Abstract

This will be a very “different” course. It is the second version of a syllabus for PHY 2049 M. The M stands for Mazur and the document is a revised form of the document that Professor Mazur uses in his class at Harvard.

Note that this syllabus is in a state of flux. As we learn more about this approach to teaching physics, some of the statements in this document may not be executed exactly as written.

Ahlam Al-Rawi, Jeff Bindell & Eric Mazur
INTRODUCTORY COMMENTS:

Most of you are probably looking to leaving the university and starting your first job. One of the things you are probably looking forward to is a life free of long lectures and devoid of tests. But you will not be free of assessments. In the world of work, your managers will be constantly assessing your value to the firm and relaying this information back to you in the form of a performance review. (Everyone hates them!)

What will be the basis of their assessments of your abilities? They most certainly will include all of the following and perhaps a few more:

- Do you have the knowledge required of your assignment?
- Are you able to function well on teams?
- Do you have the respect of your peers?
- Do you complete your assignments on time?
- Do you meet your deadlines most of the time?
- Do you arrive to meetings on time and can you be relied upon to be at your desk (or in your lab) when you are expected? Are you punctual?
- Are most of your assignments completed correctly, with few errors?
- Do you behave professionally?
- Do you demonstrate flexibility?
- Do you show respect for your fellow employees and your managers even when you think they are idiots?

This is a picture of the outside world and it is fairly accurate. And as you read the following, you will understand how you will be evaluated as the semester rolls on. You will not be subjected to long lectures although some short lectures will certainly punctuate the course. You won’t have to take tests but you will be examined. How can this be? One way is through homework assignments. When you work on a homework problem, you can use any resources available but keep in mind that you should be learning the material through this process, so work them honestly. You may certainly work with your teams (assigned below) because that is how you would work on a problem in the world of work! You will be graded on these assignments based upon how you present your solutions and how correct your procedures are. The exact answer will be secondary (but still important).

Tests are another thing. Consider how you typically take a test. You skim the textbook, review the homework and request a formula sheet. You then take the test and promptly forget anything you may have studied until the next test. Not very useful, is it? In this new approach there will be test-like components. The difference is that while you answer these questions, you can have any reference material that you want. On the job, you have this exact experience when you are asked to quickly solve a problem. You look things up. You use textbooks, articles in the literature and the internet, among other things. All you need to do is keep up with the work and bring the understanding that you have to these classes. No need to memorize anything. In fact, you may not have to actually study for these but a review won’t hurt. Can you get help from your team? At first no, then yes. You will answer the questions (electronically) by yourself but then the question will be asked a second time which you can answer after discussion with your team. Both answers count.

So, we tricked you! This isn’t a course ... it is a JOB. **Welcome to your future!**
SOME HISTORY

Physics Education Research (PER) is a 20 year old project in which studies have been performed to determine what the very best way to teach physics might be. It has been a long evolution starting with the still common lecture/lab structure to Studio Physics or SCALE-UP where students work in groups with the lecture and lab merged together. SCALE-UP has generally led to higher grades and more learning than the lecture format but lectures still remain common.

Recently, Harvard Professor Eric Mazur created a better way to teach physics. Dr. Mazur completely eliminates tests and quizzes and focuses on the main purpose of taking this course: to understand the included material and to be able to utilize the knowledge to solve problems in group environments. Preliminary data looks so encouraging that the UCF Department of Physics introduced this approach in the Fall 2014 semester and repeated in the Spring. Although there were many issues that popped up these classes, each one suggested changes that will be utilized during the current semester. Many great suggestions were made by the students in the both semesters and many of these have also been adopted.

We are very excited about this innovation and we hope that you will be as well. Keep in mind that this remains a difficult course that will still require significant effort on your part for you to be successful. Although there will be no tests and, believe it or not, virtually no lectures, there will indeed be assessments of your progress as well as formal grades. More details will be found in the pages below. You may want to watch the following to get a better idea about this class. Link: http://java.engin.umich.edu/220f13/. This video demonstrates how this method worked at the University of Michigan albeit in an engineering rather than a physics course. We hope that you will want to be a part of this type of delivery of this exciting approach to teaching physics!

