# Universal laboratory complete for optical practice

S.F.Mironov, A.A.Stolov and A.I.Fishman

Kazan State University, Physical Department,
Kazan, 420008, USSR

Set of optical elements is presented. The set helps in organization of practical classes for the first and second year students. The set is based on the principle of optical constructing. It contains different optical elements: lenses, mirrors, prisms, crystal plates, polarizers, Fabry-Perot interferometers, glass absorption light filters, Fresnel biprism, "Newton rings", transparent and reflecting diffraction gratings, phase zone plate and so on. The set presented makes it possible to avoid most of the shortcomings in the organization of practical classes.

The general course of physics is basically experimental, so the practical classes in the training laboratories are very important. This is also true about optics which is one of the most complicated physical courses. Practical classes help students to acquire deep knowledge, develop their creative abilities and independence in carrying out an experiment, help to develop experimental skills in the assembling and alignment of the simple optical schemes.

However, there are shortcomings in the organization of practical classes.

First, high accuracy devices and equipment not adapted for the purposes of training are often used. Usually the optical part of such equipment is hidden from the students eyes so that he can't change the optical scheme essentially and watch the work of separate units experimentally. Frequently a student is offered a strictly limited plan of work on this equipment. This plan doesn't allow him to understand deeply each step of the experiment. The

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creative independence in solving problems are deprived too.

Secondly, most of training laboratories are equipped with apparatuses specialized to solve one or two concrete practical problems. Because of the limited number of such uniform devices a teacher has to offer his students problems from different sections of the general course, breaking the logical sequence of the educational process. In this case there is no direct connection between lectures and practical classes. The optical set presented makes it possible to avoid most of the above mentioned shortcomings in the organization of practical classes.

The set is based on the principle of optical constructing. The students can assemble and align different optical schemes using the ample kit of optical and mechanical units. That schemes are used for watching different physical phenomena and making necessary measurements.

There are following optical units available in the set presented: five collecting and negative lenses with different focal length, plane mirror, plane-parallel plate (1 cm thick), dispersing prism (the angle of refraction is $60^{\circ}$), wedge-shaped prism, direct vision prism Amicci, two roof-prisms, cuvette-wedge for a liquids investigation, cuvette for the sugar solution (20 cm length), crystal plates $\lambda/2$ and $\lambda/4$ (for $\lambda$ = 0.63 mkm wavelength), two polarizers, three Fabry-Perot interferometers with the transmission function maxima at $\lambda$ = 0.63, $\lambda$ = 0.55 and $\lambda$ = 0.48 mkm, glass absorption light filters, Fresnel biprism, "Newton rings", transparent (300 lines/mm) and reflecting (1200 lines/mm) plane diffraction gratings, concave (600 lines/mm) reflecting diffraction grating, phase zone plate, plate with a set of double slits etc. All the optical units are mounted into the proper rims.

The set also comprises the iris diaphragm, the metal plate with a number of small round apertures, the slit (the width of opening 0-4 mm with the accuracy of 0.001 mm), the screen, the goniometer

(the accuracy of measurements is 5', with the possibility of both vertical and horizontal installation), two optical benches (with the length of 115 and 35 cm) and the special holders of optical units.

Both an incandescent lamp and laser are used as the source of light. It is also possible to use gas-discharged sources of light. The set is equipped with the photoelectric radiation detector.

The set is completed with the description of the practical problems (over 50 problems) which can be solved with the help of this set. The above mentioned problems are different sections of the general course of optics.

Following problems are described in the section "Geometrical Optics": the determination of both liquid and solid media refractive indexes by different methods, the determination of collecting and negative lenses focal length, acquaintance with the astigmatism of declined beams. The experimental skills of the students are developed by this way.

The section "Interference of Light" includes the following problems: interference on the Fresnel biprism, interference of the plane waves reflected by the plane parallel plate, investigation of Fabri-Perot interferometer and the assembly of the narrow bounded light filter on the base of it.

The great number of practical problems can be offered by a teacher in studying on Light Diffraction. The diffraction of light on the round apertures, on the thread, on one or two slits can be studied. The acquaintance with a transparent and reflecting diffraction gratings may be fulfilled. The students can also study the phase zone plate.

The following problems are described in the section "Polarization of Light": the proof of Malus's Law, the Brewster's angle determination, the examination of the $\lambda/4$ and $\lambda/2$ crystal plates, the acquaintance with the phenomenon of polarization plate rotation in optical active media.

And finally, the set presented makes it possible to assemble the model of refractometer. The determination of the refractive index of liquids is possible with its help. The spectroscopes based on both prisms and diffraction gratings can be assembled too. The process of the assembly and alignment allows the students to understand the functioning of all spectroscopes parts deeply. Some investigations can be carried out on the spectroscope assembled. For example, carry out the study of Fabri-Perot interferometers, their transmission spectra can be fulfilled.

It should be marked specially that any described problem requires from the students the understanding of every optical and mechanical parts functioning. The necessary skills of alignment are acquired by students. The described laboratory set enables the teacher to organize practical classes in a more rational way. For example, the situation when all the students perform the same task simultaneously may be realized. In this case practical classes can be closely connected with the theoretical course. The individual approach can be successfully used too, the most capable students can be given more complicated problems.

The use of the set presented has shown that the ideas of new experimental problems are generated by both teachers and students in the process of education. The realization of the above mentioned new ideas is possible mostly due to the wide number of optical and mechanical units, available in the set.

Finally, it should be mentioned that practical classes based on this approach do not exclude the use of high accuracy optical devices. Moreover, the first stage - that is the assembly and alignment of the simple optical schemes - make the use of high accuracy devices more efficient.

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