Montserrat 107Q – Thinking About Mathematics
Syllabus – Spring 2017

Professor: John Little
Office: Swords Hall 331
Office Phone: (508) 793-2274
Office Hours: Monday 10 - 11am, Tuesday 9 - 10am, Wednesday 1 - 2pm, Thursday, 2 - 3pm, Friday 10 - 11am, and by appointment
Course Homepage: `http://mathcs.holycross.edu/~little/Montserrat201617/Spring.html`

Core Human Questions Cluster Theme

If borders define us but we want to transcend them, how then shall we live?

Course Description

This course is a part of the *Core Human Questions (CHQ) Cluster* of the Montserrat program. This means that at various times we will be addressing one or several of the following objectives:

- addressing the general aims of Montserrat – continued development of your thinking, writing, and communication skills, and the fostering of connections between living, learning and doing in your college education,
- engaging with the common readings and theme of this year's CHQ Cluster,
- participating in various common activities (tentatively) scheduled for all of the seminars in the CHQ Cluster, including:
  (a) Showing of film *Pan's Labyrinth*, 7:30pm Monday, January 30, Seelos Theater.
  (b) Montserrat cross-cluster public speaking night, Thursday, February 23, Hogan Campus Center (more details to follow!).
  (c) Field trip to MASS MoCA and Hancock Shaker Village, Saturday, March 25.
  (d) Performance of "The Royal Family," 8:00pm Thursday, April 6, Fenwick Theater.
  (e) End-of-year cluster banquet, 6:00pm Tuesday May 2, Hogan Ballroom.
- and finally, studying the specific subject matter of this seminar.

In a 2005 poll discussed in *Loving + Hating Mathematics*, almost 40% of the adults surveyed said they actively hated mathematics in school, more than any other subject. Yet at the same time, almost 25% said they liked mathematics best, often because they liked its unambiguous, "right or wrong" nature. A few people even devote their lives to studying the subject, but (in my experience, at least) many of them would disagree strongly about what makes it appealing – they would point out the possiblity of exercising real creativity to discover beautiful new patterns in the mathematical realm as the most attractive feature! What is it about mathematics that creates such divergent reactions?

It is certainly true that most of the reactions to mathematics described above come from the way the subject is taught in elementary and secondary schools. For instance, consider the way you were probably taught in algebra class to solve quadratic equations:

$$ax^2 + bx + c = 0,$$

when simpler techniques such factorization do not apply directly. If your training was typical, you were probably told that you "just need to memorize the quadratic formula:"

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}. \tag{1}$$

And then you were drilled, and drilled, and drilled some more on solving lots of equations of this form using that. You may have developed a phobia about remembering the complicated formula and come to hate what should be a basic and important algebraic technique.

I think part of the problem here is that (1) seems to come out of thin air. The formula (1) also uses the full power (and potential ambiguity and scariness) of symbolic algebraic notation. There are an awful lot of questions that should come to mind when you start to dig deeper into what is going on here: Why are letters used in a formula like this? What is it about x that makes it a "variable," and how is it different from the other symbolic constants a, b, c? Does x have a value from the start? What exactly is the sequence of operations you need to do to evaluate the formula on the right? Others might come to mind as well. Bright students often ask these questions, but the response is often "don't worry about that–just memorize the formula, plug and chug." And woe unto anyone who makes a mistake carrying that out – that's when the teacher's red pen comes out! *Is it any wonder a lot of people end up hating mathematics?*

I personally believe that another aspect of the problem is that most students have no appreciation of

- how hard it was, and
- how long it took people

to come up with this compact and powerful symbolic form. They are just told to memorize the formula without any indication of how or why it is true or where it came from.

I don't necessarily want to claim that knowing the history of things like this is a panacea for learning that will solve all the problems of mathematics education. However, I do think that realizing that it took a lot of "fumbling around" before things like this were really understood and codified in the form we use now has to help some students. Real, smart people struggled in exactly the ways they still do, and mastering mathematics is more a matter of confidence and persistence than any sort of "innate talent."