The Syllabus material that now follows has been mostly “stolen” from Dr. Mazur’s document. Welcome to Harvard! Dr. Mazur is a mentor to your instructors and we consult him often.

SYLLABUS

Welcome also to PHY-2049M: Physics for Scientists and Engineers II — the third delivery of a newly formulated project-based introductory physics course. This course in Physics is at the intersection of physics and engineering. Physicists build to understand; engineers understand to build. In this course you will be doing both. If you like to learn by doing rather than by listening, thrive on the exchange of ideas, love to see how science applies to the real world, and enjoy working in teams to build things, this course is for you!

The subject area covered by PHY2049 “M” (not an official designation) includes electrostatics, conservation principles, electromagnetic forces, circuit analysis, magnetostatics, and some topics in optics. Because it is equivalent to the standard introductory physics course, this course meets the requirements for all majors that require this sequence.

There are no lectures and no examinations in the section of the course in which you are registered. At the core of the course are three, projects on which you will work in teams, mostly during the normal hours of the course. There are no additional sections or laboratories. You may want to work with your team outside of these hours but this would be voluntary.

The instructors, 1 or 2 LAs and a GTA for this course, are ready to help you gain a better understanding of how science applies to the real world and develop skills that will be useful in your career. Our goals for this course are to promote self-directed study of basic physics, explore physics in the context of real-world applications, improve collaborative and communication skills in team-driven activities, and develop research skills by working on projects and writing reports.
We look forward to getting to know you this coming semester. We take our teaching duties very seriously and will work very hard so as to attain the above goals and make this course an enjoyable, rewarding, and useful experience for you. We will make ourselves as accessible as possible — we do want to interact with you both in and out of class. We encourage you to stop by our offices, call or email with any questions you may have.

This document is meant to help you understand the course goals and logistics and to make the most of this course. Throughout the semester we will ask for your feedback to see if we are moving toward achieving the course goals and satisfying your needs.

COURSE GOALS

After successful completion of this course, you will be able to... (within and beyond the context of introductory physics)

- Use independent study and research to tackle a problem
- Apply the scientific method to advance your knowledge and to design viable methods of investigation
- Use a variety of techniques to get a handle on problems: represent the problem visually or graphically, perform order of magnitude estimates, use dimensional analysis and proportional reasoning, recognize symmetries, evaluate limits, and/or relate the problem to cases with known solutions
- Set up, solve, and interpret relevant equations
- Know how to judge the correctness of a solution
- Explain assumptions made in a model and know how to justify any approximations made
- Analyze a system, explain why it works, and how to optimize performance
- Use information to build a case for a specific design or measurement
- Describe how a measurement is performed and the limitations of the measuring instruments
- Use software to control simple experiments and accumulate data
- Analyze data, identify sources of uncertainty, and minimize measurement error
- Reflect on the result of a measurement in order to develop refinements to it
- Synthesize the data into coherent reports and presentations

In addition to these course goals, there are usually some content-specific learning goals for each of the assigned projects. These content-specific learning goals are specified in each project description (referred to as a “brief”) that will be provided to you at the appropriate time. The course and content-specific goals will form the basis for assessment in this course.

This course is also designed to contribute to the development of the following competencies:

- **Qualitative Analysis**: The ability to analyze and solve problems in science and engineering and other disciplines qualitatively, including estimation, analysis with uncertainty, and qualitative prediction and visual thinking.
- **Quantitative Analysis**: The ability to analyze and to solve problems in science and engineering and other disciplines quantitatively, including use of appropriate tools, quantitative modeling, numerical problem solving, and experimentation.
- **Diagnosis**: The ability to identify and resolve problems within complex systems through problem identification, formation and testing of a hypothesis, and recommending solutions.
- **Design**: The ability to develop creative, effective designs that solve real problems through concept creation, problem formulation, application of other competencies, balancing tradeoffs, and craftsmanship and which integrate knowledge, beliefs and modes of inquiry from multiple and diverse fields of study.
● **Teamwork**: The ability to contribute effectively in a variety of roles on teams, including diverse teams, while respecting everyone’s contributions. You will develop collaborative skills that may include questioning, listening, and identifying multiple approaches and points of view.

