Delaware State University

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AAPT
PHYSICS EDUCATION

Experimental Projects for a Capstone Engineering Physics Course at Delaware State University

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The presentation discusses capstone experimental projects designed for senior students majoring in Engineering Physics at Delaware State University.

How to develop a full immersion experience in experimental Physics and Engineering under the conditions of low budget.

- **Related courses**
  - **Theoretical and Experimental Research (PHYS 418)**
  - **Introduction to Research (PHYS 451)**
- **Capstone experience for senior students majoring in**
  - **Engineering Physics**
  - **Physics**

Experiments Proposed

Electrical Engineering

Resonant circuit

Damping electrical oscillator

Diode rectification circuit

RC time constant

A-V characteristics of linear and nonlinear resistances
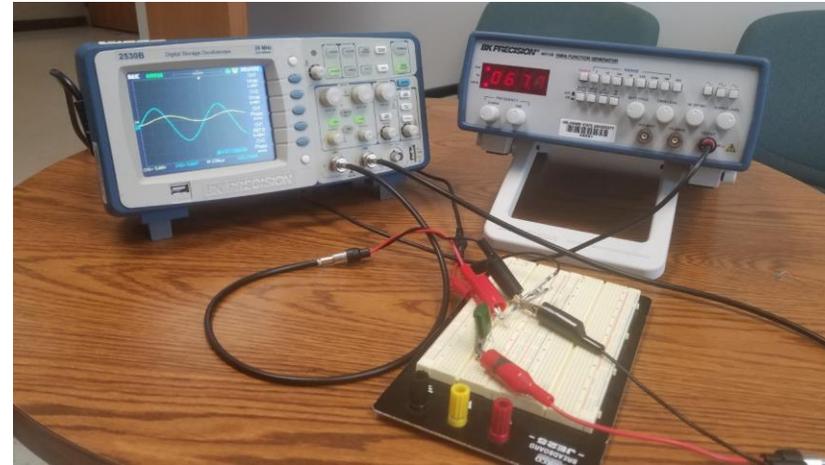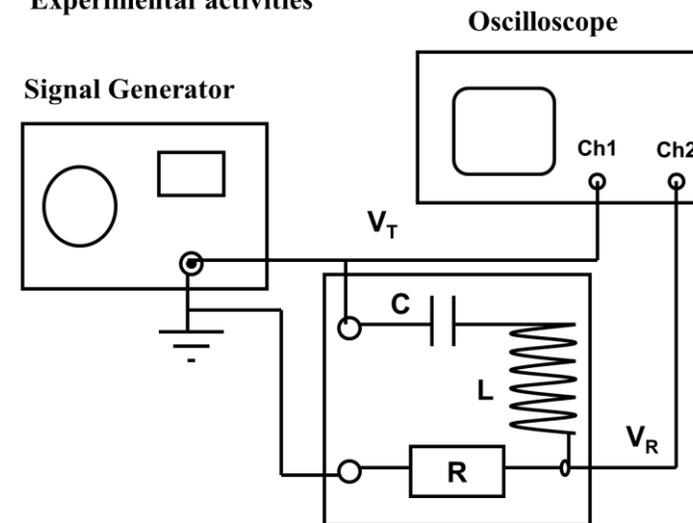
Modern Physics

Photoelectric effects and Planck constant.
Frank-Hertz experiment
Hydrogen spectrum and Bohr's model
Black body radiation spectrum
Miliken's experiment*
e/m determination*

* Under development
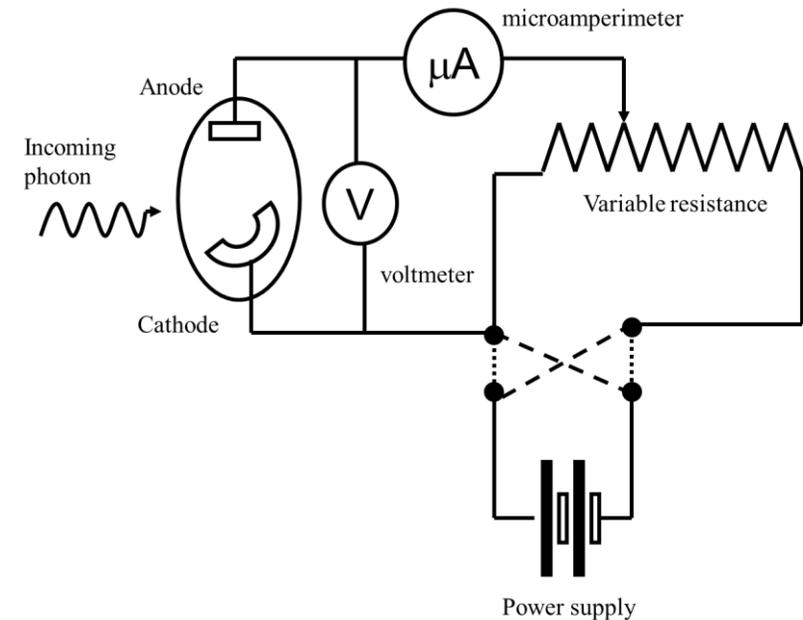
Optics and Spectroscopy

