UC 10893 1OF

APPROVED FEB 2 3 2011

CBM003 ADD/CHANGE FORM

RECEIVED OCT 0 6 2010

☒ **Undergraduate Council** ☒ **New Course** ☒ **Course Change** **Core Category: WI-ID Effective Fall 2011** (81)	or	**Graduate/Professional Studies Council** ☐ **New Course** ☐ **Course Change** **Effective Fall 2011**

1. Department: Phys College: NSM
2. Faculty Contact Person: Donna Stokes Telephone: 3-3588 Email: dstokes@uh.edu
3. Course Information on New/Revised course:
   - Instructional Area / Course Number / Long Course Title: PHYS / 3313 / Advanced Laboratory I
   - Instructional Area / Course Number / Short Course Title (30 characters max.) PHYS / 3313 / ADVANCED LABORATROY I
   - SCH: 3.00 Level: JR CIP Code: 40.0801.00 02 Lect Hrs: 0 Lab Hrs: 3
4. Justification for adding/changing course: **To meet core curriculum requirements**
5. Was the proposed/revised course previously offered as a special topics course? ☐ Yes ☒ No
   If Yes, please complete:
   - Instructional Area / Course Number / Long Course Title: ____ / ____ / _____
   - Course ID: _____ Effective Date (currently active row): _____
6. Authorized Degree Program(s): BA, BS Physics
   - Does this course affect major/minor requirements in the College/Department? ☒ Yes ☒ No
   - Does this course affect major/minor requirements in other Colleges/Departments? ☐ Yes ☒ No
   - Can the course be repeated for credit? ☐ Yes ☒ No (if yes, include in course description)
7. Grade Option: Letter (A, B, C ...) Instruction Type: laboratory ONLY (Note: Lect/Lab info. must match item 3, above.)
8. If this form involves a change to an existing course, please obtain the following information from the course inventory: Instructional Area / Course Number / Long Course Title
   PHYS / 3113 / Advanced Laboratory I
   - Course ID: 39103 Effective Date (currently active row): 8 2 2007
9. Proposed Catalog Description: (If there are no prerequisites, type in "none".)
   Cr: 3. (0-6). Prerequisites: PHYS 1322, PHYS 1122, PHYS 3315, and credit for or current enrollement in PHYS 3110. Description (30 words max.): Measurement of e/m, h/e, g; contemporary experiments in microwave diffraction and interference, quantized energy levels, energy distribution of beta-radiation, and chaotic systems.
10. Dean's Signature: ____________________ Date: __________

    Print/Type Name: _____

Memorandum

Date: September 22, 2010

To: Dr. Ian Evans, Associate Dean
College of Natural Sciences and Mathematics

From: Dr. Rebecca Forrest, Instructional & Research Assistant Professor
Department of Physics

RE: Designation of PHYS 3313 Advanced Laboratory I as a "Writing in the Disciplines" course

We are requesting the PHYS 3113 Advanced Laboratory I course be changed to PHYS 3313, and designated as a "Writing in the Disciplines" core course for the B.A./B.S. Physics degree program. The current course already has significant writing requirements. The new version of the course will place more emphasis on scientific writing instruction, as described below. The expansion of the current curriculum qualifies this course for credit towards "Writing in the Disciplines".

Current Course: PHYS 3113 is a three-hour laboratory course. It is designed to help students understand the physics in classic experiments, become familiar with experimental equipment and techniques, gain experience with independent experimentation, and learn to communicate results orally and in writing. Students, working in pairs, perform a one-week introductory experiment, followed by six two-week experiments each semester. These range from traditional experiments in modern physics to contemporary experiments with superconductivity and chaos. The students are required to keep a laboratory notebook and to write a three to four page paper for each experiment in the publication style of the American Institute of Physics. These reports are from 1000 to 2000 words in length. The students also have one brief oral exam based on their own lab reports. The course introduces students to the experimental tools and techniques used in physics, engineering, and industry laboratories, and allows them to mature as experimentalists and communicators. Writing a scientific paper is discussed in the associated Seminar course (PHYS 3110), and the students receive a "Writing About Physics Using LATEX" (S.D. Sewell, MIT) handout and a rubric that summarizes the grading criteria for the reports. The instructor grades all lab reports, giving written comments on content, grammar, and style. The graded reports are returned to the students so they can make improvements on subsequent reports.

Changes to Qualify the Course for "Writing in the Disciplines":

1. Instruction on scientific writing will be moved from the associated Seminar course to the Advanced Laboratory course. This will allow for a more thorough discussion, in a more timely manner, placing more emphasis on quality writing.

2. LabWrite, an online writing program (http://www.ncsu.edu/labwrite/) developed by North Carolina State University (sponsored by the National Science Foundation

DUE-9950405 and DUE-0231086; Development team: Michale Carter, Eric Wibe, and Miriam Ferzli) will be implemented to guide students through every step of the writing process. The program helps students develop meaningful hypothesis and to reflect on their own reasoning and logical processes. It contains Pre-Lab, In-Lab, and Post-Lab sections, to guide students through each phase of the process. It also provides tutorials to aid students with topics such as grammar, citations, using Excel, designing tables, and making graphs. We will primarily use LabWrite to guide students through the paper writing process. The students will receive an introduction to the program during the first day's lecture. This is expected to improve the quality of student writing, by providing guidance during the writing process.

