Rochester Institute of Technology
MCEE-789/PHYS-789

Special Topics: Emerging and Low-Dimensional Materials and Applications

Spring Semester (2235) – Course Syllabus

Sessions: January 17th, 2024 – April 24th, 2024
Wednesdays, 5:00 PM – 7:50 PM

Location: James E. Gleason Hall (Building 9), Room 1149

Instructors:

Dr. Parsian K. Mohseni
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Dr. Ivan Puchades
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Dr. Ke Xu
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Office Hours: Open door policy and scheduled by appointment as needed.

Course Website: Access via MyCourses: http://mycourses.rit.edu

Course Description: The purpose of this special topics course is to introduce students to the fundamental physics of emerging nanomaterials, including graphene, transition metal dichalcogenides, and more for their applications in next generation nanoelectronics and optoelectronics. The course covers 2D materials physics, monolayer materials preparation and synthesis, transfer, optical spectroscopy and microscopy, and device fabrication. In addition to lectures, the course includes hands on laboratory modules on basic processing and characterization of two-dimensional (2D) materials. Each student will fabricate their own 2D materials based nanoelectronic device and perform a series of materials and device characterizations.

Topics Include:

- How do low-dimensional materials fit in the IRDS roadmap?
- Opportunities and challenges of integrating 2D materials in next generation computation (e.g., edge-computing, neuromorphic comp.)
- Synthesis and epitaxial growth of monolayer material
- Electron and scan probe microscopy, optical spectroscopy
- 2D optoelectronics
- Transferring monolayer materials and 2D heterostructures
- Emerging applications, including twistronics, straintronics, iontronics, and nonvolatile and resistive RAM

Grading Scheme:

Table 1. Grading scheme for MCEE-789/PHYS-789 (2024 Spring Semester)

Deliverables	Percentage of Final Grade	Notes
Attendance/Participation	20 %	Instructors' Discretion
Homework Assignments	40 %	See Below
Term Project	40 %	Report: 20 % + Presentation: 20 %

Grading Methodology: MCEE-789/PHYS-789 703 will follow the Education Policies of the Institute as described in Section D05.0 of the Governance Policy Library. For each of the deliverables defined in Table 1, a grade will be provided using a percentage-based grading system, which will reflect the merits of the student's effort and quality of submissions. The instructors' percentage-based system can be converted to letter grades and quality points, as defined by the Institute, with the aid of Table 2.

Table 2. Definition of Institute letter grade with respect to instructors' percentage-based scoring system used in MCEE-789/PHYS-789 (2024 Spring Semester)

Percentage Range	Letter Grade	Percentage Range	Letter Grade
93 % or greater	A	77 % to 79 %	C+
90 % to 92 %	A-	73 % to 76 %	C
87 % to 89 %	B+	70 % to 72 %	C-
83 % to 86 %	B	60 % to 69 %	D- to D+
80 % to 82 %	B-	59 % or less	F

Assignments: Take-home assignments will be assigned throughout the semester. The purpose of these assignments is to provide students an opportunity to independently study and expand upon topics covered in lectures/labs, to practice important exercises, and to complete learning objectives.

Term Project: Details to be provided separately.

Late Submissions: A 10% per day grade penalty will be incurred for late submission of all deliverables.

Academic Dishonesty: Students are expected to uphold and comply with RIT's honor principles and code of conduct related to academic integrity. Academic dishonesty of any kind will not be condoned. ***Breach of RIT's academic dishonesty policy can result in the student receiving a failing grade in the course.*** RIT policies (including academic integrity, discrimination, Title IX) are detailed on the following website:
https://www.rit.edu/academicaffairs/policiesmanual/policies/governance

Diversity Statement:

We consider this program to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability, and other visible or nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. RIT is committed to providing a safe learning environment, free of harassment and discrimination as articulated in our university policies located on our governance website. RIT's policies require me as a faculty member to share information about incidents of gender-based discrimination and harassment with RIT's Title IX coordinator or deputy coordinators, regardless of whether the incidents are stated to me in person or shared by students as part of their coursework.

Safe Zone Statement:

I am a member of a Safe Zone Ally community network, and I am available to listen and support you in a safe and confidential manner. As a Safe Zone Ally, I can help you connect with resources on campus to address problems you may face that interfere with your academic and social success on campus as it relates to issues surrounding sexual orientation and gender identity. My goal is to help you be successful and to maintain a safe and equitable campus. For more information visit the RIT Q Center in SAU A530 or at: rit.edu/qcenter

Continuity Plan:

If an online instructional modality is adopted at any point during the spring semester, then the following academic continuity plan will be implemented for MCEE-789/PHYS-789:

- Online synchronous streaming lectures via Zoom
- Lectures will be made available for asynchronous viewing
- Assignments will be e-mailed to the instructors
- Term project presentations will be held synchronously via Zoom

Tentative Course Schedule (MCEE-789/PHYS-789 – Spring Semester 2024)

The following table outlines a tentative schedule for course lectures and laboratory sessions/demonstrations.

Dates	Lecture Subject	Lab Session	Instructors
Jan. 17th	Course Introduction and Roadmap		All/Puchades
Jan. 24th	2D Fundamentals and Synthesis		Mohseni
Jan. 31st	Fabrication and Transfer	Graphene Transfer	Puchades/Huang
Feb. 7th	Electron Microscopy	Graphene, MoS_2, h-BN SEM	Mohseni/Znati
Feb. 14th	Scan Probe Microscopy	MoS_2 AFM	Mohseni/Manimaran
Feb. 21th	Optical Spectroscopy	Graphene Raman; MoS_2 Raman/PL	Mohseni/Znati
Feb. 28th	Graphene-Based Devices		Puchades/Huang
Mar. 6th	Graphene-Based Devices	Metallization and Liftoff	Puchades/Huang
Mar. 13th	***Spring Break***		
Mar. 20th	Graphene-Based Devices	I-V Measurements	Puchades/Huang
Mar. 27th	Iontronics	Monolayer Exfoliation	Xu/Manimaran
Apr. 3rd	Emerging Applications	AFM	Xu/Morrell
Apr. 10th	Neuromorphic Computing	PL Spectroscopy	Xu/Morrell
Apr. 17th	Straintronics	Heterostructure Transfer	Xu
Apr. 24th	***Term Project Presentations***		
May 1st	***Term Project Reports Due***		