

# Optics Education in People's Republic of China

Zi-yu Wang

Zhejiang University, Department of Optical Engineering, Hangzhou, China

## ABSTRACT

The situations of Optics Education in People's Republic of China are introduced. Included are the educational programs of Bachelor's and Master's degrees in Optical Engineering, the number of universities and institutes that offered optics degree programs, the research orientations for graduate students of Master's degrees in Optical Sciences and Optical Engineering, and requirements for admission to the M.S. program

## 1. INTRODUCTION

With its own rapid development, Optics, as a branch of physics, is more and more closely related with various fields of science technology and national economy. Therefore, it is extremely important to develop optical education for training and providing technicians with solid theoretical basis and optical techniques for optical industry and other related departments. Fully aware of the importance of developing optical industry to advance national economy, while planning and setting up optical factories and institutes in the early 1950s, the Chinese Government founded the first Optical Instrument Speciality in Zhejiang University in 1952 to train optical technicians normally. In the following ten years, optical industry developed rapidly, and a lot of optical instrument factories and optical institutes were set up in many big cities. Simultaneously, about 20 departments or specialities directly to optics were founded in various universities. Most of them belonged to engineering and others science. Every year, more than 600 students graduated from these departments and specialities, thus satisfying the needs of optical factories and institutes for optical technicians and researchers. The universities and colleges themselves also replenished teachers.

The training of large numbers of graduate students did not begin until about ten years ago. Moreover, they studied mainly for Master's degrees, and very few for Doctor's degrees. This paper gives a brief account of optical education for undergraduates and graduates of Master's degrees in China, and mainly those studying optical engineering.

## 2. EDUCATION OF OPTICAL ENGINEERING FOR UNDERGRADUATES

In the 1950s and 1960s, the higher education of China basically took Soviet Union's model. Narrow specialism, clear training purposes, integration of theory with practice were the main features of this model. Practice according to the engineer's requirement was given to every engineering student. In optics education, we only had optical instrument speciality at first. With the increase of optical colleges and students enrolled, more narrow speciality, such as Geodesic Instruments, Optical Measuring Instruments, Spectral Instruments, Technical Photographic Instruments and military optical instruments, are divided. Some colleges also set up applied optics speciality, in which student majored in lens design and optical testing. Over ten universities trained optical personnel, among which were Zhejiang University, Qinghua University, Beijing Industrial Institute, Tianjin University and Harbin Industrial University etc. The period of schooling was five years. The whole training process stressed the integration of theory with practice, fieldwork and capacity development. Each student had to finish a certain number of exercises and experiments for each course and many practice items were also arranged for them, including: 1) Project for two courses, instrument elements and mechanism" and "applied optics", taken for two or three weeks respectively, in order to train the students in instrument designing and optical system design; 2) Workshop practice on the campus, with the students operating various machine tools in turn, half a day every week during one semester; 3) Two times of practice in factories outside the colleges, four weeks each time, arranged at the end of the third and fourth academic years respectively; 4) A graduation project for a whole semester (the tenth semester). If necessary, graduation fieldwork would be arranged before the graduation project. The students had to do an independent project in order to synthetically apply the basic theory and professional knowledge they had learnt and to acquire the ability to start designing in real earnest.

Students trained according to this program had not only some basic theory and plentiful professional knowledge, but also many-sided practical ability. Generally speaking, they were qualified their work and did remarkable jobs when they began to work, if they did jobs suited to their specialities. This was doubtless an acceptable training method at the time when we were extremely short of engineers and technicians. But, because there were too many

engineering and professional courses in the teaching program, there were comparatively too few basic science courses and not enough attention was paid to foreign language studies, so some years later, they found themselves lacking in basic theory as they tried to keep in step with the development of advanced science and technology and to conduct deepgoing technical work or to do pioneering work. Besides, students trained according to this model were not well adapted for the jobs offered to them and it was difficult for them to change their professions. Therefore, education for undergraduates had be reformed.

