Models of Motion, 2014-15

Program Syllabus – Fall Quarter

Models of Motion is a full-time three-quarter long interdisciplinary program that integrates the study of calculus and physics and places them in their cultural and historical context as exemplars of human experience, endeavor, and achievement. Upon completion, students will have gained hands-on experience with and a working knowledge of scientific and mathematical concepts, an ability to reason critically about and solve applied and fundamental problems in physics and math, and an increased understanding of the development of human thinking about these topics. Students who successfully complete the fall quarter of this program should achieve process skills and content mastery equivalent to:

- one quarter of differential calculus (suggested course equivalency: 6 credits in Calculus I with Lab);
- one quarter of calculus-based physics (classical mechanics) with lab (suggested course equivalency: 6 credits in University Physics I with Lab);
- one quarter of a seminar on the cultural history of physics (suggested course equivalency: 4 credits in Seminar on Cultural History of Physics).

Program Faculty

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Program Support

Seth Briney – Grader/Tutor
Geneva Mottet – Grader/Tutor
Diane Nelsen - Science Instructional Technician
Andy Berger – QuaSR Tutor

Required Texts & Materials

You must have access to your own copy of the program texts, as full participation in class activities requires your own copy to work from (electronic versions are acceptable as long as you have the capacity to annotate and, especially in seminar, catch or keep up with the class discussion)

- *A Cultural History of Physics* (Simonyi), ISBN-10: 1568813295, ISBN-13: 9781568813295. We will work through this entire text in the fall quarter.
- *Calculus* (Strang, 2nd edition), ISBN-10: 0980232740, ISBN-13: 9780521781930. The first edition is also acceptable, available freely on-line (**http://ocw.mit.edu/resources/res-18-001-calculus-online-textbook-spring-2005/textbook/**). Students continuing on in the study of mathematics and physics will find their calculus book a necessary reference so we encourage you to think about long term prospects. We use this text all year; in fall we cover chapters 0 – 4.
- *Principles & Practice of Physics* plus **MasteringPhysics** with eText — Access Card Package (Mazur), ISBN-10: 0136150934, ISBN-13: 9780136150930. You will need the full text (the "Principles" book and the "Practice" book) as well as the MasteringPhysics access card/code (MasteringPhysics is an online homework system) – all of these should come bundled using the ISBN provided. We use this text all year; in fall we cover chapters 1 – 13.
- A scientific calculator that in addition to the basic arithmetic functions is capable of powers, roots, trigonometric functions (sin, cos, tan), exponential and logarithmic functions, and the inverse of those functions. A graphing calculator is fine, as is one of the many calculator apps (free or inexpensive) available for smartphones.
- 3-ring binder.
- 1 bound notebook for math and physics lab notes. We recommend but don't require graph paper pages and pages large enough to attach handouts, printouts, graphs, etc.
- Bound notebook(s) for calculus and physics problem sets in their raw and revised versions. We recommend but don't require graph paper pages and pages large enough to attach handouts, printouts, graphs, etc. You may choose to have separate notebooks for calculus and physics problem sets.

Program Learning Goals

Through your work in fall quarter, you will have the opportunity to:

- Improve your ability to articulate and assume responsibility for your own work.
- Strengthen your collaborative skills and the ability to respond in useful ways to the work of colleagues.
- Improve your skills in clear communication of historical, mathematical, and scientific ideas, both orally and in writing.
- Improve your ability to analyze the structure, content, and objectives of a text with focus on developing conceptual understanding and procedural skills and understanding themes and argument.

- Understand key ideas in the trajectory of human thought towards modern physics.
- Strengthen research skills and knowledge of resources associated with the history of physics.

- Gain a firm understanding of the concepts of function, slope, and limits, which provide the backdrop for calculus.
- Learn the definition of the derivative and be able to relate it to algebraic, numerical, graphical, or verbal descriptions and data.
- Learn to calculate derivatives using a variety of standard techniques.
- Learn to use derivatives in applied problems, particularly in the context of the physical sciences.

- Utilize the mathematical models that describe and explain motion in the natural world.
- Understand that physics is based on a few key principles that can be applied to a wide range of natural phenomena.
- Use the main ideas of classical mechanics (kinematics to describe motion and changes in motion, and dynamics and conservation principles to understand what causes changes in motion and what limits those changes) to solve fundamental and applied problems.
- Experience that physics is both a mathematical and an experimental science.