3. A more detailed rubric describing the grading criteria for the reports will be provided to the students. This is also expected to improve the quality of student writing, by helping them to better understand what is expected.

4. The instructor will discuss their comments on the first report with the students individually, before the second report is due. Students whose writing does not improve after the second report will meet with the instructor in small groups to discuss ways to improve their writing. Students will also be referred to Lab Write for online help with the writing process.

5. Because the Writing in the Disciplines version of the course must satisfy the three hour core requirement, we are requesting that PHYS 3113 be changed to PHYS 3313. Not only will this satisfy the Writing in the Disciplines requirement for the B.A./B.S. Physics degree program, but it will also better reflect the workload of the course. In addition, we are requesting that the current PHYS 3114 Advanced Laboratory II course, which is structured similarly to the current PHYS 3113, be changed to PHYS 3214 Advanced Laboratory II. By adding one additional credit hour to this course, it will better reflect the workload for the course and lend an additional hour to meeting the 120 credit hour requirement for the BA/BS degree plan.

Attachments:

CBM003 Form to change PHYS 3113 to PHYS 3313
CBM 003 Form to change PHYS 3114 to PHYS 3214
Core Curriculum Request Form
Syllabus for PHYS 3313
Schedule for PHYS 3313
Syllabus for PHYS 3214
Writing Rubric for reports
"Writing About Physics Using LATEX"

U N I V E R S I T Y *of* H O U S T O N

CORE CURRICULUM REQUEST FOR COURSES NEW TO THE CORE

Originating Department/College: Physics/NSM

Person making request: Donna Stokes Telephone: 3-3588

E-mail: dstokes@uh.edu

Dean's signature: ______________ Date: ______________

I. General Information:

Course number and title: PHYS 3313: Advanced Laboratory I

Catalog description must be included on completed CBM 003 form and attached to this document.

Category of Core for which course is being proposed (mark only one):

- ____ Communication
- ____ Mathematics
- ____ Mathematics/Reasoning (IDO)
- ____ American History
- ____ Government
- ____ Humanities
- ____ Visual/Performing Arts Critical
- ____ Visual/Performing Arts Experiential
- ____ Natural Sciences
- ____ Social/Behavioral Sciences
- __X__ Writing in the Disciplines (IDO)

II. Objectives and Evaluation (respond on one or more separate sheets):

Call ext. 3-0919 for a copy of "Guidelines for Requesting and Evaluating Core Courses" or visit the website at www.uh.edu/academics/corecurriculum

A. How does the proposed course meet the appropriate Exemplary Educational Objectives (see **Guidelines**). Attach a syllabus and supporting materials for the objectives the syllabus does not make clear.

The proposed course, PHYS 3313 Advanced Lab I, was developed by modifying the existing PHYS 3113 Advanced Lab I course to place a greater emphasis on writing skills. PHYS 3113 already has an extensive writing component. As in the current course, the students will write seven lab reports based on their experiments, in the style of the American Institute of Physics publications. These reports are each 1000 – 2000 words long. In the new "Writing in the Disciplines" version of the course, the instructor will discuss writing scientific papers at length during the first meeting of lab. The students are also given "Writing About Physics Using Latex" (S. D. Sewell, MIT) along with their syllabus in the Advanced Lab Handout at the beginning of the semester. "Writing About Physics Using Latex" discusses writing technical papers in the physics community and "guidelines for good writing". A lab report rubric will also be included in the Advanced Lab Handout.

The instructor grades all lab reports, giving written comments on content, grammar, and style. The graded reports are returned to the students so they can make improvements on following reports. In the new "Writing in the Disciplines" version of the course, the instructor will discuss their comments on the first report with the students individually, before the second report is due. In addition, students will be encouraged to use LabWrite, an online writing tutorial developed at North Carolina State University, to guide their writing activities. The program helps students analyze their own reasoning while developing their purpose and hypothesis, and provides step-by-step guidance and tips for writing each part of their final lab report. The use of this program is expected to help students organize and improve their writing.

The proposed course meets all of the Exemplary Educational Objectives for a Writing in The Disciplines core course. Students will apply the scientific method to experiments, learn to use standard laboratory equipment and keep a laboratory notebook, and apply critical thinking skills to derive the desired results from their data. The students will learn to communicate the results of their experiments in the style and format appropriate in the physics community. Their reports will include an abstract, introduction and theoretical background, experimental procedures, results, analysis, conclusions, and references. In these sections the students will show their understanding of the issues and purpose of each experiment, their problem solving and critical thinking processes used to accomplish the purpose, and their analysis of their results. Students will also discuss their experiments during an individual Oral Exam with the instructor. Questions asked during these exams will be based on the student's own written reports.

B. Specify the processes and procedures for evaluating course effectiveness in regard to its goals.

The students submit seven reports during the Fall semester, one report every two weeks. Each of these is graded by the instructor, and is returned with written comments to the students. This provides bi-weekly feedback to enable students to make continuing improvement to their writing. Reports are currently evaluated according to the following rubric: Motivation 15%, Experimental description and results 35%, Analysis 35%, Format and Grammar 15%. A more detailed rubric for report evaluation, based on rubrics from Lab Write, will be given to the students in the new "Writing in the Disciplines" version of the course (attached). Grades based on this rubric will be used to assess improvement of student writing skills. Students whose writing does not improve after the second report will meet with the instructor in small groups to discuss ways to improve their writing. Students will be referred to Lab Write for online help with the writing process.

