

INTRODUCTION

The trends in the activities of the base departments of the Faculty of Aerophysics and Space Investigations (FASI) of the Moscow Engineering-Physics Institute are connected with theoretical and experimental investigations of the phenomena of external and internal gas dynamics and hydrodynamics. Among them are the problems of entry of space apparatuses into dense atmospheric layers, design and creation of rocket engines, gas-dynamic lasers, electrophysical systems, and other technical facilities that use a gas, liquid, or plasma as the working medium. Fundamental investigations carried out at the base departments of FASI are related to the study of the phenomena occurring in the atmosphere, ocean, and other geospheres with respect to the physics of combustion and explosion.

The above trends constitute the subject matter of the faculty cycle, "Physical Mechanics." The faculty cycle for training students includes courses of lectures, seminars, and laboratory work on aerophysics, applied gas dynamics, hydrodynamics, and physical mechanics for the training of bachelor of science candidates on "applied mathematics and physics" in the second, third, and fourth years of education.

The fundamental education in the field of continuum mechanics, hydrodynamics of media with different rheologies, and nonequilibrium systems is unthinkable if the skills of an experimental work have not been acquired, if students have not become familiar with the methods of creating dynamic media and their diagnostics. Despite the long history of the development of experimental methods, recent years have witnessed qualitative changes in this area due to the appearance of new types of probes based on a new elementary base and wide introduction of computation engineering in the methods of the processing of measurements.

The laboratory work at FASI on continuum mechanics and physical mechanics is intended for both getting acquainted with the methods of

measurements and carrying out laboratory works closely approximating up-to-date scientific experiments.

The general orientation of the cycle is associated with the investigation of the thermophysical properties of gases and plasma that include the thermodynamic properties of ideal and nonideal gases and plasma, chemical reactions, including dissociation and ionization, elementary processes in gases and plasma, and the optical properties of gases. Studied in the cycle are the hydrodynamics of motion of high-temperature gases and plasma, as well as radiative transfer. Considered in the cycle are the most general principles of hydrodynamic description with allowance for chemical reactions, self-consistent electromagnetic fields, and of translational, rotational, and vibrational nonequilibrium states; hydrodynamic, thermal, and plasma instabilities at linear and nonlinear stages; and transition from laminar modes of flow to turbulent ones. Most hydrodynamic flows are turbulent; therefore, attention is specially paid to practical methods of visualization and calculation of turbulent flows. It should be noted that the up-to-date methods of describing turbulent flows with combustion are based on the method of probability density functions that have been studied first in the world experimentally at the department of physical mechanics.

The laboratory work at the second year of education acquaints students with gas-dynamic flows; that at the third year deals with more complex types of laminar and turbulent flows of air and gases with internal degrees of freedom; that at the fourth year deals with investigation of present-day complex flows, as well as electrophysical and thermophysical phenomena, often at the level of modern scientific investigations. Experimental works are accompanied by numerical simulation on personal computers with visualization of the processes.

The work on compilation of the laboratory manual was begun at FASI at the end of 1960 by V. M. Ievlev, T. V. Kondranin, A. S. Koroteev, A. T. Onufriev, A. A. Paveliev, Yu. G. Rakogon, I. N. Rei, R. A. Safarov, V. A. Sechenov, A. A. Serebrov, Yu. A. Shcherbina, E. S. Shchetinkov, E. A. Son, B. K. Tkachenko, V. P. Vakotov, M. N. Vasiliev, V. A. Volkov, E. N. Voznesenskii, and by many other teachers. At the present time, this laboratory manual is being modified in an effort to update it, make it adequate for the needs of the FASI Department, and to reflect promising trends in high technologies in the field of continuum mechanics and physics.ii

The book prepared for publication rests on the materials submitted by the teaching staff of the Department of Mechanical Physics and those who served on the staff earlier. The setting of the text, preparation of figures, and preparation of laboratory aids were accomplished on the basis of modern technologies by D. E. Belov and O. S. Galkevich, to whom the contributors express their gratitude.

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E. E. Son

Head of Department, Professor, Doctor of Sciences

(in Physics and Mathematics)

Merited Scientist of the Russian Federation