



LEARNING OPTICS AND ELECTRODYNAMICS AS PART OF THE BACHELOR OF INFORMATION TECHNOLOGY SECURITY CURRICULUM

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INTRODUCTION

The Bachelor program in Information Technology Security was created in 2011, and it was one of the first programs in the Northeast of Mexico to offer professional formation in this field. The program is offered by the Physics and Math School (Facultad de Ciencias Físico Matemáticas - FCFM) of the Universidad Autónoma de Nuevo León (UANL).

A survey applied to graduates, employers, and experts mentioned that the technical skills of the graduates of this academic program were good. Still, some needed more problem-solving and critical thinking ability, and they needed to prepare for the evolution of technology, or the paradigm changes generated by the Fourth Industrial Revolution.

This work presents the curricular update of the Bachelor program in Information Technology Security of 2019, where a subject related to Electrodynamics and Optics was introduced. It presents the topics covered and academic activities, showing the first outcomes of this change.

METHODOLOGY

The first academic program of the Bachelor of Information Technology Security does not include any subject related to Physics, Optics, or similar fields; it only includes subjects related to Math, Programming, Telecommunications, and Cybersecurity.

For the update of the academic program, two new subjects related to Physics were included:

- **Introductory Physics.** It covers Mechanics and general introduction vectors, and physics magnitudes are covered. This subject focuses on solving problems and developing critical thinking.
- **Transmission Signals.** It is the subsequent subject to Introductory Physics, and it is a requirement to approve it for taking the subsequent classes related to Telecommunications. This subject aims to understand the electromagnetic spectrum and waves, including Optics fundamentals, how the signals associated with Information Technology are processed, stored, and transmitted, and the security challenges and related solutions.

The topics covered on this subject include:

- Electromagnetism
- Waves
- Optics
- Communication systems
- Transmission of signals on guided mediums
- Antennas and wireless transmission
- Data processing in a Physical layer
- Cybersecurity over a physical layer

During the semester, the students coursing the Transmission Signals perform the next academic activities:

- Solution of physics problems related to Electromagnetism and Optics
- Essays about storage and transmission technologies
- Research project about the physical fundamentals of emerging technologies related to the storage or transmission of information, including an analysis of the security vulnerabilities associated with it.

Figure 1. Curricula of the academic program in 2019 (top) and 2022 (bottom). It can be observed that the subject of Transmission Signals is conserved, and Introductory Physics changed to Rotational and Translational Mechanics.

RESULTS

Even today there is no graduate student from the program, it has been found some interesting results about the implementation of this new subject:

- As seen in Figure 2, the average grade increased by 4.2 points on a scale of 100, and the standard deviation decreased by 1.43 on a scale of 100.
- On average, it takes them fewer opportunities to pass the subject. The courses in this study are four telecommunications courses, including laboratory courses where students practice with physical components.
- The final projects of this course are an opportunity for the students to explore new technology from a physics and IT perspective.
- They present interest in topics such as Bluetooth, Wi-Fi, 5G communications, fiber optic, and vulnerabilities in the physical layer.
- The projects demonstrate how Physics and IT can collaborate to create innovative solutions for various challenges and domains.

Telecom subjects. Without knowledge of electromagnetism		Telecom subjects. With knowledge of electromagnetism	
80.24 Points on average		84.44 Points on average	
Standard deviation	Took	Standard deviation	Took
17.30 Points	1.18 opportunities to pass a subject	15.87 Points	1.12 opportunities to pass a subject

Figure 2. The students show better results in telecommunications when studying electromagnetism topics, including optics. In the degree, students have six opportunities to pass a subject; on average, it takes fewer opportunities to pass a telecommunications subject.

CONCLUSIONS

- Students who include optics and physics in their training can better understand the concepts of modulation, line coding, and signaling concepts that apply to this OSI model layer. They can delve into the rest of the layers of the communication model and understand how the virtual links between the nodes are established.
- Some students have taken a particular interest in vulnerabilities in the physical layer and have created clubs to investigate the hardware used in this layer.
- Students who have taken physics subjects have performed better in telecommunications-related subjects.
- According to our results, these students have obtained higher scores and have failed fewer times than those who have yet to take physics.
- Students understand optical phenomena that will serve them in new technological challenges.

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