C. Delineate how these evaluation results will be used to improve the course.

Examination of the rubric-based report evaluations should indicate areas where further writing instruction may be necessary. In addition, students will complete surveys at the end of the course to give suggestions for improving the writing instruction, as well as other aspects of the course. Areas identified as needing improvement will be addressed in the following Fall semester.

SVP. Effective 8/23/10. Replaces all previous forms, which may no longer be used.

COURSE TITLE/SECTION: Phys 3313, Advanced Laboratory, Fall 2011

TIME: Th 1 – 4 pm LOCATION: SR1 129

FACULTY:	**Dr. Rebecca Forrest**	**Dr. Seamus Curran**
OFFICE:	**SR1 515 D**	**SR1 530 C**
OFFICE HOURS:	**MW 1-2:30, TTh 11:30-12, or by appntmnt.**	**Th 10 am - 12 pm, or by appointment**
E-mail:	**rforrest@uh.edu**	**sacurran@uh.edu**
Web Page:	**http://www.phys.uh.edu/~rforrest/**	
Phone:	**(713) 743-3507**	**(832) 671-6647**
Fax:	**(713) 743-3589**	

I. Course

3313: Advanced Laboratory
Cr. 1. (0-3). Prerequisites: PHYS 1122, 1322, 3315, and credit for or concurrent enrollment in PHYS 3110. Measurement of e/m, h/e, g; contemporary experiments in microwave diffraction and interference, quantized energy levels, energy distribution of beta-radiation, and chaotic systems.

II. Course Objectives

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

1. Understand the key experiments that led to the formulation of Modern Physics
2. Perform those experiments for themselves
3. Use contemporary laboratory equipment
4. Understand the basics of error analysis
5. Keep a laboratory notebook
6. Communicate the purpose, procedures, and results of an experiment in the form of a scientific journal article in the style of the American Institute of Physics
7. Communicate the purpose, procedures, and results of an experiment orally

III. Course Content

The 3113 course will include the following topical (content) areas:

1. Fundamentals
   - Measurement & Error (*)
2. Mechanics & Waves
   - Kater's Pendulum (*)
   - Microwave Optics
3. Modern Physics
   - Photoelectric Effect (h/e) (*)
   - Franck-Hertz Experiment
   - Bainbridge Method (e/m) (*)

- β-Spectroscopy
- Young's Double Slit Experiment

(*) Experiments that require complete and detailed error analysis.

V. Textbooks

Text Book: Experiments in Modern Physics
A.C. Melissinos
Academic Press 2003

Additional Reading: Writing About Physics Using LATEX
S. D. Sewell
Advanced Lab Handout

The Art of Experimental Physics
D.W. Preston, E.R. Dietz
John Wiley & Sons 1991

Practical Physics
G.L. Squires
Cambridge University Press 2001

Introduction to Error Analysis
J.R. Taylor
University Science Books 1996

VI Course Requirements

A. Reading Assignments

Read handouts for each experiment and answer the Preparatory Questions <u>before</u> coming to the lab. Answers to the Preparatory Questions are to be in your lab notebook at the beginning of lab, along with the Objective, Procedure summary, and Analysis summary for the day's experiment.

B. Written Assignments

Prepare an experimental report for each experiment, as described below and in the Advanced Lab handout.

C. Oral Assignments

There will be one oral exam given during lab, as described below.

VII. Evaluation and Grading

60%	Experimental Reports:	Students are expected to work in pairs. There will be one introductory experiment covering one lab period (3 hours) and six experiments covering two lab periods each. Each student is expected to turn in Experimental Reports on all of the seven experiments, worth 10 points each. The reports should be three to four pages in the style of the American Institute of Physics publications (e.g. Applied Physics Letters).

Students are encouraged to use TeX or MS Word to prepare their reports; TeX and MS WORD template files are available at http://www.aip.org/pubservs/compuscript.html. Sample TeX and MSWord reports are available at Dr. Forrest's web page. Late reports will lose one point per weekday. They will not be accepted after 5 weekdays late (one week). A lab report rubric is included in the Advanced Lab Handout.

30%	Notebook:	Students are required to use laboratory notebooks during <u>every</u> lab. All writing should be in ink. Only bound, ruled and numbered notebooks are allowed. Lab Notebooks may be purchased at UH Research Stores, room 209, "Old" Science Bldg. During the experiments, students are not to use loose sheets of paper or anything else except their notebook to record experimental data and notes. Data may be plotted on Graph Paper and then glued into the notebook. One notebook per student. These will be periodically evaluated, and turned in and graded at the end of the semester. Grading criteria will be presented during a 3110 seminar.
10%	Oral Exam:	Students will have one oral exam during the semester. Students will be chosen at random each Thursday for their exam, beginning the 5th week (after the 2nd report is due). Questions will pertain to the experiments already completed by the student. Students should bring copies of their reports to lab for the oral exam.

VIII. Additional Notes

Policy on grades of I (Incomplete): The grade of "I" (Incomplete) is a conditional and temporary grade given when a student, for reasons beyond his or her control, has not completed a relatively small portion of all requirements. Sufficiently serious, documented situations include illness, death in the family, etc.

Addendum: Whenever possible, and in accordance with 504/ADA guidelines, the University of Houston will attempt to provide reasonable academic accommodations to students who request and require them. Please call 713-743-5400 for more assistance.

