Arts & Science 2D06: Physics – Course Outline (2019/20)

Instructor: Prof. Alan Chen, Department of Physics and Astronomy
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Office Hours: Thursdays, 3pm – 5pm

Class Times: Mon., Wed., Thu., 1:30pm – 2:20pm, T13 125 (Term 1), HSC 1A6 (Term 2)

Required material:

• **Textbook:** Giancoli, Physics for Scientists and Engineers with Modern Physics, 4th Edition

• **Calculator:** McMaster standard calculator (CASIO fx991) – to be used for all quizzes and exams – available in the campus bookstore.

Tutorials, run weekly by the teaching assistants, will provide opportunities to practice problem-solving in a smaller group environment.

Teaching Assistants: **TBD** (Terms 1 and 2),
Athanasios Psaltis (Term 1), psaltisa@mcmaster.ca
Johnson Liang (Term 2), liangj27@mcmaster.ca

Tutorial Times: Monday, 3:30pm – 4:20pm, ETB/237
Monday, 4:30pm – 5:20pm, JHE/210

NOTE: Room for Quizzes: 19 Sept – **CNH/103**, 9 Oct, 6 Nov and 27 Nov - **HH/103**
Winter TBD

After classes begin, a **website** will be used throughout the term for posting schedules, information, suggested problem sets from the textbook, last year's quizzes, historical links, etc. Here's the link: http://www.physics.mcmaster.ca/~chenal/2D06/

Bookmark it and check it out weekly.

The website also contains links to other websites for readings on the history of physics and the development of ideas. Some of these will be required reading and will be mentioned at appropriate times during the course.

Marking scheme:

24% April exam
24% December exam
21% In-class quizzes (best 6 of 7 scheduled quizzes; 3.5% each for total of 21%)
21% Laboratory work (2 major projects, one each term, and one class presentation)
Term 1 Project Report Deadline: November 20, 2019
Term 2 Project Report Deadline: March 25, 2020
10% Participation (e.g., project presentation days, in-class discussions)

The December and April exams and all laboratory work must be completed to pass the course.

The final percentage grade will be converted by the standard McMaster conversion scale:

12 = 90 – 100%	11 = 85 – 89%	10 = 80 – 84%
9 = 77 – 79%	8 = 73 – 76%	7 = 70 – 72%
6 = 67 – 69%	5 = 63 – 66%	4 = 60 – 62%
3 = 57 – 59%	2 = 53 – 56%	1 = 50 – 52%
0 = 49% or less		

Students should keep a copy of anything handed in for marking (such as a project report).

Missed Quizzes

There will be no re-weighting of marks to accommodate missed work. Students who submit MSAFs for quizzes will be required to write a make-up quiz, which will be different from the missed one but of comparable level of difficulty and same coverage of material. For a given quiz, one make-up quiz session for all students will be held in LRW-3038 or in ABB.

Outline of Curriculum and Objectives

Course Objectives:

• To identify and discuss the underlying ideas, principles, and natural laws that describe a wide range of phenomena in the outside physical world: motion, forces, gravity, waves, fluids, light, space and time, quantum mechanics.

• To probe how scientific thinking and the progress of science is built on the twin principles of measurement and modeling.

• To study the historical development of the 'great ideas' in physics as developed by Archimedes, Galileo, Newton, Einstein, Bohr, de Broglie, Schrödinger, Heisenberg, and others; and to see how these ideas have influenced Western cultural history.

Outline for Term I:

• Newtonian Mechanics: Motion (kinematics) in one and two dimensions. Forces and Newton's three laws of mechanics. Friction, circular motion. Work, kinetic energy, potential energy, conservation of energy. Momentum and collisions. Rotational motion.

• Special Relativity: The speed of light, time dilation, length contraction, simultaneity, the Lorentz transformation. Momentum and energy in special relativity.

Outline for Term II:

• Fluid mechanics, hydrostatics, Archimedes' principle, Bernoulli's principle.

• Simple harmonic motion, wave motion, interference and diffraction of light.

• Quantum mechanics: early atomic theory, waves and probability, the uncertainty principle, the Schrödinger equation.

• General Relativity: the equivalence principle, curved space, black holes.

