ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-724 - Introduction to Electron Microscopy

1.0 Course Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	9/15/2010	9/25/2011
College Curriculum Committee	9/28/2011	10/11/2011

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:	Introduction to Electron Microscopy
Credit hours:	3
Prerequisite(s):	Graduate standing in science or engineering or permission of instructor
Co-requisite(s):	None
Course proposed by:	Richard Hailstone
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)

X	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 1051-724 Introduction to Electron Microscopy
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	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: **X**

2.3 Student Requirements

Students required to take this course: None
Students who might elect to take the course: Graduate students in science or engineering.

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

Provide a description of the principles and techniques of imaging systems used in electron microscopy.

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-724 Introduction to Electron Microscopy

The course will introduce the basic concepts and practice of electron microscopy, including transmission electron microscopy (TEM), scanning electron microscopy (SEM) and x-ray microanalysis. During the second half of the course students will do an 8-10 hour hands-on project in SEM or TEM or both, including a project paper and a poster presentation. Laboratory demonstrations will be held in the NanoImaging Lab to reinforce the lecture material. (Graduate student standing in science or engineering, or permission of instructor.) **Class 3, Credit 3 (F, alternate years)**

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

5.1 R. F. Egerton, *Physical Principles of Electron Microscopy*, Springer, New York, NY.

5.2 Instructor's supplemental course notes.

6.0 Topics (outline):

6.1 Optical Microscopy
- 6.1.1 Optics principles
- 6.1.2 Light microscopy

6.2 Electron Optics
- 6.2.1 Imaging with electrons
- 6.2.2 Magnetic lenses and their aberrations

6.3 Transmission Electron Microscopy
- 6.3.1 Electron guns
- 6.3.2 The illumination system
- 6.3.3 The imaging system
- 6.3.4 Electron-specimen interactions
- 6.3.5 Contrast modes
- 6.3.6 Electron diffraction

6.4 Scanning Electron Microscopy

6.4.1 Operating principles
6.4.2 Imaging modes
6.4.3 Electron-specimen interaction
6.4.4 Secondary electron imaging
6.4.5 Backscattered electron imaging
6.4.6 Image formation and quality
6.5 X-ray Microanalysis
6.5.1 Atomic model
6.5.2 Emission process
6.5.3 Qualitative analysis
6.5.4 EDS system
6.5.5 Quantitative analysis

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

Course Learning Outcome	In-class evaluation	Homework
7.1 Demonstrate the application of the optics principles used in the light microscope	X	X
7.2 Explain electron beam-specimen interactions	X	X
7.3 Identify the major components of a transmission electron microscope and their use in optimizing image formation	X	X
7.4 Identify the major components of a scanning electron microscope and their use in optimizing image formation	X	X
7.5 Explain the principles of X-ray microanalysis and its limitations	X	X

8.0 Program outcomes and/or goals supported by this course

Prepares graduate students for research in imaging of nanoscale materials and structures.

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.)

10.1 Smart classroom

10.2 Laboratory with facilities for the following demonstrations:

- Transmission electron microscope
- Scanning electron microscope
- X-ray microanalysis