Proposal for Permanent Approval of Math 103

(NB: Math 103 was part of the proposal accepted in March 2014 to reform the mathematics major.)

1. School: School of Science
   Department: Department of Mathematics and Computer Science
   Course Number: Math 103
   Course Title: Introduction to Upper Division Mathematics

Upper Division Status: This course has college-level pre-requisites (see below), and entails a high level of cognitive achievement, as it is an in-depth study of areas of abstract mathematics using the method of mathematical proof.

2. Justification for the Course: Proofs are perhaps the central part of mathematics, as they are the form of the language mathematicians use to communicate. Over the past two decades the mathematical community has come to realize that we need to be explicit in teaching our students about this form and how to use it.

Pre-Math 103 we did not have a class concentrating on teaching the techniques of proof. Students learned some in Math 120. This knowledge maybe was built upon, or just repeated, in other upper division mathematics courses depending on the choices made by individual instructors and the backgrounds of the students in the class. By creating a class in which proofs are a central pillar and having this class as the pre-requisite for several upper division classes we will be able to create a more developmental major in which classes can build upon previous knowledge.

In the future some of our upper division courses will theory based, and build off of the material in Math 103 (there are Math 111, 115, 131, 150, 185, 193). Our expectation is that these courses will be able to move more quickly and students will grasp more, since they will have had a semester’s experience with our language. And others will be more applied courses and taught at a level reasonable for any student with a year of calculus (these are Math 113, 114, 120, 134, 140).

3. Student Population: Math 103 is/will be required for the mathematics major, and strongly suggested for minors. The mathematics major (as revised via submission to the UEPC in March 2014) has been revised so that this is not an additional class for students.

4. Relationship to Present College Curriculum: Currently Math 120, Linear Algebra and Applications, is the course where we try to introduce the technique of proofs. This forces Math 120 to do too much. It is trying to be the introduction to proof techniques course and teaching abstract linear algebra to the ‘pure’ math majors, as well as teaching applied linear algebra and applications to those students (sometimes math, other times physics, economics, etc.) who are interested in that. Moving the proofs theory to Math 103 will let Math 120 focus on the topics of its title.
Math 103 will cover about one-half of the material formerly in Math 111. The remainder of the material in the old Math 111 and much of that in Math 112 will be put into the new Math 111.

Finally, Math 103 (along with Math 193) is intended to serve as the departments “Writing in the Disciplines” class.

5. Any extraordinary implementation costs: None. There are no special equipment needs or unusual classroom requirements associated with this course.


7. Course Credit and grading options: Math 103 is designed as a lecture/discussion course. Students who complete the course will receive one (1) SMC course credit. Students will meet with the professor in class for 3 hours, 15 minutes per week throughout an academic semester. There will be a minimum of two hours of student work expected outside of class for every hour of in-class instruction.

8. Pre-requisites: (Math 27,) Math 28 or 38, and English 5.

9. Course description working for appropriate College Catalog: This course is an introduction to mathematical logic and includes an introduction to Abstract Algebra. Students will learn to write proofs using standard proof-writing organization and terminology. Topics form algebra will include the division algorithm, modular arithmetic and groups. Pre-requisites: English 5 and Math 38, or equivalent. Completion of Math 103 and Math 193 satisfies the Writing in the Disciplines requirement of the Core Curriculum.

10. Course Content: See attached syllabus

11. Review of Experimental Offering: Professor Sauerberg taught Math 103 in Fall 2014, basing his syllabus on the one submitted to the UEPC. This is the only time the course has been taught. He will also teach the course in Fall 2015.

He adapted the syllabus proposed to the UEPC, but found it overly optimistic. After discussion with the department we have decided that Math 103 and Math 193 should serve jointly as our Writing in the Disciplines courses. This will allow the research paper part of the course to be covered (as it already is) in Math 193. His Fall 2015 syllabus and schedule will be similar to the one submitted with this proposal.

