Dual degree Master of Science in Optical Engineering
Rose-Hulman Institute of Technology, USA
Seoul National University of Science and Technology, Korea

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Introduction

This document describes the rules and regulations for the MS dual degree in Optical Engineering between the Rose-Hulman Institute of Science and Technology (RHIT), Terre Haute, Indiana and the Seoul National University of Science and Technology (SeoulTech), Seoul, Korea.

A rationale for the dual degree, together with a history of the collaboration between RHIT and SeoulTech, are given in the appendix.

Organisation of the Dual Degree

General
Each student passing the dual degree will obtain separate degrees from SeoulTech and Rose-Hulman. The general philosophy is that Rose-Hulman and SeoulTech will each award their MS degree according to their usual custom.

Issues that arise in the working of the dual degree will be resolved by the Coordinating Committee.

Coordinating Committee
This committee will consist of six members, three from SeoulTech and three from Rose-Hulman.

The three Rose-Hulman members will include two from the PHOE department and the Dean of Graduate studies or his nominee.

Thesis Committee
Each student is required to submit a thesis that is examined for competency by a thesis committee. This committee shall consist of two members from Rose-Hulman and two from SeoulTech.

Enrollment and Registration
Prerequisite for registration in the program is a successful bachelor degree with above average results. Rose-Hulman and SeoulTech, working through the Coordinating Committee, will agree upon the number
of places to be assigned by each institution prior to the application deadline. Qualification of the applicants is assessed by independent boards at each institution. Each board is responsible for the admission the students at their home university, applicant reviews by both university boards is not required.

Students must enter the dual degree program either through Rose-Hulman or through SeoulTech.

Rose-Hulman students, accepted for the Rose-Hulman MS in OE and who wish to take the dual degree must indicate their intention before the start of the Fall quarter.

English language requirements for Korean students entering the dual degree are greater than ...... in TOEFL or greater than ....... in the IELTS test. (TOEFL is the English language test developed and run by the Educational Testing Service. IELTS, International English Language Testing System, is developed and run by the British Council, University of Cambridge ESOL and IDP Education Pty in Australia. Essentially TOEFL is from the US and IELTS is from Britain.)

Duration of the Program
The program comprises 1.5 years and consists of two quarters at Rose-Hulman (Fall and Winter) and one semester at SeoulTech (Spring Semester) followed by two months of internship in Korea and six months dedicated to the Master thesis either in SeoulTech or Rose-Hulman.

Degree Requirements
24 credit hours of required course-work
22 credit hours of elective course-work
12 credit hours of thesis-work
Internship in Korea

Required Courses(1)
OE 520 Principles of Optics(2)
OE 570 Special Topics in Optics
OE 580 Lens Design and Aberrations
OE 592 Fourier Optics & Applications
OE 594 Guided-Wave Optics
OE 585 Electro Optics and Applications
OE 595 Optical Metrology

**Suggested elective courses at RHIT**

PH 405/505 Semiconductor Materials and Applications  
OE 535 Biomedical Optics  
EP 406 Semiconductor Devices and Fabrication  
PH 437/ECE 480 Introduction to Image Processing

**Suggested elective courses at Seoul Tech**

Bio MEMS  
Advanced Mathematics  
Semiconductor Manufacturing Processes  
Advanced Robotics

(1) RHIT students who already have credit for any of the required courses must take an elective course instead.  
(2) RHIT students that have already taken two of PH 292, OE 480, OE 450, and OE 295 are exempt.  
(3) Elective courses can be chosen from RHIT approved graduate courses with the agreement of the advisor.

**Grades and Credits**

The home university is the one through which the student entered the program; the foreign university is the other one. Credit obtained in the foreign university will transfer to the home university. Grades will not transfer.

