FORMAT 1

Submit original with signatures + 1 copy + electronic copy to Faculty Senate (Box 7500).

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

TRIAL COURSE OR NEW COURSE PROPOSAL

SUBMITTED BY:			
Department	**Physics**	**College/School**	**CNSM**
Prepared by	**S.Stevens/C. Szuberla**	**Phone**	**474-7339**
Email Contact	**Uaf-physics@alaska.edu**	**Faculty Contact**	**Curt Szuberla**

1. ACTION DESIRED (CHECK ONE):	Trial Course		New Course	X	
2. COURSE IDENTIFICATION:	Dept	**PHYS**	Course #	**625**	No. of Credits **3.0**
Justify upper/lower division status & number of credits:					
3. PROPOSED COURSE TITLE:	**Inverse Problems and Parameter Estimation**				
4. To be CROSS LISTED? *YES/NO*	**YES**	If yes, Dept:	GEOS	Course #	627

NOTE: Cross-listing requires approval of both departments and deans involved. Add lines at end of form for additional required signatures.

5. To be STACKED? *YES/NO*		If yes, Dept.		Course #
How will the two course levels differ from each other? How will each be taught at the appropriate level?:				

Stacked course applications are reviewed by the (Undergraduate) Curricular Review Committee and by the Graduate Academic and Advising Committee. Creating two different syllabi—undergraduate and graduate versions—will help emphasize the different qualities of what are supposed to be two different courses. The committees will determine: 1) whether the two versions are sufficiently different (i.e. is there undergraduate and graduate level content being offered); 2) are undergraduates being overtaxed?; 3) are graduate students being undertaxed? In this context, the committees are looking out for the interests of the students taking the course. Typically, if either committee has qualms, they both do. More info online – see URL at top of this page.

6. FREQUENCY OF OFFERING:	**Spring Odd Years**

RECEIVED
JUN 25 2014
Dean's Office
College of Natural Science & Mathematics

Governance
9/29/14

	Fall, Spring, Summer (Every, or Even-numbered Years, or Odd-numbered Years) — or As Demand Warrants

7. SEMESTER & YEAR OF FIRST OFFERING (AY2013-14 if approved by 3/1/2013; otherwise AY2014-15)	**Spring 2017**

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 all that apply)		*1*		*2*		*3*		*4*		*5*	X	*6 weeks to full semester*

OTHER FORMAT (specify)	
Mode of delivery (specify lecture, field trips, labs, etc)	**LECTURE**

9. CONTACT HOURS PER WEEK:	3	LECTURE hours/weeks		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-senate/curriculum/course-degree-procedures-/guidelines-for-computing-/ for more information on number of credits.

OTHER HOURS (specify type)	

10. <u>COMPLETE</u> CATALOG DESCRIPTION including dept., number, title, credits, credit distribution, cross-listings and/or stacking (50 words or less if possible):

Example of a <u>complete</u> description:

FISH F487 W, O Fisheries Management
3 Credits Offered Spring
Theory and practice of fisheries management, with an emphasis on strategies utilized for the management of freshwater and marine fisheries. *Prerequisites: COMM F131X or COMM F141X; ENGL F111X; ENGL F211X or ENGL F213X; ENGL F414; FISH F425; or permission of instructor.* Cross-listed with NRM F487. (3+0)

PHYS F625 Physics Department
3 Credits Offered Spring Odd Years
A forward problem uses a model to make predictions; an inverse problem uses observations to infer properties of an unknown physical model. One example of an inverse problem is how to use seismometer recordings to infer the location of an earthquake. This course covers inverse theory and methods for solving inverse problems, including numerous examples arising in the natural sciences. Topics include linear regression, method of certainities, iterative optimization, and probabilistric (Bayesian) and sampling approaches. Assignments require familiarity with linear algebra and computational tools such as MathLab. Prerequesities: MATH F202X and MATH F314 or permission of instructor. (3+0)

matLab

Make sure all boxes are checked!!
Boxes unchecked →

11. *COURSE CLASSIFICATIONS:* Undergraduate courses only. Consult with CLA Curriculum Council to apply S or H classification appropriately; otherwise leave fields blank.

H = Humanities [ ] S = Social Sciences [ ]

Will this course be used to fulfill a requirement for the baccalaureate core? **If YES, attach form.** **YES:** [ ] **NO:** [X]

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

O = Oral Intensive, **Format 6** [ ] W = Writing Intensive, **Format 7** [ ] X = Baccalaureate Core [ ]

11.A Is course content related to northern, arctic or circumpolar studies? If yes, a "snowflake" symbol will be added in the printed Catalog, and flagged in Banner.

