

# *2021 Virtual MS Open House*

*Department of Chemical Engineering  
Columbia University*



*TRANSCENDING DISCIPLINES, TRANSFORMING LIVES*

# Open House Agenda

- *Welcome remarks*
- *Intro to department and program overview*
- *Research*
- *Career Placement*
- *Graduate Student Affairs*
- *Break-out Chatrooms*

Type questions you have into the **Zoom chat**  
(reply to everyone or privately to Alex Urban)





# Columbia University



in the City of New York



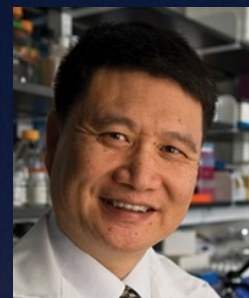
2009



Banta



Leonard



Ju



O'Shaughnessy



West



Park

## A Decade of Growth in Chemical Engineering



Kumar



Koberstein



Durning



McNeil

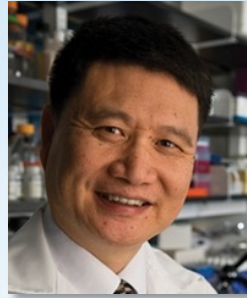
# Our Faculty



Banta



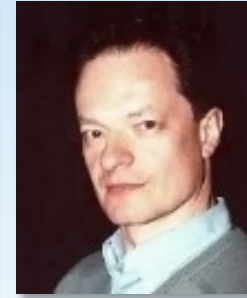
Leonard



Ju



Obermeyer



O'Shaughnessy



Moment



Simunovic



West



Steingart



Marbella



Urban



Chen



Esposito



Park



Kumar



Gang



Durning



Bishop



Boyce



McNeil



Venkatasubramanian

# MS Committee – Direction and Oversight



**Alex Urban**



**Scott Banta**  
Chair



**Robert Bozic**



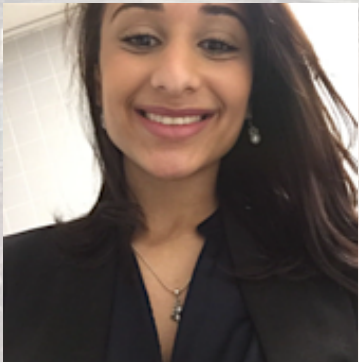
**Daniel Esposito**



**Aaron Moment**



# Our Staff



**Emely Aquino**  
Administrative  
Assistant



**Rezarta Binaj**  
Business  
Manager



**Kathy Marte-Garcia**  
Director of Finance and  
Administration



**Ariel Sanchez**  
IT Manager



**Raina Ranaghan**  
Career Placement  
Officer

# Our Students

## ○ *Chemical Engineering Students*

- ≈ 75 PhD students (growing)
- ≈ 120 undergraduate students
- ≈ 100 M.S. students
- ≈ 20 postdoctoral & staff associates

## ○ *Interactions with M.S. and undergrads*

- **Research:** MS students who do research often work closely with Ph.D. students or postdocs.
- **Shared events:** ChEGO brunch and happy hour, Gaden lecture, professional development activities
- **Classes/Teaching:** MS and Ph.D. students take the same classes; Ph.D.s serve as TAs for courses and hold office hours.



Recent Chemical Engineering M.S. graduating class



Marshall Scholarship recipient Amar Bhardwaj (class of 2020)

# Chemical Engineers....

“... take laboratory or conceptual ideas and turn them into value added products. From computer chips to innovations in recycling, treating disease, cleaning water, and generating energy, the processes and products that chemical engineers have helped create touch every aspect of our lives.”

**“Grand Challenges<sup>1</sup>” related to ChemE:**  
**Making solar energy economical**  
**Provide energy from fusion**  
**Provide access to clean water**  
**Develop carbon sequestration methods**  
**Restore and improve urban infrastructure**  
**Engineer better medicines**  
**Manage the nitrogen cycle**

<sup>1</sup> US National Academy of Engineering Poll:  
<http://www.engineeringchallenges.org>

**AIChE**  
The Global Home of Chemical Engineers



# Columbia Chemical Engineering MS Program

## Standard Timeline – 30 credits

<b>Fall Sep- Dec</b>	<b>Spring Jan- May</b>	<b>Summer Jun- Aug</b>	<b>Fall Sep- Dec</b>
<b>Core MS Course Core MS Course MS Colloquium Elective Elective</b>	<b>Core MS Course Core MS Course Elective Elective</b>	<b>Time for Summer Internships Time for Research</b>	<b>Elective Elective</b>