In the 1970s the world's science and technology were advancing very fast, especially in the field of optics, with the invention of laser and the extensive use of electronic computer, great changes took place in the study of optics. With the emergence and development of new branches and forward problems of optics, the overlapping and infiltration of optics with other branches of learning became more and more outstanding. As a field of advanced technology, optics needed the work of a large number of optical workers who had a solid theoretical basic and plentiful professional knowledge. Therefore, the optics education for undergraduates in China has developed greatly since 1978. First, science optics specialities have been offered in physics departments of some universities in order to train reserved forces for the study of optical theory. Second, considering the education for higher level graduates, the 5 year-schooling has been shortened to 4 years. And some reforms have been conducted in the former engineering optics education: 1) Specialities have been revised, cancelling the too elaborate division of specialities and only retaining such specialities as optical instruments and applied optics; 2) Greater importance has been attached to basic courses and more credits have been alloted to mathematics; 3) To suit the automation of modern optical instruments and the integration of optics, mechanism, electronic and computer, a number of related courses have been offered; 4) Some engineering and professional courses have been abridged or reduced; 5) Some courses which the students can choose to attend or not to attend have been made optional and those who have great potentialities may choose them. Table 1 shows the teaching plan of a optical instruments speciality.

Table 1. Teaching plan of a optical instruments speciality

Names of Courses	Credits	1st Academic Year		2nd Academic Year	
		1st Term	2nd Term	1st Term	2nd Term
History of CCP	4	2	2		
Political Economics	4			2	2
Physical Exercise	4	1	1	1	1
English	12	3.5	3.5	2.5	2.5
Calculus	8	4	4		
Physics	8		4	4	
Chemistry	4	4			
Computer Language and progranning	3	3			
Linear Algebra	3		3		
Ordinary Differential Equation	2			2	
Complex Function and Integral Transformation	2			2	
Probability Theory	2			2	
Special Function	2				2
Discriptive Geometry and Mechanical Drawing	5	2.5	2.5		
Metal Workshop Practice	3		3		
Engineering Mechanics	3				3
Circuit Principles	5			3	2
Instrumental Element and Mechanism	5				5
Geometrical Optics	3.5				3.5
Names of Courses	Credits	3rd Academic Year		4th Academic Year	
		1st Term	2nd Term	1st Term	2nd Term
Philosophy	4	2	2		
Calculation Method	3	3			
Analogue Electronic Technology	5	5			
Digital Electronic Technology	4.5		4.5		
Wave Optics	4.5	4.5			
Technology of Optical Elements	2	2			
Foundamentals of Laser	3		3		
Photo-electricity Technique	2.5		2.5		
Optical Design	3	3			
Optical Testing	3		3		
Instrument Producing Technology	3			3	
Microprocessor	3			3	
Practice for Graduation	4				4
Pre-graduate Design Project	12				12
Fourier Optics*	2		2		
Thin Optics*	2			2	
Holography*	2			2	

Infrared Technique*	2			2
Plastic Technology*	2			2
Photosensitive Material*	2		2	
Photometry and Colormetry*	3			3
Error Theory*	1		1	
Geodesic Instrumentation*	3			3
Interferometric Instrumentation*	3			3
Photographic Instrumentation*	3			3
Spectral Instrumentation*	3			3

Note: The courses with sign \* are elective courses

The result of carrying out this plan shows that the undergraduates have a rather solid basis of theory and foreign language and their ability to study on their own and to analyse and solve problems has been sharpened. About 20-30 per cent of them have been enrolled as graduate students, including some who study abroad for Master's degrees. They have shown high quality and have achieved excellent grade in studying graduate courses and writing thesis. This indicates that the optics education in China's universities has a considerably high quality.

### 3. GRADUATE EDUCATION IN OPTICS

China's training of graduate students in an all-round way began after the "Cultural Revolution", that is in 1978. Besides universities, institutes attached to the Chinese Academy of Sciences and to certain ministries also enroll and train graduate students. The units entitled to confer Doctor's or Master's degrees and their disciplines and specialities, and the doctors' advisers must all be examined and approved and announced by the degrees Committee of the State Council.

