the research engineer

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bamboo

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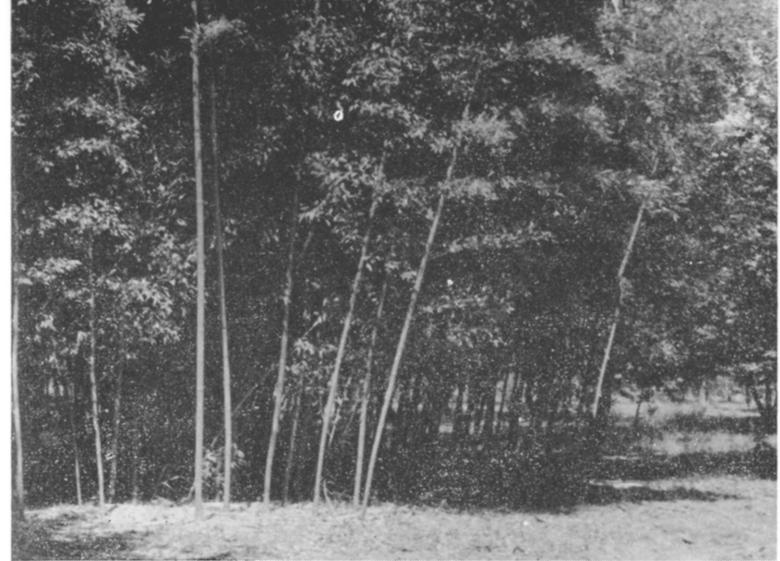
the research engineer

Fig. 1. Bamboo (Phyllostachys sulphurea) growing at USDA Station, Savannah.

Bamboo--
Plant With a Future

H. H. SINEATH, Research Engineer, and
P. M. DAUGHERTY, Research Assistant

THE BAMBOOS POSSESS several characteristics which make them promising as profitable domestic crops. For instance, they grow very rapidly, and they have many commercial uses. Substantial markets for bamboo products have existed in the United States for many years. Bamboos as crops are not entirely unknown in this country since various species have been, and are being, grown successfully for commercial sale.

The uses of bamboo are almost infinite. In the Orient, particularly, it is said that most human needs can be supplied by bamboo; the young shoots of several species are used for food, and the matured culms of many species are used for structural purposes, furnishing shelter, weapons, bridges, water pipes, paper pulp and soft boards, etc. Still other species, cut into strips of various sizes, are used in weaving a type of coarse cloth, and bags, baskets and other items.

The uses to which bamboo has been put in the United States are not as varied as in the Orient, but increasing interest has been shown in bamboo in recent years, particularly for such purposes as light but strong construction, concrete reinforcement, and pulp and soft board manufacture. Several commercial organizations are engaged in studies of some species of bamboo for specific uses. For instance, one organization is interested in using this type of material in building boards. In addition, other companies have expressed interest in bamboo as a raw material for roofing and building felts. Other possible outlets for domestically grown bamboo include the manufacture of a corrugated medium for containers, and book or wrapping papers.

Pulp source

One of the most significant facts about the bamboos is that they have been used successfully in several countries as a paper pulp source. This would indicate that bamboo might be an answer to the increasing need for an additional pulp source in this country. This looks particularly attractive when one considers that six or seven times more cellulosic material could be obtained per acre per year from a bamboo forest of the larger species than from a pine forest. If bamboos were used only to take care of the expected increased consumption of southern pine stands for pulpwood, it would have an annual volume potential equivalent to about two and one-half million cords of pine. Bamboos grown in this supplementary capacity would permit the drain and growth of pine woodlands to be brought into balance more easily. As such, the bamboos would offer assistance to the forester and would be a valuable asset to the sections of the country in which they were grown.

Construction

Perhaps the most important use to which bamboo could be put in this country, other than in the manufacture of paper pulp, is that for lightweight but strong construction. The application of modern fastening methods to the joining of bamboo shows promise in greatly increased speed and adaptability of bamboo construction. Ladders, scaffolding, temporary trestle work and many other forms of construction could be more portable and more easily handled by using bamboo culms. There are numerous other products from, and uses for, bamboo. Among the products is a wax, melting from 79° to 80°C. and possessing in general the properties of carnauba wax, and tabashir which has been found to have wide application as a catalyst because of its microporous structure.

As a plant bamboo is very interesting. The *Bambuseae* tribe is a member of the huge family Gramineae, and bamboos are, therefore, near relatives of corn, wheat, oats, barley and other grasses. They are distinguished from other members of the family in that they are woody perennials, some of which are giant species attaining heights of 70 or more feet. The estimated number of species of bamboo ranges from 500 to 1,000, composing some 60 or more genera.

