Electro-Optics In Two Years

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ABSTRACT

Texas State Technical Institute-Waco (TSTI-WACO) was the first school in the United States to offer an Associate of Applied Science degree in Laser Electro-Optics Technology. The program began in September 1969 and has produced 1,827 graduates since inception. These graduates are readily adaptable to any area of the laser electro-optics industry. Areas of study include Optics, Electronics, Vacuum, Physics, Mathematics, and English with emphasis on Electro-Optics. Graduate placement is centered around research and development, life sciences and manufacturing in technical and engineering areas.

1. INTRODUCTION

Education of technicians for the Electro-Optics industry is a unique task in a four-year university. At TSTI-WACO a program was developed to produce technicians in twenty one months. This degree plan is algebra and trigonometry based with emphasis placed on teaching the basics first in conceptual format with Lecture:Laboratories Ratio of 40:60. Then more advanced work in the same form is completed with the lab area heavily capitalized. This curriculum is graduating 100 to 110 capable technicians a year with graduation occurring four quarters a year in June, August, November, and February. The majority of these graduates are in the June and August time frame. The curriculum structure is offered for your consideration.

2. CURRICULUM STRUCTURE

First quarter curriculum includes courses in college algebra, basic electronics, and basic optics. These are enabling courses which provide training to support more advanced courses in future quarters. During this time students have the options to enroll in courses which enhance future learning skills. Such courses include Psychology, English, and basic Machine Shop Operations.

Basic Electricity and Electronic courses are troubleshooting, not design based. They are intended to familiarize the student with DC and AC circuit analysis via extensive lab work. Students must have a working knowledge of algebra to be successful in all courses. This is a good time to start the beginning student who has only basic math and physics skills into optics. Introductory optics are taught in a basic component operation theory and lab course. This course contains only basic components such as: tables, benches, supports, windows, mirrors, flats, etalons, filters, beam splitters, prisms, lenses, gratings, and polarizers with an introduction to terminology used in the optics industry. Support courses such as Computer Science are based upon languages such as basic or assembler to promote future understanding in computer and electro-optics interfacing. Machine Shop provides not only operation of milling machines, lathe and drill presses, but also places emphasis on blueprint reading and how to make specifications.

Second Quarter courses continue to strengthen the student's background in math, physics, and basic electronics. It is very important that the student use the material learned in the previous quarter during this time. Plane trigonometry is required for a further understanding of AC circuit analysis and geometrical optics.

In the Third Quarter, courses to introduce Lasers, Laser Safety, Vacuum Technology, and Geometrical Optics are approached from a conceptual view. Course work includes basic laser theory in the areas of Operation, Safety, Properties of Light, Lasing Action, Optical Cavities, Modes of Oscillation, and Temporal and Spatial Characteristics with well-equipped laboratories to support a hands-on approach to these theoretical areas. Since glass-forming processes are very important for an understanding of optical glass system characteristics, a course in Optical Glass Fabrication is offered to familiarize the student with the proper selection and use of optical glasses. The Geometric Optics course includes a more intense study of optics than basic components course. Inclusive is a study of all passive optical components using Graphical Ray Tracing and Mathematical Solution methods. The course is designed to enable the student to understand the basic geometrical principles of light and their application to elements of an optical system. Examples of elements studied are reflection prisms, refraction prisms, refraction plates, thin lenses, thick lenses, lens combination, plane and spherical mirrors. Light paths and object-image characteristics of these optical elements are analyzed by computational and graphical methods and are verified by laboratory techniques and exercises. Electronics progress into semiconductor theory and lab which finish up the basic electricity and electronics curriculum; it is important to use this basic information as a foundation to teach the more advanced Electronics and Laser Technology courses. Since lasers are such a major area of electro-optics, they are covered in detail. Vacuum science is important and is an in-depth course since it is an integral part of tube processing and coating technology. The first vacuum course includes terminology, vacuum components, mechanical pumps, diffusion, turbo molecular and cryogenic pumping systems with a brief discussion of sublimation, diode and system operation, pump down cycling. The course also familiarizes students with the proper selection, use and maintenance of vacuum instrumentation.