Characterizing a Gaussian beam
Absorption spectroscopy
Measuring radiance and irradiance
Spectra of light sources
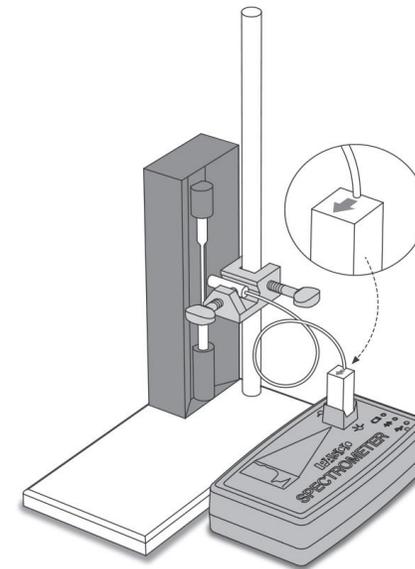
Acoustics

Modes of a tense string
Measuring the speed of sound
Resonances in an acoustic tube
Mersenne's laws
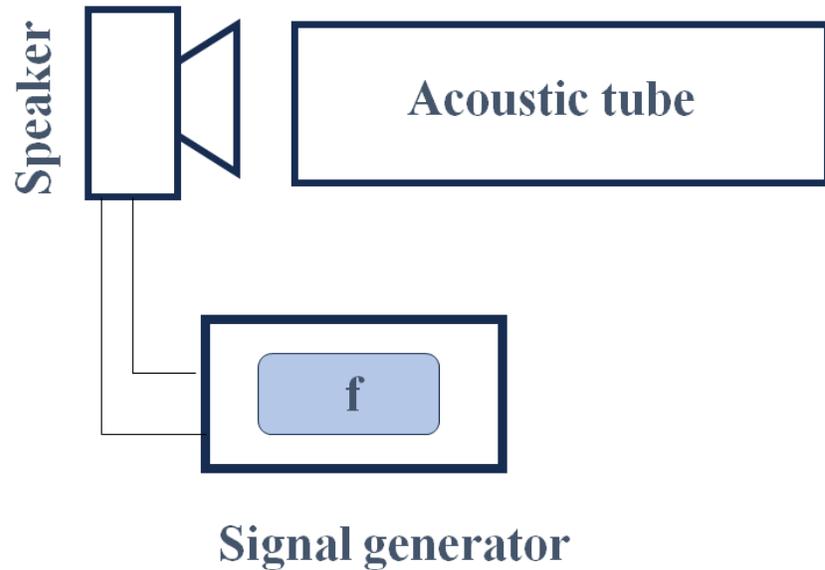
Renewable Energy Technology

Efficiency of a photovoltaic plate (PVP)
A-V characteristic of a PVP
Wind turbines power generation.
Electrolysis and fuel cell reactions.
PVP in series and parallel
Hydropower generator.
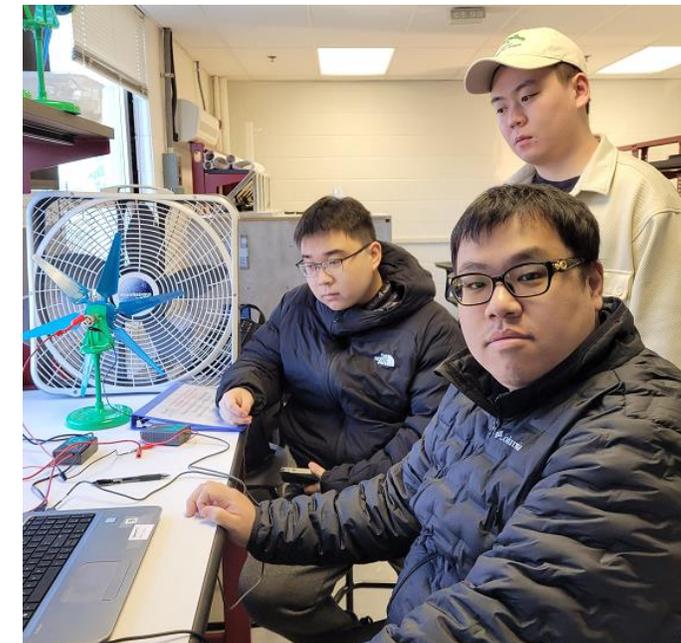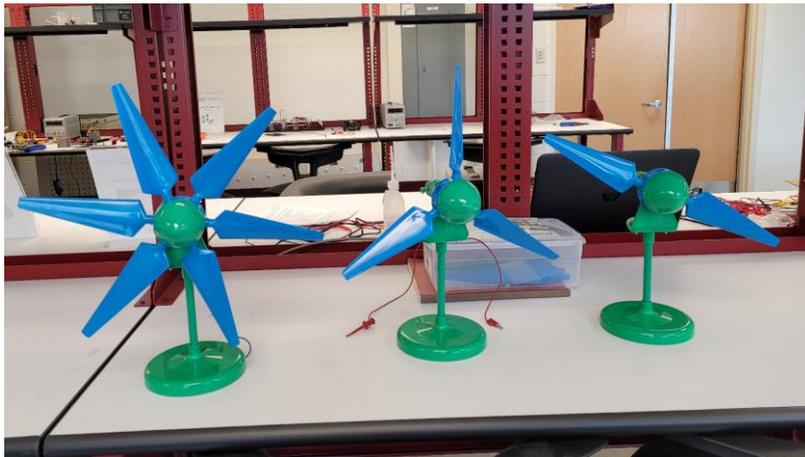
Thermodynamics