Fast growers

Bamboos grow very rapidly, attaining their full height in six to eight weeks. Such a rapid rate of growth occurs, however, only after a clump is fully established, which may take from three to six years. Because of this rapid growth, both above and beneath the soil, very few other plants can interfere with their growth. They also differ from other woody plants in that the full diameter is attained when the culm is only a few inches high. There are several other factors which make the bamboos attractive from the cultivation viewpoint. They are not affected to any appreciable extent by disease, and they are generally easy to propagate and can be harvested without difficulty. In one method of harvesting, called strip or partial harvesting, machine harvesting methods can be applied. This, of course, considerably reduces the labor required for selectively cutting only mature canes. Machine harvesting also could be used for clear cutting the bamboo, but strip harvesting has an advantage in that quicker regrowth occurs when the cut sections are interspersed with uncut sections.

Of the two general types of bamboos, the running bamboos are generally hardier than the clump forming types and may be successfully grown in all portions of the southern United States except in mountainous regions. They are now being grown in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, Texas, and the eastern parts of North Carolina and Virginia. The clump forming types are successfully grown in southern Louisiana and Florida. The term hardy has been generally accepted as referring to bamboos which are evergreen at temperatures down to about 5°F. Near 0°F. the leaves of all but the hardiest are killed, and at a few degrees below zero the stems are partially or completely killed. If, however, the roots are reasonably well protected from the cold, new shoots may develop after winters as cold as −20°F. It has been estimated that more than 50 million acres of marginal land in the southern United States are suitable for bamboo cultivation.

High Return

Some indication of the value of bamboo as a possible domestic crop can be obtained by considering the gross return per acre. Growing of the species *Phyllostachys aurea* for use as fishing poles should be profitable, since reported yields and values per pole indicate that a gross return of $170 per acre per year could be realized, and, once established, the bamboo groves would require little care. Although the market is limited at the present time for the larger poles from such species as *Phyllostachys bambusoides*, it appears that a gross return per acre of a species of this size would be about $350

Fig. 2. Phyllostachys bambusoides.

cover

The cover photograph is of—and by—Dr. W. H. Hodge, Assistant Head, Section of Plant Exploration and Introduction, Agricultural Research Service, U. S. Department of Agriculture. He took his own picture while standing in a grove of *Phyllostachys bambusoides,* the giant timber bamboo, near Savannah. The station there has the world's largest collection of the bamboos. The resident director, D. A. Bisset, a veteran of 40-plus years with USDA, took Fig. 1. P. H. Dorsett, also USDA, took Fig. 2.

bamboo

annually. It has been mentioned previously that the yield of cellulose per acre from bamboo would be about seven times greater than from pine. It would be logical, therefore, to assume that land devoted to growing bamboo as a pulp source would bring a return to the owner of approximately seven times that of land used for pulpwood production. On the basis of $13.50 per cord or $9 per ton for pine and assuming that bamboo could command a comparable price, this would present an annual gross income to the growers of approximately $100 per acre of land per year.

On the farm

Although no actual monetary value can be given to bamboo grown on individual farms for use around the farms, bamboo planted for this purpose conceivably would result in considerable savings to the farmer. In fact, for the past several years, the U. S. Department of Agriculture has recommended that individual farmers grow about one acre of bamboo for the many uses to which it can be applied on the farm. A small grove of bamboo would provide the farmer with plant stakes, bean poles, fishing poles, and other similar items. The material would also be useful for open construction such as shade houses,

poultry coops and fruit and vegetable crates. Also the leaves of many species, both fresh and silaged, make excellent fodder for farm stock. Bamboo grown for use as a landscaping material is another potential source of income for the farmer, and in the case of the development of large industrial uses of bamboo, the small tracts of the individual farmer might be worthwhile investments since they would be excellent sources of propagation material.

Research work

Much experimental work already has been done, particularly under the auspices of the United States Department of Agriculture, which operates the Barbour Lathrop plant introduction garden on the Ogeechee River near Savannah, Georgia. Experiments have been conducted on about 173 species of bamboo. Under the same sponsorship, an industrial survey has been conducted at the Georgia Institute of Technology, and currently, certain experimental work is under way at Clemson College, Clemson, S. C., and at the Herty Foundation Laboratory at Savannah, Georgia. These experimental programs are steps toward developing into a crop this plant with a future that should eventually provide farmers of this country with a money making crop beneficial to the entire country.

the president's page

A new ingredient has been added to the alphabetical soup which nourishes public education in our state. It's "APEG", the abbreviation for the Adequate Program of Education for Georgia, a far-sighted movement sponsored by the Georgia Education Association.

The GEA says that an Adequate Program of Education for Georgia will be made up of four essentials, one of which "is improvement in the quality and expansion of the scope of research."

I congratulate the association for giving research the credit it deserves. In my opinion, research is essential in an Adequate Program of Educatiion for Georgia because:

(1) education is impotent without research; (2) a balanced agricultural and industrial economy for Georgia is dependent on research; (3) every citizen of Georgia, whether he ever goes to school or not, is affected every day in his standard of living by the results of research; and (4) research produces new products, new industries, new payrolls, and new taxes—all of which, in turn, support new public schools.