● **Communication**: The ability to convey information and ideas effectively, using written, oral, and visual and graphical communication.

● **Lifelong Learning**: The ability to identify and address your own educational needs in a changing world, including awareness of personal attributes, fluency in use of information sources, planning, and self-directed learning. The ability to “think critically,” both positively and negatively, about any situation or the solutions to any problem.

The last item in this list is deserving of some comment. If we assume that you will be pursuing a professional career, you will somehow be developing something that doesn’t currently exist (or exist in an appropriate form). In order to deal effectively with this you will have to add to your knowledge base just about forever. There is no way that you can remember all of this; you will have to understand the basics and apply those basics to the development of new concepts. The conceptual understanding of these basics will give you this needed foundation for future learning.

**TEXTBOOKS, etc.**

**Text**: Mazur “Principles of Physics”.

**Tutorial (Book)**: McDermott – Tutorials in Introductory Physics. Available in the bookstore. You will get electronic access to the textbook for this course via a social document annotation system. You can use the annotation system to add notes to the book, discuss sections of the book with your classmates and the staff, ask questions, etc. There is no need to purchase any printed textbook but the text by Eric Mazur, “Principles & Practice of Physics” - Vol. II, will be made available through the bookstore. There is no real need for purchasing the hard copy since you will have access to the eBook through Mastering Physics and through the new software program “Perusall” (below). If you do decide to order the hard copy (check the prices of both!) be sure to only get Volume 2 which comes as two separate books.

*The following has been ordered by the bookstore; students are required to have either bundle.*

(A) 9780134019789 (0134019784) Mazur textbooks with Mastering Physics and McDermott Tutorials (regular bundle),

Or,

(B) *The e-access to the textbook and the McDermott tutorials*

9780321966162 – *(The Mastering Physics code) for those who don’t want a physical text book*  
9780130653642 – *(The McDermott tutorials)*

**Perusall Software**: Will be explained below and will be provided at no cost.
COURSE LOGISTICS

Prerequisites

PHY2048 or equivalent. A solid knowledge of multivariable calculus is strongly recommended. Calculus will be used extensively in this course.

Class meetings

The class meets three times a week, from (9:30AM-11:20AM) or from (11:30AM to 1:20PM) in PSB 350, a relatively new classroom designed for interactive team-based learning.

We will rarely lecture to you during the class meetings. Instead, you’ll have an opportunity to work in teams on three successive, projects. The class activities are designed to help you master the relevant physics and get you started on your projects. For details on the various activities, see the next section. A weekly schedule of class activities will be included on the on-line class (Canvas) calendar. Be sure to check the calendar and the files posted to canvas often.

Technology

You will need a laptop, smartphone or tablet in almost every session. (Some PCs are available in the classroom for emergencies!) You will be better off with a larger format device. Aside from the Perusall annotation system, a number of class activities are completed using a web-based electronic response system through these devices. Please bring your device and its charger to every class.

The document annotation system (newly developed at Harvard) is called Perusall. Instructions for registering for this program will be provided on the first day of class. If used correctly, this program will be where you learn most of the material, so it must be taken very seriously. It is an important part of your assessment (grade). See https://perusall.zendesk.com/hc/en-us/articles/207035387-Getting-started.

The electronic response system (developed at Harvard) is called Learning Catalytics. This software is included in your registration with MasteringPhysics which is also required. We will explain in class how to use this system as well. Your smart device will also act as your clicker via WiFi.


Getting help

Because we are not lecturing to you, we will make some time available to help you and provide personal assistance. Never hesitate to contact us. We will soon post office hours, but we are happy to schedule a meeting at a time that is mutually convenient. Special problem discussion sessions will be scheduled on a regular basis if there is interest. In addition to our office hours, your team will be assigned a Team Mentor for each project cycle. The Team Mentor will be your go-to person for help with any aspect of the course. You will check in with your Team Mentor in each class, and she/he will be offering you and your teammate’s feedback throughout all aspects of the course. Your Mentor will be either your instructor, an LA or the GTA.
COURSE ACTIVITIES

I. PRE-CLASS: reading assignments and annotations (Perusall)

Purpose: Provide you with a first exposure to the material so we can spend the class time doing activities that will help you better understand the concepts. These reading assignments MUST be completed on time so that you can participate successfully with the Learning Catalytics sessions. Perusall allows your instructor to know what you are reading and how effectively you are doing so. (Magic!) You will be scored on your on-time utilization of the NB software and your score will be part of your grade.