There are two kinds of graduate students in the field of optics: those studying science and those studying engineering. For science we have the Optics Speciality offered by the Physics Departments of various universities and certain institutes. For engineering we have Optical Instruments Speciality and Testing And Measuring Techniques and Instruments Speciality. Table 2 shows the number of units having optics degree programs in China.

Table 2. Number of Units Having Optics Degree Programs in China

Speciality	Master's			Doctor's		
	Universities	Institutes	Total	Universities	Institutes	Total
Optics	32	8	40	9	5	14
Optical Instruments	10	2	12	6	1	7
Testing and Measuring Techniques and Instruments	9	2	11	3	0	3

The three specialities train about 300 Master's degree graduates every year.

The specialities offer a lot of research orientations too. The research orientations offered by the Optics Speciality are: Optical Information Processing, Information Optics, Laser Physics, Laser Spectroscopy, Optical Fiber Communication, Photonics, Guide Wave Optics, Integral Optics, Quantum Optics, Nonlinear Optics, Atmospheric Optics, Crystal Optics, Astronomical Optics etc. The research orientations offered by the Optical Instrument Speciality are: Precision Optical Instruments, Optical Design and Image Quality Evaluation, Thin Optics, Technical Photographic Instruments, High Speed Photographic Technique and its Application, Laser Technique, Photo-electricity Technique, Remote Technique, Holography and its Application, Optical Image and Data Processing, Optical Material, etc. The research orientations offered by the other speciality are: Modern Optical Testing and Measuring Technique, Photo-electricity Testing and Measuring Technique, Modern Spectral Technique and Instruments, Coherent Optics and Precision Interferometric Technique and Instruments, Optical Fiber Sensor, Photometric and Colorimetric Technique and Instruments, etc. These research orientations are drawn from the whole country. As for specific units, they have their own academic speciality, orientations and research projects, and, generally speaking, each unit has three to five research orientations for its speciality.

To be enrolled as a Master degree graduate student, one has only to pass the nationwide examinations at the fixed time. Usually one takes examinations in five courses. The question for three common courses: Politics, foreign language and mathematics are set by the state (for foreign language, most students take English, but they can also take German, Japanese and so on); the other two courses and their questions are decided and set by the units themselves. When one has passed the national examinations, he will have a face-to-face examinations to decide if he can be enrolled.

The period of schooling for Master degree graduate students is 2.5 or 3 years, during which one year or one year and a half is devoted to attending related courses and one year and a half to do degree thesis.

The graduate students must obtain a certain number of credits for the courses they attended, including the six required degree courses. Of these six courses, Dialectics of Nature and foreign language are courses common to all graduate students, and the other four vary with different specialities and decided by the units themselves. They get the rest of the credits by taking elective courses from the curriculum according to their respective research orientations. Generally speaking, the institutes that enroll graduate students do not have the necessary requirements for giving courses, so they usually send their students to local universities or those in other parts of the country with the same specialities to sit in on classes and take the required courses for one year. The Optical Instrument Department of Zhejiang University, for example, admits, each year, about 20 persons sent by institutes.

Doing a degree thesis is required of every graduate student. It generally takes one year or one year and a half, and the subject must be related to the research project. Before a graduate student starts to do his thesis, he must first submit a report expounding the significance of the subject he has chosen, giving a brief account of the development at home and abroad, and setting the time and date for his thesis. Only after he gets approval from his adviser, can he start doing. In the process of doing the thesis the graduate student must regularly report to his adviser on how he is progressing and discuss and solve the probable problems with his adviser. The thesis work should include such contents as the study of theory, engineering design (including hardware and software), experimental testing and result analysis and so on. After he finishes his thesis, he will take an oral examination. Only when he passes this oral examination, can he be awarded the Master's degree.

China sets very strict demands on graduate students. So most winners of Master's degrees have quite a high level of learning. Some of them go abroad for Doctor's degrees and the majority do exceedingly well in their studies and get favourable comments from their adviser.