AGU Department of Materials Science and Nanotechnology Engineering

INSTRUCTOR RECORD

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Course Assistant(s)

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COURSE RECORD

Code	MSNE 352/AMN 542 (AGU) & MSE 5001/6001 (Missouri S&T)
Name	Molecular Engineering and Soft Nanomaterials
Hour per week	3 (Theory + Practice + Lab)
Credit	3
ECTS	7,5
Level/Year	Undergraduate & Graduate
Semester	Spring
Type	Elective
Classroom	B211-C
Prerequisites	One of the following courses: General Chemistry, Organic Chemistry, Polymer Chemistry, Materials Science etc. (undergraduate level courses)
Special Conditions	AGU and Missouri S&T designed this course collaboratively and it will take place at the same time in both campuses. Students that are enrolled from each campus will be accessing the same course content and interacting with each other to a great degree. Therefore, your attendance, full participation to the course, and the quality/quantity of your exchanges with your instructor and peers in the class is expected and will be very important for the success of this course.
Webpage	To be announced.
Content	This course focuses on the fundamentals of molecular engineering and soft nanomaterials with strong emphasis on their applications in nanotechnology, optoelectronics, air/water cleaning, and renewable/clean energy solutions. The molecular engineering approach used in this course does not only teach the fundamentals for rational design of existing soft nanomaterials but also provides the essential skills to design next-generation soft nanomaterials for future applications. Topics include principles of modern physics, carbon chemistry, rational molecular engineering, small molecules, polymers, macromolecules, nano-science/nanotechnology, organic/printed optoelectronics, metal (covalent)-organic frameworks, sustainability, and renewable/clean energy.
Objectives	1. The understanding of the fundamentals for rational design of existing soft nanomaterials. 2. Provides the essential skills to design next-generation soft nanomaterials for future applications.
Learning Outcomes	1. Develop an understanding of fundamentals and principles of molecular engineering and soft nanomaterials, and their applications. 2. Understand the opportunities and risks of current, emerging, and prospective soft nanomaterials and their related applications. 3. Demonstrate awareness for different aspects of nanomaterials and applications such as technological, sociopolitical, economical and environmental impacts. 4. Identify, analyze and propose a range of strategies/solutions to address material needs for various applications such as renewable versus non-renewable energy, clean versus carbon-based fuels, and energy-efficient lighting.

	5. Know the key stakeholders including scientists, political leaders, business leaders, philanthropists, and citizens to promote emerging and prospective materials.
Teaching Methodology	Learners will be provided with as much opportunities of hands-on practice as possible with the aim of striking a balance between learner-centeredness and sufficient guidance. Various forms of interaction (i.e. pair work and group work) will also be encouraged to cater for learners with different learning styles. Additionally, individuals will be expected to produce both in-class writings and homework assignments in addition to the reading tasks, which will encourage them to reflect and think critically. Technology will also be incorporated into the classroom procedures in order to create a better learning environment.
Requirements	Every week, articles and videos will be given as required reading/watching assignments in the course. Your performance in these assignments will be considered towards your "Assignments" under course grading.
Reading List	1. Chemistry in Context: Applying Chemistry to Society (8th Edition) - McGraw-Hill-International Edition (Chapter 1: The Air We Breathe; Chapter 2: Protecting the Ozone Layer; Chapter 3: The Chemistry of Global Climate Change; Chapter 4: Energy From Combustion; Chapter 9: The world of Polymers and Plastics; Chapter 10: Manipulating Molecules and Designing Drugs). 2. Materials Science and Engineering (8th Edition) – William D. Callister, David G. Rethwisch, John Wiley & Sons, Inc. – SI Version (Chapter 1: Introduction; Chapter 2: Atomic Structure and Interatomic Bonding; Chapter 14: Polymer Structures; Chapter 15: Characteristics, Applications, and Processing of Polymers). 3. Organic Chemistry (11th Edition) – G. Solomons, C. Fryhle, S. Snyder, Wiley – International Student Version (Chapter 1: The Basics, Bonding and Molecular Structure; Chapter 2: Families of Carbon Compounds) 4. General Chemistry (9th Edition) - D. D. Ebbing, S. D. Gammon - Houghton Mifflin Company (Part 1, Chapter 2: Atoms, Molecules, and Ions; Part 2: Atomic and Molecular Structure- Chapters 7,8,9, and 10; Part 5, Chapter 23 and 24: Organic Chemistry and Polymer Materials.