COURSE TITLE/SECTION: Phys 3214, Advanced Laboratory II, Spring 2012

TIME: Th 1 – 4 pm **LOCATION: SR1 129**

FACULTY: Dr. Rebecca Forrest **OFFICE HOURS: M - Th 10:00 – 11:00, or by appointment**
Dr. Seamus Curran **Th 10 am - 12 pm, or by appointment**

E-mail: rforrest@uh.edu, www.phys.uh.edu/~rforrest **Office: SR1 515D** **Phone: (713) 743-3507**
sacurran@uh.edu **SR1 530C** **(832) 671-6647**

I. Course

Cr. 1. (0-3). Prerequisites: PHYS 1122, 1322, 3315 and 3313. Measurement of e, G, and contemporary experiments in superconductivity, optical spectroscopy, blackbody radiation, alpha-radiation, ESR, and chaotic systems.

II. Course Objectives

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

1. Understand key experiments in Modern and Condensed Matter Physics
2. Perform those experiments for themselves
3. Use contemporary laboratory equipment
4. Understand the basics of error analysis
5. Keep a laboratory notebook
6. Communicate the purpose, procedures, and results of an experiment in the form of a scientific journal article in the style of the American Institute of Physics
7. Communicate the purpose, procedures, and results of an experiment orally

III. Course Content

The 3114 course will include the following topical (content) areas:

1. Fundamentals
   - RL Circuits
2. Mechanics
   - Chaotic Pendulum
3. Modern Physics
   - Electron Spin Resonance

- Thermal Emission

3. Condensed Matter Physics

   - Superconductivity
   - Scanning Tunneling Microscopy
   - Transport Properties
   - Solar Cells

V. Textbooks

Text Book: Experiments in Modern Physics
A.C. Melissinos.
Academic Press 2003

Additional Reading: The Art of Experimental Physics
D.W. Preston, E.R. Dietz
John Wiley & Sons 1991

Practical Physics
G.L. Squires
Cambridge University Press 2001

Introduction to Error Analysis
J.R. Taylor
University Science Books 1996

VI Course Requirements

A. Reading Assignments

Read handouts for each experiment before coming to the lab. Answers to the Preparatory Questions are to be in your lab notebook at the beginning of lab, along with the Objective, Procedure summary, and Analysis summary for the day's experiment.

B. Written Assignments

Prepare experimental report for each experiment, as described below and in the Advanced Lab handout.

VII. Evaluation and Grading

60% Experimental Reports: Students are expected to work in pairs. There will be one introductory experiment covering one lab period (3 hours), three experiments covering two lab periods, and two experiments covering three lab periods. Each student is expected to turn in Experimental Reports on all of the experiments, worth 10 points each. The reports should be three to four pages in the style of the

American Institute of Physics publications (e.g. Applied Physics Letters). Students are encouraged to use TeX or MS Word to prepare their reports; TeX and MS WORD template files are available at http://www.aip.org/pubservs/compuscript.html. Sample MSWord and TeX reports are available at Dr. Forrest's web page. Late reports will lose one point per weekday. They will not be accepted after 5 weekdays late (one week). A lab report rubric is included in the Advanced Lab Handout.

30% Notebook: Students are required to use laboratory notebooks during every lab. All writing should be in ink. Only bound, ruled and numbered notebooks are allowed. Lab Notebooks may be purchased at UH Research Stores, room 209, "Old" Science Bldg. During the experiments, students are not supposed to use loose sheets of paper or anything else except their notebook to record experimental data and notes. Data may be plotted on Graph Paper and then glued into the notebook. One notebook per student. These will be turned in a graded at the end of the semester. Grading criteria was presented during a 3110 seminar.

10% Oral Exam: Students will have one oral exam during the semester. Students will be chosen at random each Thursday for their exam, beginning the 5th or 6th week (after the 2nd report is due). Questions will pertain to the experiments already completed by the student.

VIII. Additional Notes

Policy on grades of I (Incomplete): The grade of "I" (Incomplete) is a conditional and temporary grade given when a student, for reasons beyond his or her control, has not completed a relatively small portion of all requirements. Sufficiently serious, documented situations include illness, death in the family, etc.

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UNIVERSITY *of* HOUSTON

COLLEGE OF NATURAL SCIENCES & MATHEMATICS HTTP://NSM.UH.EDU

COURSE TITLE/SECTION: Phys 3214, Advanced Laboratory II, Spring 2012

TIME: Th 1 – 4 pm **LOCATION: SR1 129**

FACULTY: Dr. Rebecca Forrest **OFFICE HOURS: M - Th 10:00 – 11:00, or by appointment**
Dr. Seamus Curran **Th 10 am - 12 pm, or by appointment**

E-mail: rforrest@uh.edu, www.phys.uh.edu/~rforrest **Office: SR1 515D** **Phone: (713) 743-3507**
sacurran@uh.edu **SR1 530C** **(832) 671-6647**

I. Course

Cr. 1. (0-3). Prerequisites: PHYS 1122, 1322, 3315 and 3313. Measurement of e, G, and contemporary experiments in superconductivity, optical spectroscopy, blackbody radiation, alpha-radiation, ESR, and chaotic systems.