**Credit Equivalency**

SeoulTech gives three credits for a three lecture hours a week, one semester course; a total of 45 hours. Rose-Hulman gives four credits for a ten week course of four lecture hours per week; a total of 40 hours. Thus we use the formula

\[ 3 \text{ Seoul credits} = 4 \text{ Rose-Hulman credits} \]

**Grading Equivalency for Accounting purposes**

Grades will not transfer between the universities but an ongoing grade point average is sometimes required. In these cases the grade equivalencies between SeoulTech's percentages and Rose-Hulman's letters will be calculated according to the following table:

<table>
<thead>
<tr>
<th>SeoulTech</th>
<th>100 - 90</th>
<th>89 - 85</th>
<th>84 - 80</th>
<th>79 - 75</th>
<th>74 - 70</th>
<th>69 - 65</th>
<th>64 - 60</th>
<th>&lt;60</th>
</tr>
</thead>
</table>

Dual MS degree in Optical Engineering; RHIT and SeoulTech  
(8th Feb 2012) p.5
Number of Credits required for Graduation
Students graduating with the dual degree will have a total of 58 credits (Rose-Hulman and Rose-Hulman equivalents).

Thesis
Thesis work can be done either in Rose-Hulman or SeoulTech.

A scholarly thesis is required that shall be reviewed by the thesis committee in accordance with the rules of the respective universities. All four members of the thesis committee must sign in order for the thesis to be accepted for the dual degree. Disputes can be referred to the Coordinating Committee. Rose-Hulman students who cannot gain four signatures may be considered for a Rose-Hulman MS and not a dual degree.

Thesis Committee
This committee will consist of four members, two from Rose-Hulman and two from SeoulTech.

Internship
The Internship is a period of at least two months working in a Korean engineering company. This experience will give the Rose-Hulman students a unique Asian experience and ready them to work in the Asian plants of US companies.

SeoulTech is responsible for placing the students in internship. SeoulTech has a long history of placing students, including non-Koreans, in engineering internships in Korea. It also has a technology park on campus among the companies of which students can be placed if there is nowhere else available.

The Internship carries no credit but is required in order to gain the dual degree.

In the unlikely event that an internship is unavailable, then the individual student’s case involved will be referred to the Coordinating Committee for a course of action.
Poor performance

Failing Required Courses taken in Rose-Hulman
Any student failing a course in Rose-Hulman can retake that course in Rose-Hulman or SeoulTech when it is next offered.

The laboratory content of a course can be passed even though the course overall is failed and no credit given. In this case the student will be able to retake the theory part of the course by a distance learning method and, in the event of passing, gain the credit for the course.

Failing Required Courses taken in SeoulTech
Any student failing a course in SeoulTech can retake that course in SeoulTech or Rose-Hulman when it is next offered.

Failing Elective Courses
Any student failing an elective course can retake it, or a substitute, whenever and wherever it is next offered.

GPA below 3.0
The GPA mentioned in this section is the equivalent GPA calculated for accounting purposes and mentioned earlier.

Students whose GPAs fall below 3.0 at the end of a grading period (term or semester) will be placed on academic probation. Academic probation of two grading periods will result in removal from the dual degree.

Students whose GPA falls below 3.0 will lose their Rose-Hulman TG.

Completion of the dual degree program requires an overall GPA greater or equal to 3.0.

Rose-Hulman students removed from the dual degree program may appeal for reinstatement into the Rose-Hulman MS OE program.

Ending the Program
Either RHIT or SeoulTech can refuse at any time to accept new students into the dual degree program.

RHIT and SeoulTech will continue to operate the program for students already enrolled until either the students graduate or three years pass since their initial enrolment.
Administration

Coordinating Committee
Academic questions and issues will be dealt with by the Coordinating Committee. This committee will have six members; three from SeoulTech and three from Rose-Hulman. The three Rose-Hulman members will include two from the PHOE department and the Dean of Graduate studies or his nominee.

Status of students in the Dual Degree program
Students in the dual degree program will receive the same consideration as students in the regular MS programs of Rose-Hulman or SeoulTech.

Housing
Students in the dual degree program are responsible for their own living expenses. But, recognizing the difficulties inherent in being a foreigner, both universities will endeavor to help visiting students obtain appropriate housing; preferably on campus.

Visas
Students in the dual degree program are responsible for obtaining the appropriate visa for Korea or the US. The two universities will help a visa seeking student by supplying the necessary invitations and documentation.

ITAR/EAR
ITAR/EAR is the acronym for International Transport in Arms Regulations/Export Areas Regulations, and its rules apply throughout the US. The PHOE department has experience in the application of ITAR through grants that have been funded by the defense department and the federal government. The appropriate protocols have been followed and there have been no difficulties.

