

COURSE AND INSTRUCTOR INFORMATION

Course: PHY 481 (Special Topics: Introduction to Nanomaterials), **Lecture**

Lecture Location: **Schmucker Science North 192**

Lecture Time: MW: 1:00 pm – 1:50 pm

Instructor: Anil K. Kandalam (Dr. Kandalam or Dr. K)

Office Location: Schmucker Science South, SSS 403A

Email: akandalam@wcupa.edu

Office Hours: Wednesday: 8:00 am – 9:00 am, Thursday: 9:00 am – 11:00 am

Friday: 10:00 am – 11:00 am and 1:00 pm – 2:00 pm or by appointment

COURSE DESCRIPTION

This course introduces students to the field of nanoscience with a special focus on the physics/chemistry behind the unique properties of nanomaterials and their applications in various fields. In addition to a historical perspective of nanoscience and a brief review of quantum mechanics, properties of a wide-variety of nanostructures, such as metal nanoparticles, carbon-based nanostructures, low-dimensional nanomaterials, and surfaces at nanoscale will be introduced and discussed in detail.

The laboratory part is designed to complement the lecture portion of the course. The laboratory section will provide you with concrete and hands-on experiments that are standard practice for exploring and characterizing material systems at the nano- and micro- scale.

RECOMMENDED TEXTBOOKS

- **Highly recommended:** *Introductory Nanoscience: Physical and Chemical Concepts*, by Masaru Kuno (Garland Science)
- *An Introduction to the Optical Spectroscopy of Inorganic Solids*, by J. Garcia Sole, L. E. Bausa and D. Jaque, J. Wiley & Sons, Inc. (West Sussex, 2005) ISBN: 0-470-86886-4
- *Introduction to Nanoscience*, S. M. Lindsay (Oxford)
- *Nanostructures and Nanotechnology*, Douglas Natelson (Cambridge University Press), ISBN: 978-0-521-87700-8
- *Introduction to Nanoscience and Nanotechnology*, Chris Binns (Wiley)

PREREQUISITES

MAT 162 and PHY240 for Physics Majors; PHY140/180, MAT 162, and CHE341 for Chemistry Majors.

COURSE COMPONENTS

Lecture: I attempt to make the lecture as informal as possible. I encourage questions during the class.

Problem Sets: There will be one problem set (almost) each week. Working the problem sets is very important for mastering this subject. Generally, they will be given out on Mondays and due the following week's Monday in class.

Exams: Two in-class exams will be given during the semester.

Lab Work Flow: Several of the laboratory class meetings will be more lecture style, where the physics behind the working of an experiment, the information on the measurement and analysis technique are discussed. In other lab meetings, you will work in groups of two or three on a particular experiment. As

the equipment is research-grade and expensive, there is only one set-up for each experiment. Therefore, you will have to take turns completing the experiment, and once you have completed the experiment, you are expected to use one of the computers in MER114 equipped with IGOR to analyze the data. **Please see Lab Syllabus for more details.**

Oral presentation: Please see *Lab Syllabus* for more details.

EVALUATION

The final grade for this course will be based on the following:

- Homework Assignments16%
- Exams (2 @ 12% each)24%
- Laboratory40%
- Final exam..... 20%

Letter grades will be assigned on the following scale. However, I reserve the right to adjust the weights of individual components, or the scale to account for unforeseen circumstances.

93 – 100 %	A	73 – 76 %	C
90 – 92 %	A–	70 – 72 %	C–
87 – 89 %	B+	67 – 69 %	D+
83 – 86 %	B	63 – 66 %	D
80 – 82 %	B–	60 – 62%	D–
77 – 79 %	C+	59% or lower	F

GRADING COMPONENTS AND POLICIES

Problem Sets: There will be one problem set *almost* every week. Generally, they will be given out on Mondays and due the following week's Wednesday in class. A large fraction of the learning in this course takes place working on these homework problems, so it is essential that you put a substantial effort into these assignments. **Late work cannot be accepted except by prior arrangement with the instructor.** Working to deadlines is an aspect of personal responsibility and, as such, it is an important skill to develop. All problem sets will be graded (**to varying degrees**) and returned the following week (typically during Monday class time). If you fail to turn in a problem set because of absences (excused or unexcused) then you will receive a zero for the problem set grade. **The problem sets will be graded only roughly.** It is your responsibility to check your work with the solution set.

