Developing Photonics Education in Iowa’s Rural High Schools
HI-TEC VIRTUAL 2021

Professor Frank Reed
Grant Director, Principal Investigator
Indian Hills Community College (IHCC)
Ottumwa, Iowa
641-777-3538
frank.reed@indianhills.edu

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Introduction

• Population of Iowa: 3.1 million in 99 counties; ~31,300 per county
  • IHCC’s 10 - county area: 137,900; Wapello County: 35,000; Ottumwa: 24,300

• Indian Hills Community College’s (IHCC) Lasers & Optics Technology program began in 1985.
  • 21 - month program with ~20 graduates per year
    • Students from all over the U.S.
  • Graduates receive ~8 – 10 job interviews and ~4 – 5 job offers
  • Average starting wage for 2020 graduates: ~$62k

• IHCC understands the national demand for Laser & Optics (photonics) technicians & seeks to increase the supply across the U.S.
IHCC’s Lasers & Optics Technology (L.O.T.) program’s five year rolling average for starting salaries. Trendline starts at ~$50k and ends at ~$60k giving an approximate salary increase of ~20%. The 2020 salary range was $52k - $70k. The education investment is ~$30k. Invest $30k, ROI $60k. The U.S. needs photonics technicians, bunches of them.
• 2018: The National Science Foundation Advanced Technology Education grant for the project *Developing Photonics Education in Iowa’s Rural High Schools* was awarded to IHCC (2018 –2022).

• A four-year mission to bring educational programming in the high-growth, high-demand field of photonics to a population rarely afforded such opportunities: rural Iowa high school students and teachers.

• Goal #1: Our *primary goal* is to increase the number of rural Iowa high school students in the photonics technician pipeline.
  • Develop relationships with rural Iowa secondary schools and homeschool groups to build sustainability.
• IHCC’s Photonics Fundamentals course, LEO102.
  • 3 – credit course, with lecture and hands-on labs
    • Labs are emphasized
  • This is the foundation for the High School Photonics Fundamentals dual credit, hybrid course which is the focus of this presentation.
  • This course may be used in community colleges and high schools
    • It may also be adapted to middle schools.
Photonics (lasers & optics)
- The study of laser light and how it reacts with and influences materials both organic (e.g. humans) and inorganic (e.g. metals).

Photonics Techs
- Build, test, maintain, repair lasers, optical and fiber optic equipment, application system install and test plus the utilization of spectrometers, interferometers, or related equipment.

Demand for photonics technicians.
- Currently the supply is ~20% of the demand.
Laser & Optics Technicians


Source: Grand View Research
Laser & Optics Technicians

• IHCC’s LOT’s have been hired by over 140 companies in more than 40 states and 2 countries
  • In these sectors and their related areas but not limited to
    • Manufacturing
      • Materials Process/3D Printing
    • Military
      • Aerospace/Drones
    • Medical
      • Bio-Sciences
    • Research & Development
      • Nanotechnology
    • Communication/Entertainment
      • Fiber Optics
Photonics Fundamentals Curriculum Outline:
(Text: *Fundamentals of Light & Lasers*)
- **Six Modules**
  - 1. Nature & Properties of Light
    - Define the nature and properties of light
    - Describe the dual nature of light to include scatter, transmission, absorption, reflection, and refraction
  - 2. Optical Components
    - Identify optical materials, properties, coatings and surface quality
    - Describe use of opto-mechanical components
  - 3. Light Sources & Laser Safety
    - Classify light sources
    - Understand the importance of laser safety
Photonics Fundamentals Curriculum Outline continued
(Text: *Fundamentals of Light & Lasers*)

- **4. Geometrical (ray) Optics**
  - Comprehend the laws of reflection and refraction
  - Recognize image formation with mirrors and lenses

- **5. Physical (wave) Optics**
  - Explain light waves and physical optics
  - Distinguish between interference, diffraction, & polarization

- **6. Basic Principles of Lasers**
  - Describe how laser light is generated
  - Identify laser types and beam modes
Pathway to Careers

Course Materials
Textbook, booklets and pamphlets for your reading pleasure.