### Core Classes:

**Kinetics**

**Math Methods**

**Advanced Thermo. or Statistical Mechanics**

**Transport Phenomena**

# Columbia Chemical Engineering MS Program

## Scientist to Engineer Timeline – 30 credits + Essentials

Fall Sep- Dec	Spring Jan- May	Summer Jun- Aug	Fall Sep- Dec
<b>CHEN E4001 Essentials A</b> <b>CHEN E4002 Essentials B</b> MS Colloquium Elective Elective	Core MS Course Core MS Course Elective Elective	Time for Summer Internships Time for Research	Core MS Course Core MS Course Elective Elective

### Core Classes:

Kinetics

Math Methods

Advanced Thermo. or Statistical Mechanics

Transport Phenomena

One Design Elective

# Scientist to Engineer Essentials of Chem Eng A and B

Essential chemical engineering principles

## **CHEN E4001x Essentials of Chem Eng – A**

1. Introduction to Chemical Engineering
2. Chemical Engineering Control
3. Transport Phenomena I
4. Transport Phenomena II

## **CHEN E4002x Essentials of Chem Eng – B**

1. Thermodynamics I
2. Thermodynamics II
3. Reaction Kinetics & Reactor Design
4. Chemical & Biochemical Separations

**A graduate-level course with substantial design**



# MS Colloquia

**Program Welcome!**  
*Life as a Graduate Student  
Pursuing a PhD*

***Guest Speakers from  
Academia and Industry***

***Networking***

***Internships,  
Resumes and  
Corporate  
Recruiting***

## **Your Academic Seminar**

***American  
Institute of  
Chemical  
Engineers  
Young  
Professionals***

***Contemporary topics in  
Chemical Engineering***



# Electives

- *Broad selection in areas such as*
  - Soft Matter and Polymer Science
  - Electrochemical Energy
  - Biotechnology and Biopharmaceuticals
  - Computation and Data Science
  
- *More details*
  - Up to two electives outside of Chemical Engineering
  - Fieldwork and internships may count as elective credit
  - Concentrations are collections of four focused electives
  - Research counts as elective credit





# Concentrations

## ○ *Three current areas*

- Computation and Data Science
- Climate Solutions
- Biotechnology and Biopharmaceuticals

## ○ *Elective choices are available here*

<https://cheme.columbia.edu/master-science-program-0>



# Advising and your calendar

Advising of MS students is currently the responsibility of the Masters Committee. Each incoming MS student will be assigned an advisor who will meet with you and approve courses.

Chemical Engineering Graduate Student Handbook:  
<http://cheme.columbia.edu/masters-program-2>)

Registration for classes is done through student services on line: <https://ssol.columbia.edu/>

Graduate student course registration dates are dictated by the CU Registrar Office and posted at the Columbia Academic Calendar site.

<http://registrar.columbia.edu/event/academic-calendar>





*Questions?*

*Please type them into Zoom Chat!*



# Concentration in Data and Computational Science

## Electives

Numerical Methods in Chemical Eng.

Chem. Eng. Data Analysis

AI in Chem. Eng.

Statistical Mechanics

Computational Fluid Dynamics

Atomistic Simulations

Research



# Concentration in Climate Solutions

## Electives

Eng. Appl. In Electrochemistry

Solar Fuels

Electrochemical Energy Storage Sys.

Carbon Utilization and Conversion

Atmospheric Aerosols

Energy Sources and Conversion

Intro. to Atmospheric Science

Managing and Adapting to Climate Change

NMR in Bio, Soft, Energy Materials

Atmospheric Radiation



# Concentration in Biotechnology and Biopharmaceuticals

## Electives

Tissue and Mol. Eng. Lab (inst. perm.)

Principles of System Pharm. (inst. perm.)

Biopharm., entrepreneurship, and Chem. Eng.

Solid State Chem. In Pharm. Dev.

Pharm. Eng.

Biopharm. Process Lab

Summer Intensive Lab in Biotech. (inst. perm.)

Research

Bioseparations

Biochemical Eng.

Principles of Genomic Tech.

Protein Eng.

Biostatistics for Eng.



