11/17/2012: Revised course description. #1-UNC

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	Physics	**College/School**	CNSM
Prepared by	C. P. Price	**Phone**	x6106
Email Contact	cpprice@alaska.edu	**Faculty Contact**	C. P. Price

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

2. COURSE IDENTIFICATION: Dept: PHYS Course #: 471J No. of Credits: 1

Justify upper/lower division status & number of credits: The prerequisites for this course include PHYS 301. This course will meet for fourteen hours.

3. PROPOSED COURSE TITLE: Advanced Topics in Physics I: Order of Magnitude Physics

4. To be 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. To be STACKED? YES/NO: No If yes, Dept: Course #:

6. FREQUENCY OF OFFERING: Fall, Spring

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

7. SEMESTER & YEAR OF FIRST OFFERING (if approved): Fall 2013

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 [X] 5 [ ] 6 weeks to full semester
OTHER FORMAT (specify)	
Mode of delivery (specify lecture, field trips, labs, etc)	Lecture/discussion.

9. CONTACT HOURS PER WEEK: 3 LECTURE hours/weeks; 0 LAB hours /week; 0 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): 13 lectures plus a final exam.

Governance
5/24/12 KO

REVISED portion of the course description: "By avoiding mathematical complexity, order-of-magnitude techniques increase our physical understanding and allow us to study difficult or intractable problems. Students will learn how to do so and to apply these techniques to problems in fluid mechanics, biophysics, astrophysics, and/or other applications."

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

PHYS 471J "Order of Magnitude Physics" (1 credit) v SEE REVISED TEXT ABOVE^
~~Application topics provide expanded exposure to subjects in physics. Three topics are offered within the fall and spring semesters of each academic year as compressed 14-lecture, one credit courses.~~ *Prerequisites: PHYS 220; PHYS 301; or permission of instructor.*

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		S = Social Sciences	

Will this course be used to fulfill a requirement for the baccalaureate core?	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		Natural Science, Format 8	

12. COURSE REPEATABILITY:

Is this course repeatable for credit?	YES		NO	X

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: Specify only one.

LETTER:	X	PASS/FAIL:	

RESTRICTIONS ON ENROLLMENT (if any)

14. PREREQUISITES	PHYS 220; PHYS 301; or permission of instructor.

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

RECOMMENDED	PHYS 341, PHYS 342

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

15. SPECIAL RESTRICTIONS, CONDITIONS	

16. PROPOSED COURSE FEES	$

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

17. PREVIOUS HISTORY

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

If yes, give semester, year, course #, etc.:	Fall 2011

18. ESTIMATED IMPACT

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

Physics Department offers three courses each semester from the 471-472 sequence. When taught, this course would be chosen from the list of courses. Hence, there is no additional impact on budget, facilities/space, faculty, etc.

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	X		4/4/2011; library to provide support for several ERes items (each comprising less than 10% of any book)

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)

No departmental or programmatic impacts.

21. POSITIVE AND NEGATIVE IMPACTS

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

This course promotes broad cross-discipline critical thinking and problem-solving skills in Physics, and will enhance the those abilities of students in and outside the major.

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.

When the Physics Department developed and deployed its revised undergraduate curriculum in 2007-2008, the Advanced Topics modules were a central part of the offering, allowing the department to present a broader range of topics to undergraduates. The list of courses instituted then was never intended to be static, and the department recognized that additional courses would be added to that list in the future as needs were identified.

The addition of this course to the suite of Advanced Topics offerings helps meet the need to better prepare students to undertake interdisciplinary work and to better understand the connections between sub-fields within Physics. Students will develop both qualitative and quantitative critical thinking skills. Students will become more adept at rapidly framing problems which are 'outside the box' by being able to decide what physical effects are important in a given situation, and will come to appreciate how the use of approximation techniques can allow the study of otherwise difficult or intractable problems. Similar courses are offered at several peer and peer-aspirant institutions.