The remaining material in the course works well, and as an intensive, and writing intensive course, this should be a successful course.
MATH 103 is required of all mathematics majors and minors as an introduction to formal proofs and high-level mathematics topics including Abstract Algebra. The writing assignment involves the creation of logical mathematical proofs. Students will be expected to achieve a deep level of understanding in a wide variety of mathematical concepts, and will benefit from resources that offer explanations and examples different from the required texts.

I. **Required Resources.** The Library will obtain the required texts for this class, for textbook reserve.

II. **Reference Sources.** Reference sources provide basic explanations and definitions, and may be helpful to students in these courses. The Library’s Subject Guide for Mathematics lists the following reference databases *Credo Literati* & *AccessScience*, and the following individual texts:

- *Princeton Companion to Mathematics*. (Ref 510 G747p and online)
- *Words of Mathematics: an Etymological Dictionary of Mathematical Terms Used in English*. (ebrary eBook)
- *CRC concise encyclopedia of mathematics* (Ref 510.3 W438)
- *Companion encyclopedia of the history and philosophy of the mathematical sciences* (Ref 510.9 G773c) 2 vols.
- *Encyclopedic dictionary of mathematics* (Ref 510.3 It6) 4 vols.
- *The VNR concise encyclopedia of mathematics* (Ref 510.2 G282)

III. **Books.** Mathematics in general is more book-dependent than other disciplines in the School of Science. The mathematics faculty are responsive and engaged in selecting the best of the new mathematics publications. The Library’s collection includes about 5,000 mathematics texts, with approximately $5,000 per year spent to maintain the mathematics book collection. This course explores many topics, including sets (87), induction (20), modular arithmetic (20), abstract algebra, proofs (95) and groups (122). The number of texts in the Library collection follows each term.

Examples of books in the Library collection that support this course include:

- *Extending the frontiers of mathematics : inquiries into proof and argumentation* (511.3 B865 )
- *Distilling ideas : an introduction to mathematical thinking* (510 K159)
- *Abstract algebra and solution by radicals* (512.02 M450)
- *The real numbers : an introduction to set theory and analysis* (511.322 St54r)
- *An invitation to abstract mathematics* (510 B167)
- *Roads to infinity : the mathematics of truth and proof* (511.322 St54 )
- *Proof in mathematics education : research, learning and teaching* (511.3 R272)
- *Proofiness : the dark arts of mathematical deception* (510 Se42)
- *Truth through proof : a formalist foundation for mathematics* (510.1 W433)
- *Charming proofs : a journey into elegant mathematics* (511.3 AL78)

IV. **Journals.** The Library’s collection also includes over 500 mathematics journals and the key database for article discovery, MathSciNet. JSTOR’s Mathematics and Statistics package of journal archives is subscribed. The cost of subscribing to these journals and databases is about $12,000 annually. Articles in many mathematics journals are highly specialized, and beyond the reach of undergraduate students. To help direct students to the core and most accessible mathematics journals, the Library Mathematics Subject Guide presents a browsing collection which can each be searched individually, including:
IV. **Librarian Recommendations.** The textbooks for the course are on order for the Library’s textbook collection. Ongoing communication with the mathematics faculty is expected to continue, and will ensure the Library’s collection is sufficient to meet the needs of students in this course. The Subject Selector Librarian is happy to see the syllabus advertising the availability of individual student appointments with the librarian. Classroom presentations can also be made available by the librarian to guide students to the wealth of resources offered by the Library’s collection.
Math 103: Introduction to Upper Division Mathematics
Saint Mary’s College
Fall 2014

Professor: Jim Sauerberg
Office: Galileo Hall 101A. Phone: 631-4248.
e-mail: jsauerbe@stmarys-ca.edu
webpage: On math.stmarys-ca.edu

Lecture: MWF 8:00 – 9:05am Garaventa 120.
Course webpage: On Moodle

Office Hours: Office hours will be posted on my office door (generally including MF 9:30am – 12:00pm and T 11:30am – 2:00pm). Office hours are the best place to get your questions about course content and homework answered.


Prerequisites: English 5 and Mathematics 38, or equivalent.

