CHESTER F. CARLSON CENTER

FOR IMAGING SCIENCE

UNDERGRADUATE STUDENT HANDBOOK

2014-2015 ACADEMIC YEAR

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1. Overview of the Chester F. Carlson Center for Imaging Science

The **Chester F. Carlson Center for Imaging Science** at RIT is a highly interdisciplinary university research and education center, dedicated to pushing the frontiers of imaging in all its forms and uses. Through education leading to BS, MS, and Ph.D. degrees in the interdisciplinary fields of imaging and via our affiliation with the graduate programs in Color Science and Astrophysical Science and Technology, we produce the next generation of educators and researchers who develop and deploy imaging systems to answer fundamental scientific questions, monitor and protect our environment, help keep our nation secure, and aid medical researchers in their quest to conquer disease.

As humans, we are highly geared to gather information, understand, process and document the world around us through imaging. Today's technology allows us to produce images of our world with unprecedented clarity. Through this technology, many things our eyes could never see—from images of earth from space to atoms and molecules at the smallest scale—are revealed with amazing resolution and detail. The images we form today use not only the visible light our eyes can see, but the full range of the electromagnetic spectrum (e.g., from gamma rays through infrared and on down to the lowest radio frequencies); while modern ultrasound and electron microscopic imaging techniques transcend the realm of electromagnetic waves.

The science of imaging encompasses a very wide range of subject areas, from the physics of light sources to the psychophysics of high-level visual perception. From how light is generated to how the world is perceived, imaging science addresses questions about every aspect of systems and techniques that are used to create, perceive, analyze, and optimize images. Application areas of imaging are equally diverse. Thus, imaging science is both interdisciplinary in its content and multi-disciplinary in its applications.

In the Carlson Center for Imaging Science and with our multidisciplinary colleagues both at RIT and in the greater community, we conduct research in and prepare students for challenging and rewarding careers in a range of imaging application areas.

- We develop imaging systems for and answer fundamental questions in **astrophysics** – probing the origin and evolution of planets, stars, galaxies, and the universe as a whole.
- We develop imaging systems for application in **biomedicine** – where imaging is used to non-invasively diagnose disease, to develop therapies and to track the success of treatment.
- We apply imaging to the reading and **reconstruction of ancient documents**, such as the Archimedes Palimpsest.
- We study the closely related field of **color science** and its application to display systems (CRTs, LCDs, printers), as well as restoration of works of art to the original palette used by the painter.
- We study **visual perception** – the way in which we as humans use our own imaging system—our eyes and the computer that is our brain—to perceive the world around us.
- We study **imaging algorithms**, data fusion and visualization, and imaging database design and development that allow full exploitation of imaging data.
- We study **remote sensing** - the use of satellite, airborne, or distributed sensor systems for purposes ranging from environmental science to national security.

- We study imaging on the smallest scales: **nano-imaging**, in concert with our multi-disciplinary colleagues in fields as diverse as nano-power, biophysics, and materials science, where their need to image is driving their research.
- We develop next generation **detector and sensor systems**.
- We develop deployable integrated **imaging systems for emergency response**, including wildlife fire-fighting.

We invite you to explore the world of imaging science with us, and join us in our obsession.

"TO SEE WITH A KEENER EYE HAS BEEN A HUMAN OBSESSION SINCE THE TIMES OF LEEUWENHOEK AND GALILEO, CONSIDERED FATHERS OF THE MICROSCOPE AND TELESCOPE, RESPECTIVELY. FOR CENTURIES KEENER VISION MEANT TO SEE MORE CLEARLY WHAT WAS FAR AWAY OR WHAT WAS VERY SMALL—TO MAGNIFY AND SHARPEN. BUT IN THE 20TH CENTURY IT ALSO CAME TO SIGNIFY ALL SORTS OF VISION THAT ONCE WOULD HAVE BEEN DEEMED 'MAGIC'—THE PENETRATION OF VEILS BOTH AROUND US AND WITHIN US AS WELL AS THE REGISTERING OF FORMS OF "LIGHT" TO WHICH HUMAN SIGHT IS UTTERLY BLIND." (HTTP://WWW.GREATACHIEVEMENTS.ORG/).

Our namesake, Chester F. Carlson

Chester F. Carlson, an American physicist and patent attorney, contributed to imaging science through his invention of electrophotography.

As a young patent engineer, Carlson was aware of the difficulty of getting carbon copies of patent documents and drawings. He decided to develop a device that could make a copy quickly. He investigated aspects of photoconductivity, experimented with various light-sensitive materials, and described the fundamental process of what he called “electrophotography”. In 1938, Carlson and his assistant were successful in replicating an image on a glass plate with an electrostatic charge.

Over the following years, Carlson received several basic patents that he used to market the idea to various corporations. Finally, Battelle Memorial Institute agreed to collaborate on development of the process. In 1946, Haloid Company of Rochester undertook commercial manufacture of the xerographic copier which reached the market in 1950. Haloid Company became Xerox Corporation in 1961.

> *“You are successful the moment you start moving toward a worthwhile goal.” Chester F. Carlson*

2. Program requirements

2.1. B.S. Imaging Science

The program requirements outlined below are specific to students admitted to the BS in imaging science in the 2014-2015 Academic Year. Students who entered the imaging science program prior to that year should refer to their Individual Advising Plan and consult with their academic adviser and faculty adviser regarding any questions about degree requirements.

