# Course Outline

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| **Course title: Digital Image Processing and Application** | **Instructor name: Jun Albert Pardillo** |
| **Credit units: 3** | **Total hours: 54** |

## Course Description:

Physics (I) is a foundational course designed for first-year mechanical engineering students. This course provides an introduction to the fundamental principles of physics and their applications in mechanical engineering. The course covers topics such as mechanics, thermodynamics, waves, and optics.  
  
Students will learn about the laws of motion, forces, energy, and momentum, and how they apply to mechanical systems. They will also study the behavior of gases, liquids, and solids, and the principles of heat transfer. The course will also cover the properties of waves, including sound and light, and their applications in engineering.  
  
Throughout the course, students will engage in hands-on activities and experiments to reinforce their understanding of the concepts covered. They will also develop problem-solving skills through the application of physics principles to real-world engineering problems.  
  
Upon completion of this course, students will have a solid foundation in physics and be able to apply their knowledge to the design and analysis of mechanical systems. They will also be prepared for further study in advanced physics courses and their applications in mechanical engineering.

## Course Learning Outcomes (CLOs)

* Understand the fundamental principles of digital image processing and their applications in engineering.
* Apply knowledge of physics, particularly in optics and waves, to the processing and analysis of digital images.
* Develop skills in using software tools for image processing and analysis.
* Analyze and solve real-world problems through the application of digital image processing techniques.
* Design and implement projects that utilize digital image processing to address engineering challenges.

## Topics / Modules and Intended Learning Outcomes

1. Introduction to Digital Image Processing

* Explain the basic concepts and principles behind digital image processing.
* Identify the components and architectures of digital image processing systems.

1. Image Enhancement in the Spatial Domain

* Implement techniques for image enhancement in spatial domain, including histogram equalization and spatial filtering.
* Evaluate the effectiveness of different image enhancement techniques on various types of images.

1. Image Enhancement in the Frequency Domain

* Describe the process of transforming images into the frequency domain using Fourier Transform.
* Apply frequency domain filters for image enhancement, including low-pass and high-pass filters.

1. Image Restoration and Reconstruction

* Understand the theoretical models of noise and degradation in images.
* Implement algorithms for image restoration and reconstruction to improve image quality.

1. Applications of Digital Image Processing

* Analyze the role of digital image processing in various fields such as medical imaging, satellite imaging, and facial recognition.
* Design and execute a project that applies digital image processing techniques to solve an engineering problem.

## Weekly Activities

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| **Week No.** | **Topic** | **Activity Description** | **Expected Output** | **Assessment Tools** |
| Week 1 | **Introduction to Digital Image Processing** | Lecture on the history and fundamentals of digital image processing. Introduction to basic concepts such as pixels, resolution, and color models. | Students will submit a summary report on the evolution of digital image processing and its impact on modern technology. | Written report assessment |
| Week 2 | **Image Enhancement in the Spatial Domain** | Hands-on lab session on image enhancement techniques using MATLAB or Python. Focus on histogram equalization and spatial filtering. | Students will enhance provided images using different techniques and compile their results and observations in a lab report. | Lab report with before and after images |
| Week 3-4 | **Image Enhancement in the Frequency Domain** | Lecture on the Fourier Transform and its application in image processing. Followed by a lab session on applying frequency domain filters for image enhancement. | Students will apply low-pass and high-pass filters on images and discuss the effects in a detailed report. | Report with images and analysis |
| Week 5-6 | **Image Restoration and Reconstruction** | Discussion on theoretical models of noise and degradation. Lab session on implementing algorithms for image restoration. | Students will restore a set of degraded images using different algorithms and compare the outcomes in a report. | Comparative analysis report |
| Week 7-18 | **Applications of Digital Image Processing** | Series of lectures and project-based learning on various applications of digital image processing. Students will propose and develop a project that solves an engineering problem using image processing techniques. | A completed project that demonstrates the application of digital image processing techniques to solve a real-world problem. Students will also present their projects. | Project presentation and final project report |

## References

*Gonzalez, R. C., & Woods, R. E. (2018). Digital Image Processing (4th ed.). Pearson.*  
Link:

*Milanfar, P. (2013). A tour of modern image filtering: New insights and methods, both practical and theoretical. IEEE Signal Processing Magazine, 30(1), 106-128.*  
Link:

*Szeliski, R. (2010). Computer Vision: Algorithms and Applications. Springer.*  
Link: