

# The Evolution of OPTI513 Optical Testing Course at the Wyant College of Optical Sciences

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## ABSTRACT

Professor James C. Wyant allowed an international visiting student to audit his OPTI513 Optical Testing class in 2005 at the College of Optical Sciences, University of Arizona. The visiting student loved this class, left his graduate study in Astronomy, and joined the College of Optical Sciences in 2006. The student signed up for the optical testing class again, and eventually received his PhD degree in a graduation ceremony led by Dean Wyant in 2009. His name is Daewook Kim and he is now an associate professor in the Wyant College. In 2017, Prof. Wyant asked this graduate to teach OPTI513. He now teaches the course regularly to both on-campus and distance learning students. This is a story of Jim and one of his students who wants to thank him one more time.

**Keywords:** Wyant Tribute, Optical Testing, OPTI513, Education, Short Course, SC213, SC212

## 1. A PROFESSOR AND A VISITING STUDENT IN 2005

On the 16th of August in 2005, a professor and a visiting student were sitting in a classroom at the Harvill building on the University of Arizona campus (Figure 1). The professor began the first session of the semester.

*“Well, say good morning to everyone. Happy to see so many here. I guess that indicates you like classes at 8 am. Well, I like teaching at 8 am. Seven would be better, but eight is, eight is okay...”*

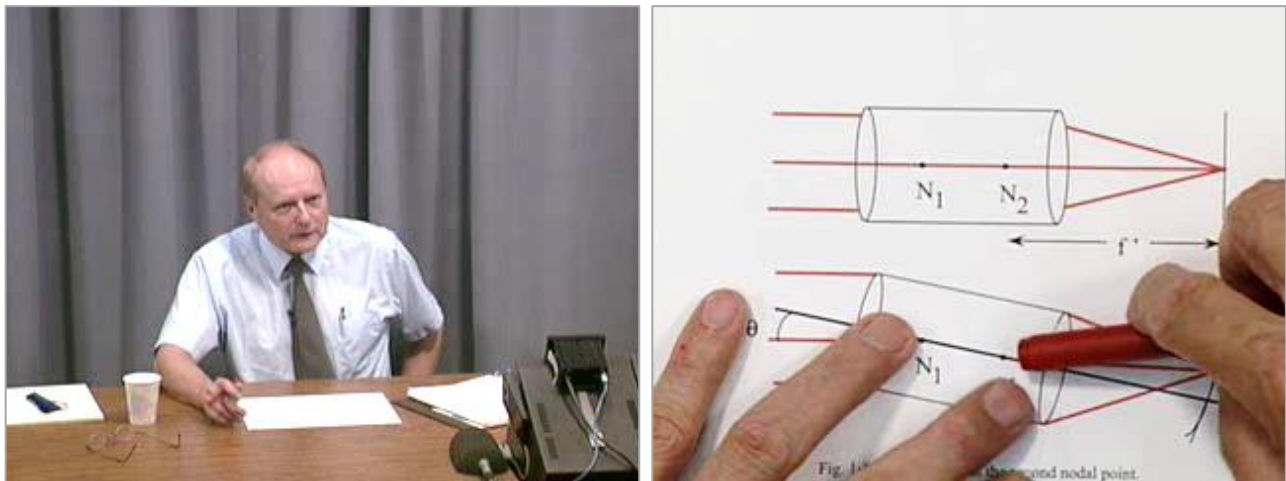


Figure 1. (Left) The first session of OPTI513 Optical Testing class by professor Wyant on 16 Aug 2005. Daewook, who was a master's degree student in the astronomy program at Yonsei University (South Korea), was auditing the class as a visiting student. (Right) The professor is explaining the concept of nodal point in order to explain the use of nodal slide to measure optical properties of a lens such as cardinal points and effective focal length.

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*“So, we're going to be talking about optical testing and I guess the official title of the course is optical testing, but I call it optical testing and testing instrumentation. I'm Jim Wyant in case you don't know. You can sometimes find me in Room 652, and what maybe is more important here is that my email address is given here, and that's probably the best way to contact me, and the website. My website is given here and all the notes for the course going to be up on the website. In fact, why don't we go right to the website and see what's there and then that will lead us into the notes. So that's my website. Just [www.optics.arizona](http://www.optics.arizona), that is the optical sciences website, and then /JCWyant.”*

This was Prof. James (a.k.a. Jim) C. Wyant’s opening remark for the OPTI513 Optical Testing class started at 8 am on 16 Aug 2005. I, Daewook Kim, was sitting in the classroom as a visiting student, who just got permission to audit the course for the semester. The classroom was located at the Harvill building at the University of Arizona campus because the west-wing expansion of the College of Optical Sciences was under construction and the Harvill building had video recording equipment for distance learning classes (Figure 2).