What you need to do: Read the chapters according to the class schedule and enter your questions, comments, and/or responses to others’ questions and comments in Perusall (see Technology above).

Details: Because there are no lectures in this class, you are responsible for familiarizing yourself with the physics principles involved in the course and in the projects by reading the relevant sections of the textbook. The course schedule includes required weekly readings – you are free to study ahead, but you must adhere to the schedule to insure that you are prepared for the activities in class and any assignments.

One word of advice: when we say “reading” we do not mean skimming the text. Study it. Understand it. Take control of your knowledge. At the other extreme, we don’t mean study until you master every little detail — the class activities are designed to reinforce your understanding of the important principles before you begin to apply them in the projects. And you certainly won’t ever need to memorize any information because we will never deprive you of access to the text (or any other source of information, including the Internet). The goal of the reading is to gain sufficient knowledge to be able to participate in the class activities in a meaningful way.

We also want to encourage you to help each other learn the material. Consult your team members and Team Mentor. Annotate the text in the Perusall system to interact asynchronously with your classmates and to get help when other people are not nearby. Annotating the text helps you and us. First, you get practice reading a technical textbook. Second, by reading with attention and with an inquiring mind, you take ownership of your learning.

Your annotations will also be monitored by your instructor as to quality and seriousness of your activity. More important, the Perusall system will indicate which portions of the text were annotated the most and which may suggest more attention in class discussions. Hence, YOU will be guiding what we discuss in class. Note that your Perusall activities are assessed by an AI computer program located in the bowels of Harvard University. To maximize your Perusall score, be sure to annotate carefully, post questions and get involved in the back and forth discussions that should take place.

II. IN-CLASS ACTIVITIES

Instead of presenting the textbook content to you, we will use the time in class to expand on your initial reading of the text using six types of interrelated activities that build on each other: Learning Catalytics, Tutorials, Estimation Activities, Experimental Design Activities, Problem Set Reflections, and Readiness Assurance Activities (details below). In addition, time will be allocated for project work. The class schedule shows the scheduled timing of these activities (including in class project work). These schedules can and probably will be modified as the class goes on. This is mostly the result of Murphy’s Law. http://www.murphy’s-laws.com/

Note: The calendar is now available in Canvas for the entire semester. Predictions are very difficult so beware of changes.
Learning Catalytics (LC)

Purpose: Probe and deepen your understanding of the course content

What you need to do: Bring your laptop or other compatible device so you can log on to LC

Details: During this activity, which can last as long as 90 minutes, the instructor will pose questions to the class, which you first answer individually using your device, then (usually but not always) discuss the question with your team member (effectively teaching each other), and then answer again. The principles involved with the more difficult questions will be discussed in class, possibly with a mini-lecture. If an issue remains, you can always review the work done in class later, or ask someone from the staff for a clarification. Office hours can also be used for this purpose. An interesting thing about LC is that it is purely a learning tool. Your score does not impact your grade but your participation in the LC sessions will. The RAA process is very similar to the LC session but it does count toward your grade.

Tutorials

Purpose: Address common misconceptions in the course content

What you need to do: Materials are included in the bookstore package or will be supplied in class when needed.

Details: During this activity, which might last 60 minutes or more, you will work with your team on a worksheet that will explore your thinking about the more difficult concepts in the material. The teaching staff will contribute to the team discussions. Check in with your Team Mentor before ending this activity to make sure that you and your team members have resolved any misunderstandings. Some Tutorials are “experiments” in disguise.

Estimation Activity (EA)

Purpose: Develop estimation skills that are essential for problem solving

What you need to do: All materials for this activity will be supplied.