# *Research Opportunities for MS Students*



*TRANSCENDING DISCIPLINES, TRANSFORMING LIVES*

# Why Get Involved In Research During your MS studies?\*

- *Research Strongly Complements Coursework*
  - *Apply core concepts to open-ended problems.*
  - *Gain hands-on laboratory experience & skills while working with state-of-the art instruments and facilities.*
- *Gain Exposure to Cutting Edge Science & Engineering*
  - Carry out in-depth study on an emerging technology.
  - Get a sense for life as a PhD student or research scientist.
- *Connect with Faculty and PhD Students*
  - Opportunity to interact more closely with faculty.
  - Expand your professional network.

\*About 1/3<sup>rd</sup> of MS students have participated in research in recent years.





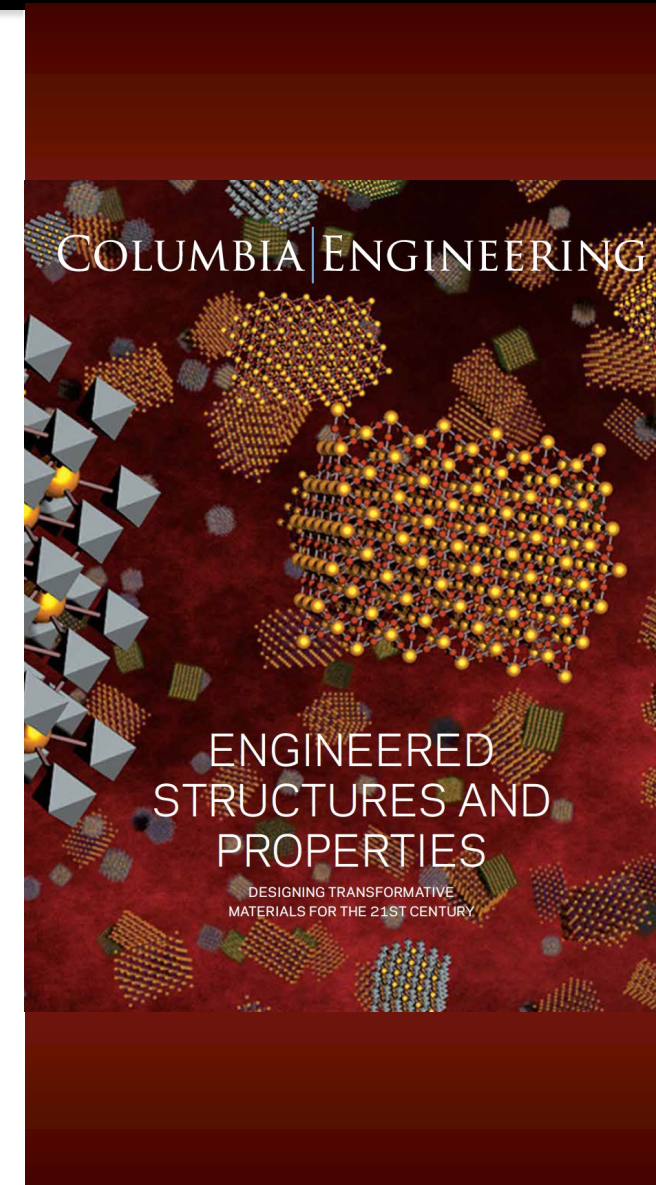
# How does an MS Student get Involved with Research?

## ○ *Process for Joining a Lab*

- Read about faculty research labs.
- Reach out to faculty with your resume and express interest in doing research in their lab.
- Begin doing research for credit (CHEN E9400) in your 2<sup>nd</sup> semester. Up to 6 credits count towards 18 point elective requirement for the MS program.

## ○ *Summer Research*

- Great opportunity to do a “deep dive” into a research project and better get to know NYC.
- Funding support available (Societe scholarship, Dean’s office fund matched by faculty)
- LifeSci NYC Intern program: R&D in bioengineering / biotech.