Specific heat of a solid
Peltier and Seeback's effects
First law of thermodynamics
Heat- Energy equivalence

Calorimeter
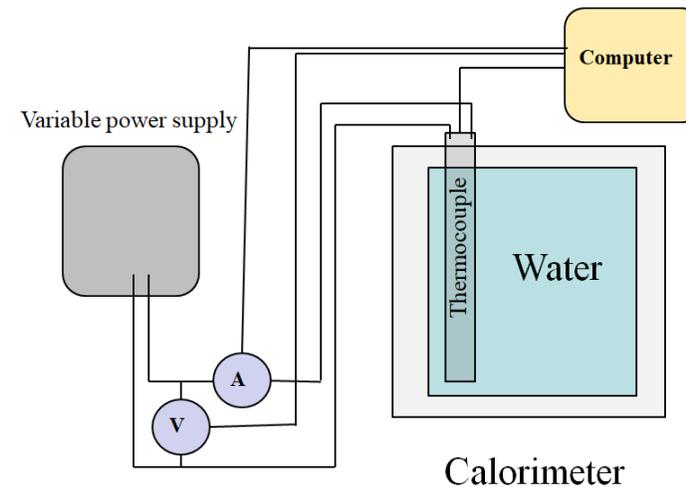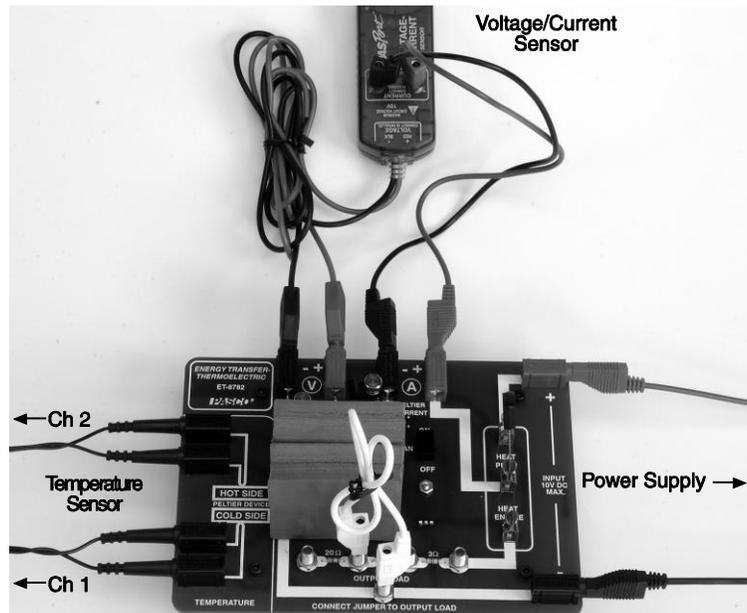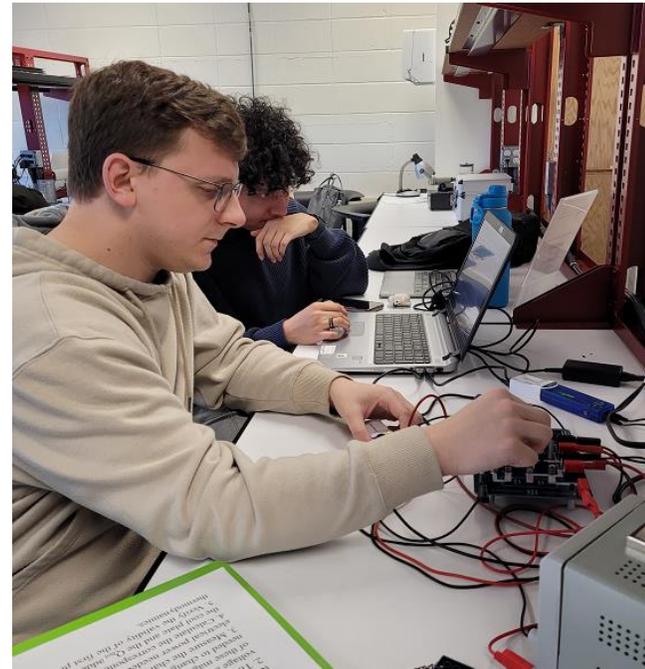
Written Reports

