ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-765 - Performance Modeling and Characterization of Remote Sensing Systems

1.0 Course Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	9/10/2010	9/25/2010
College Curriculum Committee	9/28/2011	10/4/11

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:	Performance Modeling and Characterization of Remote Sensing Systems
Credit hours:	3
Prerequisite(s):	IMGS-616 and IMGS-619
Co-requisite(s):	None
Course proposed by:	Mike Gartley
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	3	30
Lab		
Studio		
Other (specify)		

2.1 Course Conversion Designation (Please check which applies to this course)

	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

2.2 Semester(s) offered (check)

Fall X	Spring	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:

2.3 Student Requirements

Students required to take this course: None
Students who might elect to take the course: Graduate students in Imaging Science, MS and PhD Remote Sensing track. Graduate students in the College of Science or College of Engineering.

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

3.1 To provide practical understanding of the theory and techniques utilized to conduct system performance trades and how they factor into the overall design of a new remote imaging system.
3.2 To provide exposure to real-world issues that are commonly encountered with new remote sensing platforms.

4.0 Course description

IMGS-765 Modeling and Characterization of Remote Sensing Systems
This course introduces the techniques utilized for system performance predictions of new imaging platforms during their design phase. Emphasis will be placed on systems engineering concepts and their impact on final product quality through first principles modeling. In addition, the student will learn techniques to characterize system performance during actual operation to monitor compliance to performance specifications and monitor system health. Although the focus of the course will be on electro-optical collection systems, some modality specific concepts will be introduced for LIDAR, broadband infrared, polarimetric, and hyperspectral systems. (IMGS-616 and IMGS-619)
Class 3, Credit 3 (F)

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

5.1 Holst, *Electro-optical Imaging System Performance*, SPIE Optical Engineering Press, Bellingham, WA
5.2 Instructor's Course Notes

6.0 Topics (outline):

6.1 Review of Radiometric Concepts
  6.1.1 Radiance, Irradiance, Radiant Intensity
  6.1.2 Spectral and polarimetric response considerations
  6.1.3 Noise and random processes (Poisson, Gaussian, white noise etc.)
6.2 End-to-end Radiometry Budgeting
  6.2.1 Source modeling (sun, moon, sky, background, man-made)
  6.2.2 Target reflectance modeling
  6.2.3 Atmospheric background radiance, and path attenuation

6.2.4 Optical system transfer of radiance from primary aperture to focal plane
6.2.5 Focal plane irradiance to digital count values

6.3 Modulation Transfer Function
6.3.1 Pointing/Attitude MTF effects
6.3.2 Scanning MTF effects
6.3.3 Image processing MTF effects
6.3.4 Sensor MTF effects
6.3.5 Optical system MTF
6.3.6 Misc MTF effects

6.4 Noise Modeling
6.4.1 Sensor noise – thermal noise, read noise, quantization noise, etc
6.4.2 Upwelled haze (background) bias and Poisson noise effects
6.4.3 Signal Poisson noise
6.4.4 Stray light effects
6.4.5 Signal to Noise Ratio (SNR) predictions

6.5 Collection Capability modeling
6.5.1 In-track, cross-track swath
6.5.2 Ground sample distance
6.5.3 Daily area collection rates
6.5.4 Revisit rates
6.5.5 Geo-location accuracy

6.6 Modality Specific Metrics
6.6.1 EO, MS, IR – NIIRS prediction
6.6.2 Hyperspectral – Noise Equivalent Signal Radiance
6.6.3 LIDAR – Probability of Detection, Probability of False Alarm
6.6.4 Broadband MWIR/LWIR – Noise Equivalent Delta Temperature
6.6.5 Polarimetric – Noise Equivalent Delta Polarization

6.7 Operational System Characterization
6.7.1 Image based MTF measurement
6.7.2 Geo-location accuracy – LE90, CE90
6.7.3 Radiometric accuracy
6.7.4 NIIRS evaluation

7.0 Intended course learning outcomes and associated assessment methods of those outcomes

Course Learning Outcome	Homework Assignments	Examinations
7.1 Evaluate the performance of individual sub-system components such as optical, detector, and electronics sub-systems	X	X
7.2 Assemble first principles-based end-to-end system models within an engineering software package such as IDL, MATLAB, or Mathcad	X	
7.3 Conduct basic system-level trade studies and provide recommendations for preferred	X	X

system configurations given specifications		
7.4 Examine system trade study results and judge which variables are the primary drivers of performance	X	X

8.0 Program outcomes and/or goals supported by this course

Prepares graduate students in science and engineering for careers in Imaging Science that require them to work on Integrated Project Teams alongside systems engineers, electrical engineers and optical engineers.

9.0

	General Education Learning Outcome Supported by the Course	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	

10.0 Other relevant information (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

Smart classroom.