# Research themes\*

## Energy & Environment

Chen	<i>Catalysis</i>	Marbella	<i>NMR characterization</i>
Esposito	<i>Solar fuels</i>	Steingart	<i>Electrochemical systems</i>
Park	<i>Carbon capture</i>	Urban	<i>Materials discovery</i>
McNeill	<i>Air quality</i>	West	<i>Multiscale modeling</i>
Venkat	<i>Artificial intelligence</i>		

## Biotechnology

Banta	<i>Protein engineering</i>
Ju	<i>DNA sequencing</i>
Obermeyer	<i>Protein biopolymers</i>
O'Shaughnessy	<i>Cell biophysics</i>
Simunovic	<i>Synthetic embryology</i>

## Soft Materials

Kumar	<i>Polymer composites</i>
Durning	<i>Membrane transport</i>
Gang	<i>Nanoparticle assemblies</i>
Bishop	<i>Colloidal robotics</i>
Boyce	<i>Granular flows</i>

\*See the MS open house website for links to websites, posters, and videos:

SUSTAINABLE HUMANITY



McNeill

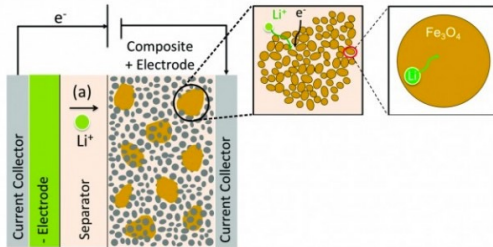
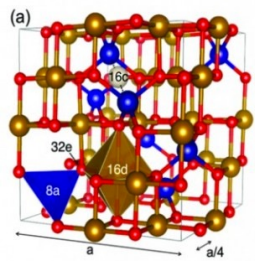
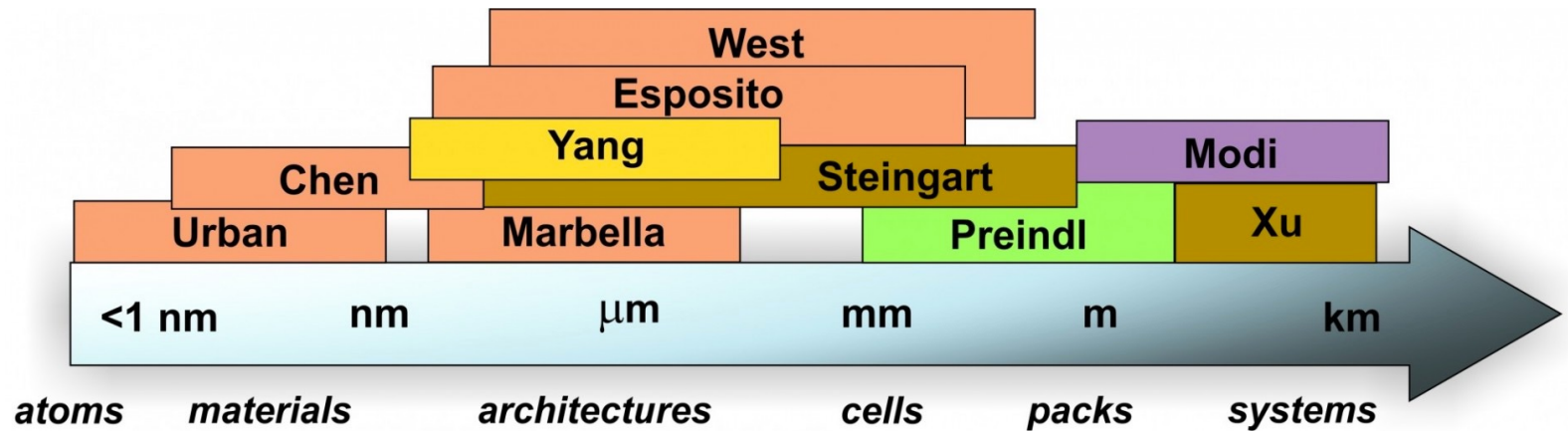
RESEARCH



Imagine a world where the power of data and atmospheric chemistry can help protect human health.

# Collaborative Research

- *Columbia Electrochemical Energy Center (CEEC)*
  - Batteries, fuel cells, and electrolyzers
  - Multiscale approach from electrons to devices to systems



COLUMBIA | ENGINEERING

TRANSFORMERS

CHARTING THE FUTURE OF CLEAN ENERGY  
AND CLEAN ENERGY STORAGE

# Shared facilities\*

- *Soft Matter Lab*
  - Shared space and equipment for Kumar, Gang, Bishop and others
- *CEEC shared lab space (10<sup>th</sup> floor of Mudd)*
- *Renovated Labs in Mudd*
- *Northwest Corner Building*
- *Lasker Building*
- *Columbia Nano Initiative (CNI)*
  - Clean Room; characterization laboratory; electron microscopy

\*See photos and description of instruments here:

<http://cni.columbia.edu/shared-labs>