Our work will take place in the context of an Evergreen learning community, and we will be responsible for our interactions within the group as well as our individual learning. In this context, it is important to keep in mind the institutional-level expectations and approaches that form the backdrop of our work together. These are articulated by the College in terms of the "Six Expectations" and "Five Foci", as follows:

Expectations of an Evergreen Graduate:

- Articulate and assume responsibility for your own work.
- Participate collaboratively and responsibly in our diverse society.
- Communicate creatively and effectively.
- Demonstrate integrative, independent, critical thinking.
- Apply qualitative, quantitative and creative modes of inquiry appropriately to practical and theoretical problems across disciplines.
- As a culmination of your education, demonstrate depth, breadth and synthesis of learning and the ability to reflect on the personal and social significance of that learning.

Five Foci of Learning:

- Interdisciplinary Study
- Collaborative Learning
- Learning Across Significant Differences
- Personal Engagement
- Linking Theory with Practical Applications

In all areas of the program, credit will be awarded based on: attendance, participation, and effort; timely submission of assignments; and on demonstrated understanding of the material. All of these will be evaluated with the program learning goals in mind.

Schedule of Activities, Assignments, and Assessments

- All students will participate in weekly ***Lectures***, ***Labs***, ***Problem Sessions***, ***Pre-Seminar***, and ***Seminar***.
- Regular weekly assignments include ***Reading Assignments***, ***Reading Responses***, ***Problem Sets***, and ***Seminar Papers, Responses, and Questions***. Each week there will be a ***Quiz***. In weeks 5 and 10, there will be an ***Exam***. Throughout the quarter, you will maintain a ***Portfolio*** of your work.

<table>
<tr><th>Monday</th><th colspan="2">Tuesday</th><th>Wednesday</th><th>Thursday</th></tr>
<tr><td>9:00 – 10:00
Quiz
Lecture Hall 2</td><td>9:00 – 11:30
Physics Lab A
Lab 1 2046</td><td>9:00 – 10:30
Pre-Seminar B
Sem 2 E3105*</td><td>9:00 – 10:30
Math Lecture
Lecture Hall 2</td><td>9:00 – 11:00
Seminar
Sem 2 E2105/E2107</td></tr>
<tr><td>10:15 – 11:15
Physics Lecture
Lecture Hall 2</td><td colspan="2">12:00 – 1:30
Problem Session
Sem 2 E3105</td><td>10:45 – 12:00
Physics Lecture
Lecture Hall 2</td><td>11:15 – 1:00
Problem Session
Sem 2 E2105</td></tr>
<tr><td>11:30 – 12:30
Math Lecture
Lecture Hall 2</td><td rowspan="2">2:00 – 4:30
Physics Lab B
Lab 1 2046</td><td rowspan="2">2:00 – 3:30
Pre-Seminar A
Sem 2 E3105</td><td colspan="2" rowspan="2">• Computer Applications Lab (CAL) is Lab 2 1st floor
• Students in Group A have Physics Lab Tuesday morning and Pre-Seminar Tuesday afternoon
• Students in Group B have Pre-Seminar Tuesday morning and Physics Lab Tuesday afternoon; *Group B can use Sem 2 E3105 from 9:00 – 9:50 but will have to meet elsewhere after that</td></tr>
<tr><td>1:30 – 3:00
Math Lab
Computer Applications Lab</td></tr>
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	Math	Physics	Seminar
Sat/Sun	Complete math Reading Assignment to prepare for Lecture; Study for Quiz	Complete physics Reading Assignment to prepare for Lecture; Submit Reading Response via MasteringPhysics by Sun 6 pm; Study for Quiz	Complete seminar Reading Assignment; (Authors) post Seminar Paper draft by Sat 11:59 pm
Monday	*Quiz, Lecture, Lab*; Attempt all Problem Set problems to prepare for Problem Session	*Quiz, Lecture*; Attempt all Problem Set problems to prepare for Problem Session	(Reviewers) post replies to 2 Seminar Papers by 6 pm; Review seminar Reading Assignment to prepare for Pre-Seminar
Tuesday	*Problem Session*; Review math Reading Assignment to prepare for Lecture	*Lab, Problem Session*; Review physics Reading Assignment to prepare for Lecture	(Reviewers) submit revised Seminar Paper from previous week to faculty by 9 am; *Pre-Seminar*: peer review Seminar Paper drafts, prepare Seminar Question
Wednesday	*Lecture*; Attempt all Problem Set problems to prepare for Problem Session	*Lecture*; Attempt all Problem Set problems to prepare for Problem Session	Review seminar Reading Assignment to prepare for Seminar
Thursday	*Problem Session*; Work to complete math homework	*Problem Session*; Work to complete physics homework	*Seminar*
Friday	Submit math Problem Set to faculty mailbox by 3 pm	Submit physics Problem Set via MasteringPhysics by 11:59 pm	

