CLASSROOM NOTES

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THE MATHEMATICAL TRAINING OF ENGINEERS*

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The Mathematical Association of America has recently introduced into its programs for the annual summer meetings a series of symposia on topics related to the teaching of mathematics. The first symposium was held in September of last year at the University of Minnesota on the question: *What should we teach our undergraduate majors in mathematics, with special reference to their subsequent employment in industry?* The second symposium was held on September 2, 1952, at Michigan State College on the subject: *The mathematical training of engineers*, with Professor Ralph Hull, Head of the Purdue Department of Mathematics, acting as chairman. Three invited speakers presented prepared talks of about twenty-five minutes each on three different aspects of the subject. The talks were followed by an extended and lively discussion.

The first and third speakers were Professor E. B. Allen of the Department of Mathematics, Rensselaer Polytechnic Institute, who spoke on *Mathematics and the engineering curriculum*, and Professor Elizabeth S. Sokolnikoff, of the Department of Mathematics, University of Wisconsin, who spoke on *Problems of mathematicians who teach engineers*. These speakers emphasized the fact that the mathematical training of engineers is a joint responsibility of the faculty of engineering and of the department of mathematics, which may be in some other college of the university. The training can only be effective as a result of close cooperation between the Schools of Engineering and Departments of Mathematics. Such cooperation is generally found in our universities and present conditions are favorable to still closer cooperation. For example, more and more staff members of schools of engineering have had advanced mathematical training; recent textbooks in engineering show a tendency to draw more frequently on mathematical ideas and consequently more of the mathematics which has traditionally been presented in courses on the calculus and differential equations is actually used in engineering courses. On the other hand, many mathematicians have worked directly with engineers in industry or in government research laboratories since the beginning of World War II and consequently are more familiar with the mathematical needs of engineers.

Various ways were suggested of developing still closer relationships between departments of mathematics and the schools of engineering, for example, joint staff appointments, exchange teaching assignments between staff members, the

* Symposium, Mathematical Association of America, September 2, 1952, Michigan State College.

familiarizing of staff members with the engineering curriculum on the one hand and the formal mathematics courses on the other, by the preparation and distribution of extensive course outlines and attendance in courses in other fields as visitors. All of these ways are being utilized but much could be gained by an increase in their use. Since mathematics takes up a large part of the generally crowded engineering curriculum (almost 25% of the first two years' work, measured in semester hours, at some schools), and since more and more engineers are taking more mathematics as undergraduates than in the past, and more and more engineers are prolonging their training to advanced degrees either at schools of engineering or in special programs set up by their employers, it is a fundamental problem of departments of mathematics to see to it that the most effective possible use is made of the time engineers devote to their mathematics courses.

The second speaker, Dr. C. H. Harry, Bureau of Aeronautics, Department of the Navy, spoke on *Mathematics used for engineering designs*. Dr. Harry maintained that the mathematical training of engineers should be based primarily on the fact that whenever an engineer at work employs mathematics he must ultimately arrive at a numerical answer. This is the case whether the numbers he seeks are, for example, merely the lumped constants of a simple electrical circuit which is to have some prescribed property, or the design parameters of a more complicated network or structure, or, at a still higher level, frequently referred to nowadays as *Operational Research*, numbers which represent the relative effectiveness of complicated systems involving machines or weapons, men, and, in military situations, tactics and strategy. It is immaterial to the engineer, and even more so to Management or Command, whether these numbers are arrived at ultimately by the substitution of numerical values of variables in "closed formulas," or otherwise, provided they are as accurate as the data permit, or as reliable as can be hoped for in the more complicated situations. In the simpler cases, the numbers will ultimately be checked by testing the circuit or network. In the more complicated cases of systems evaluation, the testing is much more difficult, as is the type of analysis involved. It is further characteristic of much of the mathematical work of an engineer that it is based largely on relatively elementary mathematical concepts, although more sophisticated mathematical ideas are finding more and more application at the present time.

Dr. Harry stated that in his opinion present mathematics courses for engineers do not give sufficient recognition to the numerical aspect of the engineers' mathematical work. Specifically, for instance, he maintained that in a first course in elementary differential equations, he would consider about two weeks as sufficient for the consideration of differential equations which can be solved in "closed form," and that the rest of the time should be devoted to solution by numerical methods. This point was seriously challenged by several of his listeners. While it was admitted that the engineer seeks always a numerical answer, it was claimed that the proper function of the mathematics department is to acquaint the engineering student with basic mathematical concepts; that while, admittedly, most of the problems in our elementary mathematics texts used by engineers were not of the type the engineer would be called upon to solve at work, they were essential to the developing of his understanding of the mathematical concepts; that the mathematics departments would not have time in present courses to develop the mathematical concepts and introduce work on numerical methods as proposed by Dr. Harry. The controversy here was summarized as covering the relative emphasis which should be given in mathematics courses for engineers to the three aspects of mathematics itself, the linguistic, the logical, and the technical or computational, or, more briefly, between the conceptual and technical aspects. The resolution of the question should be a major concern of engineering faculties and teachers of mathematics. Probably some experimentation will be required before generally acceptable answers are arrived at. In this connection, a "two-track" system for engineers, one emphasizing the conceptual, the other the technical, aspects of mathematical training, is under consideration for an early trial in at least one school.

A DERIVATION OF THE FORMULAS FOR SIN $(\alpha+\beta)$ AND COS $(\alpha+\beta)$

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The following procedure for deriving the addition formulas of plane trigonometry has been used for some time by the author. To the best of our knowledge it has not previously appeared in print.

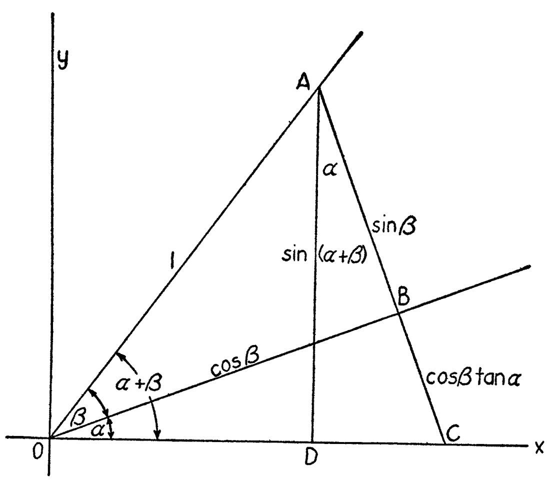

FIG. 1

We shall derive the formulas for the case when both α and β are acute angles and $\alpha+\beta<90°$.

Figure 1 will be used to prove the formula for sin $(\alpha+\beta)$.