APPROVALS:

Atam Q. Chowdhury	Date	5/9/2012
Signature, Chair, Physics Department:		
[signature]	Date	5/20/2012
Signature, Chair, CNSM Curriculum Council		
[signature]	Date	5/23/12
Signature, Dean, College of Natural Sciences and Mathematics		
	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

Signature, Chair, UAF Faculty Senate Curriculum Review Committee	

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

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

- *OOMPH : ORDER OF MAGNITUDE PHYSICS* -

PHYSICS 471J - Syllabus

Fall *year as appropriate*

Instructor : TBD

Office hours : *Days, time(s)* TBD

Class hours : *Days, time(s), location* TBD

Prerequisites : PHYS 220; PHYS 301; or permission of instructor. Recommended: PHYS 341; PHYS 342.

Texts : **Street-Fighting Mathematics**, Mahajan, ISBN 978-0-262-51429-3, (available as a free pdf download). Other readings as distributed, including selections from: **Random Walks in Biology**, Berg, ISBN 978-0691000640; and **Physics to a Degree**, Thomas, ISBN 978-9056992774.

Description : (From the catalog: Application topics provide expanded exposure to subjects in physics. Three topics are offered within the fall and spring semesters of each academic year as compressed 14-lecture, one credit courses. Prerequisites: PHYS 220; PHYS 301; or permission of instructor.) More specifically, students in PHYS 471J will learn that "By avoiding mathematical complexity, order-of-magnitude techniques increase our physical understanding, and allow us to study otherwise difficult or intractable problems." (from the abstract for Mahajan's PhD thesis [Caltech, 1998].)

Grading : 1 credit. Reading memos (25%, see rubric); homework (50%); final exam (15%). Class participation will also be graded (10%). The course will be graded on a rubric (attached), and will be graded plus/minus.

Schedule : See the attached course schedule.

Learning Outcomes : Students who complete this module will learn how: to make estimates for anything, to decide what physical effects are important in a given situation and what terms in complicated equations can be dropped, to sketch the solutions of equations without actually solving them, to develop a physical feeling for a subject, and to use physics to quantitatively understand the world around you. They will learn why it is better to stop and think before saying, "I don't know" – why (to paraphrase Fermi) "It is better to have estimated and erred than never to have estimated at all."

Remarks : The use of Order of Magnitude methods of calculation in Physics – also known as "Fermi Problems" or "Back of the Envelope Physics" – should be a essential part of every physicist's toolkit. With the increasing wealth of opportunities for interdisciplinary study available to physicists (e.g. geophysics, atmospheric physics, chemical physics, biophysics), this course will help prepare students to undertake interdisciplinary work. It will also help students to better understand the connections between sub-fields within Physics. Students will become more adept at rapidly framing problems which are 'outside the box', by being able to decide what physical effects are important in a given situation, and will come to appreciate how the use of approximation techniques can allow the study of otherwise difficult or intractable problems. (Courses similar to this are offered at leading schools.)

Disability Services : The Physics Department will work with the Office of Disabilities Services (208 WHIT, x7043) to provide reasonable accomodation to students with disabilities.

Tentative PHYS 471J Course Schedule

Lecture 1: Introduction: Everyday Estimation
"Divide and Conquer"; "Plausible Substitution"; how many snowmachines in Fairbanks; how many blades of grass in Alaska; how much money in an armored truck; recycling Newton's breath.

Lecture 2: Everyday Estimation *continued*
annual cost of lighting the streets of Fairbanks; how many words can a No. 2 pencil write; Purcell's (in)famous notecard of fundamental quantities.

Lecture 3: Dimensions and Scaling: dimensional analysis; dimensionless ratios (Buckingham Pi).
Material Properties: the atomic scales; density;

Lecture 4: Material Properties *continued*
equations of state; latent heats; heats of combustion; moduli; ultimate stress; wave speeds;

Lecture 5: Material Properties *continued*
surface tension; specific heats; conductivity and diffusion; thermal expansion; thermal and electrical conductivity.