2.1.1. Required Courses

General Education (Foundation)

http://www.rit.edu/programs/undergraduate-graduation-requirements#newgened

First-Year Seminar -OR- General Education Elective (until First-Year Seminar is established) (3 credits)
ACSC-010 - YearOne (0 credits)
CLA-UWRT-150 - FYW: Writing Seminar -OR- CLA-ENGL-150 - FYW: The Future of Writing -OR- GCCIS-ISTE-110 - FYW: Ethics of Computing (3 credits)

Subtotal
6 credits

General Education (Perspectives)

1. Liberal Arts & Sciences: Ethical (3 credits)
2. Liberal Arts & Sciences: Artistic (3 credits)
3. Liberal Arts & Sciences: Global (3 credits)
4. Liberal Arts & Sciences: Social (3 credits)
5. Natural Science Inquiry COS-PHYS-211 - University Physics I (4 credits)
6. Scientific Principles COS-PHYS-212 - University Physics II (4 credits)
7A. Mathematical: COS-MATH-181 - Project-Based Calculus I (4 credits)
7B. Mathematical: COS-MATH-182 - Project-Based Calculus II (4 credits)

Subtotal
28 credits

General Education (Immersion)

See this link: http://www.rit.edu/programs/immersions

Liberal Arts & Sciences (Immersion) (3 credits)
Liberal Arts & Sciences (Immersion) (3 credits)
Liberal Arts & Sciences (Immersion) (3 credits)

Subtotal
9 credits

General Education Program Requirements

General Education Elective (3 credits)
CIAS-SOFA-103 - Film/Video Materials & Technology (3 credits)
COS-IMGS-221 - Vision and Psychophysics (3 credits)
COS-IMGS-261 - Linear and Fourier Methods for Imaging (4 credits)
COS-IMGS-321 - Geometric Optics (3 credits)
COS-IMGS-351 - Color Science (3 credits)
COS-MATH-221 - Multivariable and Vector Calculus (4 credits)
COS-PHYS-213 - Modern Physics I (3 credits)

Subtotal
26 credits

Major Program Requirements

COS-IMGS-181 - Innovative Freshman Experience I (3 credits)
COS-IMGS-182 - Innovative Freshman Experience II (3 credits)
COS-IMGS-180 - Introduction to Computing and Control (3 credits)
COS-IMGS-211 - Probability & Statistics for Imaging (3 credits)
COS-IMGS-251 - Radiometry (3 credits)
COS-IMGS-322 - Physical Optics (3 credits)
COS-IMGS-341 - Interactions Between Light & Matter (3 credits)
COS-IMGS-361 - Image Processing and Computer Vision I (3 credits)
COS-IMGS-362 - Image Processing and Computer Vision II (3 credits)
COS-IMGS-441 - Noise and System Modeling (3 credits)
COS-IMGS-451 - Imaging Detectors (3 credits)
COS-IMGS-475 - Advanced Imaging Laboratory I (2 credits)
COS-IMGS-476 - Advanced Imaging Laboratory II (2 credits)
COS-IMGS-502 - Imaging Science Senior Project I (3 credits)
COS-IMGS-503 - Imaging Science Senior Project II (3 credits)
COS-IMGS-xxx - Imaging Science Elective Track I (3 credits)
COS-IMGS-xxx - Imaging Science Elective Track II (3 credits)

Subtotal
49 credits

Open Electives

- Open Elective (3 credits
- Open Elective (3 credits)

Subtotal
6 credits
Total
124 credits

2.1.2. Imaging Science Elective Tracks (Sample tracks below and under development)

a. Detectors

IMGS-528 Design and Fabrication of a Solid State Detector
IMGS-542 Testing of Focal Plane Array
IMGS-539 Principles of Solid State Imaging

b. Remote Sensing

IMGS-431 Environmental Applications of Remote Sensing
IMGS-432 Advanced Applications of Environmental Remote Sensing
IMGS-433 Remote Sensing Systems Engineering

c. Medical Imaging

IMGS-730 Magnetic Resonance Imaging
IMGS-731 Ultrasound Imaging
IMGS-733 Medical Imaging Systems

d. Motion Picture Science

SOFA-311 Image Capture and Production Technology
SOFA-312 Digital Post-Production Technology
SOFA-313 Film Production and Digital Cinema (optional)

e. Scientific Photography

IMPT-312 High Speed Imaging
SOFA-363 Computational Photography

Potential tracks in…

f. Computer Science
g. Astronomical Imaging
h. Physics

Q: What electives will help deepen my understanding in my required Imaging Science classes?

A: While you may have all the prerequisites to be successful in your required classes in Imaging Science, you should never consider that you are done learning. Electives give you a deeper understanding of material that is used in these classes or that will enhance your grasp of the material you learned in your required classes. The following is a list of topics, some of which are covered in required courses and courses in other disciplines at RIT that you are encouraged to consider taking, if you have time, to help you gain a deeper understanding. Please note, it's important to check the prerequisites for any of the courses listed below.

