FORMAT 1

Submit original with signatures + 1 copy + electronic copy to UAF Governance.

See http://www.uaf.edu/uafgov/faculty/cd for a complete description of the rules governing curriculum & course changes.

TRIAL COURSE OR NEW COURSE PROPOSAL

SUBMITTED BY:

Department	Chemistry and Biochemistry	College/School	CNSM
Prepared by	Tom Trainor	Phone	5628
Email Contact	tptrainor@alaska.edu	Faculty Contact	Tom Trainor

1. ACTION DESIRED (CHECK ONE): Trial Course [ ] New Course [X]

2. COURSE IDENTIFICATION: Dept: CHEM | Course #: 618 | No. of Credits: 3

Justify upper/lower division status & number of credits: The proposed course will cover intermediate to advanced topics appropriate for graduate students in the physical sciences and engineering. The course material will be consistent with 3 credit hours.

3. PROPOSED COURSE TITLE: Crystallography and Diffraction

4. CROSS LISTED? YES/NO: No | If yes, Dept: | Course #:

(Requires approval of both departments and deans involved. Add lines at end of form for such signatures.)

5. STACKED? YES/NO: No | If yes, Dept. | Course #:

6. FREQUENCY OF OFFERING: Alternate Fall

(Every or Alternate) Fall, Spring, Summer – or As Demand Warrants

7. SEMESTER & YEAR OF FIRST OFFERING (if approved): Fall 2011

8. COURSE FORMAT:

NOTE: Course hours may not be compressed into fewer than three days per credit. Any course compressed into fewer than six weeks must be approved by the college or school's curriculum council. Furthermore, any core course compressed to less than six weeks must be approved by the core review committee.

COURSE FORMAT: (check one) [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [X] 6 weeks to full semester

OTHER FORMAT (specify):

Mode of delivery (specify lecture, field trips, labs, etc): Lecture and laboratory based course (3cr). Laboratory assignments will involve the use of XRD instrumentation, and data modeling / analysis using a variety of crystallography software packages.

9. CONTACT HOURS PER WEEK: 2 LECTURE hours/weeks | 3 LAB hours /week | [ ] PRACTICUM hours /week

Note: # of credits are based on contact hours. 800 minutes of lecture=1 credit. 2400 minutes of lab in a science course=1 credit. 1600 minutes in non-science lab=1 credit. 2400-4800 minutes of practicum=1 credit. 2400-8000 minutes of internship=1 credit. This must match with the syllabus. See http://www.uaf.edu/uafgov/faculty/cd/credits.html for more information on number of credits.

OTHER HOURS (specify type):

Received
FEB 17 2010
Dean's Office
College of Natural Science & Mathematics

10. *COMPLETE CATALOG DESCRIPTION including dept., number, title and credits (50 words or less, if possible):*

618

CHEM 693 Crystallography and Diffraction
3 Credits Offered Fall Odd-numbered Years

The structure of solid-state materials and the analysis of materials using X-ray scattering techniques. Material structure topics will include crystal lattices, space-group symmetry, projections, the reciprocal lattice, and crystal chemistry. Methods for investigating the structure of materials and identification of phase will be covered in depth, including: fundamentals of X-ray scattering, diffraction from single crystals, powder diffraction, (quantitative) phase analysis, Rietveld refinements, texture analysis, and reflectivity. Students will be trained in the use of modern X-ray diffraction instrumentation and analysis software. Applications and examples will be taken from numerous disciplines including materials chemistry, mineralogy, petrology, and engineering materials, with an emphasis on methods of data collection and analysis. Special fees apply. ***Prerequisite: Graduate standing or permission of the instructor.*** (2+3)

11. *COURSE CLASSIFICATIONS:* (undergraduate courses only. Use approved criteria found on Page 10 & 17 of the manual. If justification is needed, attach on separate sheet.)