Activities Overview

Lectures: In our interactive Lectures, we will provide context for the program content and skills, work through conceptual difficulties, make connections between our various topics and texts, and gather questions. You prepare for Lecture by completing the assigned reading before coming to Lecture and taking reading notes. You participate during Lecture by taking lecture notes and engaging in lecture discussion and activities. You follow through on Lecture by preparing for the associated Problem Session.

Problem Sessions: A collaborative Problem Session is associated with each Math and Physics Lecture and occurs the day following the lectures. A set of homework problems will be assigned for each Problem Session. You prepare for Problem Session by attempting to complete all problems before Problem Session, documenting your work in your problem set notebook, and bringing your complete and incomplete problems to Problem Session. You participate in Problem Session by working in small groups to understand and explain problems that posed particular challenges to you or any group member, with the goal of improving both your private internal understanding and your public external communication of that understanding, and documenting your work in your problem set notebook. The emphasis during Problem Session will be on collaborative learning and communication about math and physics; the goals of the session are as much about mathematics/physics process and discourse as they are about problem-solving. You

follow through on Problem Session by updating and completing your problem set notebook and by submitting your Problem Sets (as described below).

Math and Physics Labs: Labs will give students opportunities to discover or apply mathematics or physics concepts or principles and to develop hands-on experience and transferable skills with equipment and computers in a structured and supportive environment. Labs will emphasize teamwork and communication capacities, observation and record-keeping skills, and problem-solving and analysis. In general, you will not need to prepare for lab sessions; exceptions will be clearly noted with sufficient lead time. You participate in Lab by engaging appropriately in the assigned activities and documenting your work in your notebook. You follow through on Lab by completing any analysis or questions that remain.

Pre-Seminars and Seminar: Our fall seminar will be focused on the history of physics, and our readings and discussions will center on Simonyi's *A Cultural History of Physics.* This book is a beautiful and rich resource, supplementing its core text with excerpts from historical documents, a wide range of diagrams and figures, and special sections separating out the higher-level mathematical ideas. Seminar groups will meet with faculty to discuss the text, with focus on the questions prepared in Pre-Seminar. Each student will be placed into one of two seminars; each seminar will have a faculty facilitator. Seminar groups will be split such that in alternating weeks, half the group are Authors and half are Reviewers, with roles switching each week. Seminar groups will also be split into Pre-Seminar groups consisting of 4 students: 2 Authors and 2 Reviewers, with roles switching each week but with stable membership.

Pre-Seminars offer an opportunity to develop long-term collaborative skills with a small group of peers and to work through a rich text in small groups to prepare for a larger group discussion. You prepare for Pre-Seminar by completing the seminar reading, and either posting your Seminar Paper by Saturday 11:59 pm and bringing 4 copies to Pre-Seminar (if you are an Author that week) or commenting on two posted Seminar Papers by 6 pm Monday (if you are a Reviewer that week). You participate in Pre-Seminar by offering thoughtful and gracious feedback on both the content and form of the Seminar Papers brought by the two Authors, and if you are an Author also by taking notes and considering carefully the feedback you receive. In addition to the peer review, the pre-seminar groups will discuss the week's reading broadly and narrowly, and prepare at least one written Seminar Question to bring to Thursday's Seminar. You follow through on Pre-Seminar peer review as an Author by starting to revise your Seminar Paper based on feedback. As a Pre-Seminar group, you follow through by polishing the Seminar Question for Thursday's Seminar.

You prepare for Seminar by reading the assignment again and completing the Pre-Seminar work, especially the Seminar Questions. You participate during Seminar through close reading of the text, collaborative inquiry into developing deeper understanding of its meaning, and demonstrable engagement with the Seminar Questions and with your fellow seminar students. You follow through on Seminar by, when possible, using insights gained in the discussion to strengthen your Seminar Papers.

Assignments and Assessments Overview

Reading Assignments*:* Each week, you will have Reading Assignments from the math, physics, and seminar textbooks.