Microelectronics Engineering

MCEE 360 Semiconductor Devices for Microelectronic Engineers

Psychology/Perception

PSYC 223 Cognitive Psychology
PSYC 224 Psychology of Perception

Mathematics

MATH 231Differential Equations
MATH 233 Linear Systems and Differential Equations
MATH 326 Matrices and Boundary Value Problems
MATH 241 Linear Algebra
MATH 381 Complex Variables
MATH 341 Advanced Linear Algebra
MATH 411 Numerical Analysis

Statistics

MATH 242 Probability & Statistics II
STAT 305 Introduction to Regression Analysis
STAT 345 Non-Parametric Statistics
STAT 425 Multivariate Analysis or CQAS 758 Multivariate Statistics for Imaging Science

Physics/Optics

PHYS 283 Vibrations and Waves
PHYS 222 Electronic Measurements
PHYS 408 Laser Physics
EEEE 505 Modern Optics for Engineers

Computer Science

CSC I 331 Introduction to Intelligent Systems
CSC I 431 Introduction to Computer Vision

Linear Mathematics for Imaging

MATH 241 Linear Algebra
MATH 341 Advanced Linear Algebra
MATH 381 Complex Variables

Vision & Psychophysics

PSYC 223 Cognitive Psychology
PSYC 224 Psychology of Perception
CSCI 431 Introduction to Computer Vision

Image Processing

MATH 241 Linear Algebra
MATH 381 Complex Variables
MATH 411 Numerical Analysis
STAT 305 Introduction to Regression Analysis
CSCI 431 Introduction to Computer Vision

Color Science

MATH 241 Linear Algebra
STAT 305 Introduction to Regression Analysis
STAT 425 Multivariate Analysis
CSCI 510 Introduction to Computer Graphics
PSYC 224 Psychology of Perception

Q: Are new elective courses planned?

A: The faculty of the Carlson Center for Imaging Science frequently adjusts the curriculum to address the most recent technological advances. New courses may be offered as Special Topics prior to becoming permanent offerings.

2.1.3. Senior Project

The faculty of the Chester F. Carlson Center for Imaging Science agree that a significant capstone research experience at the undergraduate level is a factor that is both important to the education of future imaging scientists and preparatory for the environment they will enter after graduation - whether that environment is graduate school or the work place. It is understood that this capstone research experience can be achieved in different ways, and certain unique situations may arise that allow for deviation from the proposed approach with the approval of the CIS Undergraduate Coordinator.

All students in the Imaging Science undergraduate program will complete a capstone research project. "Senior Project" (IMGS 502, IMGS 503) that will nominally commence in the fall semester of Year 4.

By the completion of Year 4 and prior to certification of degree requirements, all students will have completed a significant research experience. The manner in which this requirement can be satisfied is flexible. The options are as follows:

1. The student completes "Senior Project" (IMGS 502, IMGS 503) by conducting research under the mentorship of a CIS, CIS extended, research or affiliated faculty member. Two additional CIS, CIS extended, research or affiliated faculty members or members of the CIS research staff are to be identified by the student to serve as a research committee. The committee is required to meet twice with the primary mentor and the student; the first time at the end of the semester in which the IMGS 502 course is taken to conduct a midterm research review, and a second time at the student's technical presentation of the final research results (described below). Requirements for satisfactory completion of these courses beyond completion of the proposed research include:
   - writing a technical paper summarizing the research conducted (report, conference proceeding, journal submission) with the student as the primary author,
   - a technical presentation of the research to an audience which includes experts in the field (an internal RIT conference or symposium, a professional conference or symposium, a CIS conference or symposium, or an equivalent venue approved by the CIS Undergraduate Coordinator), and
   - the preparation and production of a poster or video summarizing the research.

   The technical paper and complete citation information must be inserted in the CIS document library as a condition for degree certification.

NOTE: That since this option requires the student's enrollment in a sequence of classes in which credit is earned, it is inappropriate to receive pay for that portion of the work that constitutes the body of the student's capstone project research.

2. The student completes a research experience as part of a cooperative educational opportunity, paid or unpaid internship, or during other employment either within or outside the Center. The satisfying requirements for this option are the same as those listed above, namely
   - writing a technical paper summarizing the research conducted (report, conference proceeding, journal submission) with the student as the primary author,
   - a technical presentation of the research to an audience which includes experts in the field (an internal RIT conference or symposium, a professional conference or symposium, a CIS conference or symposium, or an equivalent venue approved by the CIS Undergraduate Coordinator), and
   - the preparation and production of a poster or video summarizing the research.

   The technical paper and complete citation information must be inserted in the CIS document library as a condition for degree certification.

   In addition, the CIS Undergraduate Coordinator in consultation with the faculty constituting the Carlson Center's Undergraduate Curriculum Committee (UGCC) must approve the experience after consultation with the student's mentor to determine appropriateness. This approval must be obtained prior to the end of the student's third year of study. If the experience is determined to be satisfactory, the student will be excused from enrolling in and completing the IMGS 502, 503 sequence and will take professional elective credit, if necessary, to obtain the required credit count for graduation. If the experience is not determined to be satisfactory, the student will be required to complete the Senior Project sequence as described above.

2.1.4. Program Chart

The Program Chart on the following page applies to students entering the BS imaging science program fall 2141. Students are encouraged to discuss their academic and career objectives with the professional advisor and faculty advisor to determine the appropriate path for achieving their goals. Opportunities for study abroad or cooperative educational experiences that take place in a term other than summer will require careful planning in order to stay on track to complete the degree in four years.

Variations to the term in which a course is available may occur. Every effort is made to schedule courses within imaging science so that they do not conflict with other courses in the program.