II. Course Objectives

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

1. Understand key experiments in Modern and Condensed Matter Physics
2. Perform those experiments for themselves
3. Use contemporary laboratory equipment
4. Understand the basics of error analysis
5. Keep a laboratory notebook
6. Communicate the purpose, procedures, and results of an experiment in the form of a scientific journal article in the style of the American Institute of Physics
7. Communicate the purpose, procedures, and results of an experiment orally

III. Course Content

The 3114 course will include the following topical (content) areas:

1. Fundamentals
   - RL Circuits
2. Mechanics
   - Chaotic Pendulum
3. Modern Physics
   - Electron Spin Resonance

- Thermal Emission

3. Condensed Matter Physics

   - Superconductivity
   - Scanning Tunneling Microscopy
   - Transport Properties
   - Solar Cells

V. Textbooks

Text Book: Experiments in Modern Physics
A.C. Melissinos
Academic Press 2003

Additional Reading: The Art of Experimental Physics
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John Wiley & Sons 1991

Practical Physics
G.L. Squires
Cambridge University Press 2001

Introduction to Error Analysis
J.R. Taylor
University Science Books 1996

VI Course Requirements

A. Reading Assignments

Read handouts for each experiment before coming to the lab. Answers to the Preparatory Questions are to be in your lab notebook at the beginning of lab, along with the Objective, Procedure summary, and Analysis summary for the day's experiment.

B. Written Assignments

Prepare experimental report for each experiment, as described below and in the Advanced Lab handout.

VII. Evaluation and Grading

60% Experimental Reports: Students are expected to work in pairs. There will be one introductory experiment covering one lab period (3 hours), three experiments covering two lab periods, and two experiments covering three lab periods. Each student is expected to turn in Experimental Reports on all of the experiments, worth 10 points each. The reports should be three to four pages in the style of the

American Institute of Physics publications (e.g. Applied Physics Letters). Students are encouraged to use TeX or MS Word to prepare their reports; TeX and MS WORD template files are available at http://www.aip.org/pubservs/compuscript.html. Sample MSWord and TeX reports are available at Dr. Forrest's web page. Late reports will lose one point per weekday. They will not be accepted after 5 weekdays late (one week). A lab report rubric is included in the Advanced Lab Handout.

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10% Oral Exam: Students will have one oral exam during the semester. Students will be chosen at random each Thursday for their exam, beginning the 5^{th} or 6^{th} week (after the 2^{nd} report is due). Questions will pertain to the experiments already completed by the student.

VIII. Additional Notes

Policy on grades of I (Incomplete): The grade of "I" (Incomplete) is a conditional and temporary grade given when a student, for reasons beyond his or her control, has not completed a relatively small portion of all requirements. Sufficiently serious, documented situations include illness, death in the family, etc.

Addendum: Whenever possible, and in accordance with 504/ADA guidelines, the University of Houston will attempt to provide reasonable academic accommodations to students who request and require them. Please call 713-743-5400 for more assistance.

Phys 3313 Tentative Schedule r. Rebecca Forrest
Dr. Seamus Curran

Fall 2011

	Laboratory	Lab Report Due
25-Aug	ntroduction & Scientific Writing	
1-Sep	Lab 1 - Measurement & Error	
8-Sep	Lab 2	
15-Sep	Lab 2	M&E
22-Sep	Lab 3	
29-Sep	Lab 3	Lab 2
6-Oct	Lab 4	
13-Oct	Lab 4	Lab 3
20-Oct	Lab 5	
27-Oct	Lab 5	Lab 4
3-Nov	Lab 6	
10-Nov	Lab 6	Lab 5
17-Nov	Lab 7	
24-Nov	Thanksgiving / No Class	
1-Dec	Lab 7	Lab 6
8-Dec		
15-Dec		Lab 7

Phys 3313, Advanced Lab
Laboratory Report Grading Rubric

	Comments	Points	
		Max	Earned
Title • Identifies experiment adequately and briefly • Cites author first, lab partner(s) second, course, and date		0.4	
Abstract • Summarizes the full report concisely and effectively • Reports final result with uncertainty		0.5	
Introduction • Establishes concept of experiment • Establishes context of experiment • States purpose, and hypothesis if appropriate • Includes all equations used, defines all variables		1.0	
Experimental Method • Describes materials & equipment (in paragraphs, not lists) • Describes procedures (in paragraphs) • Briefly gives enough detail to allow replication of the experiment • Uses own words, not a copy of the manual		1.0	
Results • Uses text to describe data, refers to any tables and/or graphs • Uses tables and/or graphs appropriately • Any tables/graphs have captions, appear in order mentioned, and are correctly labeled • All necessary results reported – Instructor should be able to confirm analysis using the data presented		2.3	
Analysis • Uses text to describe analysis, refers to any tables and/or graphs • Uses tables and/or graphs appropriately • Any tables or graphs have captions, are shown in order mentioned, and are correctly labeled • Correctly shows or summarizes all necessary calculations– instructor should be able to confirm calculations based on what is discussed		2.3	
Conclusion • States whether the purpose was accomplished, and/or hypothesis was correct • Backs this up by referring to results • Reports final result with uncertainty • Answers any questions posed in the lab manual • Addresses any pertinent issues; possible sources of error, importance of results, possible experimental improvements, what has been learned, etc.		1.0	
References • Appropriate references listed • Listed in order referred to in text, in a standard format		0.5	
Writing Proficiency and Format • Uses specified report organization • Uses correct grammar, spelling, and punctuation • Presents ideas clearly, concisely, and logically		1.0	
Overall Grade		10	

Writing About Physics Using LaTeX

S.D. Sewell*
MIT Department of Physics and
editted by R. Forrest
University of Houston
(Dated: August 10, 2009)

We present a written summary template for use by UH Junior Lab students, using LaTeXand the **RevTeX-4** macro package from the American Physical Society. This is the standard package used in preparing most Physical Review papers, and is used in many other journals as well. The individual summary you hand in should show evidence of your own mastery of the entire experiment, and possess a neat appearance with concise and correct English. The abstract is essential. It should briefly mention the motivation, the method and most important, the quantitative result with errors. Based on those, a conclusion may be drawn. The length of the paper should be no more than 2 double-sided pages including all figures.