Continuous Wave Lasers introduce students to the world of Ion, Molecular, Eximer, Dye and Solid State laser systems. Electronics, optical resonating, troubleshooting and systems integrity are stressed. During this quarter, geometrical optics are concluded as a prelude to wave optics in the fifth quarter by presenting geometrical characteristics and nomenclature of thick lens, thin lens combinations and mirror optical systems. Lens and mirror powers and spacing in optical systems are studied to determine the effects on image locations and size. The effects of stops in an optical system and aberrations of the imaging process are studied. Finally applications of the preceding principles in functioning optical instruments, such as the eye, microscopes, telescopes and camera are surveyed. Analytical problem solving as well as graphical techniques of optical problem solving are emphasized. Wave optics is a conceptual course with extensive three-dimensional illustration and mathematical solution for classical optics. The course is designed to teach the student the fundamentals of wave optics and the concept of light as a wave with enlightenment on those areas relevant to electro-optics and lasers. Using wave theory as a basis topics covered are interference, diffraction, and polarization of light and birefrengence for later electro-optic courses. Labs support the theoretical concepts taught in lecture.

Laser Technology is continued in the Fifth Quarter with Pulsed Lasers, a study of Pulsed Configured three- and four-level systems with basic Q switching and pulsed measurement techniques covered here. Digital and Analog Integrated Circuits, Electronics, and Communication Systems are now pursued to prepare the students for their sixth quarter course work.

In the sixth quarter the student should have a good understanding of basic Electronics, Optics, Vacuum and Laser Systems to carry them through Fiber Optics, a course with advanced optics and electronics. The course stresses propagation, dispersion, multiplexing, interconnections and electro-optical (E-O) interfacing. Fiber Optic electro-optical interfacing is held towards the end of the course to allow students to become more familiar with E-O Systems. Electro-Optic course content includes Photodetectors, Photo instruments, Collimators, Expanders and Spatial filtering, Isolators, Electro-Optical and Acousto-Optical system and concluding with Second Harmonics/Parametric oscillation and mode locking. Wave Optics is continued with a Measurements course which is intended to reinforce the student's wave optic knowledge by applying these skills to make precision measurements using electro-optical instruments. Various types of light sources are covered along with the instruments and meters used in gathering data in todays E-O field. Lab includes interferometry, monochrometry and spectromety using a multiple array of equipment. A course offered in Laser Maintenance and Repair is intended to enable the student to disassemble, test, troubleshoot and reassemble various laser electro-optics and communication systems. The particular utilization of support, test, and measurements is emphasized. Laboratory exercise are conducted with the student functioning on an independent basis with the equipment. Vacuum's second and last course includes in-depth pumping and isolation systems, deposition technology, and plasma tube processing. Students are instructed in calculations to emphasize correct vacuum system operation.

The seventh quarter is the final quarter. A Microprocessors course is the conclusion to the electronics part of the curriculum. Wave Optics finishes with Holography and Holographic Nondestructive testing wave theory and production techniques are stressed. Discussions include theory of how to record and retrieve various types of holograms. Different types of media are pursued and proper setup conditions to produce a quality product are emphasized. A project course which is an independent hands-on research project with dissertation is offered. The student must choose, plan, construct, and evaluate a Laser, Electro-Optic Optical or Vacuum System during this course. Formal laboratory report writing and keeping of laboratory notebooks is stressed throughout the curriculum.

A group of courses for other curriculums is offered, such courses are, but not limited to: Biomedical Lasers, Fiberoptics, Lasers for Instrumentation and Measurements, Laser and Light Productions and Laser Safety.

A total of 2,500 weekly student contact hours over two years are suggested for completion of this course. The emphasis on concepts, mathematical solutions, and thinking the problem through to its completion is the basic method of teaching lecture and lab.

