“Applied Electronics and Optical Laboratory”- an optimized practical course for comprehensive training on optics and electronics

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In order to enhance the practical education and hands-on experience of optoelectronics and eliminate the overlapping contents that previously existed in the experiments section adhering to several different courses, a lab course of “Applied Electronics and Optical Laboratory” has been established in the College of Optical Science and Engineering, Zhejiang University. The course consists of two sections, i.e., basic experiments and project design. In section 1, basic experiments provide hands-on experience with most of the fundamental concept taught in the corresponding courses. These basic experiments including the study of common light sources such as He-Ne laser, semiconductor laser and solid laser and LED; the testing and analysis of optical detectors based on effects of photovoltaic effect, photoconduction effect, photo emissive effect and array detectors. In section 2, the course encourages students to build a team and establish a stand-alone optical system to realize specific function by taking advantage of the basic knowledge learned from section 1. Through these measures, students acquired both basic knowledge and the practical application skills. Moreover, interest in optical science has been developed among students.

Key words: practical course, optical instrumentation, sensor

1. Introduction

To improve the students’ abilities of applying knowledge and hands-on practice, as well as to broaden thinking and cultivate innovative spirits, we establish a new compulsory lab course in the College of Optical Science and Engineering. Through the series of experimental training, students should be able to understand the principle and application of light sources (including gas lasers, semiconductor lasers and solid-state lasers, etc.), radiometry, detectors (photo diode, phototransistor, avalanche photodiode, etc.), and microprocessor. The course is

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also envisioned to train students' capabilities of designing and building photoelectric detection instrument according to task demands through the project design.

2. Course design (experimental preparation, experimental form, process and test, experimental report, assessment methods)

2.1 The requirement of experimental preparation

Students need to carefully read the safety regulations before carrying out experiments preview the contents of the experiment and log on the course site for admission test. Students who do not pass the entry test are not allowed to enter the laboratory to carry out experiments.

2.2 Experimental form and cooperation

The 3 credits course includes 16 hours of instruction and 64 hours of experiment. The 16 hours of theoretical teaching includes the knowledge related to experimental content and the introduction of experimental notes, experimental principles, etc. The experimental session is divided into 32 hours of basic experiments and 32 hours of project design (comprehensive experiment). Teachers open the laboratory and guide experiment, and 3 students in a group (random combination) complete the experiments.

The project design is completed by a group of three (or two) students, and each subject can be chosen by a maximum of three groups (the early applicants have priority), reimbursable components procurement funds up to 300 yuan (subject to invoices and purchase list).

2.3 Experimental process and test

Conscientiously complete and think about each of the phenomena and problems that occur during the experiment, and use theoretical knowledge to explain the experimental principles.

At the end of the experiment, each student must immediately complete an experimental

process test, and immediately check the understanding of the content, process and results of the experiment.

Encourage collaboration: Discussing issues with team members will help everyone. However, blatant reproduction and other forms of deception are intolerable, and the teacher will punish such acts.

2.4 Experimental report or project summary

Students who attend the course experiment: Write an experimental report and upload the lab report to the course website before the deadline. If there is a personal situation that results in late submission, students must explain it in advance to the teacher.

Students who attend the project design: Participate in the opening defense, mid-term progress report and the final defense, complete the corresponding PPT according to the requirements, and each defense accounts for a certain score. At the end of the project, submit the design documents.

2.5 Marking scheme

The experimental course is set up independently, and the experimental score is the final score (the total score). There are two parts: 1) course experimental module 50 points 2) project design module 50 points.

1) Course experimental module (50 points), includes:

- experimental process and the completion: 60%
  (A part of scores are given by the test of experimental process)
- experiment report: 20%
  (Includes a full experimental report and other simplified experimental reports)
- final experiment test: 20%
  (Experimental theory and experimental design)

2) Project design module (50 points), includes:

- the progress of project design (opening and mid-term inspection) 15%

- the completion of project design (considering the difficulty) 60%
- final defense, report and introduction DV 25%

3) Additional points (bonus points): 5%

(Reward distinct creative projects, creative suggestions, project design novelty, scientific papers, patent application and putting forward projects for the future students, etc.)