Arts & Science 2D06 – 2019/20 – Estimated Weekly Schedule – Term 1

Week	Beginning	Topic
1	Sep 2	One dimensional kinematics
2	Sep 9	One and Two dimensional kinematics
3	Sep 16	Forces, Newton's Laws ***[Quiz #1 – Thu – Sep 19, CNH/103]***
4	Sep 23	Newton's laws of motion
5	Sep 30	Work, kinetic energy
6	Oct 7	Potential energy; energy conservation ***[Quiz #2 – Wed – Oct 9, HH/302]***
7	Oct 14	MID-TERM RECESS
8	Oct 21	Momentum
9	Oct 28	Momentum conservation
10	Nov 4	Momentum conservation, special relativity ***[Quiz #3 – Wed – Nov 6, HH/302]***
11	Nov 11	Special relativity
12	Nov 18	Special relativity
13	Nov 25	Project presentations ***[Quiz #4 – Wed – Nov 27, HH/302]***
14	Dec 2	Project presentations

Arts & Science 2D06 – 2019/20 – Estimated Weekly Schedule – Term 2

Week	Beginning	Topic
1	Jan 6	Fluid mechanics: hydrostatics
2	Jan 13	Fluid mechanics: fluids in motion
3	Jan 20	Simple harmonic motion
4	Jan 27	Wave motion and wave phenomena ***[Quiz #5 – Wed – Jan 29]***
5	Feb 3	Interference phenomena in light
6	Feb 10	Interference of light
7	Feb 17	MID-TERM RECESS
8	Feb 24	Historical quantum mechanics ***[Quiz #6 – Wed – Feb 26]***
9	Mar 2	Quantum mechanics and the atom
10	Mar 9	Uncertainty principle and other quantum ideas
11	Mar 16	Finish quantum mechanics ***[Quiz #7 – Wed – Mar 18]***
12	Mar 23	General relativity
13	Mar 30	General relativity + Project presentations
14	Apr 6	Project presentations

Independent Term Projects

The laboratory component of Arts and Science 2D06 this year consists of two independent term projects. In total these count for 21 % of the course grade. This is subdivided as follows:

- Write-up for Term I project: 8 %
- Write-up for Term II project: 8 %
- Class presentation (one to be done in either term): 5 %

You will do two projects one in Term I and another one in Term II (the project lists are on the course website, conveniently separated by term).

Rather than selecting from the lists, you can devise your own project. See me or your TA if you have other ideas. In addition, you will take one of your two term projects and prepare a class presentation for it.

The presentation should be 10 minutes long, plus a 5-minute period afterward for questions and general discussion with the class. Use any approach you like, and ideally don't build it entirely around Power Point or video presentations.

The ground rules for the projects are simple:

- Find one partner (i.e., no teams of 3).
- Select a term project from the list on the course website and let me know your choice. Failure to let me know your project selection will result in a 50% reduction of your report mark for that term. Develop an outline for how you want to do it. Then see your assigned TA to discuss the experimental approach you want to take. Failure to meet with your TA to discuss your experimental approach will result in a 50% reduction of your report mark for that term.
- Each project on the list can be done by at most two teams. That is, you can do the same project that some other team is working on, but remember, you will be graded on how distinctive and interesting your approach is.
- Design and carry out the experiment.
- Prepare a write-up as a team and hand it in by the deadline that you have been assigned.

Doing Your Experiment:

You will see that the outlines for the suggested projects on the website are very much less detailed, formalized, or constrained than in a typical "lab manual". Often they are nothing more than a suggestion. You will need to work out your own method and put together your own apparatus where necessary (and the simpler the better). Most of the projects are also open-ended and can be pursued in a variety of ways. All of them will work; but it's up to you to make them work. Experiments are about measurement -- an oscillation period, a fluid flow rate, a falling time -- whatever it is you are aiming for. Your emphasis should be on running a simple experiment to get a series of measurements, and not on trying to build something complicated. The end point is the measured data, not the apparatus. (To put it another way -- this is supposed to be physics, not engineering!) What pitfalls and warnings should you be aware of? Here are a few brief items:

Probably the most common problem that people run into with these independent projects is to not give themselves enough lead time to do it. Your experimental setup probably won't quite work the way you wanted it to when you designed it on paper. Things will go wrong. One working session between you and your partner won't be enough; plan for more. This is very typical of real-world experiments! Give yourself enough time to change things around, use trial and error, and finally get something that works the way you imagined it would.

