ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE (COS- IMGS-789-Special Topics: Advanced Topics in Radiative Transfer Media):

1.0 Course Designations and Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	April 2, 2014	April 2, 2014
College Curriculum Committee		

Optional designations:	**Is designation desired?**		***Approval request date:**	****Approval granted date:**
General Education:		No		
Writing Intensive:		No		
Honors		No		

2.0 Course information:

Course title:	Advanced Topics in Radiative Transfer in Media
Credit hours:	3
Prerequisite(s):	IMGS-619 and IMGS-633, or ASTP-615; Introduction to Radiative Transfer in Media (IMGS-789-01) or instructor permission
Co-requisite(s):	
Course proposed by:	Charles Bachmann
Effective date:	August, 2014

	Contact hours	**Maximum students/section**
Classroom	3	12
Lab		
Studio		
Other (specify)		

2.a Course Conversion Designation* (Please check which applies to this course).**
*For more information on Course Conversion Designations please see page four.

	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to:
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
X	New

2.b Semester(s) offered (check)

Fall	Spring X	Summer	Other

All courses must be offered at least once every 2 years. If course will be offered on a bi-annual basis, please indicate here:

2.c Student Requirements

Students required to take this course: (by program and year, as appropriate)
Students who might elect to take the course: Advanced CIS and AST Graduate Students

In the sections that follow, please use sub-numbering as appropriate (eg. 3.1, 3.2, etc.)

3.0 Goals of the course (including rationale for the course, when appropriate):

- The course should benefit both CIS students interested in remote sensing of sediment, as well as AST students interested, for example, in planetary astronomy. This is the first semester of a two-semester graduate-level course.
- By the end of the course, provide students with a solid foundation in and understanding of this material to prepare graduate students to do research in a related topic. Ensure that students understand where research opportunities exist in this area and the open research questions that could suggest dissertation topics in either CIS or AST.

4.0 Course description (as it will appear in the RIT Catalog, including pre- and co-requisites, and quarters offered). Please use the following format:

IMGS-789-02 Advanced Topics in Radiative Transfer in Media

This course is the second half of a two-semester sequence, which covers more advanced topics related to the theory of radiative transfer in disordered media. The course begins with a review of topics presented in the first semester course, including the radiative transfer solutions due to Hapke for a semi-infinite medium and the opposition effect. Hapke solutions are contrasted with other models such as those of Kubelka-Munk, Shkuratov, and Mishchenko. Modifications to incorporate the effects of surface roughness, layered media, and oriented scatters are also described. Other advanced topics such as polarization are also described. (Prerequisites: IMGS-619 & IMGS-633; or ASTP-615; IMGS-789-01; or instructor permission) **Class 3, Credit 3 (S)**

5.0 Possible resources (texts, references, computer packages, etc.)

Primary course textbook: B. Hapke, Theory of Reflectance and Emittance Spectroscopy, 2nd Edition, Cambridge University Press, 2012.

Various refereed journal papers by other authors in the field (e.g. Mishchenko,

Schkuratov and others)

6.0 Topics (outline):

- Review of end of semester 1 material: radiative transfer solutions for semi-infinite medium and the opposition effect (Hapke, 2nd ed., ch. 8-9)
- Other radiative transfer models: Kubelka-Munk theory, Shuratov albedo model (Hapke, 2nd ed., Ch. 14)
- Review of Hapke IMSA model and density effects, radiative transfer in layered media, intimate mixtures (Ch 9, Ch. 10 & Ch. 14)
- Inversion of radiative transfer models: practical approaches (Hapke, 2nd ed., ch 14)
- Modeling the effects of surface roughness in radiative transfer (Hapke, 2nd edition, Chapter 12)
- Radiative transfer models for layered media, radiative transfer models for oriented scattering and vegetation (Hapke, 2nd ed., ch. 10)
- Integrated reflectance measures/planetary applications (Hapke, 2nd ed., Ch. 11)
- Polarization in a particulate medium and the Umov Effect (Hapke, 2nd ed., Ch. 13)
- Thermal emission and radiative transfer models (Hapke, 2nd ed., Ch.15)
- If time permits: energy transport/thermal conduction, and radiation (Hapke, 2nd ed., Ch. 16)

7.0 Intended course learning outcomes and associated assessment methods of those outcomes (please include as many Course Learning Outcomes as appropriate, one outcome and assessment method per row).

Course Learning Outcome	Assessment Method
Develop familiarity with basic theory and approximate solutions to the radiative transfer models that are used to describe single particles and granular media	Homework
Develop an understanding of where open questions exist in the research literature	Student presentations on related journal articles
Develop proficiency in working with radiative transfer models in granular media and their applications	Extended take-home exam

8.0 Program outcomes and/or goals supported by this course

- The course should benefit both CIS students interested in remote sensing of sediment, as well as AST students interested, for example, in planetary astronomy. This is the first semester of a two-semester graduate-level course.
- By the end of the course, provide students with a solid foundation in and understanding of this material to prepare graduate students to do research in a related topic. Ensure that students understand where research opportunities exist in this area and the open research questions that could suggest dissertation topics in either CIS or AST.

9.0

N/A	General Education Learning Outcome Supported by the Course, if appropriate	Assessment Method
Communication		
	Express themselves effectively in common college-level written forms using standard American English	
	Revise and improve written and visual content	
	Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing)	
	Comprehend information accessed through reading and discussion	
Intellectual Inquiry		
	Review, assess, and draw conclusions about hypotheses and theories	
	Analyze arguments, in relation to their premises, assumptions, contexts, and conclusions	
	Construct logical and reasonable arguments that include anticipation of counterarguments	
	Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information	
Ethical, Social and Global Awareness		
	Analyze similarities and differences in human experiences and consequent perspectives	
	Examine connections among the world's populations	
	Identify contemporary ethical questions and relevant stakeholder positions	
Scientific, Mathematical and Technological Literacy		
	Explain basic principles and concepts of one of the natural sciences	
	Apply methods of scientific inquiry and problem solving to contemporary issues	
	Comprehend and evaluate mathematical and statistical information	
	Perform college-level mathematical operations on quantitative data	
	Describe the potential and the limitations of technology	
	Use appropriate technology to achieve desired outcomes	
Creativity, Innovation and Artistic Literacy		
	Demonstrate creative/innovative approaches to course-based assignments or projects	
	Interpret and evaluate artistic expression considering the cultural context in which it was created	
	Interpret and evaluate artistic expression considering the cultural context in which it was created	

10.0 Other relevant information (such as special classroom, studio, or lab needs,

special scheduling, media requirements, etc.)

-Request smart/electronic white-board in classroom and computer projection equipment.
-Request late morning class schedule if possible.

***Optional course designation; approval request date:** This is the date that the college curriculum committee forwards this course to the appropriate optional course designation curriculum committee for review. The chair of the college curriculum committee is responsible to fill in this date.

****Optional course designation; approval granted date:** This is the date the optional course designation curriculum committee approves a course for the requested optional course designation. The chair of the appropriate optional course designation curriculum committee is responsible to fill in this date.

*****Course Conversion Designations**
Please use the following definitions to complete table 2.a on page one.

- **Semester Equivalent (SE)** – Closely corresponds to an existing quarter course (e.g., a 4 quarter credit hour (qch) course which becomes a 3 semester credit hour (sch) course.) The semester course may develop material in greater depth or length.
- **Semester Replacement (SR) –** A semester course (or courses) taking the place of a previous quarter course(s) by rearranging or combining material from a previous quarter course(s) (e.g. a two semester sequence that replaces a three quarter sequence).
- **New (N) -** No corresponding quarter course(s).