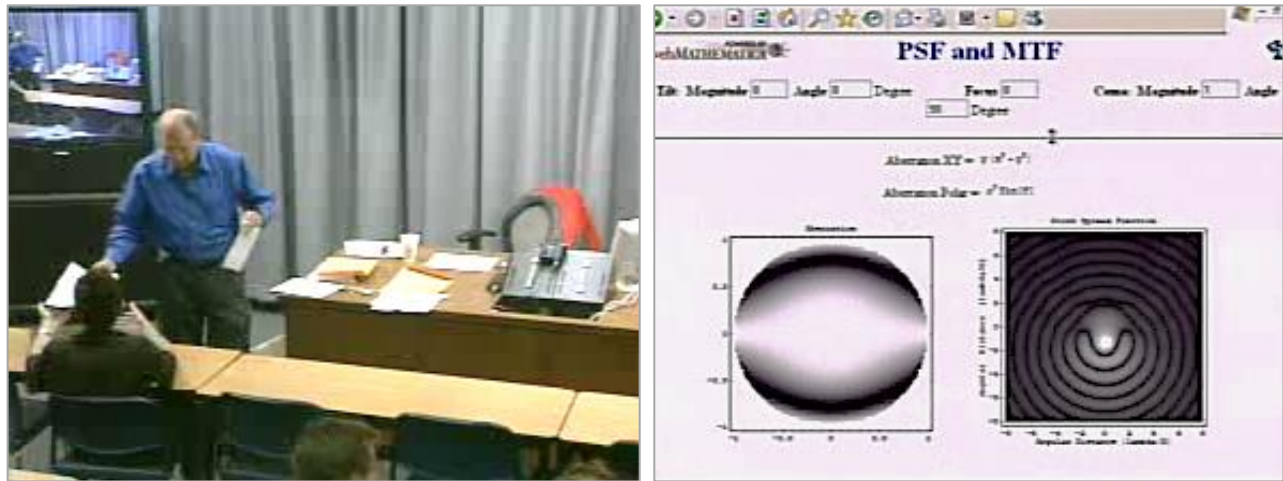


Figure 2. (Left) The last session of OPTI513 Optical Testing class by Prof. Wyant on 6 Dec 2005. Jim is handing over the class evaluation sheet to a student, apparently looks like Daewook Kim. (Right) Jim’s famous online simulation tool [1], based on Mathematica for calculating the Point Spread Function (PSF) and Modulation Transfer Function (MTF), was already being used during the class in 2005. This online simulator is still being utilized in OPTI513 course every year as of 2021.

It was an excellent course with a lot of advanced theories and exciting concepts, including interferometry and its practical applications. As an astronomy major master’s program student who never learned optics until then, this graduate-level optical metrology course was very challenging but also intriguing. On the last day of the semester, in love with optics, I was about to ask Prof. Wyant for a recommendation letter for my graduate program application to the College of Optical Sciences, which was renamed to the Wyant College of Optical Sciences in April 2019. As Jim was concluding the last lecture session he distributed the course evaluation forms to the class and talked about his upcoming conference trip to India to talk about optical testing.

*“So, while you are taking the final, you can think of me... in India, talking about optical testing. So, I will be around all day if you have questions today. With that I will shut the mic off.”*

I was running out of time to ask and receive a letter from him before his travels. Right after the class, I asked him if he would write a letter for my application. He kindly said “Yes,” although he was about to depart for a long international trip to the other side of the Earth, India. At the time, Jim and I never knew what the next 15 years would hold.

## 2. UNCONDITIONAL PASSING THE BATON IN 2017

Jim’s OPTI513 course covers a comprehensive list of topics regarding precision optical testing. It includes basic optical parameters of lens/mirrors, optical system properties, aberration theory, history of interferometric optical testing technologies, various testing configurations, and all the way to the modern freeform optical metrology solutions beyond interferometry. The course syllabus (Figure 3) was filled with an ever-growing list of various topics. Many hundreds of students including myself have been educated through this course.

