Probably the most important contribution that industry can make is to participate in policy formulation for the organization and administration of technical colleges by serving on college governing bodies and departmental advisory committees. Some colleges are still governed by a committee which is a sub-committee of the local further education committee, which itself is a sub-committee of the education committee of the local authority. "Moreover, we view with increasing concern the growing intrusion of local political issues into the deliberation of some governing bodies which has a discouraging effect on industrial participation."

Industry must co-operate in the teaching of technical colleges partly by encouraging more of its qualified young men and women to accept part-time teaching posts in the colleges and also by releasing, where necessary, men of appropriate skill and knowledge to teach on a part-time day basis. Sandwich courses in particular need teachers with close and current contact with industrial problems; these are not always to be found—nor could they be fully and efficiently employed in the technical college. Industry can offer another valuable service—that of taking in the full-time teacher for periods of refreshment in current practice. Local education authorities are empowered to release teachers for up to 12 months for industrial experience without loss of pension rights.

Since industrial firms supply the great majority of students, they must keep the college generally informed of their education requirements—qualitatively and quantitatively. They must keep the colleges informed of the latest developments in their specialized fields and of the needs to which the college can contribute. They must support the colleges in their activities and assist them in carrying out their job—whether by loaning staff or equipment or giving them the benefit of their knowledge in the advisory or administrative fields. They must consult with them on all matters of joint interest and maintain a constant flow of information in both directions.

The conference was attended by 140 representatives of education and industry from north-west England.

MODERN NETWORK THEORY IN ELECTRICAL ENGINEERING

THE first phase in the development of network theory was opened by the work of Ohm in 1827 and may be regarded as being terminated, at the end of the nineteenth century, by the work of Heaviside. By this date the main concepts and methods of network analysis were established and although mathematicians more orthodox than Heaviside were yet to present operational methods in a different light, little other work of significance appeared between 1900 and 1922. The subsequent growth of network theory was greatly stimulated by the use of the notion of a complex frequency, a concept which, in its turn, grew out of the application of the theory of functions of a complex variable to those problems of time-variation in networks which had previously been treated by the methods of Heaviside.

With the introduction of more powerful mathematical tools it became possible, in the second and present phase in the growth of network theory, to treat the problems of realizability, synthesis, approximation and practical design, that is to say, which mathematical functions may be realized as network characteristics? How may networks having prescribed, realizable, characteristics be found? By what approximations may a desired physical response be most usefully and economically translated into a set of realizable mathematical functions? In what manner do the general mathematical processes of realization and synthesis require to be treated if the outcome is to be a practicable network using a comparatively small number of relatively cheap components?

These are some of the questions with which modern network theory is concerned, and to discuss them the Department of Electrical Engineering of the University of Birmingham organized an informal conference which took place in that Department during September 21–24. The main purpose of the conference, believed to be the first on this subject to be held in Britain, was to give ample opportunities for the discussion of network problems, and the lectures and papers which were presented took up only one-half of the time of each session in order to permit this. In a limited space it is not possible to give equal treatment to every paper and discussion, but it is hoped that the nature of some of the problems discussed will be made clear by the following account.

Of all the sessions, the first was the most fundamental and abstract but also at the greatest remove from any immediate relevance to practical problems. Mr. P. R. Bryant (General Electric Co., Wembley) spoke on a topological analysis of the order of complexity of an electrical network. The 'order of complexity' was defined as the number of the natural frequencies of an electrical network and this number was shown to be equal to the number of dynamically independent network variables. In order to prevent too naïve an approach to this work it is only necessary to point out that a network of n capacitors connected in series possesses an 'order of complexity' of n, whereas the network formed by connecting the capacitors in parallel is of order 1. The other paper in this session was presented by Dr. V. Belevitch (C.E.C.E., Brussels) and was concerned with a treatment by matrix algebra of the realizability theory for general linear, stable networks with n terminal-pairs.

A discussion on a group of papers on networks with parameters varying with time was opened by the authors—Prof. D. G. Tucker, Mr. D. P. Howson and Mr. J. M. Layton (University of Birmingham). A major part of the discussion centred on the possibility of applying, to networks with parameters varying with time, theorems developed from a study of networks with constant parameters. That care is needed in making translations of this kind was shown by a demonstration in one of the papers that the input impedance of certain rectifier modulators was dependent on the nature and magnitude of the impedance associated with the source used to provide the input voltage and current. This result is more surprising than the discovery that theorems such as those of Thévenin and Norton cannot usefully be applied to many networks varying with time. Much more work is required to define the types of networks to which the main results of classical theory may be applied,

and it is evident that the analysis of networks containing reactances varying with time presents many problems, not the least of which is that of determining the conditions for stability.