Teaching laboratories at Rose-Hulman do not engage in activities subject to ITAR/EAR.

There are a very few projects in Rose-Hulman that do come under the ITAR/EAR regulations. Access to these projects for dual degree students will be dealt with on an individual basis following the ITAR guidelines and drawing on our considerable experience in this area.

Unexpected Problems
Unexpected problems will be dealt with by the Coordinating Committee.
Appendix A.

Rationale for the dual degree

Rose-Hulman is a leading engineering, science and math institution and recognizes the need for its graduates to be exposed to global experiences and multicultural exchange. The need for engineers with international and cross cultural experience grows as US manufacturers continue to build plants overseas.

The Physics and Optical Engineering (PHOE) MS degree at Rose-Hulman is in competition with similar degrees from large research universities. The Korean experience will give Rose-Hulman students in the PHOE MS program added cachet and opportunities in their future employment.

The PHOE department has a history of collaboration with SeoulTech and has experience of the excellent students it produces. The dual degree students from SeoulTech are expected to raise the quality of the present Rose-Hulman PHOE MS program.

History

The PHOE department has a long history of international collaboration in research and education through both graduate and undergraduate programs. Departmental collaboration with SeoulTech began in August 2008 when Dr. M. McInerney started a year’s sabbatical teaching in the SeoulTech UNN program. This contact was enabled by the then dean, Dr. A. Western, who had initiated an MOU with SeoulTech in the previous year.

Since Dr. McInerney’s return in August 2009 the department has hosted two summer schools for students from SeoulTech and affiliated universities. These schools occurred in 2010 and 2011 and will be given again in 2012. Students spend four weeks on campus studying English and taking our introductory MEMS course which includes a fabrication component. The students get Rose-Hulman credit for the MEMS course which is also part of the regular Rose-Hulman summer school.

Two Rose-Hulman students spent the spring 2011 semester at SeoulTech taking engineering courses taught in English. Credit for these courses was transferred back to Rose-Hulman.

Research collaboration between PHOE and SeoulTech is ongoing in which thin films produced at Seoul Tech are characterized in Rose-Hulman.

Initial Agreement to Pursue a Dual Degree

Following the success of the summer program a dual degree Master of Science in Optical Engineering was seen as an attractive proposition for both universities. This proposal was officially suggested during the June 2011 visit to Rose-Hulman by the President of SeoulTech, Mr. Jun-Hyong Roh. Mr. Roh agreed
with Dr. B. Kline, Acting Dean and VPAA who represented Rose-Hulman in the discussion, to pursue a dual degree program. Mr. Roh appointed Dr. Wonjong Joo as the coordinator on the SeoulTech side.

**SeoulTech**

SeoulTech is the short name for the Seoul National University of Science and Technology; it is situated in Nowon Gu in Seoul, Korea. It has an enrolment of 14,000 students and is funded by the Korean government. It has 32 departments and 6 graduate schools.

Dr. McInerney taught for one year as part of the UNN department within SeoulTech. UNN is a program between SeoulTech and Northumbria University in the UK. Under this program undergraduate students in Seoul take courses approved by Northumbria, taught in English, and end up with an engineering degree from Northumbria together with their own SeoulTech degree. This program began in March of 2001.

Dr. McInerney reports that the standard in SeoulTech is equivalent to the one in Rose-Hulman.

Students from SeoulTech have come to Rose-Hulman for the summers of 2010 and 2011 to do our 'Intro to MEMS' course which is part of the Rose summer school program. They did at least as well as the Rose-Hulman students who were enrolled in the course.

The Engineering schools at SeoulTech are accredited by the Accreditation Board for Engineering Education of Korea (ABEEK).
Appendix B