3. Experiment course content and allocation of hours

3.1 Routine experiment content (3 students / group)

Name of experiment	Content of experiment	Allocation of hours	Type of experiment	Requirements of experiment
Experiment 1 Photodetector and Photoconductive Detector Circuit and its Characteristic Measurement	1. Photodiode test 2. Photoelectric transistor test 3. Light characteristics 4. Volt-Ampere characteristics 5. The test results are converted by the A/D converter and then displayed 6. Set up the test system for LED light intensity distribution test	4	Basics	Compulsory
Experiment 2 The Principle and Driving Experiment of Area Array CCD	1. The method of measuring the waveform, frequency, period and phase of the vertical and horizontal driving pulses of the array CCD 2. Measurement of line, field self scanning TV system of area array CCD 3. Measurement of video output signals	4	Basics	Compulsory
Experiment 3 LCD	1. LCD read and write timing and instructions 2. LCD programming	4	Basics	Compulsory

Experiment 4 Rotating Speed Measurement and Control	1. Use photoelectric tube to achieve the click speed measurement 2. Use the microcontroller and LCD to display the measurement results in real time 3. Use the PID control to adjust the click speed	4		
Experiment 5 Measurement of Line Width and Output Spatial Distribution of He-Ne Laser	1. Laser line width 2. Laser output spatial distribution CCD measurement	4	Basics	Compulsory
Experiment 6 Characteristics of Semiconductor Laser and its Spectral Characteristics	1. Semiconductor laser safe operation 2. Measurement of working characteristics of semiconductor 3. Measurement of fluorescence spectra and laser spectra of semiconductor 4. Far-field distribution measurement of slow-axis direction of semiconductor 5. Far-field distribution curve of semiconductor 5. Measurement of near-field distribution in slow-axis of semiconductor	4	Basics	Compulsory
Experiment 7 Solid-state Laser Nd: YAG Laser Integrated Experiments (Including cavity length adjustment, cavity type transformation, beam quality, cavity length and power relationship, cavity frequency and other experiments.)	1. Construction of Nd: YVO4 Laser 2. Intracavity frequency doubling, frequency doubling condition and efficiency observation 3. Cavity length adjustment; cavity type transformation's affect on power 4. Measure the relationship between cavity length and power 5. Beam quality measurement 6. The use of the data processing program Origin 6.0	8	Basics	Compulsory

3.2 Course Design

Each year there will be some reference topics released, combined with Optical-Science-Technology Competition, scientific research and production in the photoelectric technology. Groups of students need to perform researching technologies, determining the program, building the system, contrast test and the final project reply. It is aimed to train the student's skills to solve practical problems.

No.	Title	Function realization
1	An Airborne Rescue Unmanned Aerial Vehicle Based on Optoelectronic Target Recognition	Design an unmanned aerial vehicle for airborne rescue based on photoelectric target identification. Requirements: use optoelectronic technology to find the target, and throw the table tennis ball, which is simulated as relief supplies, to the receiving basket. The amount of correctly thrown table tennis ball in specified time determines the results of the contest.
2	The best imaging system constructed by single lens	Using the given biconvex lens and CMOS image sensor, make advantage of photoelectric and image processing technology to build the best imaging system.
3	Security monitoring system in Large space (50m * 50m)	Design a security system for large warehouses, which requires the ability to detect anomalous intruders in time and to obtain clear face images and transmit images to remote terminals (computers or mobile phones) and alert them.
4	Photoelectric distance measurement	Measure the distance between the workpiece and another.
5	Shaft diameter measuring device	Measure the diameter of rod-like, linear or tubular workpieces.
6	Space visible light communication	Space information transmission. You can use laser, white light to pass a voice, music, or information coding.
7	Photoelectric intelligent infusion detector	To determine whether the infusion ends and alarm.
8	Photoelectric thermometer	Measure objects or body temperature.
9	Photoelectric velocity measurement	Measure moving object speed and alarm.
7	Photoelectric name system	Use optical face, eye recognition or fingerprint recognition to achieve automatic naming.
8	Optical signal simulation carrier	An optical signal is used as a carrier signal to perform analog signal transmission such as audio.
9	Optical listening	Use the active light source for audio signal monitoring
10	Automatic patrol car	A car that is able to identify the 8-shaped lane line and move along the line.

4.0 Conclusion

A new course of Applied Electronics and Optical Laboratory has been established at the College of Optical Science and Engineering, Zhejiang University, in order to enrich the hands-on experience and a of optical instrumentation, microprocessor, electronics and computer programming. The course includes a basic experiments module and a project design module. Basic experiments provide hands-on experience with most of the fundamental concept taught in the corresponding courses. In the project design module, students are encouraged to establish a stand-alone optical system to realize specific function by taking advantage of the basic knowledge learned from section 1. Through these measures, students acquired both basic knowledge and the practical application skills.