YES [ ] **NO** [X]

12. *COURSE REPEATABILITY:*

Is this course repeatable for credit? **YES** [X] **NO** [X] per C.A.S

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 for credit, what is the maximum number of credit hours that may be earned for this course? [ ] **CREDITS**

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:* ***Specify only one. Note: Changing the grading system for a course later on constitutes a Major Course Change – Format 2 form.***

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

RESTRICTIONS ON ENROLLMENT (if any)

14. *PREREQUISITES* **MATH F202X and MATH F314 or permission of instructor.**

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

15. SPECIAL RESTRICTIONS, CONDITIONS

16. PROPOSED COURSE FEES **$0**

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

17. PREVIOUS HISTORY

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

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

18. ESTIMATED IMPACT

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

NONE

19. LIBRARY COLLECTIONS

Have you contacted the library collection development officer (kljensen@alaska.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 Yes

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)

None

21. POSITIVE AND NEGATIVE IMPACTS

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

No negative impact on physics department. Course being taught by Geology/Geophysics instructors. Positive impact increases enrollment in the course.

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.

This was at the request of the Geology and Geophysics to be able to attract more students to the course. And Physics is in agreement.

APPROVALS: Add additional signature lines as needed.

	Date	25 June 2014

Signature, Chair, Program/Department of:	**Dr.CURT SZUBERLA** **PHYSICS**

	Date	

Signature, Chair, College/School Curriculum Council for:	**CNSM**

	Date	

Signature, Dean, College/School of:	**DR. PAUL LAYER** **CNSM**

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

	Date	

Signature of Provost (if above level of approved programs)

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

	Date	

Signature, Chair
Faculty Senate Review Committee: ___Curriculum Review ___GAAC
___Core Review ___SADAC

***ADDITIONAL SIGNATURES:** (As needed for cross-listing and/or stacking)*

	Date	

Signature, Chair, Program/Department of:	~~PAUL MCCARTY~~ Sarah Fowell, Co-Chair **GEOLOGY/GEOPHYSICS**

	Date	9-23-14

Signature, Chair, College/School Curriculum Council for:	**CNSM**

	Date	9/23/14

Signature, Dean, College/School of:	**DR. PAUL LAYER** **CNSM**

ATTACH COMPLETE SYLLABUS (as part of this application). This list is online at:
http://www.uaf.edu/uafgov/faculty-senate/curriculum/course-degree-procedures-/uaf-syllabus-requirements/
The Faculty Senate curriculum committees will review the syllabus to ensure that each of the items listed below are included. If items are missing or unclear, the proposed course (or changes to it) may be denied.

Syllabus CHECKLIST for all UAF courses
During the first week of class, instructors will distribute a course syllabus. Although modifications may be made throughout the semester, this document will contain the following information (as applicable to the discipline):

1. Course information:
θTitle, θ number, θcredits, θprerequisites, θ location, θ meeting time

(make sure that contact hours are in line with credits).

2. Instructor (and if applicable, Teaching Assistant) information:

θ Name, θ office location, θ office hours, θ telephone, θ email address.

3. Course readings/materials:

θ Course textbook title, θ author, θ edition/publisher.

θ Supplementary readings (indicate whether θ required or θ recommended) and

θ any supplies required.

4. Course description:

θ Content of the course and how it fits into the broader curriculum;

θ Expected proficiencies required to undertake the course, if applicable.

θ Inclusion of catalog description is *strongly* recommended, and

θ Description in syllabus must be consistent with catalog course description.

5. θ Course Goals (general), and (see #6)

6. θ Student Learning Outcomes (more specific)

7. Instructional methods:

θ Describe the teaching techniques (eg: lecture, case study, small group discussion, private instruction, studio instruction, values clarification, games, journal writing, use of Blackboard, audio/video conferencing, etc.).

8. Course calendar:

θ A schedule of class topics and assignments must be included. Be specific so that it is clear that the instructor has thought this through and will not be making it up on the fly (e.g. it is not adequate to say "lab". Instead, give each lab a title that describes its content). You may call the outline Tentative or Work in Progress to allow for modifications during the semester.

9. Course policies:

θ Specify course rules, including your policies on attendance, tardiness, class participation, make-up exams, and plagiarism/academic integrity.