Details: Your team will receive a list of a few unknown quantities to be determined to the nearest order of magnitude. You should estimate (not guess or Google!) the quantities using estimation skills. You gain these skills by estimating! Spend the first five minutes thinking individually about a strategy, then go at it with your team. There are only 30 minutes, so think fast! This activity will not be graded, but the skills you develop in this activity will improve your performance on the Problem Sets and Readiness Assurance Activities (RAA).

Example: How many hairs are there on a cat?

Experimental Design Activity (EDA)

Purpose: Develop experimental and/or analytical skills that are important for the current project
What you need to do: Bring your laptop or other compatible device

Details: The projects require you to take measurements, analyze data, carry out simulations, etc. The Experimental Design Activities help you master the skills that are required for successful completion of the projects. While the Experimental Design Activities are not graded, if you fail to take them seriously, you significantly impair your (and therefore your team’s) ability to do well on the projects. These activities are very similar to tutorials and many are taken directly from the McDermott text.

Problem Sets (pre-class) and Problem Set Reflection (in-class)

Purpose: Develop problem-solving skills; self-assessment of your knowledge and skills

Types of Homework There are two types of homework assignment. The first is assigned on a Chapter basis and the second is collected on a UNIT Basis. The distinction is shown in this table:

<table>
<thead>
<tr>
<th>UNIT</th>
<th>Ch</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>22-24</td>
<td>electrostatics</td>
</tr>
<tr>
<td>7</td>
<td>25-26</td>
<td>potential and charge separation</td>
</tr>
<tr>
<td>8</td>
<td>27-29</td>
<td>magnetism</td>
</tr>
<tr>
<td>9</td>
<td>30-32</td>
<td>electromagnetism and circuits</td>
</tr>
<tr>
<td>10</td>
<td>33-34</td>
<td>optics</td>
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What you need to do: Before class: solve all homework problems, giving them your best effort and following the instructions given on the Problem Set Rubric (separately distributed). In class: work with your team to improve your problem set solutions, resolve conceptual difficulties, and identify areas that need to be reviewed. You will learn from this only if you take it very seriously.

Details: Learning to develop problem-solving strategies is an important goal for this course. Good problem-solving practices include:

- Articulating your expectations for the solution to a problem before diving into the details
- Breaking down longer problems into smaller, more manageable pieces
  Checking your solution by justifying the reasonableness of your solution, checking the symmetry of your solution, evaluating limiting or special cases, relating your solution to situations with known solutions, checking units, dimensional analysis, and/or checking the order of magnitude of the answer.

You can hone these skills on five unit-based problem sets, each of which involves two phases:

1. You work on the problem set ALONE, before coming to class when it is due
2. You work in class with your team members on correcting your work, comparing it to the solutions if we hand them out to you, and completing a rubric. You hand in this rubric together with your marked-up work.

Treat the problem set as an open-book take-home exam, even though you will not be evaluated on the correctness of your answers. Instead, your work will be assessed on the individual effort you put in solving the problem set before coming to class and the correct evaluation of your own level of understanding.

You should see the problem sets as an opportunity to learn. For example, you might give the entire problem set your best effort without getting it correct, but by accurately identifying your difficulties in understanding you will earn full credit and we can put you on a productive path forward that will maximize your learning.
After the problem set “reflection”, we will hold a number of optional problem discussion sessions, based on the feedback from the rubrics. During these learning sessions, you will have an opportunity to review any remaining difficulties.

For each chapter, a few additional problems will be assigned from to be submitted in writing. These are traditional problems that will allow you to be sure that you have covered essential material adequately. These papers will be less aggressively graded but they will be a part of your homework grade. There is no in-class component to these assignments. Your instructional staff is well aware of how easy it is for you to find (or purchase) textbook problem solutions but there is no point in doing so. We will monitor your submissions to discover which problems presented the greatest difficulties and these may be reviewed in class.