Lecture 6: Approximating and simplifying analysis: integration

Lecture 7: Approximating and simplifying analysis: differential equations

Lecture 8: Fluid Mechanics
Navier-Stokes; kinematic viscosity; boundary layers;

Lecture 9: Fluid Mechanics *continued*
drags (Stokes, pressure, turbulent); flight; shock waves;

Lecture 10: Fluid Mechanics *continued*
surface waves; geophysical flows; weather systems.

Lecture 11: Biophysics
BMR; mass and size scaling; land-transport; swimming with flagella;

Lecture 12: Biophysics *continued*
cooling; force balance (trees); bio-information; information processing.

Lecture 13: Astrophysics
Chandrasekhar limit; bending of starlight; black hole evaporation.

Lecture 14: Final exam

Grading Rubric
for
PHYS 471J "Order of Magnitude Physics [OOMPh]"

What is a grading rubric, and why is it useful?
A grading rubric is simply a table showing expected performance levels for various aspects of graded work. By giving the student a clear description of the criteria applied in grading, and explicit standards of performance for those criteria, a rubric gives the student the opportunity to direct their efforts productively.

Why is there a grading rubric for PHYS 471J?
To help the student understand the basis for grading answers, and thus to understand the answer to the following question: "I got the right answer, why didn't I get full credit for this problem?"

Why can't I do problems in the way that I always have? Why do I have to learn a new way of doing problems?
A Physicist doesn't spend her/his time writing down algebraic or numerical solutions to well-posed problems – in fact, they rarely do that. Physics is about understanding how the natural world works, and about interpreting physical phenomena. Implicit in that description is the expectation that the Physicist communicates that understanding and those interpretations to others, both within and outside the field. Especially for someone outside the field, a purely mathematical answer ("solution") is the worst way to communicate a result. In this context, one can understand why the "right answer" does not always merit full credit. Thus, learning a new way to do problems is a useful bridge towards learning how to work as a Physicist.

How do I read or use this rubric?
The process of doing a Physics problem can be broken into three main parts: "Set-up and Preparation", "Solution", and "Analysis of Result". Each of those main parts can be further subdivided: for example, the part labeled solution includes outline of attack, commented analysis, and citation of non-derived material employed in the course of the solution. These parts and subparts are elucidated in the first two columns of the rubric. The remaining columns show the criteria used to identify the quality of the response to an assigned item, at three levels: Not To Expectations, Developing Mastery, and Complete Mastery. As you are preparing your solutions, you can examine your work in light of the rubric and see how it will be evaluated. I have placed some additional comments about specific items immediately after the rubric. Finally, please see the posted solutions for explicit examples of the elements described in the rubric.

Will the rubric be applied to all graded material?
Yes, the standards displayed in the rubric will be applied to homework, reading memos and exam problems. Note that use of a rubric allows the instructor to assign the grade which each student deserves (in contrast to grading on a curve, which forces a distribution of grades regardless of student performance.)

The idea for Reading Memos seems to have originated with Taylor at MIT (Am. J. Phys., 60, 201-202, 1992). His goal was to ask students to serve as experts at the task of evaluating a textbook covering material that was new to them, and thereby to improve the text he was writing. In doing so, he discovered that the students self-reported that the process of composing Reading Memos according to his instructions also benefited their learning, and so he resolved to continue to use Reading Memos in all of his classes. Our goal for using Reading Memos is similar: to help me use class time more profitably. Rather than spending time regurgitating all of the topics discussed in the text, we can focus on those items which were not effectively explicated by the text, and we can cover other material.

Instructions for composing Reading Memos:
1. The only ironclad rule is that you can never revise. When you write something, it stays on the paper and is turned in. NEVER recopy or back-edit your memo – your remarks lose their value when they are no longer "fresh".
2. Before beginning reading, set a pad of paper or several pieces of paper and a pencil to side of the text, on the same side that you write.
3. When you begin, note the date and time, and the reading you will be doing (author, pages).
4. Note down difficulties as they appear, with the page number.
5. If you cannot figure out what is wrong, note that as well. If the point in question is later cleared up, DON'T revise or erase your previous note(s) – just add the second comment noting the resolution for you.
6. At the end of a section or chapter, summarize your general difficulties and list the questions which you would like to have resolved.
7. Your frame of mind in composing a Reading Memo should be "If I don't understand something, it is the AUTHOR'S fault." However, keep in mind that your questions and comments should be presented and intended constructively.