You are encouraged to work together/collaborate on problem sets, but the work that you hand in must be your own and must reflect your own understanding of the material. The best balance between working alone and working with other people is to (i) Give each problem a good try on your own first. If you get stuck, reread the relevant section of the text and review your notes and try it again. If you're still stuck, then (ii) ask for help from other students and then (iii) complete the problem alone where you can collect your thoughts in peace. Make sure that you understand the solution to each problem that you turn in. If step (ii) does not help, you can always get hints from me during my office hours. **Please do not ask for help/hints via e-mail.** Please indicate the names of people you have collaborated with for a problem set.

Here's a handy rule of thumb: if you can do the problem without referring to any notes, then you understand the concept and the problem-solving approach. Try a similar problem and prove it to yourself.

Laboratory: This course has a laboratory component. Your lab grade will be factored into your final grade for this course. Please see the lab syllabus for more details.

Regular Exams: **Two** exams will be given during the semester. **No grades will be dropped and there are no-make up exams.** The exceptions, however, are limited to the absences related to University Sanctioned Events (see below). If you miss an exam for a University Sanctioned Event you must notify me in advance so that we can arrange for you to take the exam in a manner consistent with its integrity. You must also provide some form of documentation (performing arts program, competition schedule etc.). If you miss the exam for any other reason the same rules apply, and it must be a very good reason (sickness, death, and dismemberment qualify).

Final Exam: The final exam is a cumulative exam and is MANDATORY.

CONTACT POLICY: Please include **PHY481** in the subject line of any e-mail. I try to respond to e-mail within 24hrs. Although I will try to answer all questions directed to me by e-mail, most problems related to course content are best discussed during office hours.

ACADEMIC INTEGRITY & CONDUCT

I have a zero-tolerance policy for breaches of academic integrity. Breaches of academic integrity will be investigated, and sanctions imposed to the full extent available under University policy. It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Undergraduate Handbook, the Undergraduate Catalog, the Ram's Eye View, and the University website at www.wcupa.edu

ATTENDANCE POLICY

A regular attendance to the lectures is an important part of this course and I highly recommend it. This is your chance to ask questions, see examples and get help in solving problems. I am here to guide you through the material. However, **I do not give an attendance grade.** Students must understand that they are responsible for all material covered and assigned during their absences (excused and unexcused) and that they are responsible for the academic consequences of their absences.

EXCUSED ABSENCES POLICY

If you are participating in a University sanctioned event during one of our scheduled exams you must notify me in advance. You must provide some form of documentation. We can then arrange for you to take the exam in a manner consistent with exam integrity. Students are advised to carefully read and comply with the excused absences policy, including absences for university-sanctioned events, contained in the WCU Undergraduate Catalog. In particular, please note that the "responsibility for meeting academic requirements rests with the student," that this policy does not excuse students from completing required academic work, and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

STUDENTS WITH DISABILITIES

If you have a disability that requires accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about West Chester University's Services for Students with Disabilities (OSSD), please visit them at 223 Lawrence Center. Their phone number is 610-436-2564, their fax number is 610-436-2600, their email address is ossd@wcupa.edu, and their website is at www.wcupa.edu/ussss/ossd. In an effort to assist students who either receive or may believe they are entitled to receive accommodations under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973, the University has appointed a student advocate to be a contact for students who have questions regarding the provision of their accommodations or their right to accommodations. The advocate will assist any student who may have questions regarding these rights. The Director for Equity and Compliance/Title IX Coordinator has been designated in this role. Students who need assistance with their rights to accommodations should contact them at 610-436-2433.

REPORTING INCIDENTS OF SEXUAL VIOLENCE

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University protection of minors policy. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at the webpage for the Office of Diversity, Equity, and Inclusion at https://www.wcupa.edu/_admin/diversityEquityInclusion/aboutUs.aspx.