- The above and more at
- Please feel free to contact me for any assistance you may need/want.
- The course is developed and ready for you to adapt.
Course Materials

A list of components & equipment, vendors and approximate cost is available.

Photonics Lab Kit With Instruction Booklet

Kit Dimensions:
L 25.75” x W 15.75” x H 9.0”, Weight 35 lbs.
Course Materials

- Optical Breadboard/Plate & 45.7mm (18’’) Stainless Steel Ruler
- 2 - large & 2 - small storage boxes
- Photometer Detector with Thumb Screw & Cord placement
- Lens Cleaning Wipes & Tissues
Course Materials

Location of components in Small Storage Box #1

- 2 - Prism, Right Angle
- Prism, Equilateral
- Bi-Concave Lens Ø25.4mm f = -25mm
- Bi-Convex Lens Ø25.4mm f = 200.0mm
Course Materials

Location of components in Small Storage Box #2

- Mounted 50 μm Precision Pinhole
- Polarizer, Acrylic, green, 25mm diameter
- Microscope Slide
- 2 - Lens Mount, Fixed
- Razor blade
- 2 - Laser Diodes with cords neatly wrapped
Location of components in Large Storage Box #2

2 - Right-Angle Clamp/Post Holder

7 - Posts, 2 piece

6 - Post Holders

2 - Filter Holder, Dual

Mounted Single Slit, 100µm Mounted Slit

Block, Acrylic

Wave Plate, Multiple Order, ¼ Wave

2 - Base, Mounting
Course Materials

Location of components in Large Storage Box #1

- V-Clamp, Cylindrical Laser Mount, with Clamping Arm (packed separately)
- 2 - Kinematic Mirror Mount with mirror
- 7-piece, Hex Key (Allen wrench) Set
- LED Inspection Flashlight
- 5 - each Socket Head & Set Screws
- 5 - index cards & protractor
- 2 - Polarizers, slide mount
- Filter Set, Color (RGB, CYM)
- 1000 lines/mm Diffraction Grating
- Rotation Mount & Rotation Stage
Course Materials

- Placement with storage boxes removed
- All Equipment Documentation
- 2 - A/C Cords for Power Supplies
- Photometer, Digital, Low Power
- Photometer Detector with Thumb Screw & Cord
- Translation Stage, Single Axis
- Spectroscope
- Base with Rod for Optical Detector
- 2 - Laser Diode Power Supplies (bottom to bottom) with cords neatly wrapped
Course Materials

Photonics Lab Instructions
Course Pedagogy

Photonics *Fundamentals* Course and Lab development

- Hybrid
  - **Online** (virtual) and included in each of the six course modules
    - Introductory videos and instructions
    - Module presentations with audio and transcripts
    - Lab Instructions with 2 – demonstration videos each
    - Module Study Guide Assignments
    - Test (mostly multiple choice)
      - Students may use all module information
      - Each Module Test has a time limit
Course Pedagogy

Photonics *Fundamentals* Course and Lab development

- Hybrid (continued)
  - **Live** (face-to-face)
    - Photonics Kits are given to the high schools for student use during the course
  - Rural Iowa High Schools
    - Weekly/Monthly visits
    - Speak with High School counsellor, students and facilitator (teacher, etc.)
COVID Course Pedagogy  
Teaching is always an adventure

Effects of and coping with COVID
• The high schools shut down and went virtual
  • This course was already online so was semi-virtual
  • Designed more “face-to-face” Blackboard Collaborate sessions.
• Unable to do live visits
  • Students could not access the lab kits as they were secured at their high school.
  • Sometime ago, I had developed an online “non-hands on lab” photonics course.
  • Resurrected that method for labs (sort of an early “interactive method”)
    • Took each lab video (2 – per lab) and watched them closely to develop questions that could only be answered when the video was viewed.
    • Created ~10 questions per lab to establish a basis for their lab write-up.
      • Lab Instructions were massaged to fit “virtual lab” lab write-up
      • Students thought this was a good alternative but liked the “hands-on” better.
Results, Ongoing & Future