The first of those reasons is the closest, perhaps, to those of us on the campus of Georgia Tech; we know from experience that higher education and research are inseparable. At Georgia Tech, the Engineering Experiment Station contributes, directly and indirectly, to undergraduate and graduate education. Forty-one employees of the Station this spring received degrees, from B.S.'s to Ph.D.'s; 114 faculty members from 14 schools of Georgia Tech are employed part time by the Station.

This opportunity to perform research attracts better qualified teachers and researchers. It increases the teachers' knowledge of their fields and gives them an appreciation of practical problems their students will face. It helps them to develop their own scientific statures. At the same time, it benefits the Station, as the faculty members contribute greatly to the success of many of the Station's research programs.

Even though the Engineering Experiment Station is severely limited in funds, it now has underway 41 research projects supported by state funds for the benefit of the citizens of Georgia.

You will soon be hearing more about the Adequate Program of Education for Georgia. The GEA has put on the record its conviction that research is essential in APEG. Research means to the GEA "the search for new truth in vast areas of knowledge; the development of new and improved applications of existing knowledge in engineering and agriculture."

Blake R. Van Leer

Fig. 1. Sine functions plot as straight lines on linear sine paper. The line representing the equation y = sin (mx + Θ) has a slope of m and a y'-intercept of Θ.

Linear Sine Paper and its Engineering Applications

M. DAVID PRINCE, Research Engineer

SINES AND COSINES are among those functions most frequently encountered in engineering mathematics. A coordinate paper specifically designed for use with sines and cosines is presented here. Many engineering curves which require tedious point-by-point plotting on standard graph paper are quickly sketched in a simpler form on this linear sine paper. This type of paper, therefore, can be used for special plotting purposes in a manner similar to logarithmic, hyperbolic, and arctangent papers.

The coordinate scales will be discussed in the following section, but first the procedure for plotting sine waves will be illustrated. Fig. 1, which may be verified by point-by-point plotting, shows four sine functions which are graphed as straight lines on sine paper. The slope of each line is the coefficient of x, and the vertical intercept on the left is the "phase" constant. That is, the curve of the function $y = sin (mx + \Theta)$ is sketched by drawing the straight line, $y' = mx + \Theta$

The special coordinate paper described in this article was conceived by the author in 1950 while a member of the staff of the Georgia Tech School of Mathematics. He presented the basic information at a meeting of the southeastern section of the Mathematical Association of America at Vanderbilt University on March 16, 1951. This is the first published description of this development.

where y' refers to the vertical scale on the left and y to the vertical scale on the right. (Note that any cosine function may be written in the sine form by use of the identity, $cos A = sin [A + \frac{\pi}{2}]$ and then plotted by the foregoing rule.)

Coordinate scales

The coordinate scales of linear sine paper will now be developed in order to demonstrate the validity of the "curves" shown in Fig. 1, and to form a basis for engineering applications of the graph paper. Consider first the sine wave shown in Fig. 2(a). This can be transformed into the triangular wave shown in 2(b) by appropriately "stretching" the paper in the vertical direction, leaving the horizontal scale unchanged. This scale-stretching factor is described by