I can confidently say that the course was one of the best and beloved courses at the Wyant College of Optical Sciences. It was often recommended to graduate students who were looking for optical engineering career by many of faculty members and colleagues at the College. Surely, Jim was the only one who could cover all the aspects of such a broad-yet-deep list of topics based on both actual experiences and profound insights. I could not think of anyone who could replace him, especially in his role teaching OPTI513.

<p style="text-align: right;">J. C. Wyant Fall, 2013</p> <h3 style="text-align: center;">Optics 513 - Optical Testing and Testing Instrumentation</h3> <p><b>Term:</b> Fall 2013</p> <p><b>Instructor:</b> James C. Wyant Meinel Building Rm 652 University of Arizona Tucson, AZ 85721</p> <p><b>E-Mail:</b> jcwyant@optics.arizona.edu</p> <p><b>Website:</b> www.optics.arizona.edu/jcwyant</p> <p><b>Office Hours:</b> Email for appointment</p> <p><b>Course Time:</b> Recorded Lectures to be viewed on student's computer on days given on class schedule</p> <p><b>Classroom for exams:</b> Meinel 305</p> <p><b>Prerequisites:</b> Optics 505</p> <p><b>Course Description:</b> Paraxial properties of optical systems, material qualification, ellipsometry, aberrations, basic interferometers, direct-phase measurement interferometry, measurement of surface quality, testing mirrors, windows, prisms, and corner cubes, measurement of index inhomogeneity, testing of spherical surfaces and lenses, aspheric testing, absolute measurements, and system evaluation.</p> <p><b>Learning Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Better specify optical components and systems</li> <li>• Produce higher-quality optical systems</li> <li>• Determine if an optics supplier can actually supply the optics you are ordering</li> <li>• Test optical components and systems</li> <li>• Evaluate optical system performance</li> <li>• Explain basic interferometry and interferometers for optical testing</li> </ul> <p>Attached you will find a tentative outline and schedule. You will be given a mid-term exam during the semester, plus a final exam. All exams will be in-class, closed book</p>	<p>exams. The homework will be due by 12:00 noon on the date stated on each assignment sheet and it should be handed in to Susan Nares in room 642. Unless special permission is given to hand in homework late, credit will be reduced 25% for each day a homework assignment is late. The final grade in the course will be calculated as follows: homework - 20%; mid-term exam - 30%; and final exam - 50%.</p> <p style="text-align: center;"><b>Academic Integrity</b></p> <p>According to the Arizona Code of Academic Integrity (<a href="http://deanofstudents.arizona.edu/aboutdeanofstudents">http://deanofstudents.arizona.edu/aboutdeanofstudents</a>), "Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student's submitted work must be the student's own." Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. CO-AUTHORED WORK OF ANY KIND IS UNACCEPTABLE. Misappropriation of exams before or after they are given will be considered academics misconduct.</p> <p>Misconduct of any kind will be prosecuted and may result in any or all of the following:</p> <ul style="list-style-type: none"> <li>* Reduction of grade</li> <li>* Failing grade</li> <li>* Referral to the Dean of Students for consideration of additional penalty, i.e. notation on a student's transcript re. academic integrity violation, etc.</li> </ul> <p style="text-align: center;"><b>Students with a Learning Disability</b></p> <p>If a student is registered with the Disability Resource Center, he/she must submit appropriate documentation to the instructor if he/she is requesting reasonable accommodations. (<a href="http://drc.arizona.edu/learn/test-accommodation.html">http://drc.arizona.edu/learn/test-accommodation.html</a>).</p> <p>The information contained in this syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.</p>
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Figure 3. The first two pages (out of 10) OPTI513 Optical Testing and Testing Instrumentation course syllabus by Prof. Wyant in Fall 2013.

In 2017, Jim asked me if I could teach the OPTI513 Optical Testing course. There was no way I could cover all the material and content taught by Jim. However, he trusted this young faculty member who audited his lecture 12 years earlier, and handed me all the lecture materials, homework problems, exam questions, and presentation slides. All the course materials were in great shape and up-to-date, including various emerging topics as of 2017. Jim passed the baton to continue the educational mission of the College to me with unconditional trust and support (Figure 4).