EMERGENCY PREPAREDNESS

All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

ELECTRONIC MAIL POLICY

It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.

ALL OTHER ACADEMIC POLICIES

For any university wide academic policy not explicitly covered in this document, such NO Grade policies, please consult your major advising handbook, the Undergraduate Catalog, the Ram's Eye View, or University Website.

COURSE SCHEDULE

A tentative course content and schedule for this course is given below. *I reserve the right to adjust this schedule* as necessary during the semester to ensure a satisfactory learning experience.

Week		Date	Topic
1	1	W Jan. 22	Introduction, Ch. 1: Crystal Structure: <i>Basic Properties</i>
2	2	M Jan. 27	Ch. 1: Crystal Structure: <i>Examples of Crystal Structures</i>
	3	W Jan. 29	Ch. 1: Crystal Structure: <i>Surface-to-Volume ratio</i>
3	4	M Feb. 3	Ch. 2: Length Scales: <i>The Bohr radius, Excitons</i>
	5	W Feb. 5	Ch. 2: Length Scales: <i>Confinement regimes, The Fermi Energy, Kubo gap</i>
4	6	M Feb. 10	Ch. 2: Length Scales: <i>The mean free path in metals</i>
	7	W Feb. 12	Ch. 3: Nanostructures: <i>Semiconductors, Metallic Systems</i>
5	8	M Feb. 17	Ch. 3: Nanostructures: <i>Metallic systems, Carbon Nanostructures</i>
	9	F Feb. 21	Ch. 4: Absorption & Emission: <i>Attenuation Law</i>
6	10	M Feb. 24	Ch. 4: Absorption & Emission: <i>Molar Extinction Coefficient</i>
	11	W Feb. 26	Ch. 4: Absorption & Emission: <i>Estimating Absorption Coefficient</i>
7	12	M Mar. 2	Ch. 4: Absorption & Emission: <i>Emission Process & Quantum Yields</i>
		W Mar. 4	Exam – 1: Chapters 1 – 4
		M Mar. 9 W Mar. 11 F Mar. 13	SPRING BREAK
8	13	M Mar. 16	Ch. 5: Quantum Mechanics: <i>A review</i>
	14	W Mar. 18	Ch. 5: Quantum Mechanics: <i>Model Problems for Wells, Wires, and Dots</i>
9	15	M Mar. 23	Ch. 5: Quantum Mechanics: <i>Model Problems for Wells, Wires, and Dots</i>
	16	W Mar. 25	Ch. 5: Quantum Mechanics: <i>Model Problems for Wells, Wires, and Dots</i>
10	17	M Mar. 30	Ch. 6: Density of States: <i>Particle in a 1-D, 2-D, and 3-D box</i>
	18	W Apr. 1	Ch. 6: Density of States: <i>DOS for Bulk, Wells, Wires, and Dots</i>
11	19	M Apr. 6	Ch. 6: Density of States: <i>DOS for Bulk, Wells, Wires, and Dots</i>
	20	W Apr. 8	Ch. 6: Density of States: <i>Bands for Bulk, Wells, Wires, and Dots</i>
12	21	M Apr. 13	Ch. 6: Density of States: <i>Joint DOS for Bulk, Wells, Wires, and Dots</i>
	22	W Apr. 15	Ch. 7: Bands: <i>Kronig-Penny Model</i>
13	23	M Apr. 20	Ch. 7: Bands: <i>Kronig-Penny Model with Delta-Function Barriers</i>
	24	W Apr. 22	Ch. 7: Bands: <i>Density of States & Effective Mass</i> Exam-2 Chapters 4 – 7 (Take Home Exam)
14	25	M Apr. 27	Ch. 7: Bands: <i>Density of States & Effective Mass</i>
	26	W Apr. 29	Ch. 8: Time-Dependent Perturbation Theory: <i>Introduction</i>
	27	M May 4	Ch. 8: Time-Dependent Perturbation Theory: <i>Two-level System</i>
FINAL EXAM: Wednesday, May 6, 2020 (1:00 pm – 3:00 pm)			