H = Humanities		N = Natural Science	X	S = Social Sciences	

Will this course be used to fulfill a requirement for the baccalaureate core? [ ] YES [X] NO

IF YES, check which core requirements it could be used to fulfill:

O = Oral Intensive, Format 6		W = Writing Intensive, Format 7		Natural Science, Format 8	

12. *COURSE REPEATABILITY:*

Is this course repeatable for credit? [ ] YES [X] NO

Justification: Indicate why the course can be repeated (for example, the course follows a different theme each time).

How many times may the course be repeated for credit? [ ] TIMES

If the course can be repeated with variable credit, what is the maximum number of credit hours that may be earned for this course? [ ] CREDITS

13. *GRADING SYSTEM:*

LETTER: [X] **PASS/FAIL:** [ ]

RESTRICTIONS ON ENROLLMENT (if any)

14. *PREREQUISITES* **Graduate standing or permission of the instructor**

These will be *required* before the student is allowed to enroll in the course.

RECOMMENDED

Classes, etc. that student is strongly encouraged to complete prior to this course.

15. *SPECIAL RESTRICTIONS, CONDITIONS*

16. *PROPOSED COURSE FEES* $70

Has a memo been submitted through your dean to the Provost & VCAS for fee approval? **Yes/No** YES

17. *PREVIOUS HISTORY*

Has the course been offered as special topics or trial course previously? **Yes/No** Y

If yes, give semester, year, course #, etc.: Fall 2009

18. ESTIMATED IMPACT

WHAT IMPACT, IF ANY, WILL THIS HAVE ON BUDGET, FACILITIES/SPACE, FACULTY, ETC.

None. The course has been worked into the Department of Chemistry and Biochemistry 3 year teaching plan (it was recently offered as special topics). Facilities for the course already exist (XRD equipment was purchased on a NSF-MRI grant).

19. LIBRARY COLLECTIONS

Have you contacted the library collection development officer (ffklj@uaf.edu, 474-6695) with regard to the adequacy of library/media collections, equipment, and services available for the proposed course? If so, give date of contact and resolution. If not, explain why not.

No	X	Yes		No special materials needed

20. IMPACTS ON PROGRAMS/DEPTS

What programs/departments will be affected by this proposed action?
Include information on the Programs/Departments contacted (e.g., email, memo)

This course will be covered by the Department of Chemistry and Biochemistry. Based on the enrollment in the trial course (Fall 2009), we suspect students from Chemistry, Environmental Chemistry, Biochemistry and Molecular Biology, Geology, Geophysics, Physics, Soils Sciences, and Engineering will all be served by this course. T. Trainor has been in contact with numerous faculty on campus regarding the trial course, and training in the use of the UAF XRD laboratory, and has found a high level of interest.

21. POSITIVE AND NEGATIVE IMPACTS

*Please specify **positive and negative** impacts on other courses, programs and departments resulting from the proposed action.*

There are negative impact associated with this course. Positive impacts include offering an advanced course in a topic area that is currently not covered at UAF. The material is highly relevant to Natural/Physical Sciences and Engineering Students and will better prepare our students for future careers. This course will also train individuals and promote use of the UAF XRD laboratory.

JUSTIFICATION FOR ACTION REQUESTED

The purpose of the department and campus-wide curriculum committees is to scrutinize course change and new course applications to make sure that the quality of UAF education is not lowered as a result of the proposed change. Please address this in your response. This section needs to be self-explanatory. Use as much space as needed to fully justify the proposed course.

Currently there is no course at UAF covering this material. There is however a demand for a crystallography/diffraction course (which are traditionally taught in Chemistry and/or Geology departments) to meet the needs of current graduate students and faculty. In particular, we have recently acquired and installed a new diffraction system as part of the suite of materials analysis equipment housed within the UAF Advanced Instrumentation Laboratory (AIL). As with many of the more complicated instruments within AIL, use is limited unless there is specific and dedicated user training. Since graduate students are typically the dominant users of the instrumentation, the best method / most efficient methods of training is through the offer of a graduate course. The proposed course will provide students with the required background for successful application of diffraction in their research and train them in modern topics and methods of materials analysis needed for future careers.