**Readiness Assurance Activity (RAA)**

**Purpose:** Assessment of content-specific goals and problem-solving skills

**What you need to do:** Bring your laptop or other compatible device so you can log on to LC

**Details:** To assure that everyone is on track in the learning of the basic concepts we will have numerous chapter or unit based RAA sessions over the course of the semester. During the first portion of each RAA question you will work solo to solve a set of project-related problems similar to the preceding problem set. You are free to consult the text or the Internet, but not other people. During the second portion of each RAA question you get to discuss the problems with your team members. The goal for your team is to use the combined knowledge of the team to maximize the entire team’s RAA score. This second part of the RAA provides an opportunity to learn in a collaborative environment, consolidate your knowledge, hone your team-building skills to achieve the best possible scores, and receive immediate feedback on your performance.

Your RAA score will be determined by a combination of your individual level (50%) and your team’s level (50%).

If you fully participate in all in-class activities, and if you are fully conscientious with the relevant problem sets and annotations, then you will be well prepared for the RAAs without having to “study” for them like you do for an exam. If you do wish to practice your knowledge, be sure to review the Checkpoints in the text (solutions are at the end of each unit) and try the Worked Examples in the text. The suggested Mastering Physics problems would be helpful as well. Typically there are around 60 Checkpoints and 30 Worked Examples for each unit. The RAAs also draw from the Tutorials and sometimes involve an estimation problem, so you may want to review those as well.

**IMPORTANT:** THE RAA DOES “COUNT” TOWARD YOUR GRADE SO YOU MAY BE THINKING … “HEY … THIS IS A TEST! FOUL!” THE DIFFERENCE BETWEEN AN RAA AND A TEST OR A QUIZ IS THAT YOU ARE ALLOWED TO “CHEAT” BY USING ANY INFORMATION FROM ANY SOURCE (INTERNET, TEXTBOOK, ETC.) AND FOR PART OF THE RAA YOU WILL USUALLY BE ALLOWED TO DISCUSS YOUR ANSWERS WITH YOUR TEAM AND THEN ANSWER IT AGAIN. ALTHOUGH SOME PROBLEM SOLVING CAN BE INCLUDED IN THE RAA, MANY OF THE QUESTIONS WILL BE FACTUAL OR CONCEPTUAL IN NATURE. WITH APPROPRIATE PREPARATION, YOU SHOULD DO WELL.

**III. PROJECTS**

**Purpose:** Transfer your learning and understanding of concepts to the context of real-world problems
What you need to do: Work with your team to produce a project **presentation** and a project **report**

**Details:** There will be **three group based projects** assigned over the course of the semester. At the beginning of each project, you will receive a project brief that describes the learning goals and guidelines for that project. Be sure to carefully read the entire project brief before embarking on your project. The project brief includes design criteria and evaluation rubrics for the **project presentation** and the **written project report**. At the end of each monthly project cycle we will have a “project presentation” where teams present their results along with anything that they have constructed.

Project materials (IF REQUIRED) will be made available. In certain cases you will receive a budget for your project and your task is to stay within that budget. Funds are currently limited, so strive for inexpensive solutions if possible.

**COURSE POLICIES**

**Teamwork**

As in the real world, teamwork and professionalism are paramount. In the professional world, three important features affect your productivity and success: your own effort, the effort of people you depend on, and the way you work together. For this reason we have chosen a team-based approach that values all three of those features.

For each project, you will work closely with three or four of your classmates, as part of a project team. The teams may change for each of the projects, so as to provide an opportunity for you to become better acquainted with your peers and also to develop the interpersonal skills you need in the professional workforce where you are likely to encounter a diverse ensemble of people.

As mentioned above, you should think of this course as a job! Today, most people work in teams and do most of their learning on an as-needed basis. This is what we do in this class. Consequently, things like attendance and punctuality are important for you to succeed in your job. If you miss a session, your team will be hampered by the lack of your participation and input. We therefore will monitor attendance in various sneaky ways. Your professional assessment will be partially based on your participation in class. You will be allowed two, unexcused absences that do not occur during an RAA or a project presentation. Any absences above this level will require written documentation.