$$y = sin \; y' \quad (1)$$

where y is the ordinate of a point in Fig. 2(a) and y' is the ordinate of the corresponding point in Fig. 2(b). The original y-scale is shown on the right in this figure after being distorted by the change of scale. Finally, Fig. 2(c) shows how the triangular wave representing the sine curve is "unfolded" into a single straight line. This is accomplished mathematically by permitting y' to exceed $\frac{\pi}{2}$ in Equation (1),
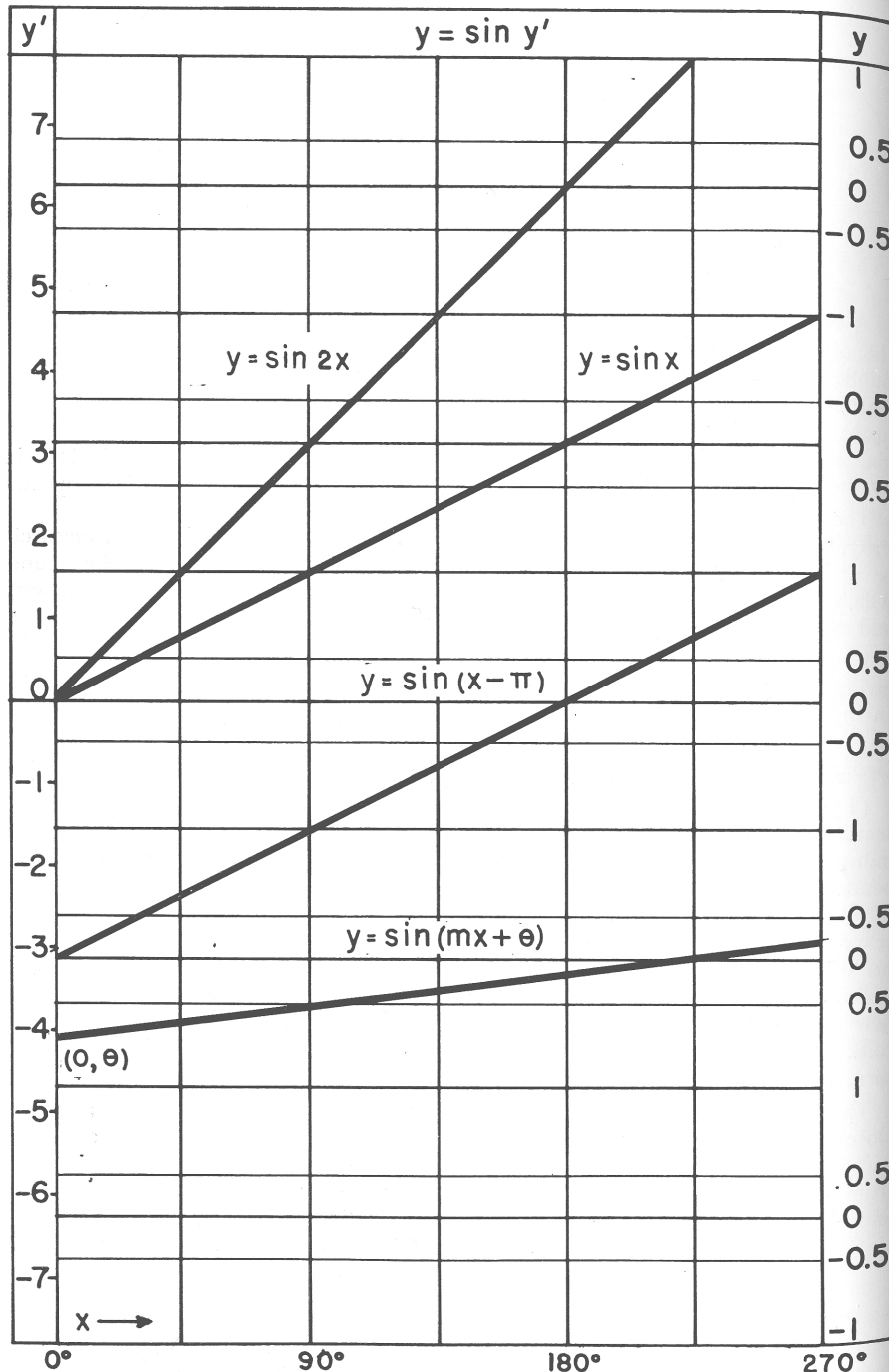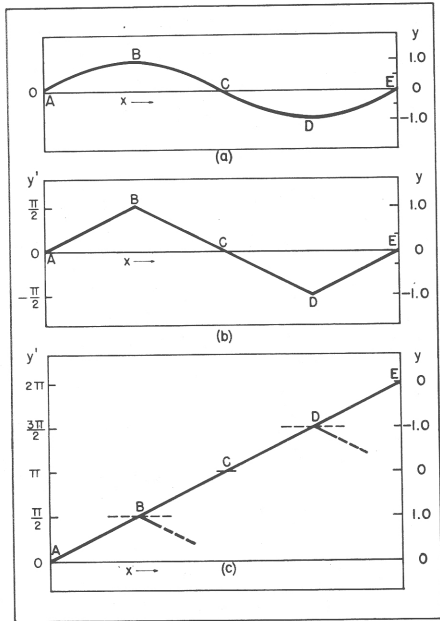
Fig. 2. Sine paper is derived by "stretching" and "unfolding" standard linear coordinate paper. (a) Sine wave on linear coordinate paper, (b) vertical scale distorted to produce a triangular wave, and (c) paper "unfolded" along horizontal lines so that the triangular wave becomes a straight line.

thus producing a y-scale which repeats periodically in the vertical direction. (A form of this paper suitable for graphical computation [Fig. 5] has been printed in quantity, and sample sheets are available from the author upon request.)

The principal properties of sine paper which follow from the preceding development are tabulated below:

1. The new y'-scale on the left is linear and the original y-scale seen on the right is non-linear. The equation $y = sin\ y'$ relates these two vertical scales (y' is expressed in radians).

2. Only values of y between the limits of -1 and $+1$ appear on the graph paper.

3. The region between $y = -1$ and $y = +1$ is repeated periodically in the vertical direction. As a result, a curve plotted in its entirety on sine paper

appears in each of these periodic regions and displays mirror symmetry about each of the horizontal lines, $y = -1$ and $y = +1$. Frequently, however, only partial plotting of a curve is required. (The *complete* plot of $y = sin$ $[mx + \theta]$ on sine paper is a grid or family of lines with slopes of $+m$ and $-m$. However, a single straight line, plotted as shown in Fig. 1, will suffice for most applications.)

4. Since both the y and y' scales appear on sine paper, a curve may be plotted using either variable, the choice depending upon which permits the simpler presentation.