Program highlights

1) The intended start for the program is the 2012-13 academic year with five students each from Rose-Hulman and Seoul Tech.
2) Total length of the program will be 18 -24 months (five – six quarters plus a summer).
3) A group of Korean/American students will enroll and take courses at RHIT and Seoul Tech together.
4) Students will begin the program at RHIT for the fall and winter quarters where most the required courses ought to be completed. Students follow up at Seoul Tech for the spring semester where one required course and three elective courses. The language of instruction will be English.
5) Course contents (see Table 2). Students will complete 180 contact hours of course work and .... Hours of internship at Seoul Tech and 300 contact hours of course work at RHIT (see Table 1).
6) An internship in Korea is required and will be arranged by SeoulTech.
7) The program finishes with a final thesis. The duration of the thesis work is two quarters (approx. one semester). Each student will require four thesis advisors; two from each of Rose-Hulman and Seoul Tech. The thesis work and defense will be performed in either institution. The thesis is not related to the internship.
8) Tuition will be considered swapped; students sponsored by Rose-Hulman will not pay tuition at Seoul Tech and vice versa.
9) Living expenses, accommodations and air fares will be responsibility of the individual students.
10) The program will be supervised by a board of six faculty, three from each of Rose-Hulman and SeoulTech.
## Appendix C

### Table 1: Timetable

<table>
<thead>
<tr>
<th>Dates</th>
<th>At Rose-Hulman</th>
<th>At Seoul Tech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring semester/Summer (Mar-Jun)</td>
<td></td>
<td>Advanced Optics (only for Korean students)</td>
</tr>
<tr>
<td>Fall quarter (Sep-Nov)</td>
<td>OE580 Lens Design and Aberrations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OE592 Fourier Optics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OE595 Optical Metrology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OE520 Principles of Optics (only for US students)</td>
<td></td>
</tr>
<tr>
<td>Winter quarter (Dec-Feb)</td>
<td>OE585 Electro-Optics and Applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OE570 Special Topics in Optics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td></td>
</tr>
<tr>
<td>Spring semester (Mar-Jun)</td>
<td></td>
<td>OE594 Guided Wave Optics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elective</td>
</tr>
<tr>
<td>Summer (Jun-Aug)</td>
<td>Internship at Seoul Tech Industrial Park / Seoul industry</td>
<td></td>
</tr>
<tr>
<td>Fall/Winter quarters (Sep-Jan)</td>
<td>Thesis work &amp; defense</td>
<td></td>
</tr>
<tr>
<td>Total Course Credits</td>
<td>Course: 30 Cr;</td>
<td>Course: 16 Cr (RHIT equivalents);</td>
</tr>
<tr>
<td>Total Credits</td>
<td>Course and Thesis: 58 Cr;</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1a: Timetable

<table>
<thead>
<tr>
<th>Background</th>
<th>Preparation of SeoulTech Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/12</td>
</tr>
<tr>
<td></td>
<td>6/12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coursework</th>
<th>Fall Quarter (RHIT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9/12</td>
</tr>
<tr>
<td></td>
<td>Winter Quarter (RHIT)</td>
</tr>
<tr>
<td></td>
<td>11/12</td>
</tr>
<tr>
<td></td>
<td>Spring Semester (SeoulTech)</td>
</tr>
<tr>
<td></td>
<td>12/12</td>
</tr>
<tr>
<td></td>
<td>2/13</td>
</tr>
<tr>
<td></td>
<td>3/13</td>
</tr>
<tr>
<td></td>
<td>6/13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internship</th>
<th>Industrial Internship (SeoulTech)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6/13</td>
</tr>
<tr>
<td></td>
<td>8/13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thesis</th>
<th>Fall &amp; Winter quarters (SeoulTech or Rose-Hulman)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9/13</td>
</tr>
<tr>
<td></td>
<td>12/13</td>
</tr>
</tbody>
</table>
### Table 2: Course descriptions