**Note to athletes.** You will obviously be excused for athletic events that you participate in (you’d better win!) but you MUST make up the work. Be sure to discuss this with your instructor. Because of the size of this class, you instructor will not remember what you need to make-up so be sure to ask. **THIS IS YOUR RESPONSIBILITY** and you must take care of it during the session following your excused absence. It is also important to inform your instructor IN ADVANCE if your team activity occurs on an RAA day. If possible, we will change the date to accommodate you. RAAs can’t be made up due to the team based nature of the activity.

Research on teamwork suggests the following good team practices:

- **Sit close together** so as to enable easy communication and eye contact, which is very important to team performance.
- **Do your part** and come prepared. Before working as a team, read any relevant material(s) and formulate your own approach to the task at hand.
- **Bring all relevant materials**, including your preparatory work, so you can share it with others.
• In all team activities, be prepared to share three things with your teammates: (a) what approach you chose as an individual, (b) why you chose that approach, and (c) how confident you are about your approach.

• Deliberate as long as time permits or after class. Regardless of the make-up of the team, teams that deliberate longer do better in team activities.

• Keep an open mind and a willing attitude. You are responsible for the success of the entire team.

• Attend as many classes as possible. Missing a class deprives you of knowledge and your team of your support and assistance. See grading scheme below for more.

Peer Assessment

It is important to provide positive feedback to people who truly worked hard for the good of the team and to also make suggestions to those you perceived not to be working as effectively on team tasks. Three times during the semester you will provide an assessment of the contributions of the members of your team (including yourself) to all the activities in class and to the project. The feedback you provide should reflect your judgment of each team members’:

- preparation – were they prepared when they came to class?
- contribution – did they contribute productively to the team discussion and work?
- respect – for others’ ideas – did they encourage others to contribute their ideas?
- flexibility – were they flexible when disagreements occurred?

Your teammates’ assessment of your contributions and the accuracy of your self- and peer-assessments play an important role in your final grade for the course — see below. Unreasonably uniform or exaggerated assessments of your peers will definitely hurt your grade. As you will see in the next section, assessments will range from 0 to 3. A 3 should be quite rare ... almost non-existent. These assessments need to be as honest as possible; to do otherwise will hurt your team.

Assessment and final grade

Unlike most courses, there are no exams or essays at the end of the course to evaluate your overall performance in 2049M. Instead, your grade is determined by the continuous assessment of the activities that are part of the course. All of these activities — (all your work in the course) — are evaluated on the same 3-point scale:

- 3 = significantly exceeds expectations (given only in the most exceptional cases)
- 2 = meets expectations
- 1 = improvement needed
- 0 = deficient

Your final grade is determined by how well you do in the following four domains during the entire course of the semester:

1. Self-directed learning
2. Achievement of the content-specific learning outcomes for the 5 units
3. Teamwork
4. Professionalism
The table below shows which activities factor into each of these four domains. Scoring rubrics for the specific activities will be made available as we engage in each activity, so you will always know what the expectations are.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Contributing activities</th>
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<tbody>
<tr>
<td>Self-directed learning</td>
<td>Perusall annotations, Completion and mastery of the Chapter Homework Assignments and Problem Sets</td>
</tr>
<tr>
<td>Achievement of learning goals</td>
<td>RAAs and Project Report</td>
</tr>
<tr>
<td>Teamwork</td>
<td>Project Presentation and Peer Assessment</td>
</tr>
<tr>
<td>Professionalism</td>
<td>Participation, Punctuality, and Engagement. Engagement includes points earned in class. Ethics is an addition for this semester. Ethical behavior is always required in professional positions and unethical actions in this course will lead to dire consequences.</td>
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</tbody>
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**Point System.** *It is not clear if we will use a point system in this course.* If we do, when you participate in class in a valuable way, your instructor will ask whoever is tracking points on that day to add points to your record of engagement. At the end of the semester, these points are normalized and the normalized score will contribute to your professionalism score.

**Important:** Because all activities are important, the score in each domain is determined by the activity for which you obtained the **lowest** score!

The computation of your final grade is as follows:

- **A** 2 (or higher) in each of the four domains
- **B** one 2, three 1
- **C** one zero
- **D** two zeros
- **F** more than two zeroes

**Feedback**

After each project you will receive *cumulative* feedback on your performance in the following form, so you know where you stand and what you need to do to improve your learning.