In the third session Dr. O. P. D. Cutteridge (Manchester College of Science and Technology) spoke on the application of a particular continued-fraction expansion to a range of problems of active and passive networks. The expansion may also be used to determine the character of the zeros of a polynomial.

A lengthy discussion was initiated by a paper on the synthesis of three-terminal resistance-capacitance networks, presented by Mr. J. T. Allanson (University of Birmingham). There exists no complete solution to the problem of designing a network of this kind if the three impedance functions of the network are specified. It can be shown, by analysis of real networks, that the impedance matrix for any three-terminal resistance–capacitance network must necessarily satisfy certain conditions : it can also be shown, by synthesis of networks, that if an impedance matrix satisfies a more extensive set of conditions a network of this type may be found to represent the matrix. The paper and the discussion were concerned with attempts to close the gap between these two—the necessary and the sufficient—sets of conditions.

A discussion of a similar kind took place after Dr. W. Saraga (Siemens Edison Swan, London) had discussed the analysis and synthesis of reactance networks in terms of the 'one-points' of various functions. The traditional methods of analysis and synthesis have regarded the poles and zeros of various network functions as constituting the most easily handled specification of these functions, but there are certain advantages in using the values taken by the complex frequency variable when the functions in question have the values of $\pm$ 1. However, the simplicity of procedure which results from using these 'one-points' in network synthesis has to be paid for by an increase in the number of network elements required to realize a given set of functions. In practical applications these redundant elements must be removed and the series of network transformations necessary to do this may be sufficiently complicated to nullify the advantages of the preceding simplicity. It appears that 'one-point' analysis may be most usefully applied as complementary to pole-zero analysis in revealing useful general relations in networks.

Dr. G. S. Brayshaw (University of Leeds) presented a paper dealing with an application of positive-real graphs and Dr. A. Talbot (Imperial College, London) discussed the use of Tchebyscheffian approximations in network synthesis, and outlined an algebraic method for the determination of rational approximating functions suitable for filters required to have Tchebyscheffian characteristics in both pass and stop bands.

In the fourth session of the conference two papers were read on the design and construction of filter networks. Mr. E. R. Austin (Post Office Research Station, London) outlined a computational procedure for obtaining, in the form of a ladder network, an image parameter filter in which advantage is taken of the theoretical possibility of specifying independently the attenuation and impedance characteristics. The design may be regarded as yielding a filter more efficient than the corresponding Zobel type but less so than one designed on an insertion loss basis. Dr. J. H. Mole (H.M. Underwater Detection Establishment, Portland) spoke on problems of component design, accuracy and tolerance, mechanical construction and the testing and measurement of practical filters.

The final session of the conference was taken up with a discussion on the place and teaching of electrical network theory in universities and technical colleges. Mr. F. E. Rogers (The Polytechnic, London), Dr. A. W. Keen (Coventry Technical College), and Mr. E. R. Broad (Post Office Research Station, London) opened the discussion, which was vigorous but inconclusive. However, it was agreed that more attention must be paid to the physical and mathematical fundamentals underlying the practical techniques for the solution of network problems and less time given to these techniques themselves.

J. T. Allanson

BRITISH OVERSEAS INFORMATION SERVICES

In a written statement circulated in reply to a question in the House of Commons on November 16 as to the implementation of the proposals in the White Paper on Overseas Information, the Chancellor of the Duchy of Lancaster, Dr. C. Hill, stated that since April 1, 1959, the British Council has recruited 140 teachers of English for overseas posts, and expenditure on exchanges of university teachers with foreign countries has risen from £6,164 in 1958–59 to about £9,014 for 1959–60 ; for Commonwealth exchanges the corresponding figures are £12,113 and £16,113. The number of scholarships awarded by the Council has risen from 284 in 1958–59 to 355 in 1959–60, and of these 98 and 141, respectively, were related to the teaching of English, including twelve new scholarships for students from the Colonial territories for teaching English as a second language, 14 studentships at the University of London Institute of Education for United Kingdom graduates intending to teach English overseas, and fifteen new posts concerned with the teaching of English established overseas. Educational exchanges with Czechoslovakia and Hungary have commenced, including a three-week visit to British universities of six professors from Czechoslovakia. Government grants to the British Council were estimated at £5,824,000 for 1959–60, compared with £4,615,000 in 1958–59.

Expenditure on British Council libraries was £234,000 in 1958–59 and will rise to about £480,000 ; for books and periodicals for presentation, the corresponding figures are £39,000 and £72,000. In consultation with the Governments concerned, twenty new British Council libraries have been, or will shortly be, set up, and long-term lending library services for students are now operating or will shortly operate at nine Council centres and through universities. Libraries of the long-lending type are already operating in Karachi, Rawalpindi and Dacca and in process of being extended to Lahore and Chittagong, and first indications are that they are a great success. More than 30,000 books have been sent out and 235 additional subscriptions to periodicals provided for