APPROVALS:

	Date	2-15-10
Signature, Chair, Program/Department of:		
	Date	2/23/10
Signature, Chair, College/School Curriculu Council for:		CNSM
	Date	2/23/10
Signature, Dean, College/School of:		CNSM
	Date	
Signature of Provost (if applicable)		

Offerings above the level of approved programs must be approved in advance by the Provost.

ALL SIGNATURES MUST BE OBTAINED PRIOR TO SUBMISSION TO THE GOVERNANCE OFFICE

	Date	
Signature, Chair, UAF Faculty Senate Curriculum Review Committee		

ADDITIONAL SIGNATURES: (If required)

	Date	
Signature, Chair, Program/Department of:		
	Date	
Signature, Chair, College/School Curriculu Council for:		
	Date	
Signature, Dean, College/School of:		

Crystallography and Diffraction

Course Id:	CHEM 618 (3 cr.)	
Prerequisites:	Graduate Standing or permission of instructor	
Lecture/Lab:	TBA	
Instructor:	Tom Trainor	
	Rm 176 Reichardt	
	474-5628	
	tptrainor@alaska.edu	
Office Hours:	TBA	
Grading:	Problem Sets/Labs	35%
	Midterm exam	20%
	Final Exam	20%
	Final Project	25%
		100%

Course web page: TBA

Course description and goals:

The goal of this course is to understand the structure of crystalline materials, and how to use X-ray scattering techniques to study materials structure and structural properties. Material structure topics will include crystal lattices, space-group symmetry, projections, the reciprocal lattice, and crystal chemistry. Methods for investigating the structure of materials and identification of phase will be covered in depth, including: fundamentals of X-ray scattering, diffraction from single crystals, powder diffraction, (quantitative) phase analysis, Rietveld refinements, texture analysis, and reflectivity. Students will be trained in the use of modern X-ray diffraction instrumentation and analysis software. Applications and examples will be taken from numerous disciplines including materials chemistry, mineralogy, petrology, and engineering materials, with an emphasis on methods of data collection and analysis.

Text

V.K. Pecharsky and P.Y. Zavalij, Fundamentals of Powder Diffraction and Structural Characterization of Materials.

Additional Sources:

- Warren B. E. (1969) *X-Ray Diffraction*. Addison-Wesley.
- IUCr *International Tables for X-Ray Crystallography, Vol A*, (2005) T Hahn, ed., Springer.
- James, R., W., (1965) *The Optical Principles of the Diffraction of X-Rays*. Cornell University Press, Ithaca.
- Als-Nielsen, J., McMorrow, D. (2001) *Elements of Modern X-ray Physics*. Wiley
- Sands, D. E. (1975) *Introduction to Crystallography*. Dover
- X-ray Data Booklet: *http://xdb.lbl.gov/*

Instructional Methods:

Lecture

Two lecture periods per week will be used to deliver the core materials. Focus will be on theory and background required for understanding the structure of crystalline materials, the use of x-ray diffraction instrumentation and interpretation of data. Lecture topics will be complimented by problem sets and tested via written exam.

Laboratory

Students will be given hands on training in the use of XRD instrumentation and analysis software. Assignments will build upon lecture topics using practical examples. Students will be expected to complete laboratory assignments working in groups.

Class Projects

Your class project will be focused on the solution of a "materials" problem using X-ray diffraction. The project should include background literature search, compilation of relevant crystallographic data, and the analysis of experimental data. The data sets may be provided by the instructor, or collected from specimens using the AIL X-ray diffraction laboratory. You will be required to submit a written report summarizing the results of the analysis (in manuscript format) and give a presentation to the class based on your topic. You will be requested to consult with the instructor early in the semester to decide on a project topic.

For performing literature searches and managing your citations I encourage the use of SciFinder Scholar, GeoRef, Endnote and other tools. If you are unfamiliar with these see: *http://www.uaf.edu/chem/Viewlets/ChemLabHowTo.html* and *http://uaflibrary.us/onlinedatabases/ui/*

Important Dates:
Sept XX – Deadline for late registration
Sept XX – Deadline for drop
Oct XX - Deadline for withdrawal

Computer Lab:
Your enrollment in Chem 618 gives you user privileges in the department's computer lab. Information and policies are available at:
http://www.uaf.edu/chem/NewNetwork.html

Student with Documented Disabilities:
Student with a physical or learning disability who may need academic accommodations, should contact the Disability Services office (203 WHIT, 474-7043). Disability Services will then notify the instructor of special arrangements for course work.