Figure 4. (Left) The first session of the OPTI513 Optical Testing course (in the Meinel building classroom 305) by Prof. Wyant on 21 Aug 2012. (Right) The session 21 of the OPTI513 Optical Testing course by Prof. Kim on 28 Mar 2019.

### 3. CONNECTED MINDS AROUND JIM IN 2019

In year 2019, I received an email from Prof. Singh inviting me to the ICOL conference in India.

*“Dear Professor Kim, I am happy to inform you that an ‘International Conference on Optics and Electro-Optics’ (ICOL-2019) is scheduled to be held at the Instruments Research and Development Establishment Dehradun (Uttarakhand, India) during the period Oct. 19-22, 2019... It is with great pleasure that I take this opportunity to invite you to deliver an Invited Lecture in ICOL-2019... Your name has been recommended to me by Professor J. Wyant, a Member of the International Advisory Committee of ICOL-2019... Kehar Singh, Formerly Professor and Dean Postgraduate Studies and Research IIT Delhi”*

It was the same conference that Prof. Wyant attended in 2005 and had talked about in his last session of the OPTI513 class. A fact I just realized, as I was watching Jim’s 2005 OPTI513 class videos in order to write this manuscript. Life is surprisingly connected with many unrecognized magical events.

The conference led me to a thankful opportunity to build a strong relationship not only with Prof. Singh, but also with Prof. Mahajan who was another invited lecturer at the conference. During the COVID-19 pandemic in 2021, Prof. Mahajan provided an invited lecture about optical wavefront analysis to the OPTI513 class. The course is continually evolving with all the connected beautiful minds centered around Jim. Prof. Wyant enables others by motivating, teaching, raising, and connecting them so they can commit to the education of future generations.

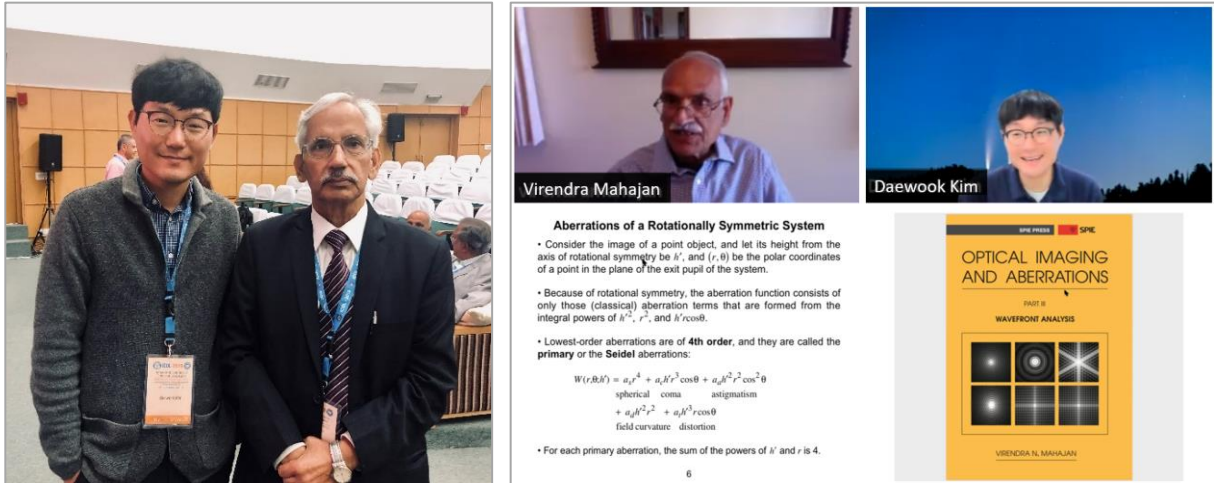


Figure 5. (Left) Daewook Kim and Prof. Singh, connected through Prof. Wyant’s recommendation, at the ICOL 2019 conference in India. (Right) Prof. Mahajan giving an invited lecture about the optical wavefront analysis [2] to the OPTI513 class in Apr 2021. Due to the COVID-19 pandemic, the lecture was given digitally using University of Arizona’s distance learning platform.