10. Evaluation:

θ Specify how students will be evaluated, θ what factors will be included, θ their relative value, and θ how they will be tabulated into grades (on a curve, absolute scores, etc.) θ Publicize UAF regulations with regard to the grades of "C" and below as applicable to this course. (Not required in the syllabus, but is a convenient way to publicize this.) Link to PDF summary of grading policy for "C": http://www.uaf.edu/files/uafgov/Info-to-Publicize-C_Grading-Policy-UPDATED-May-2013.pdf

11. Support Services:

θ Describe the student support services such as tutoring (local and/or regional) appropriate for the course.

12. Disabilities Services: Note that the phone# and location have been **updated.** http://www.uaf.edu/disability/ The Office of Disability Services implements the Americans with Disabilities Act (ADA), and ensures that UAF students have equal access to the campus and course materials.

θ State that you will work with the Office of Disabilities Services (208 WHITAKER BLDG, 474-5655)to provide reasonable accommodation to students with disabilities.

5/21/2013

UNIVERSITY OF ALASKA FAIRBANKS

QUICK REFERENCE: Section 8 contains the calendar of topics and deadlines.

Last compiled: May 2, 2013

1. **Course information.**

PHYS GEOS F627 **Inverse Problems and Parameter Estimation**, 3 credits, Spring 2013

Meeting times:	Tuesday and Thursday, 11:30–13:00
Meeting location:	301N Elvey (Geophysical Institute)
Prerequisites:	MATH 202 (Calculus III) and MATH 314 (Linear Algebra); or permission of instructor

2. **Instructor information.**

Instructor:	**Carl Tape**
Office:	413D Elvey (Geophysical Institute)
Email:	carltape@gi.alaska.edu
Phone:	(907) 474-5456
Office hours:	Wednesday, 10:00–11:00, or by appointment

3. **Course materials.**

(a) **Textbooks.** The required (R) and supplemental (S) textbooks are (see "References" at the end of this syllabus) listed in the following table. "Software" lists the software (if any) used in examples within each book. The G.I. Mather library is located in the IARC/Akasofu building.

Textbook	R	S	Software	Availability			
				UAF bookstore	Mather reserve	PDF	UAF e-book
[1] Aster	X		Matlab		X		X
[2] Tarantola	X		none		X	X	
[3] Menke		X	Matlab		X		X
[4] Parker		X	none		X		
[5] Weisberg		X	R				X

[2] can be downloaded as a pdf from Tarantoa's webpage. However, he writes: "Here are the rules: i) you are invited to download, view, and print the books; ii) if you work in a commercial company, or in a rich institution (like a university in the developed world), and your plan is to use one of the books from time to time, please purchase it (links below)."

(b) Journal articles (and PDF books) assigned as reading will be available as PDFs through the course website on UAF Blackboard.

(c) Students will need computers for their homework. General-use computers in UAF labs will be made available to students if needed.

(d) Matlab will be the primary computational program for the course. Matlab is available via a UAF-wide license.

4. **Course description.**

An inverse problem is a procedure by which observations or measurements are used with quantitative models to gain inferences about some underlying physical quantity or system. Inverse problems occur in all fields of natural sciences — even something as simple as fitting a line to scattered data is an inverse problem. This course will provide a general framework, as well as general computational algorithms, for approaching inverse problems. The training should benefit all students in natural sciences who are seeking inferences from data.

Catalog description: A forward problem uses a model to make predictions; an inverse problem uses observations to infer properties of an unknown physical model. One example of an inverse problem is how to use seismometer recordings to infer the location of an earthquake. This course covers inverse theory and methods for solving inverse problems, including numerous examples arising in the natural sciences. Topics include linear regression, method of least squares, discrete ill-posed inverse problems, estimation of uncertainties, iterative optimization, and probabilistic (Bayesian) and sampling approaches. Assignments require familiarity with linear algebra and computational tools such as Matlab.

5. **Course goals.**

   We will explore the ubiquitous realm of inverse problems in Earth sciences: how to use observations to make inferences about underlying physical quantities or processes. Our ultimate goal is to be able to recognize the fundamental components of an inverse problem — measurements, model parameters, misfit function, forward model — then to pose an approach to solving the problem, then solve the problem with computational algorithms. Concepts of inverse theory and parameter estimation are fundamental to all observational scientists, which includes most students in the natural sciences. During this course students should acquire both a philosphical and scientific appreciation for inverse methods and problems.

