ANATOLII ISAKOVICH LUR'E

On his sixtieth birthday

Anatolii Isakovich Lur'e was born on July 19, 1901, of a doctor's family in Mogilevo.

He was educated at the Mogilevo Boys' School and the Physico-mechanical Department of Leningrad Polytechnical Institute named after M.I. Kalinin (LPI). He graduated from this institute in 1925 and was appointed to the Department [Chair] of Theoretical Mechanics of LPI which, at that time, was headed by I.V. Meshcherskii.

His subsequent scientific and educational activity was in close association with the Leningrad Polytechnical Institute, where he was successively appointed as Assistant (1926-1930), Docent (1930-1932), Acting Professor (1932-1935) and Head of the Department of Theoretical Mechanics (1936-1941). During the Great Patriotic War, Anatolii Isakovich was head of the Department of Theoretical Mechanics of the Ural Industrial Institute named after S.M. Kirov at Sverdlovsk. In 1944 he returned to Leningrad and has since directed the Department [Chair] of the Dynamics and Strength of Machines at LPI.

In 1939 A.I. Lur'e was awarded the degree of Doctor of Technical Sciences without having to defend his dissertation.

The scientific and administrative activity of A.I. Lur'e has been concerned with a number of research establishments, among them the Institute of Mechanics of the Academy of Sciences of the USSR, the Institute of Agricultural Machinery, the Institute of Structures, the Central Boiler Turbine Institute named after Polzunov, the Institute of Electromechanics of the Academy of Sciences of the USSR, etc.

Anatolii Isakovich has been very active in other scientific fields, also. For example, from 1931 to 1936 he was, together with Professor E.L. Nikolai, the editor of "Prikladnaia matematika i mekhanika". When the journal was taken over by the Academy of Sciences of the USSR, Lur'e became a member of its editorial board.

For his contributions to mechanics Lur'e was elected Corresponding Member of the Academy of Sciences of the USSR and was awarded the Order of the Labor Red Banner.

Lur'e's field of interest is extremely wide. He has worked on the

theory of elasticity, the theory of vibrations, the dynamics of automatic-control systems, analytical mechanics, hydrodynamics and applied mathematics. He has 95 publications to his credit, including five monographs and one textbook.

Lur'e's earlier papers [3-5] are concerned with hydromechanics and, in particular, the motion of solid bodies in viscous fluids. These were followed by papers concerned with the theoretical aspects of the vibration of elastic rods [8-11,13,14].

In 1936 Lur'e published his monograph on operational calculus [20], which was an important contribution to the development of the operational method. The monograph contained accounts of original applications of the operational method to various problems in the theory of vibrations, theory of elasticity and hydrodynamics. An important contribution was Lur'e's method for deriving, in closed form, the periodic motions of linear mechanical systems subjected to a periodic perturbation, which does not involve the expansion of the perturbation into a trigonometric series. This method has been used in practice in the design of mechanical and electrical circuits.

For many years Anatolii Isakovich has been concerned with three-dimensional problems of the theory of elasticity [41,47,50,78,79,80]. The results of this work were summarized in his monograph "Three-dimensional Problems of the Theory of Elasticity" [83], which was published in 1955. This book contains a series of original results, among them a symbolic method for constructing solutions of boundary problems in the theory of the elastic layer and the thick plate, the solution of the contact and the Hertz problems with the aid of Lamé functions, the introduction of a class of "homogeneous solutions" used to construct solutions of the problem of a circular cylinder subjected to an axially symmetric load (in the form of rapidly converging series), the solution of the general case of the problem of the equilibrium of an elastic hollow sphere, the problem of the stress distribution in the neighborhood of a triaxial ellipsoidal cavity, the solution of the thermo-elastic problem for a layer, etc.

In 1937 he began his work on the general theory of shells. Using the three-dimensional equations of the theory of elasticity, he formulated the basic equations of the theory of shells [26] and investigated the accuracy which can be achieved with the aid of theories based on classical kinetic and static hypotheses [46]. He also established self-consistent relationships between the stresses and strains in this problem [72].

The paper "General theory of thin elastic shells" [46] was of particular importance. In this paper Lur'e formulated the equations of

the theory of shells in tensor form, introduced stress functions which identically satisfied the equations of statics (now known as the Lur'e-Gol'denveizer functions) and put forward a general method for determining the displacements from given strain components.

Lur'e's papers on the theory of shells were collected in his monograph "The Statics of Thin-walled Elastic Shells" [58]. In this monograph he gave a consecutive derivation of the solutions of the shell-theory equations, whose accuracy corresponded to the accuracy of the original hypotheses. Using the method of asymptotic integration he was able to find the solutions of many problems, including the symmetrically-loaded shell of revolution and the arbitrarily-loaded cylindrical shell. By simplifying the basic equations of the latter problem, he was able to obtain in a closed form various formulas which led to the same numerical results as those which were obtained earlier with great difficulty by numerical methods. Lur'e then used these equations to solve the difficult problem of the stress distribution in the neighborhood of a circular aperture on the surface of a cylindrical shell [57].

Anatolii Isakovich has thus been one of the pioneers who evolved the theory of shells. He showed that the earlier solutions involving complicated and slowly-converging series could not be used to achieve greater accuracy than the simple solutions given by him in his monograph [58]. Lur'e's book has been translated into Chinese and later into English (USA) and has been widely used in mechanical-engineering design offices.