Major, Minor and Core Curriculum: Math 103 is required for all tracks of the mathematics major, and is also a required part of the math minor. Completion of Math 103 and Math 193 satisfies the Writing in the Disciplines requirement of the Core Curriculum.

Catalog Course Description: “This course is an introduction to mathematical logic and proofs and includes an introduction to Abstract Algebra. Students will learn to write proofs using standard proof-writing organization and terminology. Topics from algebra will include the division algorithm, modular arithmetic, rings and groups.”

Course Objective: The central purpose of this course is to teach you the careful use of language in the context of mathematical reasoning and proof. Most of your courses so far have concentrated on learning algorithms for solving particular types of problems; most courses after this one will focus on logical reasoning, conceptual understanding, and proofs. This course is the “bridge” between the two ways of approaching mathematics. Indeed, after introducing formal, rigorous mathematics which emphasizes logic and axiomatic thinking, and learning various standard techniques of proof, we will apply this learning to several areas of mathematics.

Grading: Grades measure performance, not desire or work ethic or personality or time spent or any other quality. Thus, preparation is essential and demonstration is crucial.
300 pts Homework, Quizzes, Participation
200 pts Midterm Exams (100 pts each)
200 pts Final Exam
Course Goals: This course is an introduction to mathematical logic and proof writing. Students will become proficient at:

- Recognizing and composing basic logic statements, including the boolean operators and quantifiers.
- Recognizing and composing statements of implication, converse statements, contrapositive statements, and negations of statements.
- Explaining the difference between Axioms, Definitions, Lemmas, Theorems, and Corollaries.
- Reading proofs, understanding the assumptions made in the proof, and following the clear and careful organization of well-constructed statements of implications leading to a logical conclusion.
- Writing proofs using standard proof-writing organization and terminology, making the assumptions clear and using careful organization of well-constructed statements of implications to lead to a logical conclusion.
- Techniques of proof-writing, including the techniques of direct proof, proof by contradiction, and induction.
- Analyzing arguments so as to construct ones that are well supported, are well reasoned, and are controlled by well-defined axioms and/or assumptions.
- Using the process of pre-proof-writing and scratchwork to enhance intellectual discovery and unravel complexities of thought.

You will also practice your new proof reading and proof writing skills in the areas of

- Sets and their operations
- Divisors, the division algorithm, and Euclid’s Algorithm
- Mathematical Induction
- Injective and Surjective Functions
- Modular Arithmetic and Linear Congruences
- Groups and their subgroups

Attendance and Participation: You are expected to attend and participate in every class session. Time in the classroom will be spent on lecture, small-group discussions, short presentations by students, and larger interactive discussion as an entire class. If you miss class you will miss these opportunities to learn and practice skills that contribute to your development as a mathematical thinker. You may also miss a quiz and there are no make-ups. Finally, if you miss numerous classes, I will think that you are not serious about your education and will remember that when assigning your grade at the end of the semester.
**Homework:** Homework is the most important part of this class. You should work often and assiduously on it, rereading and revising your solutions until they are correct, concise, efficient, and elegant. Such efforts are the best way (the only way?) to deepen your understanding of the material. Don’t think of homework as problems that have answers but as essay prompts with responses that can (almost) always be polished and improved.

Homework will be “scaffolded” in that you will build continually upon previously learned skills. After you learn to write logic statements and implication statements, you will learn to use quantifiers and to write negations of these more complicated implication statements. This basic mathematical grammar will be used when you learn to write proofs of your implication statements. You will then practice these writing and proving skills in the areas of Set Theory, Elementary Number Theory, and Abstract Algebra. Proof writing is the core of mathematics (and of this class). In order to master proof-writing, you must read and write many proofs. Homework will where this will happen.

It is understood that your only sources of information for the homework will be our texts, any notes you took in or for class, your classmates (when permissible), your professor and your brainpower.

Late homework will **not** be accepted for any reason.