6. **Student learning outcomes.**

   Upon completion of this course, students should be able to:

   (a) Articulate the basic features of forward problems and inverse problems.

   (b) Describe numerous examples of inverse problems and the basic components of each problem.

   (c) Set up and solve an inverse problem using the least squares approach.

   (d) Obtain a linear model from a set of data using multiple linear regression.

   (e) Understand and use data covariances and model covariances within an inverse problem.

   (f) Describe singular value decomposition and its relevance to inverse methods.

   (g) Explain and implement a regularization technique.

   (h) Explain the importance of sampling algorithms for estimating uncertainties of model parameters.

   (i) Pose and answer statistical questions from a particular set of model samples.

   (j) Describe probabilistic approaches to inverse problems.

   (k) Write, improve, and run computational algorithms in Matlab.

7. **Instructional methods.**

   (a) Assignments and grades (along with general course information and handouts) will be posted on Blackboard: `classes.uaf.edu`.

   (b) Lectures will be the primary mode of instruction. Some lectures will be supplemented with computational examples to prepare students for homework problems.

8. **Course calendar (tentative).**

Day	Date	Topic	Reading Due†	Homework Due	Homework Assigned
Thurs	Jan-17	Overview of inverse problems	A1	—	PS-1
Tues	Jan-22	Review of linear algebra	AA		
Thurs	Jan-24	Review of linear algebra	AA		
Tues	Jan-29	Taylor series and least squares (`taylor.pdf`)	notes,T3,AC	PS-1	PS-2
Thurs	Jan-31	LAB: least squares (`lab_linefit.pdf`)	notes,T3,AC		
Tues	Feb-05	Taylor series and least squares	notes,T3,AC	PS-2	PS-3
Thurs	Feb-07	LAB: sampling $\sigma_M(\mathbf{m})$ (`lab_epi.pdf`)	T2,T7.1		
Tues	Feb-12	Covariance	notes,AB	PS-3	PS-4
Thurs	Feb-14	LAB (PS-3)			
Tues	Feb-19	Probability density (`tarantola.pdf`)	AB,notes		
Thurs	Feb-21	Generalized least squares (`tarantola.pdf`)	T3,notes	PS-4	PS-5
Tues	Feb-26	LAB: Newton method (`lab_newton.pdf`)	T6.22		
Thurs	Feb-28	LAB: iterative methods (`lab_iter.pdf`)	A6,A9		
Tues	Mar-05	Linear regression	A2	PS-5	PS-6
Thurs	Mar-07	Linear regression	A2		final project
Tues	Mar-12	SPRING BREAK			
Thurs	Mar-14	SPRING BREAK			
Tues	Mar-19	Singular value decomposition	A3	PS-6	PS-7
Thurs	Mar-21	Singular value decomposition	A3		
Tues	Mar-26	LAB: truncated SVD			
Thurs	Mar-28	Singular value decomposition	A3	PS-7	
Tues	Apr-02	InSAR and parameter estimation			PS-8
Thurs	Apr-04	LAB: Mogi source from InSAR			
Tues	Apr-09	Tikhonov regularization	A4	PS-8	final project
Thurs	Apr-11				final project
Tues	Apr-16	Discretizing problems with basis functions	A5		final project
Thurs	Apr-18				final project
Tues	Apr-23	Principal component analysis	handout		final project
Thurs	Apr-25				final project
Tues	Apr-30	final presentations			
Thurs	May-02	final presentations			
Fri	May-03			final report	

†A = Ref. [1], T = Ref. [2]

Some Important Dates:

First class:	Thursday	January 17
Last day to add class:	Friday	January 25
Last day to drop class:	Friday	Feb 1
Last day for student- or faculty-initiated withdraw:	Friday	March 22
Last class:	Thursday	May 2
Final project report:	Friday	May 3
Final project presentation:	Tuesday	April 30
	Thursday	May 2

9. **Course policies.**

(a) **Attendance**: All students are expected to attend and participate in all classes.

(b) **Tardiness**: Students are expected to arrive in class prior to the start of each class. If a student does arrive late, they are expected to do so quietly and inform the instructor without disturbing the class.

(c) **Participation and preparation**: Students are expected to come to class with assigned reading and other assignments completed as noted in the syllabus.

(d) **Assignments**:

i. All assignments are due **at the start of class** on the due date.

ii. Late assignments will be accepted with a 10% penalty per day late, up to five days late; an assignment that is ≥ 5 days late will receive a zero. (An assignment that is "one day late" would be handed in less than 24 hours after the start time of class on the due date.)

iii. No digital submission of assigments will be accepted (e.g., email or Blackboard).

