EFD 46-07

Print Form

Office of the Registrar
FORM 40 REV. 7/08

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

DEPARTMENT Materials Engineering

EFFECTIVE SESSION Spring 2009

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- [X] 1. New course with supporting documents
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [ ] 6. Change in course credit/type
- [ ] 7. Change in course attributes (department head signature only)
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered (department head signature only)
- [ ] 12. Transfer from one department to another

PROPOSED:

Subject Abbreviation MSE

Course Number 270

Long Title Atomistic Materials Science

Short Title Atom Mtls Sci

EXISTING:

Subject Abbreviation

Course Number

Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)

TERMS OFFERED
Check All That Apply:

- [ ] Summer
- [ ] Fall
- [X] Spring

CAMPUS(ES) INVOLVED

- [ ] Calumet
- [ ] Cont Ed
- [ ] Ft. Wayne
- [ ] Indianapolis
- [ ] N. Central
- [ ] Tech Statewide
- [X] W. Lafayette

CREDIT TYPE

1. Fixed Credit: Cr. Hrs. 3
2. Variable Credit Range:
   Minimum Cr. Hrs
   (Check One) To [ ] Or [ ]
   Maximum Cr. Hrs.
3. Equivalent Credit: Yes [ ] No [ ]

COURSE ATTRIBUTES: Check All That Apply

- [ ] 1. Pass/Not Pass Only
- [ ] 2. Satisfactory/Unsatisfactory Only
- [ ] 3. Repeatable
- [ ] Maximum Repeatable Credit:
- [ ] 4. Credit by Examination
- [ ] 5. Special Fees
- 6. Registration Approval Type: Department [ ] Instructor [ ]
- [ ] 7. Variable Title
- [ ] 8. Honors
- [ ] 9. Full Time Privilege
- [ ] 10. Off Campus Experience

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	50	3	16	100
Recitation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

Introductory course with an atomistic veiw point on material properties. Three primary class sections: bonding crystallography and statistical mechanics. Bonding topics include introduction to quantum mechanics, emphasis on understanding of metallic, ionic and covalent bonding. Crystallography topics include crystal descriptions and symmetry principles. Statistical mechanics developed with application to electronic and thermodynamic properties.

Calumet Department Head — Date	Calumet School Dean — Date
Fort Wayne Department Head — Date	Fort Wayne School Dean — Date
Indianapolis Department Head — Date	Indianapolis School Dean — Date
North Central Department Head — Date	North Central Chancellor — Date
West Lafayette Department Head — Date	West Lafayette College/School Dean — Date 11/10/08

West Lafayette Registrar — Date 12/19/08

12/19/08

OFFICE OF THE REGISTRAR

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Indianapolis Department Head	Date	Indianapolis School Dean	Date
North Central Department Head	Date	North Central Chancellor	Date
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date 11/10/08

West Lafayette Registrar   Date

OFFICE OF THE REGISTRAR

Engineering Faculty Document No. 46-07
April 17, 2008

TO: The Engineering Faculty

FROM: The Faculty of the School of Materials Engineering

DATE: March 1, 2008

RE: New Undergraduate Course, MSE 270

The faculty of the School of Materials Engineering have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

MSE 270 **Atomistic Materials Science**
Sem. 2. Class 3, Cr. 3.
Prerequisite: MA 261 and MA 265; Co-requisite: MSE 230 or consent of instructor.

Description: Introductory course with an atomistic viewpoint on material properties. Three primary class sections: bonding, crystallography and statistical mechanics. Bonding topics include introduction to quantum mechanics, emphasis on understanding of metallic, ionic and covalent bonding. Crystallography topics include crystal descriptions and symmetry principles. Statistical mechanics developed with application to electronic and thermodynamic properties.

Reason:

This class is currently (Spring 2008) offered as MSE 497S with an enrollment of 35 students. Updated School of Materials Engineering curriculum (EFD 50-07) will make this a required course for students entering MSE. This course represents a new emphasis on developing a fundamental understanding of atomistic material science, which is consistent with undergraduate topics covered by peer institutions, increased interest in nanoscience and nanotechnology and expertise of recent faculty hires.

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes #6
Date 10-8-08
Chairman ECC R J Cipra

Keith J. Bowman, Professor and Head
School of Materials Engineering

MSE 270
Atomistic Materials Science

Instructors: Alejandro Stachan, strachan@purdue.edu, ARMS 2229, 496-3551
Eric Stach, eastach@purdue.edu, BRK 1299, 494-1466

Course Description: Introductory course with an atomistic viewpoint on material properties. Three primary class sections: bonding, crystallography and statistical mechanics. Bonding topics include introduction to quantum mechanics, emphasis on understanding of metallic, ionic and covalent bonding. Crystallography topics include crystal descriptions and symmetry principles. Statistical mechanics developed with application to electronic and thermodynamic properties.

Prerequisite: MA 261 and MA 265; Corequisite: MSE 230 or consent of instructor.

Goals: Students will learn introductory level concepts in quantum mechanics and use these to develop an increased understanding of bond formation in molecules and solids. The role of bonding in crystal structure will be explored, with and emphasis formal classification of crystal structure and crystal symmetry. The effect so temperature on crystal structure and properties will be explained through the use of stastical mechanics concepts.