1. WRITING PAPERS IN THE PHYSICS COMMUNITY

An important part of your education as a physicist is learning to use standard tools which enable you to share your work with others. In Junior Lab, we will instruct you in the use of LaTeXon your own personal Windows machine to write scientific papers in a widely accepted professional style. This source file (sample-paper.tex) for this document should be used as a template for your Junior Lab papers. Spending a few hours studying and altering this document will allow you to develop sufficient mastery of LaTeXto easily generate all manner of technical documents. Specific instructions for compiling LaTeXdocuments on Windows systems are contained in the Appendices.

The introduction section should succinctly report the motivation, purpose and relevant background to the experiment.

2. GUIDELINES FOR GOOD WRITING [4]

The essence of expository writing is the communication of understanding through a clear and concise presentation of predominately factual material. Most people cannot compose successful expository prose unless they put the need to communicate foremost among their priorities. Two things predominate in generating understanding in the reader:

1. ORGANIZATION: The reader must be provided with an overview or outline, know how each fact that he reads fits into that overall picture, and he must be alerted if it is an especially important fact. Furthermore, the facts must be presented in a logical order (so that fact 17 is not important for understanding fact 12).

2. UNIFORM DEPTH of PRESENTATION: Bearing in mind the preexisting knowledge of the reader, the writer must budget the length of discussion allotted to each topic in proportion to its importance.

Of course clarity of presentation and elegance of explanation will greatly enhance the ease and pleasure of understanding; still, a murky explanation can be fairly useful if the reader has been told what he is reading about and where it fits into the overall scheme of things - especially if the reader is familiar with the general subject matter under discussion.

The Junior lab writeup is one of the few opportunities undergraduates are given to practice technical writing. Thus we urge you to concentrate on your overall presentation, not only on the facts themselves. We strongly recommend that you:

1. Base your report on an outline.

2. Begin each paragraph with a topic sentence which expresses the main area of concern and the main conclusion of the paragraph. Put less important material later in the paragraph.

Point 2 is frequently absent in 8.13 reports; they are your mechanism for telling the reader what the topic under discussion is and where it fits into the overall picture.

You can check your topic sentences by reading them in order (i.e. omit all the following sentences in each paragraph) - this should give a fair synopsis of your paper.

If you are individually writing up results you obtained with a partner, use we and I appropriately.

Use the past tense for your procedure and analysis, the past perfect for preparation and the present for emphasis or conclusions, e.g. Since we had previously installed Matlab, we quickly concluded that electrons are waves.

1. Be sure your Figures have comprehensible captions.

2. Make a complete estimate of your errors (not just statistical) - even if it's crude.

3. Trace origin of formulae you use (eg. Moseley's Law) to well known physics (in this case to the

*Electronic address: sewell@mit.edu

Bohr atom) - don't derive, just indicate what new assumptions are needed.

Please consult the MIT's Online Writing and Communications Center's web page at `http://web.mit.edu/writing/` for further guidance in all aspects of writing, style and to make appointments with consultants for free advice. They even have an on-line tutor to which you can submit sections of your paper for critique at any stage of the writing process!!!

Lastly: Remember to proofread your paper for spelling and grammar mistakes. Few things are as offensive to a reviewer as careless writing and such mistakes will count against you!

3. THEORY

The report should be type-written in a form that would be suitable for submission as a manuscript for publication in a professional journal such as the American Journal of Physics - Physical Review Letters, `http://prl.aps.org/`. One helpful website is the APS Physics Review Style and Notation Guide at `http://publish.aps.org/STYLE/`. Figures (created as PDF files) should be inserted into the text in their natural positions. The body of the summary should include a discussion of the theoretical issues addressed by the experiment. This should be done at a level, so that another student could follow your development.

3.1. Typesetting Mathematics

One of the great powers of LaTeXis it's ability to typeset all manner of mathematical expressions. While it does take a short while to get used to the syntax, it will soon become second nature. Numbered, single-line equations are the most common type of equation in *Junior Lab papers* and are usually referenced in the text; e.g. see Equation (1).

$$\chi_+(p) \lesssim [2|\mathbf{p}|(|\mathbf{p}| + p_z)]^{-1/2} \begin{pmatrix} |\mathbf{p}| + p_z \\ px + ip_y \end{pmatrix} . \qquad (1)$$

Mathematics can also be placed directly in the text using delimeters: $\vec{\psi}_1 = |\psi_1\rangle \equiv c_0|0\rangle + c_1|1\rangle\chi^2 \approx \prod\sum\left[\frac{y_i - f(x_i)}{\sigma_i}\right]^2 |\psi_1\rangle \sim \lim_{\mu\to\infty} p(x;\mu) \geq \frac{1}{\sqrt{2\pi\mu}} e^{-(x-\mu)^2/2\mu} P(x) \ll \int_{-\infty}^{x} p(x')dx'a \times b \pm c \Rightarrow \nabla\hbar$.