ASSESSMENT

The final grade will be determined numerically by averaging your scores with the following weights:

Evaluation Criteria	**Weight** (%)
Weekly Assignments	25%
(*In-Class Discussions, Reading/Video Assignments, One-on-One Meetings*)	
Midterm Exam	30%
Project Presentation & Project Report (20% & 80%)	40%
Class Attendance	5%

Most grades given during the course of the term will be based on a 100-pt scale. The **official decimal class grades** (0.0 - 4.0) will be determined from a weighted average of your individual grades. For a detailed description of grading policy and scale of AGU please refer to the website https://goo.gl/HbPM2y section 28.

Midterm Exam

The mid-term examination will be based upon the first seven weeks of the semester's course material. The exam may be based on quantitative problems, short answer questions, multiple choice, and short essay questions. You may not use a smart phone or other network device during the exam. There is no final exam in this course.

PROJECT PRESENTATION AND REPORT

1. Through project work, students are expected to propose a solution for a chosen problem by using reverse engineering approach, which is expected to be nature-, bio-, or technology-inspired. Reverse engineering approach should offer a one shot solution by using the following steps:

   (i) **Problem statement**: *CO_2 gas emission from factories/engines and its adverse effects on environment and society.*
   (ii) **Technological bottle-neck:** *fossil fuels are efficient sources of energy and it seems that the world will continue to use it for another ca. 50 years. So, we should find a solution to filter and trap CO_2 gas before being emitted to the atmosphere.*
   (iii) **Solution proposal for the problem:** *highly porous materials with large surface areas and good chemical/pyhsical attractions to CO_2 molecules could be used. These materials could be placed inside the factory chimneys and engine exhausts.*
   (iv) **Inspired from what (technology, nature, human, etc.):** *Sand is a porous material (ca. 100 m^2/g) with a large surface area. Some organic moieties (with multiple –OH functional groups) will be placed between oxygen atoms in SiO_2 network structure which will expand the pores and provide good attraction to CO_2 molecules.*
   (v) **Feasibility:** *Synthetic organic chemistry could be used to develop these materials. Some related examples already exist in the literature.*
   (vi) **Impact on Quality of Life**: *It will increase the quality of air and water, and we can safely use fossil fuels to meet our energy need.*

2. Students from AGU and Missouri S&T are expected to meet (Instructors are not involved) during Module-1 of the course to exchange their project ideas and submit a short report (150-200 words) on their progress.
3. Oral presentations (20 minutes) and discussions (15-20 minutes) will be performed in Module-2 of the course, and it is considered as a chance to discuss the project idea with the fellow students and the instructors to obtain useful feedbacks for writing the project report.
4. At the end of the presentations, presenter student will ask two questions (creative/innovative) to stimulate critical thinking and to start the discussion.
5. The project report is due the end of the semester, and each student is expected to submit one project report (maximum 10 pages including main text, graphs, images, table of content, etc.).
6. Students are expected to improve their oral, written and visual communication skills.

ETHICAL RULES AND COURSE POLICY

Course Policies

- English should be used at all times to communicate with one another during instruction hours.
- Please, respect the allotted times provided for breaks.
- Cell phones must be turned off and put away during class. Personal computers are only to be used during in-class activities and only for class assignments. Unless it is part of the lecture time activity assigned by the instructor, do not use the computer. When using the computer do not surf on the web or write personal emails, etc. Consequences include but are not limited to loss of participation points and/or being asked to leave the classroom.
- Conducting personal business should be done outside of the classroom, on your own time, where it does not interfere with the learning environment of your fellow students.
- Unless the class is working on an exercise, or you are interacting with the instructor, you are asked to refrain from talking after the beginning of the class.
- Please be prepared, having read, written, watched and studied the assigned lessons, articles, passages, or videos;
- Please be ready to write assignments in class that will be graded; and most importantly work cooperatively with other students.