Objectives:
1. All Students
A. Understand the origins of metallic, covalent and ionic bonding
- Schrödinger's Equation and its solution for simple situations
- Origin of cohesive energies and relationship with elastic constants
- Descriptions of metallic, covalent and ionic bonding

B. Understand how symmetry in materials leads to crystal structure
- Be able to identify symmetry elements, such as mirror planes, rotation axes, glide planes and screw axes
- Identity the underlying symmetry elements in specific crystallographic point and space groups

C. Are able to describe crystal classes, crystal directions and lattice planes
- Describe crystal directions and lattice planes using Miller indices
- Describe unit cells and lattices

D. Understand the origin of statistical expressions of population occupancy
- Show how different assumptions about the character of a population lead to different occupancies of energy levels
- Correlate statistical distributions of occupied energy levels with internal energy, entropy and free energy

2. Most Students
A. Have an understanding of the underlying origins of bonding
- Show how solution of the Schrödinger Equation for the hydrogen atom can be expanded to atoms with more than one proton, leading to the periodic table of the elements
- Understand the origin of cohesive energy in ionic crystals
- Understand how wave function overlaps lead to molecular orbitals and covalent bonding, and why these bonds are both directional and strong
- Understand how state splitting provides an intuitive understanding of crystal bands and metallic bonding

B. Understand how particular combinations of crystal symmetry lead to specific point and space groups

C. Utilize the stereographic projection to relate planes and directions in a crystal

D. Understand how statistical descriptions of energy states lead to material properties such as heat capacity and specific heat.

3. Some Students
A. Are able to utilize the information in the International Tables of Crystallography to create models of a crystal structure

B. Correlate the existence of anisotropy in materials with specific bonding characteristics

C. Correlate changes in temperature with changes in thermodynamic quantities

Textbook
"Crystals and Crystal Structure", R. Tilley, John Wiley & Sons, West Sussex, England, 2006.

Assessment: Class participation (5%), Homework (15%), Exams (80%) [Two exams (25%) & Comprehensive final (30%)]

Instructors: Alejandro Strachan, Eric Stach, Eric Kvam

Spring 2008 - Syllabus

Date	Topic
1/07 (M)	Context, Perspective and Organization. Intro to bonding
Part I: Bonding & Crystal Binding	
1/09 (W)	Why do we need quantum mechanics? The hydrogen atom
1/11 (F)	Quantum mechanics: postulates and the Schrödinger Eq.
1/14 (M)	Solutions of the Schrödinger Eq: square well + hydrogen atom
1/16 (W)	Electronic structure of atoms: energy levels, wave functions
1/18 (F)	Electronic structure of atoms: 1st and 2nd rows
1/21 (M)	*University Holiday – no class*
1/23 (W)	Electronic structure & bonding in molecules: H2+
1/25 (F)	Elect. Struct. & bonding in molecules: bonding and anti-bonding
1/28 (M)	Elect. Struct. & bonding in molecules: 1st row hydrides
1/30 (W)	Elect. Struct. & bonding in molecules: 1st row hydrides
2/1 (F)	Elect. Struct. & bonding in molecules: ionic bonding
2/4 (M)	Elect. Struct. & bonding in molecules: van der Waals
2/6 (W)	Electronic structure & bonding in crystals: bands
2/8 (F)	Elect. Struct. & bonding in crystals: bands
2/11 (M)	Elect. Struct. & bonding in crystals: covalent vs. metallic bonding
2/13 (W)	Elect. Struct. & bonding in crystals: covalent vs. metallic bonding
2/15 (F)	Review of Part I
2/18 (M)	**Midterm #1**
Part II: Symmetry, Crystal structure and Crystallography	
2/20 (W)	Relationship between bonding and crystal structure
2/22 (F)	External crystal forms: mineralogy and the origins of crystallography
2/25 (M)	Elements of Symmetry; 2-D Unit Cells and Asymmetric Units
2/27 (W)	Coordinates; Directions; Lattices; Symmetry Groups in 2D

2/29 (F)	Crystallography in 3-D; Miller Indices

3/3 (M)	Rational Directions; Weiss Zone Law; Miller-Bravais Indices
3/5 (W)	32 Crystallographic Point Groups; Bravais Lattices
3/7 (F)	Glide Planes; Screw Axes
3/10 (M)	*Spring Break – no class*
3/12 (W)	*Spring Break – no class*
3/14 (F)	*Spring Break – no class*
3/10 (M)	Using the International Tables of Crystallography
3/19 (W)	Creating Crystal Structures with Software Tools (CrystalMaker)
3/21 (F)	The Stereographic Projection – Construction & Uses
3/24 (M)	The Stereographic Projection – Construction & Uses
3/26 (W)	Tensors & Tensor Description of Materials Properties
3/28 (F)	Review of Part II
3/31 (M)	**Midterm #2**
Part III: Thermal properties & Statistical Mechanics	
4/2 (W)	Motivation / Elementary Statistical Concepts
4/4 (F)	Population of Energy States (Partition Functions)
4/7 (M)	Distinguishable Particles – Maxwell-Boltzman statistics
4/9 (W)	Distinguishable Particles – Maxwell-Boltzman statistics (continued)
4/11 (F)	Indistinguishable Particles – Bose-Einstein statistics
4/14 (M)	Indistinguishable particles – Fermi-Dirac statistics
4/16 (W)	Relationship between stat. mech. & thermodynamic quantities
4/18 (F)	Relationship between stat. mech. & thermodynamic quantities (continued)
4/21 (M)	Phonons
4/23 (W)	Heat transfer and heat capacity
4/25 (F)	Review of Part III