Laboratories must be well capitalized to support the conceptual base training, while expensive, it is very effective. Students must also be instructed in the proper use of the laboratory notebook for reconstruction of future projects.

The following curriculum and course description is offered for your consideration.

3. TSTI-WACO LASER ELECTRO-OPTICS TECHNOLOGY 1988-1989

		PERIODS PER WEEK			CONT. HRS.
		LEC.	LAB.	CR.	PER QTR.
FIRST QUARTER					
LET 108	Laser Electro-Optic Components	3	3	4	72
LET 1000	Electrical Theory I	0	8	2	96
LET 1100	Series Parallel Circuits	0	2	1	24
LET 1200	Circuit Theory	0	2	1	24
CST 2030	Assembly Language	0	6	3	72
MATH 104	Intermediate Algebra	4	0	4	48
		7	21	15	336
SECOND QUARTER					
LET 2000	Electrical Theory II	0	6	2	72
LET 3000	Electrical Theory III	0	6	2	72
LET 4000	Electrical Measurements	0	8	2	96
MATH 124	Plane Trigonometry	4	0	4	48
PHYS 124	Fundamentals of Physics	4	0	4	48
		8	20	14	336
THIRD QUARTER					
LET 305	Vacuum Sys. I & Glass Fab.	3	6	4	108
LET 4100	Electronic Devices I	0	2	1	24
LET 4200	Electronic Devices II	0	4	1	48
LET 102	Fund. of Lasers & Laser Safety	3	4	4	84
PHY 204	Geometrical Optics	3	3	4	72
		9	19	14	336
FOURTH QUARTER					
LET 4300	Electronic Devices III	0	4	1	48
LET 5000	Electronic Application	0	4	1	48
LET 202	Continuous Wave Lasers	3	6	4	108
MSO 108	Intro. to Metal Working Proc.	2	6	4	96
PHY 205	Advanced Geometrical Optics	3	3	4	72
		8	23	14	372
FIFTH QUARTER					
LET 303	Pulsed Lasers	3	6	4	108
LET 304	Wave Optics	3	4	4	84
LET 321	Laser Maintenance and Repair I	2	6	4	96
INT 206	Digital Instrumentation I	3	3	4	72
		11	19	16	360
SIXTH QUARTER					
LET 306	Fiber Optics - Electro Optics	3	4	4	84
LET 312	Electro-Optics Measurements	3	4	4	84
LET 317	Vacuum Systems II	3	4	4	84
ENGL 104	Composition I	4	0	4	48
PSYC 104	General Psychology	4	0	4	48
		17	12	20	348
SEVENTH QUARTER					
LET 6000	Laser Electro-Optics Projects	0	12	3	144
LET 325	Holography and HNDT	3	6	4	108
INT 322	Microprocessors I	3	3	4	72
ENGL 134	Interpersonal Communications	4	0	4	48
		10	21	15	372
	Program Totals	**70**	**135**	**108**	**2460**

4. COURSE DESCRIPTIONS 1988-1989

CST 2030 Introduction to Micro Assembly Language (0-8-4) An introduction to assembly language programming for microcomputers.

ENGL104 Composition I (4-0-4) Principles and techniques of written composition, textual analysis, and critical thinking. Prerequisite: Successful completion of diagnostic testing.

ENGL 134 Interpersonal Communication (4-0-4) Theories and exercises in verbal and nonverbal communication with focus on interpersonal relationships.

INT 206 Digital Instrumentation (3-3-4) Binary, Octal and Hexadecimal numbering systems, the basic digital logic gates and the use of these gates to build more complex digital circuits such as flip-flops, counters, registers; adders and semiconductor memory chips are introduced; the application of these basic building blocks in digital systems is introduced. Prerequisites: ELT 200, or ELT 217, or INT 3000.

INT 322 Microprocessors (3-3-4) A study of the basic hardware and software considerations in the utilization of microprocessors for common instrumentation applications. Input control is emphasized. Machine language is stressed. Prerequisite: INT 206.