5. A curve may be translated vertically by any integral multiple of 2π as measured on the y' scale.

Curve plotting

Sine paper is useful for plotting the curves of functions which are simplified by the "sine substitution", $y = sin\ y'$. As an example, consider the equation,

$$y = sin\ (\propto cos\ x) \qquad (2)$$

which is an important function encountered in frequency and phase modu-

Table I. Some common engineering functions which are readily plotted on sine paper.

Function	Resulting Form on Sine Paper
$y = sin\ (mx + \theta)$	$y' = mx + \theta$
$y = sin\ (m \pm n)x$	$y' = (m \pm n)x$
$y = sin\ (\propto cos\ x)$	$y' = \propto cos\ x$
$y = sin\ (\propto sin\ x)$	$y' = \propto sin\ x$
$y = cos\ (\propto cos\ x)$	$y' = \dfrac{\pi}{2} + \propto cos\ x$
$y = cos\ (\propto sin\ x)$	$y' = \dfrac{\pi}{2} + \propto sin\ x$
$y = cos\ (n\ arcsin\ x)$	$x = sin\ \dfrac{y' - \dfrac{\pi}{2}}{n}$
$y = cos\ (n\ arccos\ x)$	$x = cos\ \dfrac{y' - \dfrac{\pi}{2}}{n}$
$y = sin\ (n\ arcsin\ x)$	$x = sin\ \left(\dfrac{y'}{n}\right)$
$y = sin\ (n\ arccos\ x)$	$x = cos\left(\dfrac{y'}{n}\right)$

lation theory, antenna design, and other branches of engineering.

Combining Equation (1) with Equation (2) yields

$$y' = \propto cos\ x. \qquad (3)$$

Equation (3) shows that sine substitution permits the evaluation of y in Equation (2) by sketching a sine wave with amplitude $\propto$ on sine paper. This is shown in Fig. 3 where the curves of Equation (3) are given for $\propto = \dfrac{\pi}{2}$, $3\dfrac{\pi}{4}$, and π in comparison with the same curves plotted on standard coordinate paper. Note that it is immediately evident, for example, that for $\propto = 3\dfrac{\pi}{4}$ y reaches its maximum value of unity at $x = 48°$, (calculated as 48.2°) and dips to $y = 0.71$ (calculated as 0.707) at $x = 0$. Another useful presentation of Equation (3) is obtained by regarding $\propto$ as the independent variable and x

Fig. 3. (a) (below) Plots of the function $y = sin\ (\propto cos\ x)$ are shown on linear coordinate paper. (b) (right) Curves of this function appears as cosine curves with amplitude $\propto$ on sine paper.
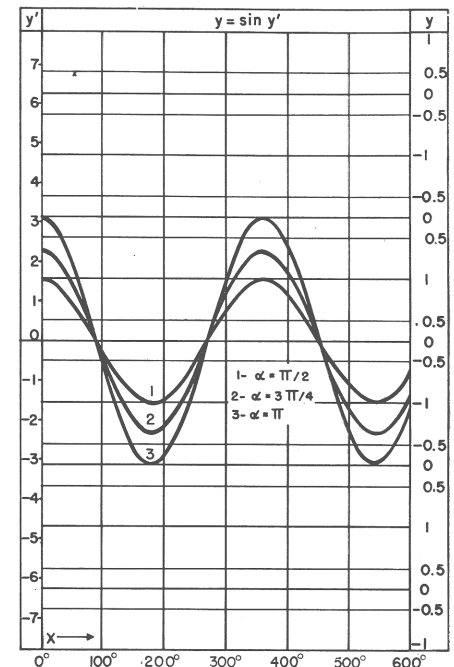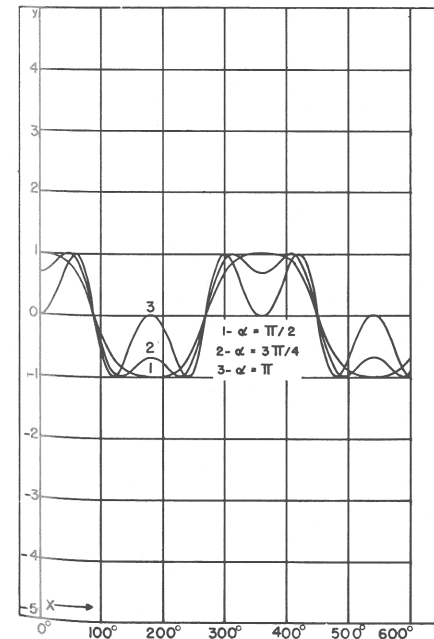
as the parameter. Using $\propto$ rather than x for the horizontal coordinate, Equation (3) is then plotted by drawing a straight line passing through the point $x = 0$, $y' = 0$, and having a slope of $cos\ x$. This construction is facilitated by using an auxiliary vertical slope scale which varies as $cos\ x$. Then for any x and $\propto$, the corresponding values of y can be found by use of a straight-edge without interpolation.

As a second example, consider the Tschebyscheff polynomial of order n which can be written in the form $T_n(x) = cos\ (n\ arccos\ x)$. It can be shown that the plot of this equation on sine paper is a cosine curve with vertical axis, unity amplitude, and with period of $2n\pi$.