Infrequently, you may wish to typeset long equations which span more than one line of a two-column page. A good solution is to split-up the equation into multiple lines and label all with a single equation number, like in Equation 2. See the LaTeXfile to see how this is done.

$$\sum |M_g^{\text{viol}}|^2 = g_S^{2n-4}(Q^2)\ N^{n-2}(N^2-1) \times \left(\sum_{i<j}\right) \sum_{\text{perm}} \frac{1}{S_{12}} \frac{1}{S_{12}} \sum_\tau c_\tau^f . \qquad (2)$$

Finally, it is often useful to group related equations to denote their relationship, e.g. in a derivation. Enclosing single-line and multiline equations in `\begin{subequations}` and `\end{subequations}` will produce a set of equations that are "numbered" with letters, as shown in Equations. (3a) and (3b) below:

$$\left\{abc123456abcdef\alpha\beta\gamma\delta1234556\alpha\beta\frac{1\sum_b^a}{A^2}\right\} \qquad (3a)$$

$$\mathcal{M} = ig_Z^2(4E_1E_2)^{1/2}(l_i^2)^{-1}(g_{\sigma_2}^e)^2\chi_{-\sigma_2}(p_2) \times [\epsilon_i]_{\sigma_1}\chi_{\sigma_1}(p_1). \qquad (3b)$$

4. EXPERIMENT

This section describes the main components of the apparatus, procedures used and always makes reference to a figure(s) which contains a block diagram or schematic of the apparatus and perhaps includes the most important signal processing steps. **The figure should be referenced as early as possible in this section with the placement of the figure as close to the descriptive text as is possible.** It is usually necessary to place additional information within the figures themselves or in their captions for which there is no room in the main body of text. This will help you stay within the two page limit.

Example first sentence of an experimental section The experimental apparatus consists of a specially prepared chemical sample containing $^{13}CHCl_3$, a NMR spectrometer, and a control computer, as shown in Figure 1.

Graphics, such as Figure 2 should be well thought out and crafted to maximize their information content while retaining clarity of expresson! If you 'reuse' graphics from your paper in oral presentation slides, make sure to increase the size of all the fonts so that they remain legible from 20 feet away!

5. DATA AND ANALYSIS

All papers should have at least one graphic showing some assemblage of raw data, see for example Figure 3. There should also be one graphic which summarizes the experimental data, and which conveys primary finding(s) of the laboratory exercise. You may find that you need more but these two should be a minimum. Finally, it

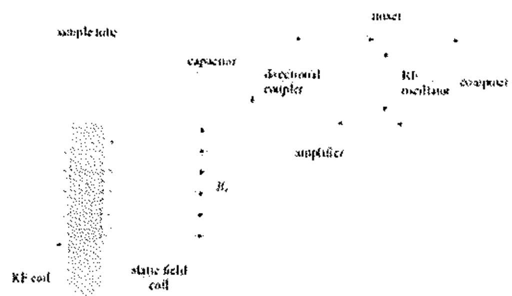

FIG. 1: This is a schematic of the main apparatus. Use the caption space to elaborate on specific issues or complication, or operating procedures. Especially valuable given the limited about of space in the main body of text. The size of this graphic was set by the width command, the aspect ratio defaults to 1.0 if the height is not also set. Adapted from [1, 2].

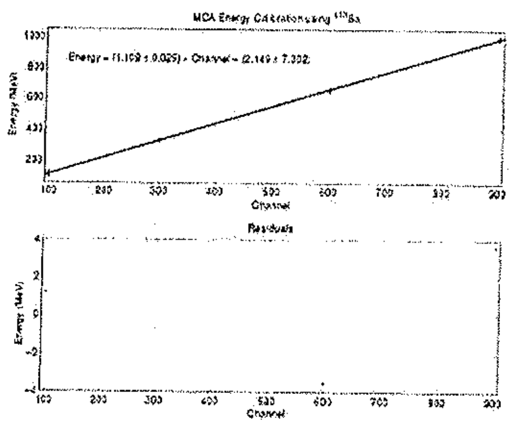

FIG. 2: Sample figure describing a set of data, fit procedures and results. Use the caption space to provide more details about the fitting procedure, results or implications if you do not have sufficient room in the main body of text. The size of this graphic was set relative to the textwidth, see the TeX file for details.

can be useful in some circumstances to have a table of results, see Table I

Try to avoid the temptation to inundate the reader with too many graphics. It is worth spending some time thinking of how best to present information rather than just creating graph after graph of uninformative data. All figures and tables must be properly captioned. Material and ideas drawn from the work of others must be properly cited, and a list of references should be included at the end of the text but before the graphics.

If circumstances in an experiment are such that you cannot get your own data (e.g. broken equipment, bad weather), **you may use somebody else's data provided you acknowledge it.**

TABLE I: A example table with footnotes. Note that several entries share the same footnote. Inspect the LaTeX input for this table to see exactly how it is done.

	r_c (Å)	r_0 (Å)	κr_0		r_c (Å)	r_0 (Å)	κr_0
Cu	0.800	14.10	2.550	Sn[a]	0.680	1.870	3.700
Ag	0.990	15.90	2.710	Pb[a]	0.450	1.930	3.760
Tl	0.480	18.90	3.550				

[a]Here's the first, from Ref. [3].

6. CONCLUSIONS

And finally, conclusions. Remember to report all your results with appropriate significant digits, units, and uncertainties, e.g. $Q = (2.12 \pm 0.06)$ disintegrations s^{-1}. It is often very useful to express the quality of your result by measuring how many standard deviations it lies from other published values.