Term: FALL 1					
Course Number & Title	CR	LAS	Maj	Grade	Prerequisite(s)
COS-IMGS-181 Innovative Freshman Experience I	3		3		Permission of instructor
COS-IMGS-180 Introduction to Computing and Control	3		3		
COS-MATH-181 Project-Based Calculus I (P7a)	4	4			
CLA-UWRT-150 FYW: Writing Seminar (F2)	3	3			
Liberal Arts & Sciences (P1)	3	3			
Year One	0	0			
Term credit total:	16	10	6		

Term: SPRING 1					
Course Number & Title	CR	LAS	Maj	Grade	Prerequisite (s)
COS-IMGS-182 Innovative Freshman Experience II	3		3		COS-MATH-171/181 or permission of instructor
CIAS-SOFA-103 Intro Imaging&Video Systems	3	3			
COS-MATH-182 Project-Based Calculus II (P7b)	4	4			COS-MATH-181
COS-PHYS-211 University Physics I (P5)	4	4			COS-MATH-181
First-Year Seminar (F1)	3	3			
Term credit total:	17	14	3		

Term: FALL 2					
Course Number & Title	CR	LAS	Maj	Gtade	Prerequisite(s)
COS-IMGS-211 Probability & Statistics for Imaging	3		3		COS-MATH-173/182
COS-IMGS-221 Vision and Psychophysics	3	3			Matriculation as Imaging Science or Motion Picture Science or permission of instructor
COS-MATH-221 Multivariable Calculus	4	4			COS-MATH-182
COS-PHYS-212 University Physics II (P6)	4	4			COS-PHYS-211
Liberal Arts & Sciences (P2)	3	3			
Term credit total:	17	14	3		

Term: SPRING 2					
Course Number & Title	CR	LAS	Maj	Grade	Prerequisite (s)
COS-IMGS-351 Color Science	3	3			COS-IMGS-221
COS-IMGS-261 Linear and Fourier Methods for Imaging	4	4			COS-MATH-221
COS-PHYS-213 Modern Physics I	3	3			COS-MATH-182
Liberal Arts & Sciences (P3)	3	3			
Liberal Arts & Sciences (P4)	3	3			
Term credit total:	16	16			

Term: FALL 3					
Course Number & Title	CR	LAS	Maj	New	Prerequisite(s)
COS-IMGS-321 Geometric Optics	3	3			COS-PHYS-212
COS-IMGS-251 Radiometry	3		3		COS-MATH-182, COS-PHYS-212
COS-IMGS-361 Image Processing & Computer Vision I	3		3		COS-IMGS-211, COS-IMGS-261, COS-IMGS-189 or equivalent
Open Elective (1)	3				
Liberal Arts & Sciences (l1)	3	3			
Term credit total:	15	6	6		

Term: SPRING 3					
Course Number & Title	CR	LAS	Maj	New	Prerequisite (s)
COS-IMGS-322 Physical Optics	3		3		COS-PHYS-212, COS-IMGS-261
COS-IMGS-341 Interactions Between Light & Matter	3		3		COS-PHYS-213
COS-IMGS-362 Image Processing & Computer Vision II	3		3		COS-IMGS-361
Open Elective (2)	3				
Liberal Arts & Science (l2)	3	3			
Term credit total:	15	3	9		

Term: FALL 4					
Course Number & Title	CR	LAS	Maj	Grade	Prerequisite(s)
COS-IMGS-441 Noise & System Modeling	3		3		COS-IMGS-211, COS-IMGS-261
COS-IMGS-475 Advanced Imaging Laboratory I	2		2		
COS-IMGS-502 Imaging Science Senior Project I	3		3		Permission of instructor
Imaging Science Elective Track / Course 1	3		3		
Liberal Arts & Sciences (l3)	3	3			
Term credit total:	14	3	11		

Term: SPRING 4					
Course Number & Title	CR	LAS	Maj	Grade	Prerequisite (s)
COS-IMGS-451 Imaging Detectors	3		3		COS-IMGS251, COS-IMGS341 or equivalent
COS-IMGS-476 Advanced Imaging Laboratory II	2		2		COS-IMGS-475
COS-IMGS-503 Imaging Science Senior Project II	3		3		Permission of instructor
Imaging Science Elective Track / Course 2	3		3		
General Education Elective	3	3			
Term credit total:	14	3	11		

Program Totals

Credits: 124

Liberal Arts & Sciences: 69

Major: 49

Elective & Other: 6

2.2. Additional Institute Requirements

http://www.rit.edu/programs/undergraduate-graduation-requirements

2.3. Other Degree Options

Students in the imaging science BS degree may consider pursuing a double major in any number of related areas. Additionally, with approval of the professor of the course, undergraduate students may enroll in a maximum of 3 courses (9 credits) of graduate level course work while enrolled in the undergraduate program.

3. Minors

RIT Minors Policy: http://www.rit.edu/~w-policy/sectionD/D1_1.html

3.1 Minor in Imaging Science

Carl Salvaggio, Minor Adviser
(585) 475-6380, salvaggio@cits.rit.edu

Students have the opportunity for additional study in imaging science in order to build a secondary area of expertise in support of their major or other areas of interest. (Not available to imaging science majors.)

Imaging science

Choose three of the following

IMGS-201	Introduction to Imaging Systems
IMGS-261	Linear and Fourier Methods for Imaging
IMGS-361	Image Processing and Computer Vision I
IMGS-362	Image Processing and Computer Vision II
IMGS-462	Multivariate Statistical Image Processing
IMGS-221	Vision and Psychophysics
IMGS-251	Radiometry
IMGS-351	Color Science
IMGS-341	Interactions Between Light and Matter
IMGS-451	Imaging Detectors
IMGS-528	Design and Fabrication of a Solid State Camera
IMGS-539	Principles of Solid State Imaging Array
IMGS-542	Testing of Focal Plane Arrays
IMGS-321	Geometric Optics
IMGS-322	Physical Optics

Non-imaging science

Choose two of the following

MATH-233	Linear Systems and Differential Equations
MATH-241	Linear Algebra
MATH-251	Probability and Statistics I
PHYS-213	Modern Physics I
PHYS-283	Vibrations and Waves

PHYS-320 Mathematical Methods in Physics
PHYS-365 Physical Optics

3.2 Minor in Optical Science

Optical science techniques are used in a variety of consumer products (e.g., digital cameras, CD players), communication technologies (optical fibers), medical imaging (infrared imaging), and the sciences (surveillance, remote sensing, and astronomical systems). This minor can be an important complement to studies in electrical and microelectronic engineering, the biological sciences, physics, chemistry, mathematics, technical photography, and various programs in the applied science and technology area.