### 4. OPTICAL TESTING COURSE IN 2021 AND BEYOND

Jim always wanted to teach more students and professionals and share his knowledge with broader community members worldwide. A short version of OPTI513 course has been created and offered as the SPIE Short Course SC213, Introduction to Interferometric Optical Testing, at the annual SPIE Optics + Photonics conference in San Diego. Also, another Short Course SC212, Modern Optical Testing, has been presented at the SPIE Photonics West in San Francisco conference every year.

Professor Wyant taught the short courses until 2020. In 2021, he handed them over to me, along with all the course materials just like the OPTI513 course (Figure 6). In addition to the two short courses, Daewook is now discussing a third short course series with SPIE at the SPIE Astronomical Telescopes + Instrumentation conference. Jim’s passion and vision will continue to reach more students and peers in the world through his academic sons and daughters, including myself, in 2021 and beyond.



← Browse program

Course SC213

## Introduction to Interferometric Optical Testing

🕒 Sunday, 1 August 2021 • 1:30 PM - 5:30 PM PDT

Conv. Ctr. Room 16B (Mezzanene)

Level: Introductory Member: \$380.00 Non-member: \$445.00 Student member: \$208.00

Register for this course

📅 Add to My Schedule

This short course introduces the field of interferometric optical testing. Topics covered include basic interferometers for optical testing, and concepts of phase-shifting interferometry including error analysis. Long wavelength interferometry, testing of aspheric surfaces, measurement of surface microstructure, and the state-of-the-art of direct phase measurement interferometers are also discussed.

### Learning Outcomes

- explain the basic concepts of interferometric optical testing
- describe the power, capabilities, and limitations of phase-shifting interferometry
- describe techniques, advantages, and disadvantages of long-wavelength interferometry
- compare different aspheric testing techniques
- list capabilities and techniques for measuring surface microstructure
- describe the current state-of-the-art of direct phase measurement interferometers

### Audience

Engineers, scientists, and managers who need to understand the basic concepts of interferometric optical testing.

### Instructor

**Daewook Kim** - Wyant College of Optical Sciences (United States)

Daewook Kim is an assistant professor of optical sciences and astronomy at the University of Arizona. He has been working in the field of optical engineering for more than 15 years, mainly focusing on very large astronomical optics, such as the 25 m diameter Giant Magellan Telescope primary mirrors, and commercial freeform optics, such as Virtual Reality lenses. His research area spans precision freeform optics fabrication and various metrology options, such as interferometric test systems using computer generated holograms, direct curvature measurements, and dynamic deflectometry systems. He is the chair of SPIE's Optical Manufacturing and Testing conference, SPIE's Astronomical Optics: Design, Manufacture, and Test of Space and Ground Systems conference, and OSA's Optical Fabrication and Testing conference. He has published over 100 journal/conference papers, is a senior member of both SPIE and OSA, and has served as an associate editor of OSA's Optics Express journal.

### Textbooks

COURSE PRICE INCLUDES the *Field Guide to Interferometric Optical Testing* (SPIE Press, 2006) by Eric P. Goodman and James C. Wyant.

Figure 6. The SPIE Short Course SC213, Introduction to Interferometric Optical Testing, registration page for the 2021 SPIE Optics + Photonics conference in San Diego. It also shows the short course textbook authored by Eric Goodman and Jim Wyant [3].

## 5. THANK YOU, JIM

There are many ways to describe professor Wyant's contributions to our optics community. No words can be enough. Sometime, simple words may deliver more.

*"Thank you, Jim, from the bottom of our hearts."*

Optics community and your students will remember you, your lectures, and your smile forever.



Figure 7. Lunch gathering with Daewook Kim, James C. Wyant, Virendra N. Mahajan, and Arvind S. Marathay at the Student Union, University of Arizona, in 2019.

## REFERENCES

- [1] James C. Wyant, "Using webMathematica to Solve Optics Problems." <https://wp.optics.arizona.edu/jcwyant/mathematica/webmathematica/> (11 July 2021).
- [2] Virendra N. Mahajan, [Optical Imaging and Aberrations, Part III: Wavefront Analysis], SPIE Press (2013), PDF ISBN: 9780819491121, Print ISBN: 9780819491114
- [3] Eric P. Goodman and James C. Wyant, [Field Guide to Interferometric Optical Testing], SPIE Press (2006), ISBN: 9780819465108