

Fall 2018

# CHEM 748-101: Nanomaterials

Zafar Iqbal

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## Recommended Citation

Iqbal, Zafar, "CHEM 748-101: Nanomaterials" (2018). *Chemistry and Environmental Science Syllabi*. 43.  
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## Chemistry: *Fall 2018 Course Syllabus*

**[NJIT Academic Integrity Code](#):** All Students should be aware that the Department of Chemistry & Environmental Science (CES) takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

### COURSE INFORMATION

**Course Description:** This **3 credit** course [3 hrs/week of class] on Nanomaterials is designed to introduce advanced undergraduates and graduate students in chemistry, materials science, physics, electrical engineering and bio-engineering to the emerging area of nanotechnology that has the potential to revolutionize techniques by which materials and products will be created in the future with new and superior properties and functionalities. Nanotechnology refers to the world as it works on the nanometer scale from **below a nanometer to a few hundred nanometers**. The synthesis and control of nanomaterials will involve so-called “**bottom up**” strategies of self-assembly starting with the smallest possible entities, such as atoms and molecules, much in the same way as synthesis is conducted in natural biological systems. Some “**top down**” mechanical methods will also be discussed. The goal of the course will be to prepare and train students in this evolving technology which lies at the interfaces of chemistry, physics and biology. The course will start with fundamental concepts and then proceed to nanoscale phenomena and properties. This will be followed by discussions on the synthesis and self-assembly of nanomaterials and methods for their characterization. Emerging and potential applications of nanomaterials will be considered in the final segment of the course.

**Number of Credits:** 3

**Prerequisites:** Senior undergraduate level quantum mechanics, calculus, chemistry and physics

#### Course-Section and Instructor

Course-Section	Instructor
Chem 748-101	Zafar Iqbal

**Office Hours for All Chemistry & Environmental Science Instructors:** [Fall 2018 Office Hours and Emails](#)

#### Required Textbook:

Title	The Physics and Chemistry of NanoSolids
Author	F.J. Owens and Charles P. Poole Jr

<b>Edition</b>	First, 2008
<b>Publisher</b>	John Wiley and Sons Inc, Hoboken, New Jersey
<b>ISBN #</b>	978-0-470-06740-6

**University-wide Withdrawal Date:** The last day to withdraw with a **W** is Monday, November 12, 2018. It will be strictly enforced.

**Learning Outcomes:** Understanding the chemistry and physics of nanomaterials, how nanomaterials are synthesized including both bottom up and top down methods, how best to characterize nanomaterials, and finally to get an overview of conventional and potential applications in emerging areas of nanotechnology related to electronics, energy and biology.

## **POLICIES**

All CES students must familiarize themselves with, and adhere to, all official university-wide student policies. CES takes these policies very seriously and enforces them strictly.

**Grading Policy:** The final grade in this course will be determined as follows:

<b>Homeworks</b>	20%
<b>Quizzes and term paper</b>	20%
<b>Midterm Exam I</b>	15%
<b>Midterm Exam II</b>	15%
<b>Final Exam</b>	30%

Your final letter grade in this course will be based on the following tentative curve:

<b>A</b>	80% and above	<b>C</b>	40-49.5
<b>B+</b>	70-79.5	<b>D</b>	30-39.5
<b>B</b>	60-69.5	<b>F</b>	Below 30
<b>C+</b>	50-59.5		

**Attendance Policy:** Attendance at classes will be recorded and is **mandatory**. Each class is a learning experience that cannot be replicated through simply “getting the notes.”

**Homework Policy:** Homework is an expectation of the course. The homework problems set by the instructor are to be handed in for grading and will be used in the determination of the final letter grade as described above.

**Exams:** There will be two midterm exams held in class during the semester and one comprehensive final exam. The following exam periods are tentative and therefore possibly subject to change:

<b>Midterm Exam I</b>	October 10, 2018
<b>Midterm Exam II</b>	October 31, 2018
<b>Final Exam Period</b>	December 15 - 21, 2018

The final exam will test your knowledge of all the course material taught in the entire course.

