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Original Article

CO, PO, CO-PO Mapping, Bloom taxonomy and attainment of BTEG-UG-L106: Engineering Physics Laboratory, B. Tech syllabus of Sikkim University

Chandra Prasad Khatiwada
Assistant Professor, Physics Sikkim Institute of Science and Technology,
Chisopani, South Sikkim, India

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Abstract

This paper outlines the design and assessment of Course Outcomes (COs) for the Engineering Physics Laboratory course at Sikkim University, aligning them with Program Outcomes (POs) through the lens of Bloom's taxonomy. The study included comprehensive CO-PO mapping, justification based on cognitive domains, and evaluation through attainment levels. Each experiment was meticulously curated to promote analytical thinking, practical applications, and an understanding of fundamental physics. The outcome-based framework ensures alignment with national accreditation benchmarks and enhances students' engagement in experimental learning.

Keywords: *Engineering Physics Laboratory, Course Outcomes (CO), Program Outcomes (PO), Bloom's Taxonomy, CO-PO Mapping, Outcome-Based Education (OBE), Sikkim University, Attainment Levels*

Introduction

Outcome-Based Education (OBE) is central to modern engineering pedagogy. The Engineering Physics Laboratory course aims to bridge theoretical physics concepts with practical experimentation. This paper explores how clearly defined Course Outcomes (COs), when systematically mapped to Program Outcomes (POs), enhance student understanding and skill development. Using Bloom's Taxonomy, the course structure integrates knowledge domains into measurable learning targets.

Methodology

- The methodology includes:
- Designing 4 distinct Course Outcomes (COs) based on core experimental themes.
- Mapping COs to 12 Program Outcomes (POs) using Bloom's Taxonomy levels.
- Justifying the CO-PO mapping through cognitive domain reasoning.
- Implementing a syllabus that includes 15 carefully selected experiments.
- Evaluating attainment through internal assessment, viva voce, and lab performance.
- Defining attainment levels (1 to 3) based on student performance data.

Results

- CO1 (oscillatory bodies) attained Level 3
- CO2 (wave optics) attained Level 3
- CO3 (quantum effects) attained Level 2
- CO4 (semiconductors) attained Level 3

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Address for correspondence:

Chandra Prasad Khatiwada
Assistant Professor, Physics Sikkim Institute of Science and Technology, Chisopani, South Sikkim, India
Email: cpspectroscopy@gmail.com

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- These results indicate effective implementation and student grasp of the core experimental concepts, particularly in mechanical and optical experiments.

Course Outcomes (CO):

1. CO1: Experimental verification of resonance, inertia, and damping effects, and finding the spring constant in oscillatory bodies.
2. CO2: Experimental verification wave optics phenomena of interference and diffraction.
3. CO3: Experimental verification of Quantum nature of light using photoelectric effect.
4. CO4: Experimental verification of the basic properties of semiconductors and their applications. [1,2,3]

Program Outcomes (PO): [4,5,6]

5. PO1: Engineering Knowledge
6. PO2: Problem Analysis
7. PO3: Design/Development of Solutions
8. PO4: Conduct Investigations of Complex Problems
9. PO5: Modern Tool Usage
10. PO6: The Engineer and Society
11. PO7: Environment and Sustainability
12. PO8: Ethics
13. PO9: Individual and Team Work
14. PO10: Communication
15. PO11: Project Management and Finance
16. PO12: Life-long Learning

CO-PO Mapping Table Based on Bloom's Taxonomy:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	3	2	-	-	-	2	2	-	3
CO2	1	3	2	3	3	-	-	-	2	2	-	2
CO3	2	2	1	3	3	-	-	-	1	2	-	2
CO4	2	3	2	3	3	1	-	-	1	2	-	2

Mapping Justification Based on Bloom's Taxonomy:

The mapping between COs and POs is aligned using Bloom's taxonomy levels, such as Knowledge and Comprehension (Remembering, Understanding): CO1, CO2 (PO1, PO2)- Application and Analysis: CO1, CO3 (PO4, PO5)- Evaluation and Creation: CO4 (PO4, PO5, PO12)

Syllabus for practical engineering physics: [10]