So in MONT 107Q, one of our major themes will be an examination of where the mathematics you have learned, in particular the quadratic formula (1), came from and how the historical development of algebra, (and geometry and arithmetic) might influence the ways the subject is taught.

We will do this by considering passages from some of the most important original texts, in as close as possible to their original form (but translated into English):

- some Old Babylonian problem texts – actual records of students learning mathematics in scribal schools from around 1800 BCE,
- several sections of one of the most famous Greek mathematical texts – the *Elements* of Euclid (around 300 BCE),
- the *Arithmetica* of Diophantus (around 250 CE), one of the first surviving attempts at a symbolic algebra
- the very influential *Hisab al-jabr w'al muqabala* (around 830 CE) of Muhammad ibn Musa al-Khwarizmi

- the *Ars Analytica* of François Viète, and
- *La Géometrie* of René Descartes.

Some Groundrules

Most class meetings will be devoted to discussions, oral presentations, or work in smaller groups, so your active participation will be important for the success of what we do.

- Unless specifically directed otherwise, please *turn off* all cell phones, tablet or laptop computers and other similar electronic devices for the duration of each class meeting – your full attention and participation will be necessary.
- No distracting or "provocative" clothing, headgear, or other personal items in class, please.
- In on-campus events, possible off-campus trips next semester, etc. you are representing this seminar, the Montserrat program, and, by extension, Holy Cross in a wider community. Take responsibility and regulate your behavior accordingly.
- In discussions, there may be times that you disagree with Prof. Little or with a classmate. Please feel free to express that disagreement and be prepared to say why you disagree and back up your ideas with evidence. But please keep the conversation civil and respectful.

Course Texts

The main mathematical texts for the course are:

1) G. G. Joseph, *The Crest of the Peacock*, Princeton University Press (carried over from last semester)
2) Reuben Hersh and Vera John-Steiner, *Loving + Hating Mathematics*, Princeton University Press, ISBN 978-0-691-142470

We will also read and discuss the Core Human Questions Cluster common readings:

3) Cormac McCarthy, *All the Pretty Horses*, Vintage Paperback, ISBN 978-0-679-74439-9,
4) The *Metamorphoses* of Ovid, verse translation by Allen Mandelbaum, Harvest Books, ISBN 978-0-15-600126-7,
5) Ursula Le Guin, *The Left Hand of Darkness*, Penguin Paperback, ISBN 978-0-441-47812-5.

It is expected that Holy Cross students will have textbooks and other required class materials in order to achieve academic success. If you are unable to purchase course materials, please speak to a representative at the Office of Financial Aid for assistance.

Course Schedule

A detailed day-by-day course schedule and listing of required and suggested outside events will be maintained on the course homepage. That listing is a tentative, evolving schedule, so you will probably want to refer to it frequently. Any important changes will also be announced in class well in advance.

Assignments and Grading

1) Midterm Exam (15 % of course grade) – tentative date: Friday, March 31.

2) Final Project (30 % of course grade: bibliography, paper, and oral presentation) – presentations will be scheduled for the final four class meetings in May; papers due Monday, May 8.

3) Problem Sets (about 5 through the semester – 10 % of course grade)

4) In-class group work leading to oral presentations (about 4 assignments – 10 % of course grade). More information about these assignments will be distributed later.

5) Two essays related to the readings and other topics. More information and guidelines for each of these assignments to be distributed later (20 % of course grade)

6) Reflection paper (10 % of course grade) – this can be written in response to any of our CHQ common events (the film *Pan's Labyrinth*, the field trip to MASS MoCA and the Hancock Shaker Village, or the play *The Royal Family*.

7) Participation in preparations for and program of Montserrat public speaking night (5 % of course grade)

I will be keeping your course average in numerical form throughout the semester, and only converting to a letter for the final course grade. The course grade will be assigned according to the following conversion table (also see Note below):

- A – 94 and above
- A- – 90 - 93
- B+ – 87 - 89
- B – 84 - 86
- B- – 80 - 83
- C+ – 77 - 79
- C – 74 - 76
- C- – 70 - 73
- D+ – 67 – 69
- D – 60 - 66
- F – 59 and below.

