Associate Degree in Optical Systems Technology at Pima Community College

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Abstract: Pima Community College in Tucson, Arizona offers a two year Associate Degree of Applied Science in Optical System Technologies. It started the optics program under the Technology Department in August 2001 due to the local industry demand for optics technicians. In this paper, the history of the formation of the program will first be presented. The optics courses offered leading to the degree includes geometrical optics, wave optics, radiometry, fiber optics, lasers fundamentals, and optical testing. Much of the lab equipment were donated by local optics companies. Pima Community College in August of 2006 began to offer two geometrical optics courses whose credits can be transferred to the University of Arizona leading to a Bachelor Science in Optical Engineering.

Introduction

The Optical System Technology program started in the Technology Department at Pima Community College in 2001. The department also offers associate degrees in electronics, computer networking, and semiconductor manufacturing. Students who get a two-year associate degree in Optical System Technology work as optics technicians after they graduate. Starting the optics program was in part influenced by the mayor of Tucson, Arizona who wants to make Tucson an Optics Valley by attracting optics companies to locate here. The optics industry is a clean industry and is growing with much promise in the future. One criterion that attracts optics companies to settle at any particular city is whether there are colleges and universities nearby that offer optics classes to train their employees. Also the companies will have a greater access to a pool of graduates they can hire from. The Tucson city government, Pima Community College, and the University of Arizona are all working together for this initiative. The College of Optical Sciences at the University of Arizona has a great influence in developing the optics industry in Tucson since it began in 1965. Pima Community College is the only community college in Arizona that offers an associate degree in optics.

Just as electronics companies need both electronics engineers and technicians to develop and manufacture products, the optics companies also need optics engineers and technicians. Not many colleges in the U.S. train people to become optics technicians and there is a growing need for these people. The College of Optical Sciences at the university wants to turn out only optics engineers and scientists. They have no desire to train optics technicians and would like Pima College to fill this gap. Some companies are using their optics engineers to do optics technicians work. At Raytheon in Tucson, they are taking electronics technicians and training them as optics technicians. Some optics technicians started out as assemblers after graduated from high school. They have no formal training in optics and everything they learned are from on the job training. Bob Breault, the president of Breault Research Organization and chairman of the Arizona Optics Industry Association (AOIA), has been a great supporter of the optics technician program at Pima Community College. He sees the program is serving a need for the community. AOIA is a consortium of optics companies in Tucson, and it has made financial contribution to the optics program.

Donation of Optics Equipment

Without the donation of optics equipment from local optics companies, even with political support, the optics program probably would never have gotten started. The cost of purchasing optical

components to setup up teaching labs is much more expensive than purchasing electronic equipment. Pima College probably did not have the finances to equip the optics lab alone. Pima College has acquired closed to $1 million dollars of optics equipment from the generous donation from various optics companies in Tucson. This reason may explain why other public and private colleges in Arizona do not offer an associate degree in optics. The initial cost is just too high to bear. In year 2000, ETEC Polyscan was bought out by Applied Materials in Oregon. ETEC was closing its plant in Tucson and donated much of their optics equipment to Pima College and the University of Arizona. Coherent sold its optical components branch to Ealing. Coherent has donated optical isolation tables and optical components like mirrors, beam splitters, waveplates, and mounts. The donation from these two companies had helped greatly in getting the optics program started. The donation has not stopped. In year 2004, the Photon II project operated by the New England Board of Higher Education and funded by the National Science Foundation has contributed some optical components necessary for teaching labs. In year 2006, Coronado Instruments in Tucson was purchased by Meade Instruments in Irvine, California and the company has donated mirrors, windows, etalons, and glass blanks. Raytheon has donated filters, laser safety goggles, glass blanks, and some optical equipment. This year the Photovolatic Testing Lab (PTL) at the Arizona State University in Tempe, AZ wants to donate several large solar panels but the optics lab is running out of room to receive these donations.

Description of Optics Courses

Students enrolled in the optics program needs to have a total of 71 credits to graduate with an associate degree, and they can graduate in 2 years if enrolled full time and longer if enrolled part time. The classes include areas in humanities, electronics, and optics. There are 7 required optics classes and they are TEC 117 Optical Assembly Techniques, TEC 140 Geometrical Optics, TEC 141 Wave Optics, TEC 284 Calibration of Optical System (Radiometry), TEC 286 Fiber Optics, TEC 287 Laser Fundamentals, and TEC 288 Optical Testing. In all of these courses, the description of the nature of light is limited to algebra and trigonometry and the knowledge of calculus is not required. Much emphasis is on doing the labs and understanding through seeing. The TEC 117 is an introduction to optics class and students get hands on experience of putting optical components together on an optical table. Labs include building an interferometer, reflecting telescope alignment, verifying lens equation, and measuring index of refraction of air. The TEC 140 teaches student about how light refracts through lenses and reflects off mirrors. It uses rays to represent the propagation of light. The TEC 141 models light as waves instead of rays to describe diffraction effects. TEC 284 shows how to measure visible and invisible radiation and gives radiometric definition of radiance, irradiance, intensity, solid angles, and throughput. TEC 286 shows how light can be confined in an optical fiber. The dispersion and bit rates are compared in single and multimode fibers. The class uses the fiber optics kits from Newport Corporation and there are ten labs to be done. The labs includes demonstration of wavelength division multiplexing, pressure and temperature sensing, and distribution of modes. TEC 287 describes how gas and semiconductor lasers work. TEC 288 shows how light can be used to measure the surface profiles of flats, mirrors, lenses. It shows many different types of interferometers. It also shows different non-interferometric tests such as the Foucault knife edge test and the wire test to test mirrors. Students also learn about making holograms. More description of these optics classes can be found on Pima College website at www.pima.edu. The drawback of taking these optics courses offered in the Technology Department is that they cannot be transferred to the university for credit if a student wants to continue his education and get a bachelor of science in optical engineering. The main reason is that these classes do not use calculus in their theoretical analyses. Almost all of these optics classes are offered during the late afternoons or night time to allow working professionals to enroll.