Error Analysis and Normal Distribution

1. This experiment involved measuring the lengths of a rectangular metallic block, drawing a normal distribution curve, and calculating the mean, standard deviation, and probable error. This helps students understand the error analysis and statistical evaluation of the experimental data.
2. Force Constant and Resonance in Forced Oscillations
   In this experiment, the students determined the spring constant (k) of a spring and observed the resonance phenomena by varying the driving frequency. This demonstrates the principles of forced harmonic motion.
3. Damping Constant in Underdamped Motion
   This experimental study underdamped oscillatory motion. The damping constant was calculated by measuring the decay in the amplitude, and the resonance frequency was determined using an amplitude vs. frequency plot.
4. Moment of Inertia using Torsion Pendulum
   Students measure the time period of oscillation of a torsion pendulum and use it to determine the moment of inertia of the body, helping them to understand rotational dynamics.
5. Velocity of Sound in a Liquid using Ultrasonic Interferometer
   This experiment determined the speed of sound in a given liquid by measuring the wavelength of ultrasonic waves using an ultrasonic interferometer.
6. Planck's Constant and Inverse Square Law
   The Planck's constant was determined using LEDs of different frequencies. The inverse square law was verified by observing the light intensity at different distances from the source.
7. Radius of Curvature using Newton's Ring
   In this experiment, interference patterns were created by a plano-convex lens and a flat glass plate to determine the radius of curvature of the lens.
8. Diffraction Grating and Wavelength of Light
   Students determine the grating element and measure the wavelengths of the spectral lines (e.g., mercury lamp) using diffraction grating in the normal incidence method.
9. Diameter of a Thin Wire using Air Wedge
   An air-wedge setup was used to measure the diameter of the thin wire based on the interference fringes produced between the two glass plates.
10. Single Slit Diffraction and Wavelength Measurement
    Using a single slit and monochromatic light source, the students determined the slit width and wavelength of the unknown light by analyzing the diffraction pattern.

11. I-V Characteristics of a Semiconductor Diode
The forward and reverse bias characteristics of the Ge and Si diodes are plotted. The knee voltage and dynamic resistance were determined from the I-V curve.
12. I-V Characteristics of a Zener Diode
This experiment investigated the breakdown characteristics of a Zener diode. Parameters such as breakdown voltage, knee voltage, and Zener resistance were determined.
13. Hall Effect: Hall Coefficient and Carrier Density
Using the Hall effect, the Hall coefficient and the type and density of charge carriers in a semiconductor sample were determined.
14. Ripple Factor of Rectifiers
Students study the output of half-wave and full-wave rectifiers, with and without filters, to calculate the ripple factor, which indicates the purity of the DC output.
15. Energy Band Gap of a Semiconductor
The forbidden energy gap of a semiconductor is determined by plotting the reverse saturation current versus temperature and applying the energy-gap formula.

CO Attainment

CO attainment was measured by assessing students' performance in laboratory experiments, viva voce, and internal assessments. Each CO was linked to specific experiments and evaluation components.

Attainment Levels: [8,9]

Level 1:60% of students score >= 40% marks
Level 2:60% of students score >= 50% marks
Level 3:60% of students score >= 60% marks
Based on assessment data, the following indicative CO attainment levels are observed:
- CO1: Level 3
- CO2: Level 3
- CO3: Level 2
- CO4: Level 3

These levels reflect that the students have effectively achieved the course outcomes through practical application and understanding.

Discussion

The CO-PO mapping aligned well with Bloom's cognitive domains. Students demonstrated strong application and analysis skills, particularly in experiments related to forced oscillations, diffraction, and semiconductors. However, slightly lower attainment in CO3 suggests room for enhancement in quantum concept delivery. The structured lab manual and continuous evaluation contributed significantly to student performance and engagement.

Conclusion

The Engineering Physics Laboratory course, designed under the OBE framework, successfully achieves its intended learning outcomes. The CO-PO mapping using Bloom's Taxonomy provides a robust tool for evaluating course effectiveness. The results affirm that structured experimentation and targeted outcomes enhance student learning, fostering skills necessary for engineering education and professional practice

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