Homework Tips: Please type or write neatly, keep the solutions in the order assigned and staple pages together. Include only relevant computer output in your solutions (a good approach is to cut and paste the relevant output for each problem into an editor such as MS Word or Latex). Also clearly circle or highlight important numbers in the output, and label them with the question number. I also suggest that you to include your Matlab code in your answers, both so that you can refer back to it for future assignments and so that I can identify where a mistake may have occurred. Display numerical answers with a reasonable number of significant figures and with *units* if the quantity is not dimensionless.

Homework scores are based on clarity of work, logical progression toward the solution, completeness of interpretation and summaries, and whether a correct solution was obtained. I encourage you to discuss homework problems with other students, however the work you turn in must be your own.

(e) **Graded Assignments**: Assignments will be graded for students within seven days of their receipt and returned at the end of the next class.

(f) **Reporting Grades**: All student grades, transcripts and tuition information are available on line at `www.uaonline.alaska.edu`.

(g) **Consulting fellow students**: Students are welcome to discuss with each other general strategies for particular homework problems. However, the write-up that is handed in—including any computer codes—must be individual work.

(h) **Plagiarism:** Students must acknowledge any sources of information—including fellow students—that influenced their homework assignments or final project. Any occurrence of plagiarism will result in forfeiture of all points for the particular homework assignment. If the plagiarism is between two students, then both students will potentially receive the penalty.

Furthermore, the UAF catalog states: "The university may initiate disciplinary action and impose disciplinary sanctions against any student or student organization found responsible for committing, attempting to commit or intentionally assisting in the commission of ... cheating, plagiarism, or other forms of academic dishonesty..."

(i) All UA student academics and regulations are adhered to in this course. You may find these in the UAF catalog (section "Academics and Regulations").

10. **Evaluation.**

(a) Grading is based on:

5%	Attendance and participation
70%	Homework Assignments
25%	Individual Final Project

(b) Overall course grades are based on the following criteria:

A	$x \geq 93$	excellent performance:
A–	$90 \leq x < 93$	student demonstrates deep understanding of the subject
B+	$87 \leq x < 90$	strong performance:
B	$83 \leq x < 87$	student demonstrates strong understanding of the subject,
B–	$80 \leq x < 83$	but the work lacks the depth and quality needed for an 'A'
C+	$77 \leq x < 80$	mediocre performance:
C	$73 \leq x < 77$	student demonstrates comprehension of some
C–	$70 \leq x < 73$	essential concepts only
D	$60 \leq x < 70$	poor performance:
		student demonstrates poor comprehension of concepts
F	$x < 60$	Failure to complete work with 60% quality

(c) **Final Project.** The final project will constitute 25% of the course grade. The project will involve independent research into one aspect of seismology. It will require some computation and will be presented in the form of a written report, due on the last lecture class of the semester, and a short in-class presentation during the scheduled final exam. The report will be written in manuscript-submission style and format, using the guidelines for *Geophysical Research Letters*. Additional details, including project suggestions, will be provided by the instructor midway through the course.

11. **Support Services.**

The instructor is available by appointment for additional assistance outside session hours. UAF has many student support programs, including the Math Hotline (1-866-UAF-MATH; 1-866-6284) and the Math and Stat Lab in Chapman building (see `www.uaf.edu/dms/mathlab/` for hours and details).

12. **Disabilities Services.**

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and it ensures that UAF students have equal access to the campus and course materials. The Geophysics Program will work with the Office of Disability Services (208 Whitaker, 474-5655) to provide reasonable accommodation to students with disabilities.

13. **References listed in syllabus.**

[1] R. C. Aster, B. Borchers, and C. H. Thurber, *Parameter Estimation and Inverse Problems.* Waltham, Mass., USA: Elsevier, 2 ed., 2012.

[2] A. Tarantola, *Inverse Problem Theory and Methods for Model Parameter Estimation.* Philadelphia, Penn., USA: SIAM, 2005.

[3] W. Menke, *Geophysical Data Analysis: Discrete Inverse Theory.* Waltham, Mass., USA: Academic Press, 3 ed., 2012.

[4] R. L. Parker, *Geophysical Inverse Theory.* Princeton, New Jersey, USA: Princeton U. Press, 1994.

[5] S. Weisberg, *Applied Linear Regression.* Hoboken, New Jersey: Wiley, 3 ed., 2005.