Zoran Ninkov, Minor Adviser
(585) 475-7195, ninkov@cis.rit.edu

Michael Kotlarchyk, Minor Adviser
(585) 475-6115, mnksps@rit.edu

Group A

Choose one of the following:

IMGS-321 Geometric Optics
IMGS-322 Physical Optics
PHYS-365 Physical Optics
MCEE-515 Nanolithography Systems
PHPS-211 Photographic Optics

Group B

Choose one of the following:

PHYS-408 Laser Physics
IMGS-251 Radiometry

Group C

Choose one of the following:

IMGS-451 Detectors
IMGS-528 Design and Fabrication of a Solid State Camera
IMGS-542 Testing of Focal Plane Arrays

Group D

Choose two of the following:

IMGS-221 Vision and Psychophysics
IMGS-322 Physical Optics

IMGS-341	Interaction of Light and Matter
IMGS-471	Modulation Transfer Function
PHYS-213	Modern Physics I
PHYS-412	Electricity and Magnetism II
CHMP-442	Quantum Chemistry
EEEE-374	Electromagnetic Fields
MCEE-515	Microlithography Systems and Lab
PHPS-316	Scanning Electron Microscopy

4. Advanced placement and transfer credit

If you have AP, IB or transfer scores/credits to report that were not submitted to RIT prior to admission, please request that your official scores and/or transcripts be sent directly from the issuing body to:

RIT Office of Registrar
60 Lomb Memorial Drive
Rochester, NY 14623-5603

Visit the College Board at www.collegeboard.com to request AP/CLEP score reports.

For information about math/science AP transfer credit:

http://www.rit.edu/cos/advanced-placement-credits

Liberal arts exams with a score of 3 or higher qualify for RIT course credit. See this link:

http://www.rit.edu/cla/student-services/apibcleptransfer-credits

The College of Liberal Arts evaluates courses for transfer to satisfy the Ethical, Artistic, Global and Social Perspectives for the degree. The academic department evaluates courses for transfer to satisfy the Natural Science Inquiry, Scientific, and Mathematical Perspectives, as well as program requirements. You are encouraged to seek pre-approval for any courses you plan to take at another university to satisfy RIT requirements.

5. Program enhancement opportunities

5.1 Co-op http://www.rit.edu/emcs/oce/

What Is Co-op? Our program features an optional cooperative education plan. A co-op experience not only provides the student with the opportunity to work in his/her chosen career field prior to graduation but also enables the student to earn attractive salaries that can substantially offset educational costs. The additional experience and expertise acquired by the student through co-op expands the opportunities for obtaining a permanent job after graduation.

When Can I Co-op? We recommend you complete two years as a full-time student in the program (or the equivalent if you have transfer or advanced placement credit) before you co-op. Most students begin during the summer or fall after their second year.

How Do I Find a Co-op Job? The Office of Co-operative Education and Career Services offers a full range of services to help you locate a co-op job:

- Identification of employment opportunities
- Career fairs and on-campus co-op interviews
- Directories of technical companies to contact
- Individual assistance in writing your resume and cover letters
- Individual counseling for your co-op search
- Mock interviews and panel discussions

Why Should I Co-op? Although co-op is optional, the Carlson Center for Imaging Science urges you to co-op in order to obtain valuable experience that will make your education more relevant and give you an advantage in finding a job when you graduate. Also, in terms of financing an RIT education, with co-op you should be able to earn enough money to substantially help in meeting your college expenses.

5.2 Research

Research is an important element of your experience in the Carlson Center for Imaging Science. Student researchers have the opportunity to present their work at a variety of conferences around the country and submit articles for publication in professional journals.

The first step to working on a research project is to become aware of the opportunities throughout the Center. CIS has several active research groups performing interesting work in a variety of imaging-related technologies and applications. A list of these groups is available on the CIS web site at http://www.cis.rit.edu/research/areas. A student who would like to get involved in research should start by reading through the information on this page to determine their areas of interest. Then speak to one or more of the faculty in these areas to find out what opportunities are available for undergraduates.

After selecting a project to work on, you may be given the option of doing your research for credit or for pay, depending on whether your faculty research advisor has secured funding from an outside agency. If the work will be for credit, you will need to register for IndependentStudy (see section 5.3 below) or Undergraduate Research. If you will be working for pay, you will need to be hired as a student employee (see section 5.4 below).

5.3 Independent Study/Research Contract

The purpose of an Independent Study course is to study material that is not available in the required courses in the curriculum. For example, you can take as an independent study a course in Digital Texture Mapping Systems – it is a course that is not offered by our department.

The Process: If you are interested in taking an independent study course, you need to find an instructor who is willing to mentor you. Complete an Independent Study/Research Contract Form found at this link: http://www.rit.edu/cos/student-forms . You and the instructor will write up a contract that will include:

- Objective
- Description

- Method of Evaluation

The contract must be signed by you, the instructor, and the Program Coordinator or Director. At the end of the term, a grade will be assigned for the course to indicate quality and completion of the work. Additionally,

a. No more than 12 quarter credit hours of independent study work may count toward a bachelor's degree. b. The maximum number of credit hours for an Independent Study course is four.