1. **Introduction (20 %)**

2. **Experimental method (20%)**

3. **Initial data (20%)**

4. **Analysis and discussion (30%)**

5. **Results and conclusions (10%)**

Arduino Technology

Arduino is an Italian open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.
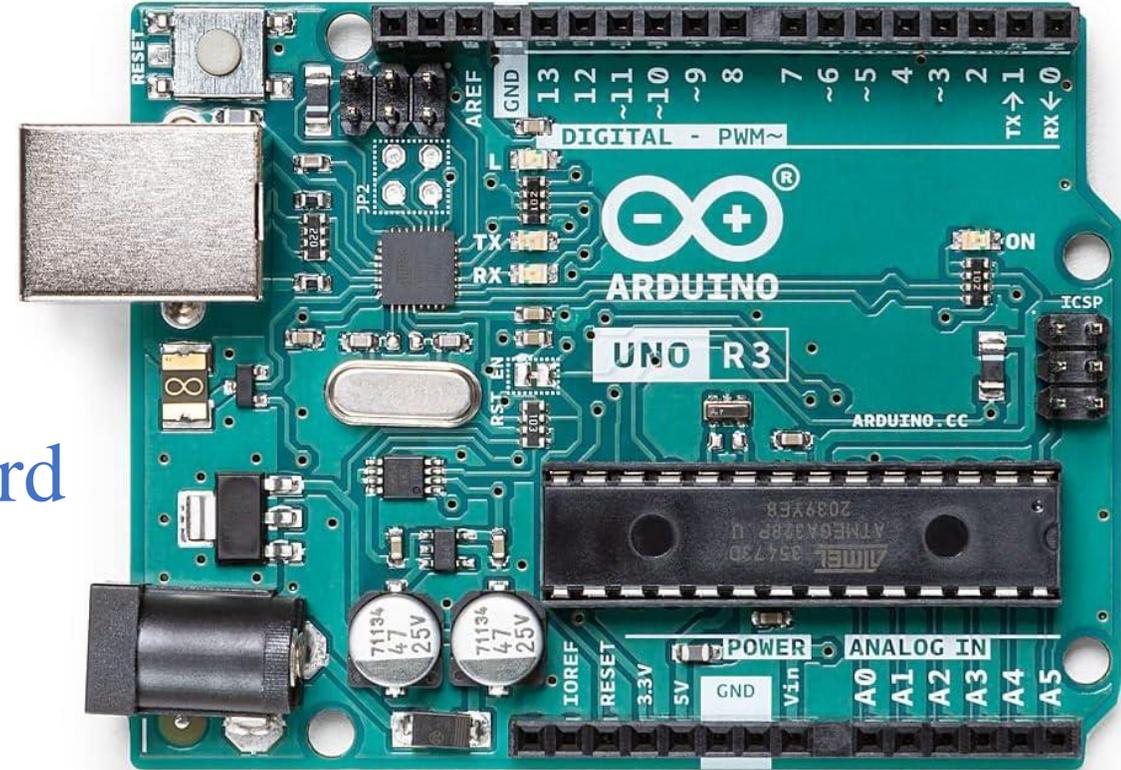
The Arduino projects include

Microcontroller technology

Programming

Service applications

Project 1: Switch Controlled LED

```
const int buttonPin=2;
const int ledPin=13;
int buttonState=0;

void setup(){
pinMode(ledPin, OUTPUT);
pinMode(buttonPin, INPUT);
}
void loop() {
buttonState= digitalRead(buttonPin);
if (buttonState ==HIGH {
digitalWrite(ledPin, HIGH);
}
else {
digitalWrite(ledPin,LOW);
}
}
```

Lectures

Introduction to Research

- **The purpose of science**
- **The importance of ethics in science**
- **Denying science**
- **Renewable energy revolution**
- **Pandemics**
- **Oral presentation basics**

Theoretical and Experimental Research

- **Scientific publications**
- **Principles of Mechanics**
- **Electromagnetism**
- **Quantum Mechanics**
- **Quantum Computing**
- **AI revolution**
- **Poster presentation basics**

Conclusions

We have developed a full immersive learning experience in Physics and Engineering for senior students majoring Engineering Physics and Delaware State University. Applying a similar approach starting at freshman years should represent a substantial impact in the quality of our graduates.

Acknowledgements