Solution of equations

Linear sine paper is particularly adapted to the solutions of equations which contain several parameters. An important class of such problems is represented by the expression

$$sin\ (mx + \theta) = F(x) \qquad (4)$$

where x is the unknown, m and θ are parameters, and $F(x)$ is an exponen-

tial, polynomial, or some other function of x alone.

The complete solution to any equation of this type is readily displayed for various values of m and θ by separation into the two component equations:

$$y_1 = F(x) \qquad (5)$$

and

$$y_2 = \sin(mx + \theta). \qquad (6)$$

Equation (5) is plotted point-by-point on sine paper in each of the periodic regions mentioned previously. Then, for any specified value of m and θ, Equation (6) is graphed as the straight line, $y' = mx + \theta$. Each intersection between this line and any of the branches of Equation (5) designates a value of x which satisfies the original equation.

Transmission line problem

As a practical example of the type of equation outlined above, the general solution to a classical problem in transmission line theory will be given on linear sine paper.[1] It is well known that the voltage at the end of an open-circuited transmission line may equal the voltage at the generator. This phenomenon, known as the Ferranti Effect, occurs for certain values of length, attenuation, and phase constants as specified by the equation:

$$\sin \beta L = \pm \sinh \alpha L \qquad (7)$$

where α and β are the attenuation and phase constants, and L is the length of the line.

It is desired to present the solutions of this equation so that the critical lengths may be easily determined for any specified value of α and β. Following the procedure outlined in the preceding section, Equation (7) may be written in the form

$$\sin mx = \pm \sinh x \qquad (8)$$

where $x = \alpha L$ and $m = \dfrac{\beta}{\alpha}$. Then, let

$$y_1 = \pm \sinh x \qquad (9)$$

and

$$y_2 = \sin mx. \qquad (10)$$

The hyperbolic curve is plotted point-by-point on linear sine paper using the vertical y-scale on the right as shown in Fig. 4, the curve being repeated as
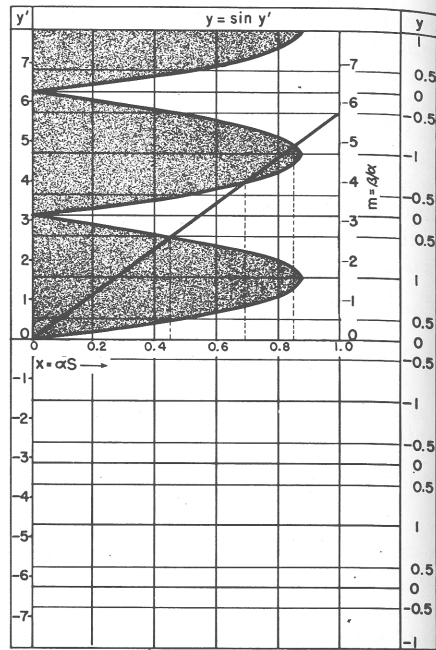

Fig. 4. General solution of the "Ferranti Effect" transmission line problem expressed by the equation, $\sin \beta L = \pm \sinh \alpha L$. The voltage at the receiving end of the transmission line exceeds the generator voltage where the line lies within the shaded areas.

required by the periodic vertical scale. The sine wave is then plotted as a straight line passing through the origin and having a slope m. An auxiliary m-scale has been added to aid in drawing this straight line. The intersections of the straight line and the curves are read on the horizontal scale, as shown by the dotted lines, and denote the lengths of transmission line for which the receiving-end voltage exactly equals the generator voltage. Furthermore, the receiving voltage exceeds the generator voltage where the straight line lies inside the shaded regions.

Fig. 4 illustrates the solution for $\alpha = 0.0048$ nepers/mile and $\beta = 0.0275$ radians/mile, giving a value of $m = 5.73$. The figure shows that Equation (13) is satisfied if x is equal to 0.460, 0.696, or 0.864. Since $\alpha = 0.0048$, from the relation $x = \alpha L$ we find the corresponding lengths, L, of the

line are 96, 145, and 180 miles. Therefore the receiving voltage will exceed the sending voltage if the length of the line is less than 96 miles or between 145 and 180 miles.

It should be noted that Fig. 4 is a universal chart since the solutions for any transmission line with given attenuation and phase constants can be found by drawing a straight line through the hyperbolic curves, which themselves do not have to be redrawn. However, if this problem were solved graphically on standard coordinate paper, a new sine curve would be required for each different transmission line.

Conclusions

This article has described a special coordinate paper on which sines and cosines plot as straight lines. This linear sine paper is useful for plotting any equation which is simplified by the substitution, $y = \sin y'$.

Fig. 5. A form of this paper suitable for graphical computation. Full size sample sheets are available from the author on request.