5.4 Student Employment Opportunities

There are several types of academically-related student employment opportunities on campus. These are excellent opportunities to earn experience and money while enrolled in classes. Some examples of such opportunities include grader, teaching assistant, tutor, and note taker. Many of these positions are posted through the Student Employment Office.

For students wishing to find jobs within the Carlson Center for Imaging Science, opportunities may include assisting in one of our laboratories or the stockroom, serving as a teaching assistant, or performing administrative tasks in the Director's office. Occasionally these opportunities will be publicized by broadcast e-mail, but in most cases they are either announced at meetings of the Imaging Science Club, or they are disseminated by word of mouth. If you are offered one of these positions, you must first visit RIT's Student Employment Office to receive a Student Employee Card. Your supervisor will need to send an e-mail to the CIS Staff Assistant for Student Employment indicating your hourly wage and the account from which you'll be paid. You will then need to personally visit the Staff Assistant with your Student Employee Card to complete the hiring process.

6. Advising

Upon entering the Imaging Science BS degree program, every student will have a professional staff adviser and a faculty adviser appointed by the Center. The professional staff advisor is primarily responsible for working with the advisees in the planning of their academic programs. The faculty adviser will also oversee the performance of the advisees and work with them in solving any problems they might confront and assist the advisee with professional and career advice. A request for a change of a faculty adviser should be made to the Undergraduate Program Coordinator or the Director of the Center.

Advisors are listed on the Student Information System https://sis.rit.edu/

First Year and New Transfer Advising Holds

All students new to RIT are required to meet with their adviser to discuss academic progress and planning before the next semester's registration period. Students will not be able to register for classes until meeting with their adviser. Students are encouraged to arrange their advising appointment at least two weeks in advance of enrollment. In the event that their adviser does not have compatible meeting availability before registration begins, the student can arrange an advising appointment with the Undergraduate Program Coordinator and/ or Academic Coordinator in order to have the registration hold removed.

You are encouraged to use the resources provided by RIT and the Institute Advising Office at this link: http://www.rit.edu/academicaffairs/advising/student-resources

7. Scholarships

Each year the Carlson Center awards several scholarships to students majoring in Imaging Science. Among the scholarships available:

- The Carlson Scholarship in Imaging Science. Incoming freshmen who request financial aid are automatically considered for a need-based Carlson Scholarship. Those receiving the scholarship will have it automatically renewed annually as long as they remain in good academic standing. Students already in the Imaging Science program can also apply for a merit-based Carlson Scholarship. Multiple scholarships are given on the basis of merit to students who will be entering at least their second year of studies but who have not yet graduated. Instructions for applying for this scholarship are distributed by e-mail each January. Awards are typically announced by April. These scholarships are good for one year, but students may re-apply each year regardless of whether they have received a Carlson scholarship in the past.

- The Jerry G. Hughes Memorial Scholarship. This scholarship is given to one student who is a current Imaging Science major entering at least their second year of studies but who has not yet graduated. The award is made on the basis of both need and merit. Students who apply for the annual Carlson Scholarship are automatically considered for the Hughes Scholarship.

- John Wiley Jones Award for Outstanding Students in Science is a College of Science award for students who are in the third year of their academic program. One Imaging Science student is selected by the CIS faculty for this award each year.

8. Academic Policies

8.1 RIT Writing Policy

http://www.rit.edu/academicaffairs/policiesmanual/sectionD/D1_5.html

8.2 Placement in Calculus

One of the most important factors in student success in mathematics is correct placement, so calculus at RIT begins with the math placement exam. Based on the results of this placement test, students in imaging science are enrolled in the appropriate course.

http://www.rit.edu/cos/sms/placementexam/course-placement

8.3 C- or Better Policy

Both common sense and experience point to adequate preparation as an important element in student success. Particularly when courses are in sequence, demonstrated competence in one course provides the best foundation for success in the next.

Students enrolled in the calculus and physics sequences must have earned a grade of C- or better in the prerequisite course.

Students with a grade of “D”, "W" or "F" in the prerequisite course will be automatically dropped from the class list of the subsequent course. These students will be notified directly by the registrar’s office.

8.4 Grades, Repeat of a Course, Grade Exclusion

Grades are earned, not given. Any course can be repeated to improve a grade, but the reason to repeat a course is to learn the material so you can apply it in future courses. The only means to have a grade excluded is by changing your program. For more information see:

http://www.rit.edu/~w-policy/sectionD/D5.html

8.5 Graduation

In order to participate in the May Commencement Ceremony a student must have completed all degree requirements within fall semester or be enrolled spring semester and/or summer term in courses that will result in satisfaction of all degree requirements. An application for graduation must be filed with the Registrar's Office by April 15 for the student's name to appear in the Commencement Book.

9. Academic Resources

9.1 Tutoring and Assistance

Many resources are available to help you be successful at RIT. **Use them!**

Student Learning, Support and Assessment

http://www.rit.edu/studentaffairs/slsa/

Academic Support Center

The ASC works in a variety of ways to increase students' effectiveness as learners. Students learn how to develop basic skills, enhance advanced skills, or cope with the academic environment. The ASC offers workshops and instruction in study skills and alternative learning strategies. Other services such as Academic Assessment Program, Structured Monitoring, and Tutor Training are available.