<table>
<thead>
<tr>
<th>Required courses</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OE580 Lens Design and Aberrations</td>
<td>4 credits (40 hours of instruction) Chromatic and third order aberrations, exact ray tracing, ( y \ y ) bar diagrams as a design tool, methods for reducing aberrations in initial designs, optimization. Design of simple lens systems. Introduction to computer aided design, design of optical systems including camera lenses, mirror systems and catadioptric systems. Students must do additional project work on a topic selected by the instructor.</td>
</tr>
<tr>
<td>OE592 Fourier Optics</td>
<td>4 credits (40 hours of instruction), lab activities Two-dimensional linear systems; diffraction theory (Fresnel &amp; Fraunhofer); imaging properties of lenses; frequency analysis of optical imaging systems; spatial filtering; optical information processing; Vander-Lugt filters; wavefront reconstruction; holography; optical computing.</td>
</tr>
<tr>
<td>OE594 Guided Wave Optics</td>
<td>4 credits (40 hours of instruction), lab activities Theory of optical waveguides; waveguide modes; fabrication techniques; input and output coupling techniques; waveguide losses; waveguide gratings; electro-optic modulators; integrated optical detectors; applications of integrated optics.</td>
</tr>
<tr>
<td>OE570 Special Topics in Optics</td>
<td>2 credits (20 hours of instruction) Lectures on special topics in optics such as: optical materials, optics of thin films and infrared optics.</td>
</tr>
<tr>
<td>OE595 Optical Metrology</td>
<td>4 RHIT credits (40 hours of instruction), lab activities Optical testing: geometrical test methods (refractometers, knife edge, Ronchi, Wire, Hartmann); review of interference and coherence; fringe visibility; conventional interferometers (Newton, Fizeau, Twyman-Green and shearing); fringe localization; phase shifting, holographic, Moire, photoelastic and speckle interferometry; emerging optical methods. Students must do additional project work on a topic selected by the instructor.</td>
</tr>
<tr>
<td>OE585 Electro-Optics and Applications</td>
<td>4 RHIT credits (40 hours of instruction), lab activities Optical wave propagation in anisotropic media; normal surface, birefringence, index ellipsoid, optical activity, Faraday rotation, Pockels and Kerr effects, electro-optic modulators, electro-optic effect in liquid crystals, photorefractive effect, acousto-optic effect and modulators, second-harmonic generation, optical phase-conjugation and applications. Students must do additional project work on a topic selected by the instructor.</td>
</tr>
<tr>
<td>OE520 Principles of Optics</td>
<td>2 RHIT credits (20 hours of instruction) Classical optics; exact ray tracing; aberrations, interference, polarization, spatial and temporal coherence; lasers and Gaussian beam propagation; diffraction; optical sources and detectors; selected applications of optics.</td>
</tr>
<tr>
<td>Elective courses at SeoulTech</td>
<td>Description</td>
</tr>
<tr>
<td>Advanced Mathematics</td>
<td>3 SeoulTech credit (45 hours of instruction) This course introduces students to those advanced topics in applied mathematics most important for solving practical engineering problems as aligned with the undergraduate course of engineering mathematics.</td>
</tr>
</tbody>
</table>
Topics covered include: ordinary differential equation, series solutions of ordinary differential equation, Fourier analysis and partial differential equations, matrix theory and nonlinear systems. The course is appropriate for first year graduate students and is particularly suited as a preparatory course for graduate school.

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical systems Applications</td>
<td>3 SeoulTech credit (45 hours of instruction including Lab)</td>
<td>This course help student understand science and engineering knowledge and theories of optics. Students learn about properties of light and its mathematical model, optical components and their characteristics, geometric and wave optics which cover lens, mirror, interferometers, polarization, and diffraction. It also covers basics of Fourier optics and optical systems design.</td>
</tr>
<tr>
<td>BioMEMS</td>
<td>3 SeoulTech credit (45 hours of instruction including lab)</td>
<td>This course covers the basics of Bio-MEMS (biological microelectromechanical systems) which are applied to biological &amp; biomedical analysis and measurements. Various bio-chips such as DNA chip, protein chip and cell including lab-on-a-chip will be introduced and studied.</td>
</tr>
<tr>
<td>Semiconductor Manufacturing Processes</td>
<td>3 SeoulTech credit (45 hours of instruction including lab)</td>
<td>This course provides the students with an overview of semiconductor manufacturing process which is essential to fabricate semiconductor, display and MEMS devices. Starting with the understanding on vacuum and plasma, this course explains the principles and applications of each manufacturing process such as lithography, deposition and etching.</td>
</tr>
<tr>
<td>Advanced Robotics</td>
<td>3 SeoulTech credit (45 hours of instruction including lab)</td>
<td>This course covers analysis and control of the robot system. Main subject is dynamics equation using Lagrange formula, robot control algorithm, visual sensory system, and visual perception including image processing, image feature extraction, and geometric feature description. It also covers sensors and actuators for developing advanced robots.</td>
</tr>
</tbody>
</table>