- Seminar Reading Assignments must be completed in time for Authors to post the first drafts of their Seminar Papers by 11:59 pm Saturday or for Reviewers to post their responses by 6 pm Monday (see below).
- Physics Reading Assignments must be completed in time for you to submit your Reading Response by 6 pm Sunday (see below).
- Calculus Reading Assignments must be completed prior to the discussion of the material in lecture.

Details of Reading Assignments are provided at the Calendar links at the program website.

Reading Responses: For each week's physics Reading Assignment, you will complete a Reading Response. The Reading Responses are intended to help you keep up with the reading, orient you to the material for the upcoming week, and to give your instructor feedback on how best to use our class time, based on what you have difficulty with. You are welcome to use your book and other resources to complete the Reading Response, but should take it individually. Reading Responses are due on-line via MasteringPhysics by 6 pm Sundays (if you don't have access internet access on Sunday, there are alternatives; please come speak with us). Additionally, to promote close attention to the calculus reading assignments, students will at times be asked to bring to class a written response to a question or questions about the math reading.

Problem Sets: Problem Sets in calculus and physics give you practice with important basic concepts and calculations, as well as with problems that are generally richer and more complicated, requiring an application of concepts and skills beyond the basics. You should attempt all problems on the Problem Set before the associated Problem Session (see above). You submit selected problems from the week's Problem Set for assessment. For calculus, you submit a neat write-up of selected problems from that week, due in the faculty mailbox by Friday 3 pm. For physics, you submit your answers via MasteringPhysics no later than Friday 11:59 pm. In addition, clear and complete written solutions to Problem Sets are required in your problem set notebook, which may be checked during the quarter.

Seminar Papers, Responses, and Questions: You will be placed in either Seminar Group A or Seminar Group B. Within your seminar group, you will be further placed into a Pre-Seminar group of 4. In addition, you will alternate between Author and Reviewer each week, such that in your Pre-Seminar group of 4, there will be 2 Authors and 2 Reviewers each week, switching roles the following week.

- ***Seminar Questions*** – In Tuesday's Pre-Seminar, your group of 4 will prepare at least one high-quality discussion question to bring to Thursday's Seminar based on that week's reading. While your question(s) can be inspired by the Seminar Papers you peer reviewed in Pre-Seminar, your question(s) should go beyond those in Seminar Papers, which after all, have already had an attempt at being answered by the author.
- ***Seminar Paper Responses*** – In weeks that you are a Reviewer, you will respond to (at least) 4 Seminar Papers.
    - You will respond on-line as a reply to 2 Seminar Papers posted by Authors in the *other* Seminar from you (this is in order to promote cross-seminar discussions). While you are welcome to offer comments intended to help improve formal issues (writing mechanics, sentence structure, etc.), your primary goal should be to take up the intellectual content and substance of the Seminar Paper with attention to engaging in such a way that it invites a genuine conversation with the author and other readers. You will reply with your 2 responses by Monday 6 pm.
    - In Pre-Seminar, you will workshop the Seminar Papers written by the 2 Authors in your group of 4. The peer review may take up issues of writing mechanics but hopefully not much copy-editing will be required. The goal should be to engage with the ideas of the Seminar Paper in such a way as to help the Author improve the substance of the Seminar Paper.
- ***Seminar Papers*** – In weeks that you are an Author, you will write and revise drafts of a Seminar Paper based on that week's seminar reading assignment. You will post the draft of your Seminar Paper to the program forum, and based on posted feedback and peer review workshops, you will revise the Seminar Paper to submit to your seminar faculty. Authors post their Seminar Paper by 11:59 pm the Saturday before the associated Pre-Seminar, and submit their revised paper for faculty review by 9 am the Tuesday following the associated Seminar.
    - *Seminar paper requirements:* Papers will be up to 2 pages long (double-spaced, max 500 words), and will be based on the week's reading. Your paper needs to focus on a specific passage or diagram from the reading. The paper should be in a question-and-answer format: you pose a question (examples below) based on the passage or the diagram, and you proceed to do the research, calculations, analysis, and/or reflection which is required to attempt to answer the question. You should use standard academic citation conventions to cite work from Simonyi or from your outside research sources (citations don't count for the paper length). In addition, we ask you to address the following standing question in each one of your papers: *How does the passage or diagram that you have focused on fit into the overall arc of the week's reading? (What is the author's goal or point in including this material/concept/historical moment?)*
    - *Examples of the type of questions you might pose* (these are just examples, not a comprehensive list!):
        - *On p 18-19, Simonyi makes reference to Marxism and the concept of historical materialism. What is historical materialism and how does it relate to the history of physics (according to Simonyi)?* [This question is about clarifying a complex piece of text, and filling in some background related to historical and cultural context.]
        - *On pp 25, Simonyi uses Figure 0.20 along with some brief textual discussion, to comment on Chinese culture and mathematics. What is the significance of the fact that the ancient Chinese drew "Pascal's triangle...long before Pascal"?* [This question invites further research on a topic Simonyi briefly alludes to, and allows you to draw your own conclusions on the relationship between various cultures' intellectual histories.]
        - *On p. 11, figure 0.13 presents a complex pathway illustrating the scientific process. Is there a simple and concrete example that might illustrate and therefore clarify the pathway the author is representing here? What are some other illustrative representations of the scientific process?* [This question provides an opportunity to clarify the meaning of a complicated diagram through an example and to investigate other representations of the process illustrated by that diagram.]