ASC offices are located on the second floor of Monroe Hall, room 2080. You are paying for these services through your tuition whether you choose to use them or not. Some services may result in additional charge, such as the Structured Monitoring Program. For more information, visit the ASC website at http://www.rit.edu/studentaffairs/asc/

Mathematics and Physics

The Bates Study Center in Gosnell Hall is open weekdays. Some students come to the study center and work on homework and ask for help as needed. Others come to ask specific questions. Student tutors from the Academic Support Center (ASC), as well as faculty from the College of Science, are available to answer your questions. This assistance is provided at no additional cost to all RIT students.

Imaging Science

Students are encouraged to seek assistance from faculty, teaching assistants, and upper class students. The Reading Room CAR 2150 is an environment where students can study in groups and have easy access to faculty and other students.

9.2 Early Alert System

The Early Alert System is a system by which instructors e-mail students (and their advisor) if a student is at risk of failing a class and suggest areas for improvement. Students' advisers are included on this correspondence so both faculty and staff can assist the student and identify strategies for success.

9.3 College Restoration Program

The College Restoration Program (CRP) is a specialized program of instruction for students who have been placed on suspension. If, after diagnostic testing which includes measures of aptitude, interest, achievement, and personality, it is determined that CRP can be helpful, a very structured program including content courses, ASC instruction, and counseling is arranged. The entire program is designed to strengthen the student's self-confidence.

Although the College Restoration Program does not guarantee a participants re-admission to his/her former college/program, nor does it guarantee status as a transfer student to another school, the CRP program provides recommendations and resumes of student achievement in the program to colleges upon request of the student. Details may be obtained at http://www.rit.edu/studentaffairs/crp

9.4 Useful Links

The RIT website http://www.rit.edu

RIT Policies & Procedures Manual http://www.rit.edu/academicaffairs/Manual/

Undergraduate Bulletin http://www.rit.edu/upub/pdfs/Undergrad_Bulletin.pdf

SIS (Student Information System) https://sis.rit.edu/

Information about Immersions: http://www.rit.edu/programs/immersions

Information about Minors http://www.rit.edu/programs/minors-and-concentrations

College of Science Student Resources http://www.rit.edu/cos/current-undergrad

10. Shared Expectations and Ethics

The Chester F. Carlson Center for Imaging Science is dedicated to a challenging and collaborative educational experience in imaging science that is grounded in the integrity of the students, faculty, and staff. That integrity is expressed by our actions, individually, as well as by our actions collectively, including those in research; on laboratory, programming, and homework assignments; on examinations; and in our collaborations and interactions with one another; and in our use of the facilities and resources of the Carlson Center for Imaging Science and RIT.

RIT has a policy on academic honesty:

http://www.rit.edu/studentaffairs/studentconduct/rr_academicdishonesty.php

The shared expectations described in this document below build on, and are in addition to, the RIT policy. The purpose of this shared expectations document is to assure that we in CIS are taking an active and engaged approach to maintaining the highest possible levels of scientific and professional ethics and integrity and that the students, faculty, and staff of CIS have a common code of ethics and integrity and a common understanding of the consequences of violating that code.

Research: it is unethical to falsify any data in an experiment, or computational or theoretical results, whether the data or results are to be submitted to internal or external review (e.g., in a thesis or dissertation or for a conference or journal paper or a grant proposal). Similarly data and results cannot be plagiarized. If data are demonstrated to have been falsified or plagiarized on a capstone or graduate thesis or dissertation, the faculty has discretion to determine the penalty, up to and including expulsion from the program. If data have been falsified on a paper submission, the paper shall be withdrawn and the faculty shall have discretion to determine the penalty.

Examinations: students must not plagiarize the work of others nor allow others to plagiarize their work on written examinations. The faculty will try to arrange the room in such a manner to remove or discourage such temptation. Faculty may require students to attest to their conduct on any submitted material by signing a statement such as, *"I have neither given nor received unauthorized assistance on this examination."* The faculty member has discretion to determine the penalty for violations of this policy.

Homework: the faculty member has the obligation to specify the conditions to be fulfilled on homework submissions (e.g., can be done collaboratively, must be done alone, etc.). As a rule, students may not submit the work of others as their own. In many, if not most, homework scenarios, collaborative effort on homework is part of the learning process and is therefore useful, but students may be asked to reference any assistance that they have received. Similarly, group planning and/or checking of final answers may be permissible, but both are examples of collaborative efforts that must be attributed if required by the professor. Faculty may require students to attest to their conduct on any submitted material (e.g., laboratory reports, computer programs, term papers) by signing a statement such as, "*I have followed all guidelines and requirements and have attributed all assistance received.*"

Collaboration: collaboration among students is often encouraged as an integral part of the learning experience, be it in the classroom or for research. Some examples include group projects, laboratory assignments, and test preparation. Whenever submitted work is the result of such collaboration, clearly crediting all who contributed will eliminate the possibility that the collaboration is in violation of *RIT's Academic Honesty Policy*, which states, "Any act of improperly representing another person's work as one's own is construed as an act of academic dishonesty."

Incoming students will discuss with faculty and each other this Shared Expectations *for Ethics and Professional Integrity,* and the RIT Academic Honesty Policy and after having an opportunity to ask questions, will sign a copy of the Expectations indicating that that they have read and discussed it and are aware of the consequences of policy violations. In some cases, the penalties for violation of the policy are stipulated; in others they are not rigidly defined, giving the faculty discretion in specifying the consequences. Those consequences may include failure in a course, suspension of funding for a term or longer (if student is the recipient of a Carlson Center for Imaging Science Scholarship or assistantship), or expulsion from the program in severe cases such as falsifying

research data or multiple violations. In all cases, academic honesty violations will be reported to the CIS Director, so that the Director can maintain an overview of instances of academic dishonesty occurring with the Center for Imaging Science and so that the Director can assure that penalties are applied consistently and fairly.