Field Trips to Local Companies

To show that much research and development activities in optics are happening in Tucson, every year the instructor of the class has taken the students to a local optics company to observe the type of work being done. The students enjoy going on a field trip and gain more insight of what optics is about. One year the students have gone to Steward Observatory Mirror Lab at the University of Arizona. They got to see how large mirrors are made and tested. The mirrors were for a large binocular telescope on Mt.

Graham. Another year the students went to a company called Electro Optics System Technology (EOST) who makes large telescope mounts. Another company they saw was NP Photonics who makes erbium-doped fibers for optical amplifiers and fiber lasers. They have gone to Tucson Optical Research Corp. (TORC) to see the instruments that grind and polish mirrors and lenses. One year the students went to Zygo Optical Systems and saw how optical components are assembled in their clean room. Another year they went to Veeco Metrology and saw the instruments that perform interferometric measurements of lens, mirror surfaces, and micro-electro-mechanical (MEMS) devices.

Increase Enrollment

Although there is much support for the optics program from the administrators at Pima College and from the industry, the student enrollment has been low. On average, there have been consistently less than 10 students per class. The class still runs even if there are 4 or 5 students. The class is cancelled if there are 3 or fewer students. The administrator would like to have a class between 15 – 20 students. The reason the administrators allow the low enrollment per class is that they see a positive result that all the students who graduate with an associate degree in optics find employment at various optics companies. This indicates there still a need for this skill set in Tucson. If the enrollment had been higher, then not all the students will find jobs in Tucson because the optics industry here is not large enough to absorb all them.

Even though classes still run with low enrollment, increasing enrollment is still a goal to strive for. Pima College has participated in the Photon II project where its purpose is to have collaboration between high schools and colleges so more students will choose optics as their future careers. Pima College has partnered with Desert View High School in the Photon II project from 2004 – 2006. Each school has received optics teaching kits to do optics demonstrations and labs. They are to help students to see that optics is fun and exciting and get them interested in science. Donations for the optics kit had come from the Arizona Optics Industry Association (AOIA) and the National Science Foundation. From the outcome of the project, Pima College hopes that the more students who graduate from Desert View High School will enter the optics program to increase enrollment.

Another project that Pima College participated is the Hands-On-Optics operated by National Optical Astronomy Observatory (NOAO) in Tucson, AZ and funded by the National Science Foundation. The purpose of the Hand-On-Optics project is similar to that of the Photon II project, to broaden the knowledge of optics among young students and hope they would choose optics as their future career, but the format is different. Instructors from the Hands-On-Optics would give optics demonstrations to middle school and high school teachers. There are volunteers from colleges, universities, and local optics companies who already have some knowledge about optics. The teachers would then return to their schools and teach the students what they have learned from the demonstrations. Again their duty is to make optics fun and exciting. The purpose of the volunteers is to help the teachers if they have questions. Pima College has been paired up with Totecalli Academy, a chartered high school.

Transfer Program with the University

In 2006 Pima Community College began to offer two optical engineering classes that are transferable to the College of Optical Sciences at the university. The two courses are Geometrical Optics I, offered in the fall semester, and Geometrical Optics II, offered in the spring semester. They are taught at a sophomore level. The first part pertains to learning the basic fundamentals of light and the second part pertains to optical systems such as how a telescope, a binocular, and a zoom lens work. These are required classes leading to a Bachelor of Science in Optical Engineering. Many students are already taking advantage of the transferability in other course subjects such as math, physics, and general engineering. They prefer taking this route because of the lower tuition cost and also most feel that Pima College professors in general care more about their academic success than professors at the university. Much support has been provided by the optics professors at the university to ensure that the course contents are the same. They believe that they got the best undergraduate optical engineering curriculum in the world and they want Pima College to keep them at a high standard. The lab instructor at the university also has contributed some lab equipment necessary for students to do the labs and provided help when needed. The support for the transfer program from the College of Optical Sciences has been beyond expectation.

Conclusion

In this paper, the formation of the optics program at Pima Community College is presented. There must be support from many different groups in order for the program to be a success. The administrators at Pima Community College overlook the present low enrollment because they know the program serves the local optics industry needs. With money spent on optics education in the middle and high schools, we hope the younger generation will choose this rapid growing and promising field as their future career and hopefully the enrollment will be higher. The faculty in the Technology Department admire those working professionals who are taking the night classes wanting to make a career change. They have invested their time and money in hoping to get a higher paying job to better support their families. We encourage those who got associate degrees not to stop their education but to get higher degrees and have their employers pay for them. For those who are middle age and do not want anymore degrees, we say it is never too late to get retrained. With technology changing ever so fast today, we need keep the workforce up to date.

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