<table>
<thead>
<tr>
<th>Domain/Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-directed learning</td>
</tr>
<tr>
<td>Achievement of learning goals</td>
</tr>
<tr>
<td>Teamwork</td>
</tr>
<tr>
<td>Professionalism</td>
</tr>
</tbody>
</table>

**Policy on collaboration**

Because teamwork is stressed in this class, collaboration, consulting information sources, and working with others is permitted. Please note the following restrictions, however.
1. During the individual parts of the problem sets and the RAAs you are not allowed to consult others (you may, however, look up information in the textbook, consult your notes, or carry out Internet searches).

2. During the course of the semester, you may be asked to complete a number of surveys online. The purpose of these surveys is for us to better tailor the course to your needs and to evaluate how well the course works for you. Your answers will be used only to provide feedback on your learning and make adjustments to the course. They will not affect your grade in any way. Unless stated otherwise, you may neither look up any information, nor consult others during these surveys.

RAA Appeals

If your team feels strongly about the correctness of an item on an RAA, the team may submit a written appeal. This appeal process must occur immediately following an RAA and only teams, not individuals, may write appeals. Only teams that write successful appeals get credit for that appeal, even if another team missed the same question(s). Appeals are not simply an opportunity to dig for more points. Rather, they are an opportunity for teams to make scholarly arguments for their collective positions. All arguments must be supported by evidence from the text or other source. If the appeal is based on an ambiguously phrased question, the team must suggest wording that is less ambiguous. The decision to grant or refuse an appeal will be made by the instructors after class via e-mail. The following is an example of a successful appeal:

Argument: “We feel that A, rather than B, should be the correct answer to question 15.”

Evidence: “According to Figure 12.42 in the text, friction affects the motion of the objects. The speed of cart 2 decreases over time. Because friction cannot be excluded in question 15, we would expect the same decrease in speed to occur for the cart in this question.”

Missed activities and assignments

Because of the emphasis on teamwork, it is important that all team members attend and proactively participate in class. Due to the collaborative nature of the activities, it is not possible to make up any team activities, such as project work, problem set discussions, or RAAs. (The same, incidentally, is true in the professional world.) We understand, however, that certain factors may occasionally interfere with your ability to participate. If that factor is an extenuating circumstance, we will ask you to provide documentation directly issued by the University, and we will try to work out an agreeable solution with you (and your team). In the absence of an extenuating circumstance:

If you miss class during which project work occurs, you will have to make arrangements with your team members. Remember that they will evaluate your contributions to the project, so you’ll probably want to find a way to make up for your absence.

If you miss a class during which we work on an RAA, you will need to make up the individual part of the RAA before being allowed to take another RAA; your team score for that RAA, however, will remain zero. This will not always be an option, so do not skip a class without a documented and valid reason for doing so.

If you miss class during which we discuss a problem set, you will miss the benefit of the discussion and the opportunity to learn from others. You also will miss being able to accurately assess your own learning. If you fail to hand in the problem set altogether, your problem set score will be zero.
Accessibility

If you have a documented disability (physical or cognitive) that may impair your ability to complete assignments or otherwise participate in the course and satisfy course criteria, please meet with us at your earliest convenience to identify, discuss, and document any feasible instructional modifications or accommodations. You should also contact the Office of Disability Services to request an official letter outlining authorized accommodations.

Actual Grades

Your score in each domain is determined by the LOWEST score in the components of the domain. The letter grade was described above and the chart above shows how a Perusall score of 0 can demolish your overall assessment. Since this grading scheme is slightly different from one we used in the past, be aware that minor changes can occur during the semester. You will be informed of any of these changes.
GETTING STARTED

To get started in 2049 “M”, you need to:

1. Create a student account if necessary.
2. Complete E&M Background and Pre-course Self-Efficacy surveys on Learning Catalytics. This will be done in class.
3. Subscribe to Perusall and take the tutorial.
4. Purchase the textbook package in one of the two available options. Register for Mastering Physics.

Instructions for completing these steps will be provided during the first class.

Welcome to Harvard!