Paul Dimo

NODAL ANALYSIS of POWER SYSTEMS

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APPENDIX

"REI" graphs and their nodal images (generalized nodal analysis)

Author's foreword to the English edition

In 1958 a new method was presented under the title "Graphic Analyser" at the CIGRE conference [16] (Report N° 302, 1958); the new method had been already used by various Romanian research institutions (Institute of Energetics of the Romanian Academy and the I.S.P.E. Institute of the Department of Energy) with excellent results. A first monograph describing the new graphic method was published in 1959. It contained the unitary solutions which the new method supplied for problems of power system [17].

The method in its initial form was applicable to a network with a radial configuration. It was perfectly applicable to any network containing a reduced number of loops which would be always transformed in a radial equivalent network for the *study of a given node*. The behaviour of the central node of the radial network was then analysed with the help of a standard diagram — which we have subsequently called the "nodal image" — for any evolution of the state of the network.

The diagram was established by a vector representation of the components of the current at the central node. The diagram permitted complete graphic calculations for any state of the system, starting from a first representation effected for a reference state.

A new general and unitary (graphic) method which permitted in addition the characterisation of the state of a network by the simple inspection of a diagram was thus found for all the special problems concerning power systems (regulation, static and transient stability, etc.) and for which the literature gave only particular methods adapted to special problems.

We have proposed for the application of this method a mechanical device made up of small hinged rules known as a "Graphic Analyser" [16] and by means of which one can characterize any state of the network, without calculations, by simply varying the position and length of the rules.

The device, brought up to date and at present known as an "Anagraph", constitutes a peripheral device of the computer (see chapter 11 and references [29] and [41]).

The many computations effected by this graphic method have proved the possibility of introducing direct and simple reasoning and even intuition into problems whose complexity and large number of elements seemed to preclude rapid and intuitive comprehension of the physical phenomena.

But it is only after the advent of digital computers that the method underwent a spectacular evolution. In order to retain the possibility of direct reasoning and intuitive representation offered by graphical methods we have associated to the new methods of numerical calculation the graphical representation of two standardized "graphs": an equivalent radial net which we have denoted by "REI" and which corresponds to the radial net of the graphical method, and a standardized diagram which we have called the "Nodal Image" and which corresponds well to the standard diagrams established by using the components of short-circuit currents.

The method was presented in 1944 at a CIGRÉ conference under the title "Simplification of network problems by the introduction of a new concept: the equivalent REI net and its image" [24].

★

Now — with the presentation of this work which follows the publication in other languages* of a number of monographs — it may be stated that "Nodal Analysis" and its new "philosophy" has acquired a certain degree of maturity [52], [85].

★

In this "maturity" stage where its methods are closely dependent on the revolution introduced by computers, the "Nodal Analysis" may be considered as an attempt to strengthen man's position in his relations with the computer. Towards the year 2000 the relation man-computer will certainly be one of the important components of man's activity. But at present this component is not completely defined, not even for the near future. Some authors have pointed out our ignorance concerning the trend of this new development.

Others [62] have remarked that if it can be proved that the computer cannot reproduce or transcend certain specifically human characteristics, *this will be one of the most important discoveries of the 20th century.*

On the new road of information theory, electronics and automation one may already distinguish the main lines of a dramatic difficulty namely that of "*not understanding the object of our investigation or inability to grasp the whole problem wherein it is placed, the absence of accessibility*". This aspect has been recently underlined in an essay which tried to outline the future characteristics of the human brain activity [70], in a world where presumably the computer will be the master.

"Nodal Analysis" may be considered as an *endeavour to mitigate this adversity, to restore man in his traditional position of master and active participator* with his intuition and judgement in the processes which he oversees or analyses.

★

In "Nodal Analysis" the computer plays an auxiliary part. It only transforms an extended and complex system into a simple and standardized model (REI model) which the human mind comprehends easily. A simple diagram, also standardized,

* P. Dimo. *Nodal Analysis of power systems* (in Romanian), Editura Academiei, Bucharest, 615 p., 1968.

P. Dimo, *Analyse nodale des réseaux d'énergie*, Editions Eyrolles, Paris, 269 p., 1971.

P. Dimo, *Uslovoy Analis Elektrichesky Sistem*, Edition MIR, Moscow, 264 p., 1973.