A series of Lur'e's papers [2,15,25,36,44,50] was devoted to thin and thick plates. We recall that Anatolii Isakovich applied the method of N.I. Muskhelishvili to the problem of thin plates [2, 44] and obtained important results in the theory of thick plates.

Among other papers in the theory of elasticity we must mention those concerned with the theory of thin rods [29,48], the torsion and bending of rods [34,37-40], the solution of two-dimensional problems (wedge and slotted plane) [33,35,49], generalization of the Castigliano theorem and nonlinear problems in the theory of elasticity and plasticity [56].

Lur'e's work on the stability of motion of automatic-control systems and the theory of nonlinear vibrations in such systems is widely known. In the series of papers [53,55,61-63,65,66,73-75] which first appeared in 1944, he gave effective methods for the solution of such problems. In a paper written in collaboration with V.N. Postnikov [52], he used a special case described by a set of three first-order equations containing a nonlinear term to formulate a Liapunov function which enabled him to determine the range of the parameters within which the asymptotic stability "in the large" must occur In 1945 he extended this idea to a wide class of automatic-control systems containing a nonlinear link and

a single control element.

The next important step was taken in 1948 when, in a paper entitled "On the canonical form of the equations of the theory of automatic control" [66], he obtained a set of quadratic equations whose roots provided information about the stability criteria. Since then the canonical form of the equations of the theory of automatic control has been widely used. Lur'e later showed how the problem could be reduced to the study of a system of equations leading to closed stability criteria for nonlinear systems.

The second line of research pursued by Lur'e in the field of control theory is concerned with the development of exact and approximate methods for the determination of self-oscillations in automatic-control systems. In 1951, in a monograph entitled "Some Nonlinear Problems in the Theory of Automatic Control" [76], he summarized and amplified the results of the above papers. This monograph has been translated into German and English. Among new results first published in the monograph, the most important are concerned with the approximate solution of the problem of self-oscillations.

Papers on the theory of vibrations occupy an important part among Lur'e's publications. Here, we must note the paper written in collaboration with A.I. Chekmarev [21], which is concerned with the method of B.G. Galerkin as applied to the Duffing problem and the paper "On forced nonlinear vibrations" [32].

The paper "On the effect of hydraulic shock in a pipeline on steam turbine control" [28], written in collaboration with Chekmarev, was an important contribution to the theory of vibrations and control of linear systems with distributed constants.

In recent years Lur'e has become interested in analytical mechanics [84,85,89-92]. His "Analytical Mechanics" is extremely interesting and rich in content. It gives an account of the subject with particular emphasis on its possible applications. The book includes many original results of a classical nature.

During his thirty years of teaching at LPI, Lur'e has substantially modified the approach to a number of subjects (theoretical mechanics, analytical mechanics, theory of vibrations, solid dynamics, theory of elasticity and automatic-control theory) and has developed new courses (theory of shells, theory of elastic vibrations, theory of stability of motion). He has closely collaborated with Professor E.L. Nikolai in the organization of the Department of Dynamics and Strength of Machines, of which he is now the head.

The two-volume work "A Course of Theoretical Mechanics" (six editions,

1937-1955) and the three-volume work "Theoretical Mechanics" (1932-1934) were written by Lur'e and L.G. Loitsianskii and are widely used both in the USSR and abroad. These books are not only valuable text-books for students but they also contain many applications of a technological nature and have thus become standard works of irreplaceable value to both industrial and academic mechanical and structural engineers. The former book has been translated into Chinese, Armenian and Bulgarian.

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The personal qualities of Anatolii Isakovich, his interest in the scientific work of all those who approach him, his unceasing readiness to help both the beginner and the experienced scientist and engineer ensure the great respect and love of all students, colleagues and others who know him.

The Editorial Board of this Journal greets Anatolii Isakovich on his sixtieth birthday and wishes him health and a long creative life.

List of Scientific Works of A.I. Lur'e

1. On the theory of rectilinearly-controlled mechanisms. *Zh. prikl. fiz.* Vol. 2, Nos. 3-4, 1925.

2. On the equilibrium of a plate. *Izv. Leningr. politekhn. in-ta* Vol. 31, 1928.

3. On the problem of the motion of a sphere in a liquid. *Izv. Leningr. politekhn. in-ta* Vol. 32, 1929.

4. *Some Cases of the Motion of a Solid Body in a Viscous Liquid.* Litografia. Izd. Leningr. politekhn. in-ta, 1929.

5. Nonsteady motion of a circular cylinder in a viscous liquid. *Vestn. mekhan. i prikl. matem.* Vol. 1, 1929.

6. *Theoretical Mechanics.* Part I. 1st edn. ONTI, 1932 (in collab. with L.G. Loitsianskii).

7. *Theoretical Mechanics.* Part II. 1st edn. ONTI, 1933 (in collaboration with L.G. Loitsianskii).

8. The effect of the elasticity of the ground on the frequency of oscillation of a frame. Collection of papers: *Vibrations of Foundations.* Gosstroiizdat, 1933.

9. The effect of the elasticity of the ground on the frequencies of oscillation of turbine foundations. Collection of papers: *Vibrations of Foundations.* Gosstroiizdat, 1933.

10. On the determination of the oscillation frequencies of turbine foundations. Collection of papers: *Vibrations of Foundations.* Gosstroiizdat, 1933.

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