Ethical Considerations:
The Chemistry Department Policy on Cheating is: "*Any student caught cheating will be assigned a course grade of F. The student will not be allowed to drop the course.*"
The UAF Honor Code states: "*Student will not collaborate on any quizzes, in-class exams, or take-home exams that will contribute to their grade in a course, unless permission is granted by the instructor of the course. Only those materials permitted by the instructor may be used to assist in quizzes and examinations. Student will not represent the work of others as their own. A student will attribute the source of information not original with himself or herself (direct quotes or paraphrase) in compositions, these and other reports. No work submitted for one course may be submitted for credit in another course without the explicit approval of both instructors. Violations of the Honor Code will result in a failing grade for the assignment and, ordinarily, for the course in which the violation occurred. Moreover, violation of the Honor Code may result in suspension or expulsion*"

In this course students may collaborate on homework assignments, however, each individual should submit their own copy showing all their work. Exams and projects are to be completed independently.

Topics

I. Crystallography

- Crystal lattice and crystal structures
  - Definition of a unit cell, unit cell contents
  - Periodicity, lattice points and lattice vectors
  - Crystallographic planes, directions and indices
  - Reciprocal lattice
- Symmetry operations and symmetry elements
  - Finite symmetry elements (point groups)
  - Infinite symmetry elements (space groups)
- The International Tables, Volume A, Space Groups, and Structure Viewing Software

II. Diffraction

- Properties and sources of radiation
- Geometrical treatment of diffraction by lattices
  - Laue equations and Bragg's Law
  - Reciprocal lattice and Ewald sphere
  - Powder vs single xtal XRD
- Derivation of the structure factor
  - Scattering by electrons, atoms and lattices
  - Fourier analysis
  - Diffraction from imperfect crystals and powders (kinematic diffraction)
  - Phase problem
    - Patterson technique
    - Direct methods

III. Powder XRD

- Powder intensities and positions of diffraction peaks
  - Integrated intensities
  - Geometric factors
  - Absorption
  - Orientation
- Powder diffractometry
  - Sample preparation
  - Phase identification
  - Phase quantification
  - Unit cell refinement
  - Structure determination/refinement (Rietveld)

IV. Single crystal XRD and Materials Characterization

- Single crystal diffratometry (4-circle diffractometer)
  - Crystal orientation / alignment
- Texture analysis
- Stress analysis

V. Special Topics (possible)

- Interfaces
  - X-ray reflectivity
  - Grazing incidence diffraction
  - Truncation rods
- Anomalous scattering
- Micro-Diffraction
- Diffraction from perfect crystals,
- X-ray standing waves

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February 12, 2010

To: Susan Henrichs, Provost
Through: Paul Layer, Interim Dean, CNSM
From: John Keller, Chair
Tom Trainor. Professor
Re: Lab Fee for Proposed Course Chem 618, Crystallography and Diffraction

Chem 618 is a 2-credit lecture + 1-credit lab course that is being submitted for curriculum council approval this spring, and which will be offered with the 618 moniker in the fall 2011 semester. The course will be taught by Tom Trainor who taught a similar course in the fall 2009 semester as a 3-credit special topics lecture course. Last fall the assignments in the course involved mostly hands-on use of the new diffraction instrument installed in 2009 in the Advanced Instrumentation Laboratory in the Reichardt Building. Tom found that there were significant expenses for consumables, and therefore it would be appropriate to assign laboratory credit for the course, and charge a lab fee.

We propose a fee of $70 which is consistent with the recently approved lab fee schedule for various chemistry laboratory courses. We anticipate that the revenue generated from this fee would cover most of the incidental expenses for the course.

approved 2/23/10 Paul Layer