Note: Depending on how the class as a whole is doing, some downward adjustments of the above letter grade boundaries may be made. No upward adjustments will be made, however. (This means, for instance, that an 85 course average would never convert to a letter grade of B- or below,

although it might be a B+ in some circumstances.) If you ever have a question about the grading policy or your standing in the course, don't hesitate to ask me.

Advice On How To Succeed In This Class

A good "work ethic" is key. As you should be able to tell from the course description above, you do not need to be a "math genius" to do well in this course. But you will need to put in a consistent effort and keep up with the reading and assignments.

Come to class. Unless you are deathly ill, have a genuine family emergency, are away at a game or meet of a college athletic team, etc. please plan on showing up here at 9:00 am every Monday, Wednesday, and Friday this semester. As mentioned before, many of the class meetings will be structured around discussions or student presentations. Your regular attendance and participation is expected and needed for the success of the course!

Take notes and use them. This may seem obvious, but it is worth saying! Used intelligently, your notes can be a valuable resource as you work on problem sets and prepare for exams.

Use the texts and class notes actively. Reading about mathematics is not like reading a novel. You will probably need to read and think over things more than once. You may want to work through examples or draw your own diagrams to understand some of the Euclidean proofs that we do.

Set up a regular study schedule and work at a steady pace. It's not easy to play catch-up in a mathematics course (even when the course is part of a first-year program with additional goals beyond the mathematics). You should expect to budget at least 6 hours in a typical week for work outside of class. The best way to use your time is to do a few problems, some reading from the books, and reviewing of class notes every day.

Most importantly, if you are having difficulty learning something, get help as soon as possible. You can do this by asking questions during class (any time something isn't clear), or seeing me during office hours.

Statement on Academic Integrity

All education is a cooperative enterprise between teachers and students. This cooperation works well only when there is trust and mutual respect between everyone involved. To be become an engaged and advanced learner, you must be able to think and work both independently and in concert with your peers. The College academic honesty policy states: "As an institution devoted to teaching, learning, and intellectual inquiry, Holy Cross expects all members of the College community to abide by the highest standards of academic integrity. Any violation of academic honesty undermines the student-teacher relationship, thereby wounding the whole community. The principal violations of academic honesty are plagiarism, cheating, and collusion.

Plagiarism is the act of taking the words, ideas, data, illustrative material, or statements of someone else, without full and proper acknowledgment, and presenting them as one's own.

Cheating is the use of improper means or subterfuge to gain credit or advantage. Forms of cheating include the use, attempted use, or improper possession of unauthorized aids in any examination or other academic exercise submitted for evaluation; the fabrication or falsification of data; misrepresentation of academic or extracurricular credentials; and deceitful performance on placement examinations. It is also cheating to submit the same work for credit in more than one

course, except as authorized in advance by the course instructors.

Collusion is assisting or attempting to assist another student in an act of academic dishonesty.

The full statement on Academic Honesty in the College Catalog is available at

`http://www.holycross.edu/catalog/academic-honesty-policy.pdf`

The temptation to engage in an act of academic dishonesty will almost certainly arise, but the chance to possibly enhance a single grade is not worth the loss of your personal integrity. If you do not know how to correctly cite reference materials, consult with your professor or the campus Writers Workshop. NOTE: If you are in doubt about whether what you plan to do or write violates academic honesty guidelines, PLEASE ASK!

Specific Guidelines for this Course

In this course, all examinations will be closed-book. No sharing of information with other students or consultation of electronic or physical sources in any form will be permitted during exams. On group discussion write-ups, close collaboration with the other members of your group is expected. On the individual problem sets, discussion of the questions with other students in the class and with me during office hours is allowed, *even encouraged*. However, your final problem solutions should be prepared individually and the wording and organization of your final problem solutions should be entirely your own work. Moreover, if you do take advantage of any of the above options for discussion of problems with others, you will be required to state that fact in a footnote accompanying the problem solution. Failure to follow this rule will be treated as a violation of the College's Academic Integrity policy. For the essays, if you do consult a source other than the course texts, include a full reference in a bibliography section at the end of your paper, and identify any direct quotations. Information about the acceptable formats for doing this will be distributed with the paper assignments.