Quizzes: There will be an in-class Quiz each Monday at 9:00. The Quiz will primarily cover math and physics material from the previous week. Quizzes will help you and us keep track of your understanding of the material. The quiz problems will often be very similar or identical to homework, workshop, and lab problems from the previous week. To study for the quiz, the most important work you can do is to complete the labs and especially the homework and check your answers against solutions provided online in the books. Make use of QuaSR resources and tutors as well as classmates, tutors, and faculty, to be sure you understand the homework problems in advance of the quiz. If you are concerned about your performance on a Quiz, you can revise the Quiz and submit the revision in your Portfolio.

Exams: There will be in-class Exams in weeks 5 and 10 in both calculus and physics (on the same day). These exams offer you an opportunity to demonstrate what you have learned through reading, lectures, labs, homework, and other program activities. Details about Exam Revision opportunities will be provided after Exams are returned.

Portfolio*:* Throughout the program, you will maintain a portfolio of your work consisting of all the above assignments and assessments as well as any notes or other material that reflect your work. The portfolio will be submitted at the end of week 10 and will inform faculty evaluations. It will also provide a lasting record and resource for your own future reference. In addition to the above assignments and assessments, your Portfolio will also include a Self-Evaluation and updated Academic Statement.

- ***Self-Evaluation***: Each student is required to write and submit to faculty an evaluation of their own work and achievements in the program. We will have short evaluation writing workshops to help you through this process (see below).
- ***Academic Statement***: Each student is required to write and submit to faculty an updated draft of their Academic Statement. We will devote six hours of seminar time in fall quarter to support students in writing or updating their Academic Statement; this work will also support self-evaluation writing. Students who started at Evergreen in fall 2013 or later are required to upload their updated Academic Statement to the appropriate location at their my.evergreen.edu portal in order to be allowed to register for the following year.

Schedule of reading assignments (may be subject to change):

Week	Math	Physics	Seminar	Notes
1	0.1, 0.2, 0.3, 1.1	Ch. 1	Ch. 0 - Intro	Pre-seminar – Library Research Workshop
2	1.2, 1.3, 1.4	Ch. 2; Ch. 3	Ch. 1	Group 1 writes Paper 1 draft
3	1.5, 1.6. 2.1, 2.2	Ch. 4; Ch. 5	Ch. 2	Group 2 writes Paper 1 draft; Group 1 submits Paper 1 revision
4	2.3, 2.4, 2.5	Ch. 6; Ch. 7	Ch. 3	Group 1 writes Paper 2 draft; Group 2 submits Paper 1 revision
5	2.6, 2,7	Ch. 8	TBA	Midterm Exams, math & physics (Monday) No Simonyi reading, Academic Statement/Planning
6	3.1, 3.2, 3.3, 3.4	Ch. 8; Ch. 9	Ch. 4	Group 2 writes Paper 2 draft; Group 1 submits Paper 2 revision
7	3.5, 3.6, 3.7	Ch. 10	TBA	Veteran's Day holiday – Tue. 11/11 No Simonyi reading, Academic Statement/Planning
8	3.8, 4.1, 4.2	Ch. 11; Ch. 12	Ch. 5 (5.1 – 5.3)	Group 1 writes Paper 3 draft; Group 2 submits Paper 2 revision
9	4.3, 4.4	Ch. 13	Ch. 5 (5.4 – 5.7)	Group 2 writes Paper 3 draft; Group 1 submits Paper 3 revision
10	TBA	TBA	TBA	Group 2 submits Paper 3 revision Final Exams, math & physics Self-Evaluation/Academic Statement
Evaluation Week				