Probably the second most common problem is to plan the experiment but then run the whole measurements not quite knowing exactly how you are going to analyze the numbers afterward. Don't say to yourselves, "We'll just collect all our data now and figure it all out later". This is almost guaranteed to get you into trouble -- and if you are discovering this the night before your write-up

is due, you're sunk. It's better to do one trial run of the experiment, then take the measurements and go all the way to the end of the calculations you need to do afterward. Things will come up that you didn't predict, and you can then go back and fix it. (And of course you will also understand your experiment a whole lot better.)

For a few suggested projects, safety may be an issue. Be aware of the risks ahead of time and plan your experiment accordingly. Make sure that neither you nor innocent bystanders will get hurt, and that no property damage occurs.

Writing It Up:

Your write-up does not need to be in any specific format -- organize it how you wish. However:

- It should be no more than about 8 pages in length (not including graphs or illustrations).
- It should carefully document any resources from other texts, the published literature, the internet etc. that you used in developing your experiment.
- It should document which of you did what parts of the work.
- It should contain photos of your apparatus and your experiment in action.

The due date for your written report in Term I is **Wednesday**, **November 20**, before 5 PM in my office. If you hand in your write-up on November 19 or before, you will get a 1-mark bonus (out of a total mark of 20). Reports handed in after November 21 will have a per-day 2-mark penalty applied.

The due date for your written report in Term II is **Wednesday**, **March 25**, before 5 PM. If you hand in your write-up on March 24 or before, you will get a 1-mark bonus (out of a total mark of 20). Reports handed in after March 26 will have a per-day 2-mark penalty applied.

Evaluation of your Write-up and Presentation:

Your written reports will be marked on these criteria:

- Originality of approach and quality of experimental design.
- How deeply you investigated the question and understood the physics involved.
- Quality of your measurements, data.
- Quality of the write-up (completeness, polish, readability, organization, and documentation of your procedure).
- Inclusion of sample calculations and error analysis (where appropriate -- this may differ from one project to another).

Your class presentation will be marked on these criteria:

- Description of the necessary background (explain the background physics and experimental setup).
- Concise summary of results and appropriate "style" (Is it best to use the blackboard or overhead projector with a mini-lecture? Run a sample experiment in real time in front of the class? Skit format?)
- Energy, enthusiasm, class involvement, originality.
- Confidence of delivery (Can everyone hear you? Did you practice beforehand? Are both you and your partner participating equally?)

Timing and selection of material (stay within time limits and pick what you want to say...)

Academic Integrity Statement
McMaster Policy on Academic Integrity:
You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences—e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty, please refer to the *Academic Integrity Policy*, located at: http://www.mcmaster.ca/academicintegrity.
The following illustrates only three forms of academic dishonesty: 1) Plagiarism—e.g., the submission of work that is not one's own or for which other credit has been obtained. 2) Improper collaboration in group work. 3) Copying or using unauthorized aids in tests and examinations.

MSAF Statement
McMaster Student Absence Form (MSAF):
In the event of an absence, students should review and follow the Academic Regulations in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work." Please consult the MSAF statement on our website (https://artsci.mcmaster.ca/forms-requests/) and direct any questions or concerns to Shelley Anderson or Madeline Van Impe in the Arts & Science Program Office.

Academic Accommodation of Students with Disabilities Statement
Academic Accommodation of Students with Disabilities:
Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. SAS can be contacted by phone 905-525-9140 ext. 28652 or email sas@mcmaster.ca. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO) Statement
Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO):
Students requiring academic accommodation based on religious, indigenous, or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request to their Faculty Office (i.e. to Shelley Anderson or Madeline Van Impe in the Arts & Science Program Office) normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Email Contact and Student Responsibility Statement
Please Note:
The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L, and/or McMaster email. It is the responsibility of students to check **their McMaster email** and course websites regularly during the term and to note any changes. Announcements will be made in class and by using the course email distribution list.