**Makeup Exam Policy:** There will normally be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event that a student has a legitimate reason for missing a quiz or exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the CES Department Office/Instructor that the exam will be missed so that appropriate steps can be taken to make up the grade.

**Cellular Phones:** All cellular phones and other electronic devices must be switched off during all class times. Such devices must be stowed in bags during exams or quizzes.

## ADDITIONAL RESOURCES

**Chemistry Tutoring Center:** Located in the Central King Building, Lower Level, Rm. G12. Hours of operation are Monday - Friday 10:00 am - 6:00 pm. For further information please click [here](#).

**Accommodation of Disabilities:** Office of Accessibility Resources and Services (*formerly known as Disability Support Services*) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director at the Office of Accessibility Resources and Services at **973-596-5417** or via email at [lyles@njit.edu](mailto:lyles@njit.edu). The office is located in Fenster Hall Room 260. A Letter of Accommodation Eligibility from the Office of Accessibility Resources Services office authorizing your accommodations will be required.

For further information regarding self-identification, the submission of medical documentation and additional support services provided please visit the Accessibility Resources and Services (OARS) website at:

- <http://www5.njit.edu/studentssuccess/disability-support-services/>

**Important Dates** (See: [Fall 2018 Academic Calendar, Registrar](#))

Date	Day	Event
September 4, 2018	T	First Day of Classes
September 10, 2018	M	Last Day to Add/Drop Classes
November 12, 2018	M	Last Day to Withdraw
November 20, 2018	T	Thursday Classes Meet
November 21, 2018	W	Friday Classes Meet
November 22 - 25, 2018	R - Su	Thanksgiving Break - University Closed
December 12, 2018	W	Last Day of Classes
December 14, 2018	F	Reading Day
December 15 - 21, 2018	F - R	Final Exam Period

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## Course Outline

Lecture	Section	Topic	Assignment
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1		<b>I. Introduction</b> 1. Definitions and course organization 2. Historical development of nanomaterials 3. Classification of nanomaterials	Homework 1
2,3		<b>II. Size &amp; Scale</b>  1.Units 2.Scaling Atoms, Molecules, Clusters and Supramolecules 3. Structure and Bonding in Nanomaterials  Chemical Bonds (types and strength) Inter-molecular Forces  Molecular and Crystalline Structures  Hierarchical Structures  Self-assembly and thermodynamics	Homeworks 2, 3
4,5		<b>III. Properties and Size dependence of properties</b>  1.Chemical  2.Optical  3.Electrical  4.Magnetic  5.Mechanical  6.Theoretical Aspects-e.g. density functional theory	Homeworks 4,5

6,7		<p>IV. Nanomaterial Synthesis</p> <ol style="list-style-type: none"> <li>1. Chemical routes</li> <li>2. Electrochemical methods</li> <li>3. Vapor growth</li> <li>4. Thin films methods: chemical vapor deposition, physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth</li> <li>5. Mechanical methods: ball milling, mechanical attrition</li> <li>6. Sol-gel methods</li> <li>7. Synthesis of special nanomaterials: <i>carbon nanotubes, fullerenes, nanowires, porous silicon</i></li> <li>8. Bio-inspired synthesis</li> <li>9. Nanocomposite fabrication</li> <li>10. Nanolithography</li> </ol>	Homeworks 6,7
8,9		<p>V. Nanomaterial characterization techniques</p> <ol style="list-style-type: none"> <li>1. Scanning and Transmission Electron Microscopy</li> <li>2. Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy</li> <li>3. Diffraction and scattering techniques</li> <li>4. Vibrational spectroscopy</li> <li>5. Surface techniques</li> </ol>	Homework 8,9
10		<p>VI. Applications</p> <ol style="list-style-type: none"> <li>1. Nano-electronics</li> </ol>	Homework 10, term paper
		<ol style="list-style-type: none"> <li>2. Nanoscale chemical- and bio-sensing</li> <li>3. Biological/bio-medical applications</li> <li>4. Photovoltaic, fuel cells, batteries and energy applications</li> <li>5. High strength nanocomposites</li> <li>6. Nanoenergetic materials</li> </ol>	
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*Updated by - 2018  
Department of Chemistry & Environmental Sciences  
Course Syllabus, Fall 2018*

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