Rubric for Reading Memos

Stage	Criteria \ Standard	Not To Expectations	Developing Mastery	Full Mastery
Set-up and preparation	Date and time	Absent	Incomplete	Complete
	Reading citation (author, pages)	Absent	Incomplete	Complete
Commentary	Spontaneity	Revisions or strikeouts; insincere; unforthcoming	Somewhat guarded and hesitant about comments	Open and honest stream of consciousness
	Comments	Irrelevant	Somewhat focused	On point; highly relevant
	Immediate questions or disconnects	Perfunctory or obfuscatory	Some thought applied	Thoughtfully and constructively posed
Summary of reading	Summary of outstanding issues	Absent	Incomplete or cursory	Clear summary in plain English
	Questions needing resolution	Absent; unnecessarily hostile; not constructive	Incomplete or cursory list; somewhat constructive	Questions are clearly posed and constructive

Rubric for Homework and Exam Problems

Stage	Criteria \ Standard	Not To Expectations	Developing Mastery	Full Mastery
Set-up and preparation	Explicit statement of problem (1)	Absent	Incomplete: missing text and/or reference	Complete
	Problem interpretation, placement into context (2,7)	No discussion of problem context	Partial discussion of problem context	Thorough interpretation of problem, noting general area and specific points
"Solution"	Outline of attack (3)	No preview to solution	Partial preview of method to solution	Clear preview of method to solution
	Commented analysis (4)	Sloppy, sketchy development; no commentary on methods	Analysis is directed properly but not always correct; some comments on methods	Precise and correct analysis, with explicit notes on methods at each step
	Explicit citation for non-derived material (equations, methods) (5)	External material introduced *inter alia*	Partial citation of non-derived material	All non-derived materials are completely cited
Analysis of result (6,7)	Summary statement of result	No recapitulation of result	Partial summary of result	Complete summary of result in plain English
	Physical interpretation of result	No interpretation of result	Partial interpretation of result	Thorough interpretation of result in context
	Critical examination of result	No examination of result	Partial examination of result	Full critical examination of result

Comments:

1. The value of an explicit statement of the problem cannot be overstated! Not only does the student avoid doing the wrong problem, but the problem statement is the key part of the context of the answer. This can be copied and pasted.
2. Placing the problem into context can help motivate it, and promotes connections to other results.
3. Although I think that John Archibald Wheeler's statement to "Never start a problem to which you do not already know the answer" is a bit extreme at this stage of your career, one is always well-served by knowing what you are trying to do before you start doing it. Not only does it help guide your steps, it can help you pinpoint where you have run into difficulties.
4. Similarly, a running commentary during the analysis is also very illuminating, both to the student and to the grader. (I personally hope to reduce the number of times that I think to myself: "this student has no clue what they are doing".)
5. If you use material which is not immediately recognizable (*e.g.* solution to the quadratic equation), or if you employ a result or method which is also not immediately obvious, you must cite your source. Every time. Whether you found something in a book or using the internet, give the source, and cite it completely. Failure to do so could constitute plagiarism – which has wrecked careers. It should clear that a graph or a result counts for nothing if we don't know how it was made.
6. I know – from years of experience – that when you *finally* wrestle the code into place, you want to be done with the problem immediately. Go take a break, but come back, because that answer is incomplete. You need to test and check it. It needs to be interpreted and to be critically examined. What does it tell us? Does it make physical sense? Is there a way of testing it – perhaps by taking a limiting case, or by making a comparison to another known result? Don't forget to finalize the documentation.
7. A few well chosen sentences will be sufficient in providing an interpretation, discussion or analysis.