Pathway to Careers

Albia High School

Centerville High School

Davis County High School

Hybrid (online & hands-on) High School Photonics Training

Davis County High School

Ottumwa High School

North Mahaska High School
Three year NSF project

**Sep 2018 – Aug 2019, Year 1:**
- Prepare for 2019 – 2020 school year.
- Contacted and presented project at 8 – area high schools.
- 4 – participated for Fall 2019

**Sep 2019 – Aug 2020, Year 2 results:**
- 17 – students (sophomores, juniors & seniors)
- 9 – completers
  - COVID pedagogy put into place March 2020
- 1 – registered for IHCC Fall 2020
- Early 2020: Contacted 21 - IHCC area high schools
Three year NSF project

• **Sep 2019 – Aug 2020, Year 2 results** (continued)
  • *Then COVID happened*
    • 2020’s summer events for teacher professional development cancelled
      • 4 – day Photonics Institute
      • 2 – day Photonics Symposium
    • Unable to contact and present at all high schools
    • Continued communicating with little or no response
      • Conducted two area wide ZOOM outreach meetings
        • Difficult for them to make decisions when not knowing what is on the horizon
    • 2 - high school did respond with 3 - students registering
      • IHCC’s High School Programs Office anticipated more will register
        • Unfortunately, that did not happen
Results, Ongoing & Future

- **Sep 2020 – Aug 2021, Year 3 results and ongoing:**
  - 3 – students (juniors & seniors)
  - 1 – completer (junior)
    - Reportedly registering for Fall 2022
  - Submitted a supplemental grant proposal for 1 - year extension: NSF accepted
    - COVID eliminated the effectiveness of meeting the objectives
  - Early 2021: Contacted (continuing to do so) for Fall 2021
    - 39 – Great Prairie Area Education Association (GPAEA) of Iowa high schools
    - Also contacted 8 – greater Des Moines area high schools
      - Requested expansion rights: NSF allowed.
  - GPAEA highs schools did not permit career days
  - Combined Photonics Fundamentals I & II (LEO103 & 104) to equal IHCC’s LEO102
    - Offering Photonics Fundamentals LEO 102 in Fall 2021 and Spring 2022.
    - Scheduled 1 – Photonics Symposium and 1 – Photonics Institute summer 2021
      - Will expand to 2 – of each if registration demands
Results, Ongoing & Future

• Sep 2021 – May 2022, Year 4:
  • UREKA!
    • Spring 2022 School Year
    • 1 – high school has dedicated 1 – class period and 1 – teacher/facilitator for LEO102
    • 18 – students registered for this and 2 - other IHCC dual credit courses.
    • Therefore it is assumed (hoped) the majority of these students will register for IHCC’s Laser & Optics program.
Summary

• Indian Hills Community College in Ottumwa, a small city in rural Iowa, has a premiere Laser & Optics Technology program.
  • Those that want a job, get a job.
• The National Science Foundation granted funds to IHCC to develop and conduct a Photonics (lasers & optics) Fundamentals dual credit High School course.
  • The demand for these technicians is 5 times the supply.
• To date there have been 20 - students registered with 10 - completers (2 - have registered for IHCC).
  • 18 - have registered for the upcoming 2021 - 2022 school year!
• What with COVID19 happening in the middle of this grant’s lifetime, the outlook is good for sustainability.
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Thank you for your attention.

Please email me your questions/comments or feel free to give me a call.

Frank Reed
frank.reed@indianhills.edu
Mobile: 641.777.3538 (best)
Office: 641.683.5111, ext 1743
Toll Free: 800.726.2585 ext 1743