LET 102 Fundamentals of Laser and Laser Safety (3-4-4) The theory of laser operation, characteristics of light emitted by lasers, components of lasers, laboratory procedures using lasers, and safety considerations necessary for laser operation. Prerequisite: MTH 112 or concurrent enrollment.

LET 106 Laser Electro-Optics Calculations (0-3-1) The use of electronic calculators in solving common problems involving lasers, optics, and electronics.

LET 108 Electro-Optics Components (3-3-4) Properties, applications, and commercial sources of optical and mechanical components commonly used in industry. The laboratory will stress the specifying and ordering of components from manufacturers catalogs and technical publications.

LET 198 Industrial Coop Training I (0-20-6)

LET 199 Special Problems I (1-4-2)

LET 202 Continuous Wave Lasers (3-6-4) A study of continuous wave lasers including in-depth descriptions of helium-neon, argon ion, neodymium:YAG, and carbon dioxide systems. The laboratory will stress the operation and maintenance of these systems and the measurement of their output characteristics. Prerequisites: LET 102.

LET 298 Industrial Coop Training II (0-20-6)

LET 299 Special Problems II (2-4-3)

LET 303 Pulsed Lasers (3-6-4) A study of pulsed lasers including in-depth descriptions of ruby, neodymium:glass, TEA molecular, semiconductor, and liquid dye systems. The laboratory will stress the operation and maintenance of these systems and measurement of their output characteristics. Prerequisites: LET 4000 and LET 202.

LET 304 Wave Optics (3-4-4) The basic wave properties of light including interference, diffraction, coherence, and polarization. Laboratories will consist of the analysis and measurement of light and optical components using the above properties. Prerequisites: PHY 205, LET 108, and LET 102.

LET 305 Vacuum Systems I and Glass Fabrication (3-6-4) Vacuum basic principles and operation of high vacuum systems, troubleshooting vacuum systems, vacuum instrumentation, and vacuum deposition of thin films. Elementary glass forming operations includes laboratory exercise in joining and bending of tubing.

LET 306 Fiber Optics - Electro Optics (3-4-4) Characteristics and applications of detectors, modulators, Q-switches, beam deflectors, frequency doublers, Fiber Optics, and Fiber Optics Systems, and special photographic equipment. Prerequisites: LET 304 and LET 108.

LET 312 Electro-Optics Measurements (3-4-4) State-of-the-art optical measurement devices and techniques including the use of monochromometers, spectrometers, spectrum analyzers, and a variety of interferometers. Laboratories will stress accuracy of measurement. Prerequisites: LET 304.

LET 316 Special Projects and Field Work (1-8-3) Recognizing the educational value of actual work experience, an instructional schedule will be arranged for special projects and work assignments to give students an opportunity to apply principles and concepts studied. Prerequisite: Permission of Program Chairman.

LET 317 Vacuum Systems II (3-4-4) A study of industrial vacuum equipment including: mechanical pumps, oil-diffusion pumps, turbo-electric pumps, and vacuum instrumentation. Laboratory work includes disassembly, cleaning, and assembly of vacuum systems; and the deposition of metallic and dielectric coatings. Prerequisite: LET 305 or permission of Program Chairman.

LET 321 Laser Maintenance and Repair I (2-6-4) A course designed to enable the student to plan, disassemble, test, and troubleshoot various systems. The practical utilization of support and test equipment will be emphasized. Laboratory exercises will be conducted with the student functioning on an independent basis.

LET 325 Holography and HNDT (3-6-4) A course designed to give a student the working knowledge of the principles and applications of holographic processes. Topics to be discussed include HNDT, time-lapse, time-averaged, and multiple exposure holography. The setting up of holographic systems and film processing will be emphasized in the laboratory. Prerequisite: LET 304 or permission of Program Chairman.