	For the AGU Make-up policy, please refer to the website https://goo.gl/HbPM2y section 26.
Attendance Policy	• Be in the class on time (being late for class is an extreme annoyance to the entire class). • Class attendance is strongly recommended and will count toward your participation grade. Regular class time will include informal assessment activities for which points will be assigned. Participation in these activities will help you prepare for exams and homework and also provide me with feedback on your progress. For a detailed description of AGU attendance policy, please refer to the website at https://goo.gl/HbPM2y section 25.
Email Policy	When contacting the instructor or the course assistant, please use the Canvas email feature. Only use the official university mail service if Canvas is not accessible (server down, etc). Include in the subject line the course number (MSNE 352, AMN 542, MSE 5001/6001). If this information is not included, your email may not be answered. All announcements or warnings will be send to your official university email address. Therefore it is the responsibility of every student to read his/her official university email address and check the CANVAS regularly.
Cheating & Plagiarism	You are responsible for knowing the University policies on cheating and plagiarism. Not giving credit to a person for their intellectual work and passing it off as your own is stealing. Specifically: • Copying or allowing someone to copy your work on an exam, homework, or in class assignment is cheating. • Cutting and pasting material from the web or any other electronic source is plagiarism. • Copying and turning in the same assignment as someone else, from this class or from another class, is cheating. Unless explicitly told otherwise, you can discuss and problem- solve on homework together but the final product has to be your own – not just your own handwriting but your own way of explaining and organizing your ideas. • Making superficial changes (minor additions, deletions, word changes, tense changes, etc) to material obtained from another person, the web, a book, magazine, song, etc. and not citing the work, is plagiarism. The idea is the intellectual property, not the specific format in which it appears (e.g., you wouldn't reword Einstein's theory of relativity and imply that relativity was your own idea, would you?) • If you find material and it is exactly what you are trying to say, or you want to discuss someone's idea, give the person credit and cite it appropriately. Don't overuse citations and quotes: instructors want to know how you think and reason, not how some one else does. • If you have any questions or concerns about whether your behavior could be interpreted as plagiarism, please ask the assistants or me before you submit the work. For a detailed description of AGU policies, please refer to the website at https://goo.gl/FjLhzH

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Week	Date		Topic
	22 - 26 January	MODULE 1	No class at AGU/Reading Assignments at Missouri S&T
	29 January – 2 February		No class at AGU/Reading Assignments at Missouri S&T
1st	05 – 09 February		**The world of Quantum Theories, Atoms, and Introduction to Covalent Bonding**: Modern Physics, Quantum Theories, Wave-Particle Duality, Atomic Theories, Covalent Bonding
2nd	12 – 16 February		**Covalent Bonding, Valence Bond Theory and Molecular Structures:** Lewis Structures, Valence Bond Theory, VSEPR Theory, Molecular Orbital Theory, Hybridization Theory, Sigma-Pi Bonds
3rd	19 – 23 February		**The King of Elements, Carbon, and Families of Organic Compounds:** Molecular/Polymeric Structures, Functional Groups, Hybridization Theory, The Study of Carbon-Containing Molecules and Polymers, Liquid Crystals, Light-Emitting Organic Compounds, Teflon
4th	26 February – 2March		**Molecular Engineering and Soft Nanomaterials** The World of Small Things, Characterization Techniques, NMR Spectroscopy, Mass Spectroscopies, Nature and Bio-Inspired Soft Nanomaterials, Superhydrophobic Surfaces
5th	5 – 9 March		**Nanotechnology and Energy:** Nanoscale Energy Materials for High-Performance Batteries, Super capacitors, Fuel Cells, Sun to Fuel and Other Energy Storage/Conversion Systems
6th	12 - 16 March		**Flexible and Low-Cost Plastic Optoelectronics:** Organic Semiconductors and Conductors, Dielectric Materials, Liquid Crystal Displays (LCDs), Organic Light-Emitting Diodes (OLEDs), Field-Effect Transistors (OFETs), and Light-Emitting Transistors (OLETs).
7th	19 – 23 March		**Renewable and Clean Energy Solutions:** Organic Photovoltaic Technologies (BHJ-OPVs, DSSCs, and Perovskite Solar Cells), Metal-Organic Frameworks, Covalent-Organic Frameworks
8th	**26 – 30 March**		**Spring Break (for AGU and Missouri S&T)**
9th	**2 – 6 April**		**Project Presentations/In-Class Discussions**
10th	9 – 13 April	MODULE 2	**Project Presentations/In-Class Discussions**
11th	16 – 20 April		**Project Presentations/In-Class Discussions**
12th	23 – 27 April		**Project Presentations/In-Class Discussions**
13th	30 April – 4 May		**Project Presentations/In-Class Discussions**
14th	7 – 11 May		**Project Reports Due**
15th	14 – 18 May		**Reading Assignments at AGU/No class at Missouri S&T**