# ANALYSERS AND COMPUTERS FOR ELECTRICAL SYSTEMS

A VACATION school on analysers and computers for electrical systems was held in the Electrical Engineering Department of the Imperial College of Science and Technology, London, during the week July 13–17, and was attended by some sixty engineers drawn from industry, the British Electricity Authority, research associations, technical colleges and the universities. The purpose of the school was to encourage the wider use by electrical engineers of analysers and computers for solving the problems that arise in the fields of electrical machines, electrical control systems and power networks. In an opening address, Mr. F. J. Lane, transmission design engineer to the British Electricity Authority, stressed the value of vacation schools in providing opportunity for discussion and exchange of information, and referred to the continuing development of more accurate methods of calculating the design and performance of electrical systems.

The first lecture was by Mr. B. Adkins, of Imperial College, who described the course as an opportunity for electrical engineers to review recent improvements in the methods available for the solution of numerical problems with the aid of computers, analysers and models. He went on to discuss electrical machine problems, grouping these as design calculations and performance calculations, each group comprising routine calculations and research investigations, and showed some examples of each type. In the following lecture, Dr. J. R. Mortlock, of British Thomson-Houston Co., Ltd., Willesden, introduced some of the more common problems met in the design of power systems, showing the types of equation encountered in each and the usual methods of solving them. The third lecture, by Dr. J. H. Westcott, of Imperial College, dealt with the design of closed-loop control systems. A discussion of steady-state calculations and graphical methods using harmonic responses was followed by a survey of methods of estimating transient response with suggestions for applying more comprehensive criteria to the performance, and hence design, of control systems.

Dr. W. J. Gibbs, of British Thomson-Houston Co., Ltd., Rugby, opened the next section of the course with a lecture on the mathematics of the problems. He showed that problems first require formulation by the specification of an ideal system which can be represented in mathematical terms, and then reviewed the types of calculation often required. He demonstrated that matrices can assist the orderly arrangement and manipulation of performance equations of all types of system. The remaining lectures dealt with methods for solving equations of the types described by Dr. Gibbs.

In a lecture on "Systematic Computation", Mr. M. W. Humphrey Davies, of Imperial College, put forward suggestions for processes intermediate between simple slide-rule calculations and the complex methods used in automatic computers. After surveying existing types of hand-operated calculating machines, he demonstrated a convenient method for the solution of sets of linear simultaneous equations, and described an improved type of semi-automatic machine, designed for handling two-dimensional quantities, that is being constructed at Imperial College. He concluded by suggesting that semi-automatic machines might be specially suitable for many routine calculations.

On the evening of July 14 members of the school visited the laboratories at Imperial College and saw the automatic digital computers constructed by Dr. Tocher in the Mathematics Department and a transformer-analogue analyser, a semi-automatic decimal computer for complex quantities and other analogue devices in the Electrical Engineering Department. July 15 was spent at the National Physical Laboratory seeing the automatic computer (known as the ACE), the analogue differential analyser and the punched-card tabulating equipment in the Mathematics Division and an analogue device for the design of control systems in the Servo-mechanisms Laboratory.

Dr. J. M. Bennett, of Ferranti, Ltd., described several types of automatic digital computer and discussed the advantages of their rapidity and accuracy in dealing with different types of engineering problem. The lecture concluded with details of the method of handling typical problems. Mr. L. Gosland, of the Electrical Research Association, in a lecture on "Analogue Analysers" gave an extensive survey of analogue computers, network analysers, models and simulators, giving examples of their application to practical problems.

The final lecture, by Dr. G. R. Slemon, of Imperial College, was concerned with the solution of non-linear problems, confining itself to two methods of considerable generality: namely, numerical or step-by-step methods, and approximate steady-state methods using modified linear techniques. Finite difference methods were described for the solution of first-order, simultaneous and higher-order differential equations with variable parameters. Dr. Slemon then explained his 'fundamental frequency' approach to steady-state non-linear circuits and showed how this could be applied to both power-frequency and stability problems. Finally, adaptations of mathematical, graphical and other techniques for use with the fundamental-frequency method were surveyed.

The discussions that followed the various lectures and the general discussion at the end of the course showed that the vacation school had provided a useful meeting-ground for experts in various types of electrical design problems who had been able to exchange useful information concerning developments in the use of analogues and computers. It appeared that there would be considerable demand for the facilities of automatic computing machines as these become available and that there is scope for improvements in desk machines. It was felt that a desk computer with a trained operator would be a useful adjunct to many engineering offices, but that analogue rather than digital devices would often be preferred by engineers because explicit mathematical formulation of the problem is unnecessary and because such devices are frequently analogous to the physical system, with the added advantage in power network and similar problems that the general behaviour of the system can be observed directly. Such devices make it possible for the engineer to solve his own problems with only occasional assistance from a mathematician, and this was thought to be preferable to the use of external computing services.