It is worth mentioning here some thoughts on **ethics and writing in Science.**

When you read the report of a physics experiment in a reputable journal (e.g. Physical Review Letters) you can generally assume it represents an honest effort by the authors to describe exactly what they observed. You may doubt the interpretation or the theory they create to explain the results. But at least you trust that if you repeat the manipulations as described, you will get essentially the same experimental results.

Nature is the ultimate enforcer of truth in science. If subsequent work proves a published measurement is wrong by substantially more than the estimated error limits, a reputation shrinks. If fraud is discovered, a career may be ruined. So most professional scientists are very careful about the records they maintain and the results and errors they publish.

In keeping with the spirit of trust in science, Junior Lab instructors will assume that what you record in your lab book and report in your written and oral presentations is exactly what you have observed.

Fabrication or falsification of data, using the results of another person's work without acknowledgement, or copying from *"living group files"* are intellectual crimes as serious as plagiarism, and possible causes for dismissal from the Institute.

The acknowledgement of other people's data also applies to the use of other people's rhetoric. The appropriate way to incorporate an idea which you have learned from a textbook or other reference is to study the point until you understand it and then put the text aside and state the idea in your own words.

One often sees, in a scientific journal, phrases such as "Following Bevington and Melissinos [1, 3] ..." This means that the author is following the ideas or logic of these authors and not their exact words.

If you do choose to quote material, it is not sufficient just to include the original source among the list of refer-

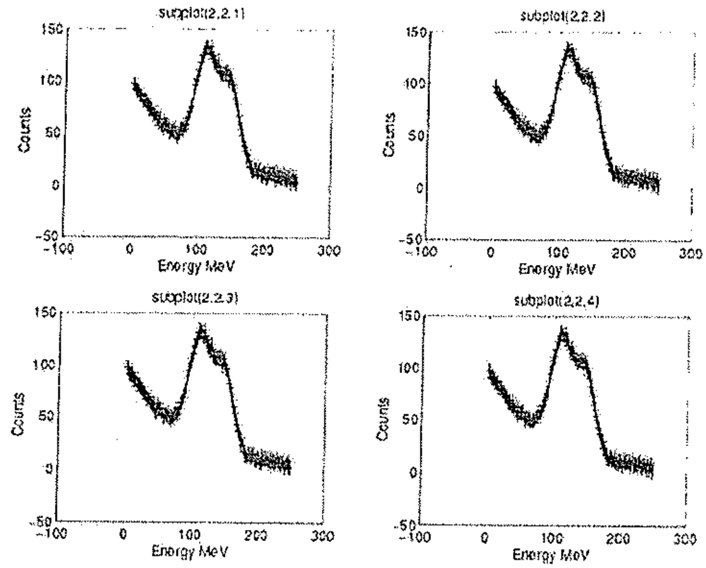

FIG. 3: Sample paneled figure created in Matlab using the subplot(2,2,x) command where x is the element of the plot array into which all subsequent commands such as plot(x,y) and xlabel('Volts'), etc. get processed. Use the caption space to provide more details about the data, their acquisition or how they were processed if you do not have sufficient room in the main body of text. Figures can be rotated using the angle command, see the TeX file for details. If a figure is to be placed after the main text use the "figure*" option to make it extend over two columns, see the LaTeXfile for how this was done.

ences at the end of your paper. If a few sentences or more are imported from another source, that section should be

> indented on both sides or enclosed in quotes, and attribution must be given immediately in the form of a reference note.[1]

If you have any question at all about attribution of sources, please see you section instructor.

7. REFERENCES

Bibliographies are very important in Junior Lab papers. Beyond the requisite citation of source material, they provide evidence of your investigations beyond the narrow scope of the labguide, something explicitly required of all Junior Lab students! Good bibliograhies are doubly important in the real world where they are very (often the most) important sources of information for researchers entering the field. Bibliographic entries may be made either in the '.tex' file itself or within a separate '.bib' file which gets attached during process of building a final PDF document. This latter method is the preferred method and is then one used in this template by default. An example of the alternative style, currently commented out, is contained in the '.tex' source file.

[1] Melissinos, A.C., Experiments in Modern Physics - 1st Edition, Academic Press, [1966]
[2] Melissinos, A.C., Napolitano, J., Experiments in Modern Physics - 2nd Edition, Academic Press, [2003]
[3] Bevington and Robinson, Data Reduction and Error Analysis for the Physical Sciences - 3rd Edition, McGraw-Hill, [2003]
[4] Professor D. Pritchard, Personal Communication

Acknowledgments

FAC gratefully acknowledges Dr. Francine Brown for her early reviews of this manuscript.

8. USING LaTeX UNDER WINDOWS

For those students who would like to use a Windows platform, TexMaker is a LaTex editor available for free at http://www.xml math.net/texmaker/. You can also try MiKTeX (pronounced *mik-tech*, a freely available implementation of TeX and related programs available from `www.miktex.org`. Note that MiKTeX itself runs from a command line prompt and is not terribly convenient. Once you've installed the above software, you can obtain the .tex file on http://www.phys.uh.edu/ rforrest/ and put it on your Windows machine in order to 'rebuild' this document from scratch.

If you wish to view postscript files under Windows, we suggest downloading and installing Ghostscript available from `www.cs.wisc.edu/~ghost`.