11. Activities

The Imaging Science Club meets regularly in the Carlson Building for both professional and social events. Students in imaging science benefit from this organization as well as from SPIE and OSA. Throughout the academic year there are Imaging Science seminars as well as talks given as part of the College of Science Distinguished speakers' series. The College of Science provides opportunities for students to present their research at the COS Undergraduate Research Seminars typically scheduled one/week.

12. Faculty and staff

See this link: http://www.cis.rit.edu/

13. Recommended Books

There are certain books that should be on every imaging scientist's bookshelf while they are here at RIT and for the duration of their career. These are the books that after many years will have the binding coming undone, the pages dog-eared, and notes in the margins ... you know, the books you can't live without.

The following are those books recommended by the faculty of Center for Imaging Science.

GENERAL IMAGING

The Science of Imaging: An Introduction Graham Saxby (Author)

High Dynamic Range Imaging: Acquisition, Display, and Image-Based Lighting (The Morgan Kaufmann Series in Computer Graphics) [Hardcover]
Erik Reinhard (Author), Greg Ward (Author), Sumanta Pattanaik (Author), Paul Debevec (Author)

The Focal Encyclopedia of Photography, Fourth Edition [Hardcover]
Michael R. Peres (Editor)

The theory of the photographic process, [Hardcover]
C. E. Kenneth Mees (Author)

DIGITAL IMAGE PROCESSING / MATHEMATICS

Digital Image Processing (3rd Edition) [Hardcover] Rafael C. Gonzalez (Author), Richard E. Wood (Author)

OPTICS / RADIOMETRY / LINEAR SYSTEMS

Optics (4th Edition) [Hardcover]
Eugene Hecht (Author)

Linear Systems, Fourier Transforms, and Optics (Wiley Series in Pure and Applied Optics) [Hardcover]
Jack D. Gaskill (Author)

Electro-Optical Imaging System Performance (Spie Press Monograph) [Hardcover]
Gerald C. Holst (Author)

Radiometric System Design [Hardcover]
Clair L. Wyatt (Author)

Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles [Hardcover]
Robert Eisberg (Author), Robert Resnick (Author)

COLOR SCIENCE

Digital Color Imaging Handbook (Electrical Engineering & Applied Signal Processing Series) [Hardcover] Gaurav Sharma (Editor), Raja Bala (Editor)

Computational Color Technology (SPIE Press Monograph Vol. PM159) [Hardcover]
Henry R. Kang (Author)

The Reproduction of Colour (The Wiley-IS&T Series in Imaging Science and Technology) [Hardcover]
R. W. G. Hunt (Author)

Color Science: Concepts and Methods, Quantitative Data and Formulae (Wiley Series in Pure and Applied Optics) [Paperback]
Günther Wyszecki (Author), W. S. Stiles (Author)

Billmeyer and Saltzman's Principles of Color Technology, 3rd Edition [Hardcover]
Roy S. Berns (Author)

Color Appearance Models (The Wiley-IS&T Series in Imaging Science and Technology) [Hardcover]
Mark D. Fairchild (Author)

COMPUTER GRAPHICS / RENDERING / VISUALIZATION

Principles of Digital Image Synthesis (The Morgan Kaufmann Series in Computer Graphics) 2 Volume Set [Hardcover]
Andrew S. Glassner (Author)

Fundamentals of Computer Graphics, Second Ed. [Hardcover]
Peter Shirley (Author), Michael Ashikhmin (Author), Michael Gleicher (Author), Stephen Marschner (Author), Erik Reinhard(Author), Kelvin Sung (Author), William Thompson (Author), Peter Willemsen (Author)

DIGITAL VIDEO PROCESSING

Digital Video and HD: Algorithms and Interfaces (The Morgan Kaufmann Series in Computer Graphics) [Hardcover] Charles Poynton (Author)

VISION

Foundations of Vision [Illustrated] [Hardcover]
Brian A. Wandell (Author)

Vision Science: Photons to Phenomenology [Hardcover]
Stephen E. Palmer (Author)

Psychophysics: The Fundamentals [Hardcover]
George A. Gescheider (Author)

REMOTE SENSING

Remote Sensing: The Image Chain Approach [Hardcover]
John R. Schott (Author)

Remote Sensing and Image Interpretation [Hardcover]
Thomas Lillesand (Author), Ralph W. Kiefer (Author), Jonathan Chipman (Author)

Remote Sensing Digital Image Analysis: An Introduction [Hardcover]
John A. Richards (Author), Xiuping Jia (Author)

MISCELLANEOUS

The ACS Style Guide: Effective Communication of Scientific Information (An American Chemical Society Publication) [Hardcover]
Anne M. Coghill (Editor), Lorrin R. Garson (Editor)

Mathematical Statistics [Hardcover]
John E. Freund (Author)

A Guide to LATEX: Document Preparation for Beginners and Advanced Users (3rd Edition) [Paperback]
Helmut Kopka (Author), Patrick W. Daly (Author)

Numerical Recipes 3rd Edition: The Art of Scientific Computing [Hardcover]
William H. Press (Author), Saul A. Teukolsky (Author), William T. Vetterling (Author), Brian P. Flannery (Author)

The Art of Electronics [Hardcover]
Paul Horowitz (Author), Winfield Hill (Author)

Practical IDL Programming [Paperback]
Liam E. Gumley (Author)

Mastering MATLAB 7 [Paperback]
Duane C. Hanselman (Author), Bruce L. Littlefield (Author)