An example shows that the function, $y = \sin(\alpha \cos x)$ is represented by a cosine wave with period 2π and amplitude α' on sine paper, while it appears as a more complicated curve on standard graph paper. It is also pointed out that the Tschebyscheff polynominals of any degree are represented in the range from -1 to $+1$ by sine waves of unity amplitude. It is further demonstrated that a two-parameter equation of the form $\sin(mx + \theta) = F(x)$ can be readily solved for x by drawing the curve $F(x)$, and then constructing a straight line with the proper slope and intercept.

In view of the results listed above, linear sine paper seems to have applications in many fields of engineering. Other properties and uses will doubtless suggest themselves to those concerned with graphical problems.
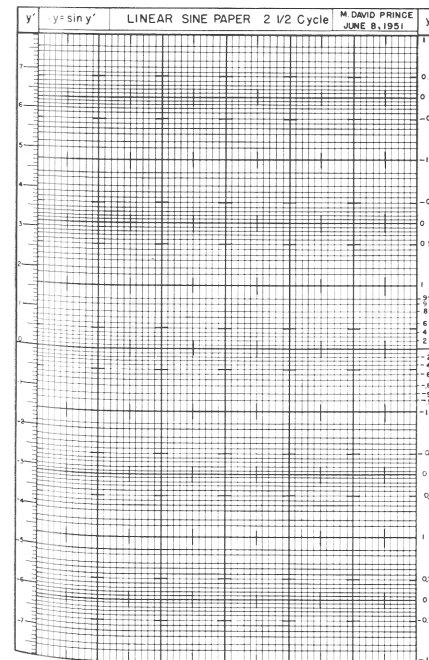
REFERENCE

1. WARE, L. A., AND H. R. REED, *Communications Circuits.* New York: John Wiley and Sons, Inc. 2nd ed., 1944, p. 76.

"The patent system added the fuel of interest to the fire of genius."—Abraham Lincoln.

David Rubinfien, Computer Center supervisor at Armour Research Foundation of Illinois Institute of Technology, says the national shortage of engineers will hasten the approach of automation, the push button age.

Daily reading time for engineers averages four and one-half hours, a survey by Case Institute of Technology shows.

publications

BULLETINS

Daugherty, P. M., H. H. Sineath, and T. A. Wastler, Industrial Raw Materials of Plant Origin. III. A Survey of Candelilla Wax, 1953. 56 pages. Gratis. Bulletin 16.

This is the third in a series of five bulletins sponsored by the U. S. Department of Agriculture. It presents the results of a literature search and industrial survey on candelilla and candelilla wax, a commercial wax obtained from various species of plants native to Mexico and the southwestern United States. The bulletin evaluates candelilla-bearing plants as possible chemurgic crops in the United States.

Daugherty, P. M., H. H. Sineath, and T. A. Wastler, Industrial Raw Materials of Plant Origin. IV. A Survey of Simmondsia chinensis (Jojoba), 1953. 36 pages. Gratis. Bulletin 17.

Comprehensive coverage of the information available on *Simmondsia chinensis*, desert shrub of the southwestern United States and Mexico, leads to the conclusion that it is potentially a very valuable plant. A number of uses, as yet unexploited, might be found for the liquid wax which comprises about 50 per cent of the dark brown seeds, according to this publicatiion.

Sineath, H. H., P. M. Daugherty, R. N. Hutton, and T. A. Wastler, Industrial Raw Materials of Plant Origin. V. A Survey of the Bamboos, 1953. 230 pages. Gratis. Bulletin 18.

Possibilities for bamboo as a money-making crop for southern farmers are foreseen by the Department of Agriculture as a result of this study. Some 70 uses are listed and discussed, and the potential market for bamboo in this country is estimated at $1,500,000 to $2,000,000. The bibliography contains 1,034 references. (See *Bamboo-Plant with a Future*, this issue.) The demand has been so great that copies are no longer available from Georgia Tech, except to libraries. We will be glad, however, to refer you to an institution in your locality from which you might borrow a copy.

REPRINTS

Burrows, W. H., Some Properties of Hyperbolic Coordinate Systems, 1952. Twenty-five cents. Reprint 61.

The purpose of this article is to provide a clear picture of the properties of hyperbolic coordinate systems in general and to give a concise and systematic theoretical background for further applications.

Kethley, T. W., M. T. Gordon, and Clyde Orr, Jr., A Thermal Precipitator for Aerobacteriology, 1952. Twenty-five cents. Reprint 62.

This short note regards a thermal precipitator incorporating a warm horizontal plate facing downward, instead of the hot wire previously used. Preliminary tests indicate that it is effective at flow rates as high as 400 cubic centimeters per minute, and that particles suspended in the air sample are uniformly precipitated over the surface of the cover slip on which collected.

Ingols, Robert S., and Alfred T. Navarre, "Polluted" Water from the Leaching of Igneous Rock, 1952. Twenty-five cents. Reprint 63.

In this brief report the authors present evidence that the concentration of soluble compounds in spring water or surface water that has a chance to flow slowly over granite is determined by the rate of rock-weathering. The nitrogen content of waters in an area where there is rapid weathering of granite cannot be used to determine the load of human pollution, as is frequently done in areas where granite weathering is very slow.

