CHEM 899 -- ST: Nanoscience for High School Teachers (Fall 2017)

1 credit hour
Online Format
(August 21 – December 15, 2017)

Instructor: Christopher L. Exstrom
Office: 405C Bruner Hall of Science
Phone: (308) 865-8565
E-mail: exstromc@unk.edu

Required textbook: None – video lectures, examples from the scientific literature, and open access materials will be provided by the instructor

Technical Requirements and Competencies. Course delivery will be made entirely through Canvas. A broadband internet connection (DSL, cable, etc.) is recommended but the instructor will make every effort to keep the size of course documents down to accommodate those with dial-up internet connections. Course documents may be in Adobe PDF or Microsoft Office (Word, Excel, Powerpoint) formats. Links to downloadable free viewers will be provided. It is expected that you be able to download documents and open them in their appropriate programs. Exams will be taken on Canvas. Familiarity with standard online form functions – radio buttons, check boxes, fill-in blanks, etc. – is required.

Course Description. This course provides an introduction to the preparation and properties of nanoscale materials in connection to current and future scientific applications. Approaches to integrating nanoscience in grade 7-12 instruction will be explored. Specific materials systems discussed will be influenced by the publicity of recent research breakthroughs and may include quantum dots, gold and silver nanosensors, semiconductor nanoparticles, and carbon nanotubes. **Credit will not be granted for both this course and CHEM 821.** *Prerequisite:* none.

Course Learning Objectives. This course features science content with a directed project that focuses on integrating nanoscience material into the grade 7-12 science curriculum.

- Understand how the properties of particles in the nanoscale size regime are determined by the particle size, not its atomic/molecular composition
- Understand the preparation, shape modification and sensor applications of gold and silver nanoparticles
- Understand how semiconductor nanoparticles are prepared and their applications in photovoltaic solar cells
- Understand the properties of a variety of carbon nanostructures, including Buckminsterfullerenes, graphine, and nanotubes
- Develop an original nanoscience activity for incorporation into one of the student's grade 7-12 science classes

Course Learning Structure. Welcome to the world of nanoscience! Course content is divided between four modules:

Module 1 (weeks 1-4) – Introduction to the nanoscale and quantum dots
Module 2 (weeks 5-8) – Gold and silver nanoparticle synthesis and their sensor applications
Module 3 (weeks 9-12)– Semiconductor nanoparticles
Module 4 (weeks 13-16) – Carbon nanostructures

Within each module, the following types of assignments must be completed:

Video Lectures – one per week each of the first three weeks. A post-lecture quiz must be completed after each lecture

Homework Problems – generated by the instructor. One assignment per module.

Your grade will be based on the number of accumulated points as a percentage of the total possible number of points according to the distribution given below:

GRADING DISTRIBUTION*

Post-lecture quizzes (12)	36% (3% each)
Graded Homework (4)	36% (9% each)
Original Nanoscience Activity	28%

Post-lecture quizzes. Short Canvas-delivered quizzes with a variety of formats, including essay, multiple-choice, and/or short-answer questions. Open-lecture/notes/other resources

Homework. You will receive assigned homework as handouts (one per module) from the instructor. All problems will be graded.

Original Nanoscience Activity (deadline: Tuesday, December 12, 5:00 p.m. CT). At the graduate level, one must develop the ability to create original instructional material from existing knowledge. As a term project, you are required to write an "original" **one-day** lesson plan that introduces and/or reinforces one or more concepts from this course. A demonstration or lab activity must be included – this may constitute the entire lesson if it fills an entire class period. Your writeup should include a lesson plan summary in the format that you would turn in to your principal or department head, detailed outlines of any lectures, full descriptions and "teacher notes" for any demonstrations, and complete handouts for any lab experiments (include a background section, procedural instructions for students, additional notes for teachers, and information on chemical hazards, safety, and storage considerations). There will be intermediate deadlines that correspond to the course module timeframes:

- **Week 4 –** Discussion Board assignment on identifying places in the grade 7-12 curriculum for nanoscience material
- **Week 8 –** Discussion Board assignment on topic proposal for the nanoscience activity
- **Week 12 –** Detailed outline of nanoscience activity with peer and instructor review
- **Week 16 –** Submit final nanoscience activity

Discussion Board Responses. Each response will be graded according to rubrics posted in Canvas.

Grading Scale. The following weighted percentage point scale will be the initial starting point: A (93-100), A- (90-92.9), B+ (87-89.9), B (83-86.9), B- (80-82.9), C+ (77-79.9), C (73-76.9), C- (70-72.9), D+ (67-69.9), D (63-66.9), D- (60-62.9), F (below 60). This scale may be moved downward at the instructors discretion.

DEADLINES. A table of deadlines for all assignments and exams is given on the last page of this syllabus. ***To keep the class flowing smoothly, these deadlines will be strictly adhered to.*** The following penalties will be applied to late work:

Up to 24 hours late	25% of possible points (or zero score for discussion board response)
Between 24-48 hours late	50% of possible points (or zero score for discussion board response)
Over 48 hours late	Zero score

(NOTE: These late times apply to business days only. Business days are defined as Monday-Friday except the following – September 4 (Labor Day), October 16-17 (UNK Fall Break) and November 22-24 (UNK Thanksgiving Break)

CHEM 823 Course Material Outline and Objectives

Module	Broad Objectives	Nanoscience Activity Project Assignment
Introduction to Nanoscale and Quantum Dots	• Be able to distinguish how the nanoscale size regime differs from the atomic/molecular scale and the macroscopic size scale • Understand that "quantum dots" are nanoparticles within a size regime in which electronic properties are determined by the particle's size, not its atomic/molecular composition • Understand how light absorption and emission by quantum dots vary with particle size	• Discussion Board response on identifying places in the grade 7-12 curriculum for nanoscience material
Gold and Silver Nanoparticles and their Sensor Applications	• Understand how chemical oxidation-reduction reactions are employed to prepare gold and silver nanoparticles • Understand the surface plasmon resonance (SPR) phenomenon that gives gold and silver nanoparticles their visible color appearance • Understand how a variety of gold and silver nanoparticle shapes may be prepared and stabilized • Understand how the SPR phenomenon enables gold and silver nanoparticles to act as biological sensors	• Discussion Board assignment on topic proposal for the nanoscience activity
Semiconductor Nanoparticles	• Understand how a semiconductor differs from conducting and insulating materials • Understand chemical reaction techniques used to prepare semiconductor nanoparticles • Understand how semiconductor nanoparticles may be applied in photovoltaic solar cells	• Detailed outline of nanoscience activity with peer and instructor review
Carbon Nanostructures	• Understand the origin of modern nanoscience with the discovery of Buckminsterfullerene (C_{60}) carbon in the 1980s • Understand the structural differences between graphite, graphene, and nanotube forms of carbon • Understand current and future applications of carbon nanomaterials	• Submit final nanoscience activity