LET 327 Laser Fabrication (1-6-3) A laboratory course in which a student will use the skills and knowledge acquired in previous courses to design, build, and test a working laser. Prerequisite: LET 4200.

LET 330 Biomedical Lasers (3-3-4) A course designed to teach state-of-the-art Biomedical laser techniques and equipment maintenance and repair. Topical areas are Photocoagulation Lasers, Abated Surgery Lasers, Dermatology and Research Lasers and equipment. Prerequisite: Permission of Laser or Biomedical Program Chairman.

LET 399 Special Problems III (3-4-4)

LET 1000 Electrical Theory I (0-8-2) Orientation and safety, tools and fabrication, electronic component and symbols with Ohm's Law and series circuit testing, parallel circuits and testing.

LET 1100 Series Parallel Circuits (0-2-1) A continuation of LET 1000 combining series parallel systems. Prerequisite: LET 1000.

LET 1200 Circuit Theory (0-2-1) Analyzing unloaded and loaded voltage dividers superposition and Thevenin's Theorems, balanced and unbalanced bridge circuits. Prerequisite: LET 1100.

LET 2000 Electrical Theory II (0-6-2) Alternating current and voltage, with introduction to oscilloscopes and capacitance. Prerequisite: LET 1200.

LET 3000 Electrical Theory III (0-6-2) Magnetism and inductors, frequency and transformers and series RCL circuits. Prerequisite: LET 2000.

LET 4000 Electrical Measurements (0-8-2) Parallel RCL circuits, filters and coupling, multimeter analog and digital and Semiconductors I, diodes. Prerequisite: LET 3000.

LET 4100 Electronic Devices I (0-2-1) Common emitter, Common base, Common collector transistors circuits are discussed. Prerequisite: LET 4000.

LET 4200 Electronic Devices II (0-4-1) Field effect transistors, Unijunction transistors, triacs, wiacs, silicon controlled rectifiers; VMOS are investigated. Prerequisite: LET 4100.

LET 4300 Electronic Devices III (0-4-1) Operational amplifier's theory and operation will be presented. Prerequisite: LET 4200.

LET 5000 Electronic Applications (0-4-1) Rectifiers and filters, oscillators and circuit applications with extensive troubleshooting will be studied. Prerequisite: LET 4300.

LET 6000 Laser Electro-Optics Project (0-12-3) The student will choose, plan, build, and evaluate a laser or electro-optical system. The laboratory log book will be maintained throughout the project and a final report will be prepared. Prerequisite: LET 202.

MATH 104 Intermediate Algebra (4-0-4) A study of relations and functions, inequalities, factoring, polynomials, rational expressions and quadratics with an introduction to complex numbers, exponential and logarithmic functions, determinants, and matrices, sequences and series. Prerequisite: Successful completion of diagnostic testing.

MATH 124 Plane Trigonometry (4-0-4) Trigonometric Functions, identities, equations and applications. Prerequisite: MATH 104.

MSO 108 Introduction to Metal Working Processes (2-6-4) A course designed for the student enrolled in technologies that are associated with metal working processes to become familiar with metal working equipment and processes used in industry. Equipment and processes introduced will include foundry, bench work, drills, grinders, lathe, milling machines, and demonstrations on Computerized Numerical Control machining.

PHY 204 Geometrical Optics (3-3-4) A study of reflection and refraction of light at plane and curved surfaces, the imaging processes and characteristics of lenses and lens combinations, and their application in selected optical instruments. Prerequisite: MTH 124.

PHY 205 Advanced Geometrical Optics (3-3-4) A study of lens and mirror aberrations, the effects of stops, and optical instrument design. Prerequisite: PHY 204.

PHYS 124 Fundamentals of Physics (4-0-4) An algebra level, problem oriented course. Presents special topics in classical physics, such as basic mechanics, optics, acoustics, or electricity. Prerequisite: Math 104.

PSYC 104 General Psychology (4-0-4) A survey of the major topics in psychology. Introduces the study of behavior and the factors that determine and affect behavior.