Young, R.A., and W. T. Ziegler, Crystal Structure of Lanthanum Nitride, 1952. Twenty-five cents. Reprint 64.

Lanthanum nitride has been prepared by direct combination between lanthanum metal and nitrogen to yield a product having approximately the composition LaN. The crystal structure of LaN has been confirmed as the NaCl type.

Ingols, R. S., and E. S. Kirkpatrick, Study of Chromium Toxicity by Several Oxygen Demand Tests, 1952. Twenty-five cents. Reprint 65.

The data indicate that the toxic level of chromium is controlled by several variable factors, including the presence or absence of oxygen, the valence of the chromium, the type of organism (autotrophic vs. heterotrophic), and the amount of organic matter present (rate of metabolism).

Young, R. A., A Simple, Inexpensive Jig for Aligning Specimens in the Philips Powder Camera, 1952. Twenty-five cents. Reprint 66.

This short report describes a device which costs only a few cents to make; the title is self-explanatory.

Ziegler, W. T., R. A. Young, and A. L. Floyd, Jr., Crystal Structure and Superconductivity of Lanthanum, 1953. Twenty-five cents. Reprint 67.

The crystal structure of lanthanum has been studied by powder X-ray diffraction techniques at room temperature, and the existence of the hexagonal close-packed (h.c.p.) and face-centered cubic (f.c.c.) modifications confirmed. Six different samples of lanthanum have been examined for superconductivity by a magnetic method.

Ingols, R. S., Fluoridation and Dental Caries, 1953. Twenty-five cents. Reprint 68.

Facts concerning fluoridation and dental caries are presented. This article is designed to inform non-dental scientists why dentists and public health workers are promoting this means of reducing the pain and economic loss of poor teeth.

Ingols, R. S., H. A. Wyckoff, T. W. Kethley, H. W. Hodgden, E. L. Fincher, J. C. Hildebrand, and J. E. Mandel, Bactericidal Studies of Chlorine, 1953. Twenty-five cents. Reprint 69.

Hypochlorous acid and chlorine dioxide are shown in one study to be effective as bactericidal agents in water treatment because either oxidant forms an irreversible product from its reaction with the sulfhydryl radical. Other studies also are discussed.

To order any of these bulletins or reprints, or to get a complete list of Georgia Tech Engineering Experiment Station technical publications, write Publications Services, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia.

by design

The editors of most periodicals, no matter how well received, occasionally re-examine their product and decide to redesign, to freshen up. That's what the editors of **The Research Engineer** have done, with the result which you see on the pages of this issue.

C. P. GRAVES

We looked around for professional talent to help in remoulding the contours. After a long search, we discovered what we should have known all along— that practically any specialized service needed could be found within the staff of the Engineering Experiment Station.

Charles P. (Chuck) Graves, a fifth-year architecture student was at the end of the hall in the north wing of the Research Building, bent over a drawing board, producing some intricate drawings connected with a Station research project. Did he know anything about magazine design? As a matter of fact he did; his professional experience included two years, 1947-49, on the art staff of *The Leatherneck,* the excellent monthly magazine published by the U. S. Marine Corps. For the last four months of that period, he was assistant art director.

After a second hitch in the Corps, he received the B.S. from Georgia Tech. In September he will receive the B.Arch., after which he will teach at Clemson.

Thanks to a talented architect for leaving his alma mater a small heritage in design.

NEWS

DR. CUDD

Dr. Herschel H. Cudd, Director of the Station, resigned on April 1 to become Manager of Research and Development, American Viscose Corporation, Philadelphia. He holds the B.S. in chemistry from Texas College of Arts and Industries and the M.A. and the Ph.D. from the University of Texas. He has held important posts in industrial research and development and in scientific societies. Dr. Cudd has been at the Station since 1950.

DR. CALAWAY

Dr. Paul K. Calaway, Director of the School of Chemistry, was named by the Board of Regents to succeed Dr. Cudd. His title is Acting Director. He holds three degrees in chemistry, the B.A. from Arkansas College, the M.S. from Georgia Tech, and the Ph.D. from the University of Texas. Drs. Cudd and Calaway, the retiring Director and the new Acting Director, first became friends while they were in graduate school at Texas.

Dr. Fred W. Cox, Jr., Assistant Director for Research, resigned recently to take a position with the Deering-Milliken Research Trust, Pendleton, S. C. Dr. Cox, a graduate of Georgia Tech, with the B.S. in Ch.E., 1936, had been Assistant Director since 1949. He received the Ph.D. in Organic Chemistry from the University of Wisconsin, 1939.

DR. COX

Dr. James E. Boyd, Head of the Physics Division since 1950, was named in April to succeed Dr. Cox as Assistant Director for Research. He holds the B.A. from the University of Georgia, in mathematics, the M.A. from Duke University, and the Ph.D. in physics from Yale University. Dr. Boyd has been at Georgia Tech continuously since 1935, except while on Navy leave, 1942-46.

DR. BOYD