

# OPTI 421/521 – Introductory Optomechanical Engineering

## Homework 1

**1) Writing assignment.** I would like to learn about you, your background, and your goals. Please write about each of the following topics. **Please submit your write-up electronically.**

### Introduce yourself

A few sentences about who you are, where you are from.  
*Please include a picture of yourself.*

### Mechanics background

**Write a summary of your background in mechanics**

(1 or 2 paragraphs)

What courses have you taken that covered mechanics or mechanical engineering?

What topics did you cover?

What outside exposure have you had to mechanical engineering?

What about practical mechanics? (Using machine tools, fixing cars, ...)

### Technical writing experience

**What technical writing experience do you have?**

(1 or 2 paragraphs)

What courses have you taken that cover technical writing?

Have you worked where you needed to report your results?

Do you have other writing experiences?

### Professional goals

**What are your career plans, and why are you here?**

(1 or 2 paragraphs)

When do you expect to graduate, with what degree?

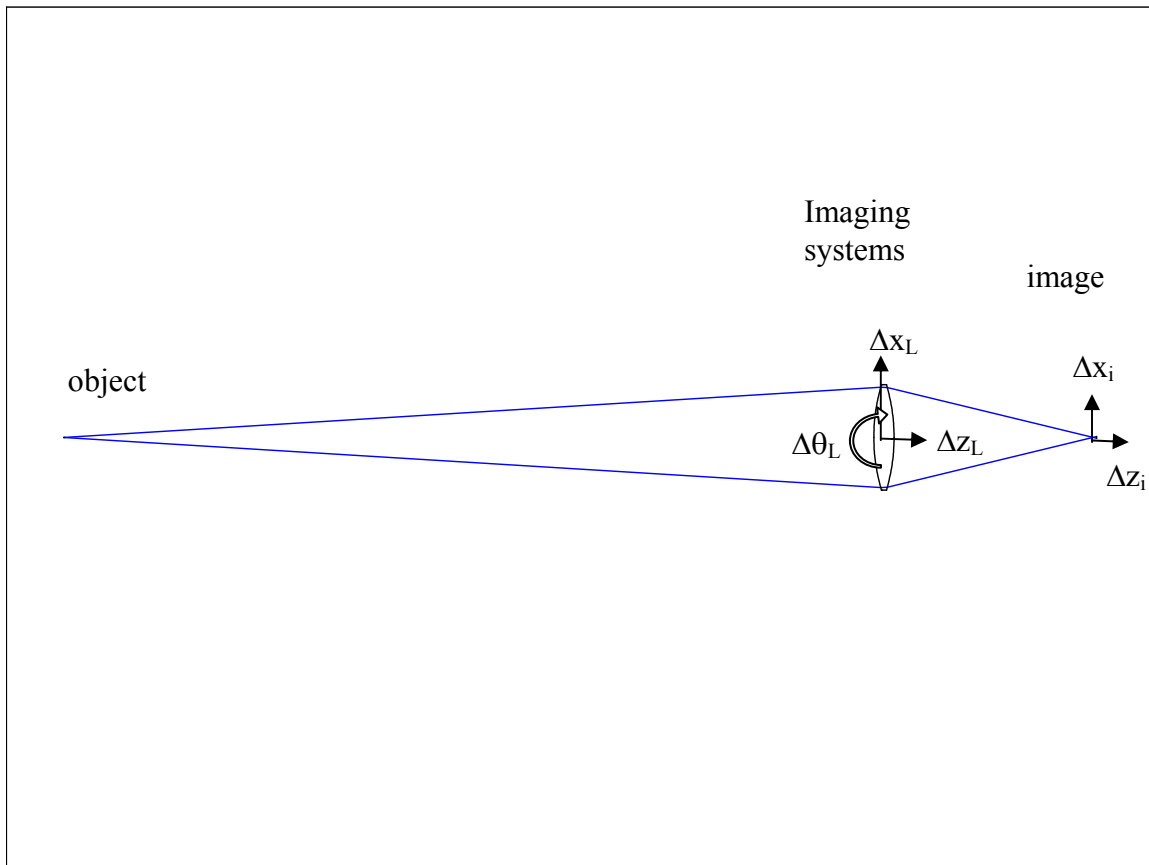
What type of job do you expect to pursue? (What would you avoid?)

What attributes and interests do you have that have led you to these goals?

**Part 2: Derivation, can be submitted on paper or electronically.**

**1. First order derivation: Lens motion**

- a) For the case of a thin lens, derive the relationships between image motion  $\Delta x_i$ ,  $\Delta z_i$  and lens motion  $\Delta x_L$ ,  $\Delta z_L$ ,  $\Delta\theta_L$  in terms of the system magnification  $m$ . Use your own sign convention, but be consistent!
- b) Prove that the image shift  $\Delta x_i$  calculated above for  $\Delta x_L$  is consistent with the general relationship :  $\Delta x_i \cong F_n D_i \Delta\theta_i$



**2. First order derivation: Mirror motion**

Repeat a) and b) for the case of an image formed by a single mirror with focal length  $f$ .

Does your solution make sense for a flat mirror? What about a convex mirror (negative focal length)?

**3. 521 students only (extra credit for 421 students)**

Review the paper on image motion. Apply the optical invariant to derive Eq. 10. Show how this changes for an afocal aystem

### Part 3. Rules of Thumb

Decisions are made by efficiently by applying “rules of thumb” to make quick approximations. Throughout your career, you should make sure to collect these and know how and when to use them.

As part of your homework assignments, you should review the relevant notes and find at least 3 useful rules of thumb from the last week. Report them in the following format:

<u>Name for Rule:</u> Small Angle Approximation
<u>The Rule of Thumb:</u> $\sin \theta \cong \theta$ where $\theta$ has units of radians
<u>When is this used?</u> This is used for small angles ( $< 0.2$ radians)
<u>Why is this useful?</u> Application of this approximation greatly simplifies analysis and calculation.
<u>Limitations:</u> The percent error in the approximation is roughly $\theta^2/6 \times 100\%$ so the approximation is valid to $< 1\%$ for angles $< 0.24$ radians ( $14^\circ$ ) and is valid to $0.01\%$ (100ppm) for angles $< 1.4^\circ$ .