k (x^{-k}) = O(x^{2k+\nu+\lambda+3/2}) \quad (x \to \infty)$

$$\theta^k (x^k) = O(x^{-2k-\nu-\lambda-3/2}) \quad (x \to 0+)$$

Or

$$D^k \; x^{2k-2\nu} D^k \; x^{\nu-\lambda-1/2} f(x) = O(x^{-2k-3/2-\nu-\lambda}) \quad (x \to 0+) \; .$$

Integrating the above relation k times from x to ∞ ; we find

$$D^k \left\{ x^{\nu-\lambda-1/2} f(x) \right\} = O(x^{-3k-\lambda+\nu-3/2}) \qquad (x \to 0+)$$

which yields

$$f^k(x) = O(x^{-3k-1}) \qquad (x \to 0+) \; .$$

Thus this satisfies the corollary 11a [5: p. 304]. Hence applying the corollary to the function $[f(x) - f(\infty)]$, we get the desired result since

$$L_{k,x} \left[f(x) - f(\infty) \right] = L_{k,x} \left[f(x) \right] \; .$$

Theorem 3.2. The necessary and sufficient conditions f(x) may have the representation as

(3.2) $\quad f(x) = (2/\pi)^{1/2} \int_0^\infty (xt)^{\lambda+1/2} K_\nu(xt) \phi(t) \, dt$

with $\phi(t) \in L^p$ in $(0 \leq t < \infty)$ and $p > 1$ are that

(i) $f(x)$ is infinitely differentiable in $0 < x < \infty$,

(ii) $f(x)$ tends to zero as $x \to \infty$, and that

(iii) there exists constants p and M such that for $p > 1$

(3.3) $\quad \int_0^\infty | L_{k,t} [f(x)] |^p \, dt \leq M \; .$

Proof. The necessity conditions of (i) and (ii) are obvious. For the necessity of (iii) we suppose that (3.2) holds. If $\lambda + 3/2 \pm \nu > 0$ and $\lambda \geq 0$ the integral (3.2) converges absolutely for $x > 0$. Then by Hölder's inequality we have

$$\int_0^\infty | L_{k,t} [f(.)] |^p \, dt$$

$$= \int_0^\infty \left| \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)^{2k+1+\lambda}}{\pi\,\Gamma(2k+1)} \int_0^\infty \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right) \phi(x)\, dx \right| dt$$

$$\leq \int_0^\infty \left(\int_0^\infty \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)^{2k+1+\lambda}}{(2k+1)} \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right) |\phi(x)|\, dx\right)^{p} dt$$

$$= \int_0^\infty \left(\int_0^\infty \left(\left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)}{\pi\,\Gamma(2k+1)}^{2k+1+\lambda} \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right)\right)^{1/p}\right.$$

$$\left. \left(\left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)^{2k+1+\lambda}}{\pi\,\Gamma(2k+1)} \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right)\right)^{1/q} |\phi(x)|\, dx \right)^{p} dt$$

$$\leq \int_0^\infty \left(\int_0^\infty \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)^{2k+1+\lambda}}{\pi\,\Gamma(2k+1)} \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right) |\phi(x)|^p\, dx\right)$$

$$\left(\int_0^\infty \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)^{2k+1+\lambda}}{\pi\,\Gamma(2k+1)} \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right) dx\right)^{p/q} dt \ .$$

Since the integral

$$\left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)}{\pi\,\Gamma(2k+1)}^{2k+1+\lambda} \int_0^\infty \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right) dx = O(1) \quad (k \to$$

so that we have

$$\int_0^\infty \left| L_{k,t}\left[f(.)\right] \right|^p dt$$

$$\leq \int_0^\infty \left(\int_0^\infty \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)(2k)}{\pi\,\Gamma(2k+1)}^{2k+1+\lambda} \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K_\nu\left(\frac{2kx}{t}\right) |\phi(x)|^p\, dx\right) dt$$

$$= \int_0^\infty |\phi(x)|^p\, dx \left(\frac{e}{2k}\right)^{2k} \frac{\Gamma(2k+1-\lambda)\,(2k)}{\pi\,\Gamma(2k+1)}^{2k+1+\lambda} \int_0^\infty \frac{x^{2k+1/2+\lambda}}{t^{2k+3/2+\lambda}} K\left(\frac{2kx}{t}\right) dt$$

$$= \int_0^\infty |\phi(x)|^p\, dx \leq M \ .$$

The change of order of integrations is justified as the resulting integral converges and has the value less than M. Thus (3.3) is established.

Conversely we suppose that $f(x)$ satisfies all the conditions of the hypothesis. Then by use of Hölder's inequality, we have

$$\int_0^x | L_{k,t}[f(.)] | \, dt \leq \left(\int_0^x | L_{k,t}[f(.)] |^p dt\right)^{1/p} \left(\int_0^x dt\right)^{\frac{1}{q}}$$

$$\leq \left(\int_0^\infty | L_{k,t}[f(.)] |^p dt\right)^{1/p} \left(\int_0^x dt\right)^{1/q}$$

$$= M^{1/p} x^{1-1/p}$$

Thus there exists for each positive integer k

$$\int_0^x L_{k,t}[f(.)] \, dt = 0(x) \qquad (x \to \infty) .$$

So the theorem 3.1 is applicable and hence by that theorem we have $f(\infty)$ (which is zero) exists and

$$\lim_{k\to\infty} (2/\pi)^{1/2} \int_0^\infty (xt)^{\lambda+1/2} K_\nu(xt) \, L_{k,t}[f(.)] \, dt$$

$$= f(x) \quad (0 < x < \infty)$$

Now we may apply a theorem on Weak compactness 5: p. 33 according to which there exists a sequence $\{k_i\}$ of the positive integers and a function $\phi(t)$ belonging to the class L^p in $0 \leq t < \infty$, $p > 1$ such that

$$\lim_{k\to\infty} (2/\pi)^{1/2} \int_0^\infty (xt)^{\lambda+1/2} K_\nu(xt) \, L_{k_i,t}[f(.)] \, dt$$

$$= (2/\pi)^{1/2} \int_0^\infty (xt)^{\lambda+1/2} K_\nu(xt) \phi(t) \, dt .$$

Hence

$$f(x) = (2/\pi)^{1/2} \int_0^\infty (xt)^{\lambda+1/2} K_\nu(xt) \phi(t) \, dt$$

which proves the theorem.

References

1 Boas, R. P., Inversion of a generalised Laplace integral, Proc. of the Nat. Acad. of Sci. U.S.A., 45(1942) p.24 -24.

2 Erdelyi, A., Higher Transcendental Functions vol II, McGraw-Hill 1953

3 Hirschman & Widder, The convolution transforms, Princeton Univ Press, 1955.

4 Lebedev, N.N., Special functions and their applications, Prentice Hall.

5 Widder, D.V., The Laplace transform, Princeton Univ. press, 1963 1963

PROBLEMS

In each issue of the Report there will be a section on problems. You are invited to send your solutions to the problems to any member of the Coordinating Committee. One solution to each problem will be published in later issues of the Report with credit given to the solver. Other persons who submit correct solutions to the same problem will be acknowledged by name.

You are also invited to send your favorite problems for inclusion in the problem section to challenge others. A solution may be sent along if one is known.

The following four problems will serve to start the section. They are of a general introductory nature.

No. 1: Show that a number consisting of 3^n equal digits is divisible by 3^n.

No. 2: Find the smallest natural number with the following property: If the first digit on the left is transferred to the right end, then the new number will be 1.5 times the old number.

No. 3: A set of n points in the plane has the following property: Any 3-subset of it forms a triangle of area ≤ 1. Show that the set can be enclosed in a triangle of area ≤ 4.

No. 4: Let $0 < a < b$. Ram chooses a number c in the interval $[a, b]$ and Shyam must guess this number. Let Shyam's guess be d. Then the relative error $\frac{|d - c|}{c}$ is his loss to Ram. How should Shyam choose his guess so that his maximum possible loss is as small as possible ?

ANNOUNCEMENTS

1. The Mathematics Seminar is held usually on the first Friday of each Nepali month. Announcements for the meetings are sent in advance giving details as to time, place, speaker, and topic. You are invited to attend. If you do not now receive the announcements and wish to do so, please let us know your name and address and a copy will be mailed to you each month. Your comments and suggestions concerning the Seminar are also invited.
2. Articles are needed for succeeding issues of the Report. Please submit them to any member of the Coordinating Committee.
3. Mathematics specialists at CDC - HMG, Harihar Bhawan, Pulchowk, Lalitpur, are preparing a special Handbook on applications of mathematics for distribution to teachers and supervisors to improve the teaching of problem solving and to permit more relevant applications to be taught in the schools. They desire to have these applications reflect local conditions in the Kingdom. You are invited to send lists of such problems to the CDC for inclusion in the Handbook. They may be at any of the school levels - primary, lower secondary, or secondary and should refer to your local situation. Your assistance in this matter will be greatly appreciated.

The End

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