**Written Assignments:** Because in many ways this is a language course, you will be expected to learn to clearly and precisely express mathematical ideas in writing. In addition to considering its mathematical content, the grading of your work will take into consideration clarity of expression, completeness, proper usage of both English and mathematical grammar, and whether you really said what you meant to say. The problems will be graded on a scale of 1 to 5. You should not think of the grade as representing a percentage but as delivering a message:

5 — excellent work; no real complaints on content or on writing.
4 — argument basically correct but missing some minor details or containing small error(s).
3 — argument mostly correct, but contains significant misstep in the mathematics; or, an especially poorly written proof.
2 — serious gaps in the mathematics.
1 — some ideas in the right direction, but didn’t really get there.
0 — didn’t do the problem or it was completely wrong.

When you write up an assignment, you are expected to include sufficiently many details to enlighten someone who does not already know what you are trying to say. This may require that you restate a definition or previous theorem and say how it is used in your proof. Do not be afraid to include too many details.

**Quizzes:** Days may begin with a short quiz on recent material. (This will almost always be definitions and quick computations.) Absolutely no late quizzes will be given.

**Take-home exams:** Homework will regularly include questions that you are to solve by yourself. These are meant to provide both you and me with an indication of your personal
progress in the class. As opposed to the other parts of the homework, you are on your honor not to discuss these questions with anyone but Professor Sauerberg. You are free to use any class notes, any previously proved theorems, and anything that is distributed in class. However, you may not consult any books except the textbooks, nor any outside sources, including on-line sources.

**Culture of Cooperation and Plagiarism:** You are expected to work cooperatively, as well as to take responsibility for your own learning.

What you should do: Discuss ideas and ask each other (and me) for help. Give and ask for constructive input, praising and criticizing where appropriate. Individually digest all ideas and individually write your proofs/solutions. Note on each problem who (if anyone) you worked with. Remember that on the quizzes and the exams you are on your own, so you need to fully understand each solution. In summary, keep collaboration constructive and reasonable.

Be clear that *Any material you submit must be your own work.* It is an act of plagiarism to copy, in any way, all or part of any solution without acknowledgment. It is also an act of plagiarism to permit another to copy in any way all or part of one of your solutions. If you use someone else’s ideas in your solution (or any other work that you do anywhere), you must give credit to that person, and be sure that you understand that work as well as if it were your own. See the Student Handbook for specific details.

**In-class exams:** The purpose of exams is to encourage the development of the next level of proficiency of the course material. The questions will generally be straightforward for anyone who has been digesting the material along the way. Typical questions will ask you to define important terms, answer and explain true/false, give a short answer to questions on the material, state an important theorem, develop and give simple proofs.

There will be two in-class, closed-book exams, likely **Monday September 29th** and **Wednesday October 29th**. The final exam will be **Monday December 8th at 8:00am**.

The only acceptable reason for missing an exam is a sudden unexpected severe personal emergency. A 0 will result from an unexcused absence. Makeup exams will *not* be given for illness, broken alarm clock, flat tire, roommate from hell, bad mystery meat, etc.

**Grading Policy:**

A. College definition: Excellent
   Math 103: Outstanding achievement; available only for the highest accomplishment. You are thoroughly familiar with all definitions and examples covered, can precisely state and correctly prove almost all assigned theorems from class, can do all of the homework exercises, and can use the concepts you learned in this course to solve unfamiliar problems comparable in complexity to those done in class and on the homework.

B. College definition: Very good
   Math 103: Praiseworthy performance; definitely above average.
You are thoroughly familiar with all definitions and examples covered, can precisely state and correctly prove most theorems from class, can do most of the homework exercises, and can use the concepts you learned in this course to solve most unfamiliar problems of comparable complexity.

C. College definition: Satisfactory
   Math 103: Satisfactory performance.
   You are familiar with all definitions and most examples covered, can state and prove without major mistakes many theorems from class, can do the majority of the homework exercises, and can use the concepts you learned in this course to solve some unfamiliar problems of comparable complexity.

D. College definition: Barely passing
   Math 103: Minimally passing; less than the typical undergraduate achievement.
   You are familiar with the majority of definitions and many examples covered, can state and prove at least half of the theorems from class, can do at least half of the homework exercises, and can use the concepts you learned in this course to solve at least a few unfamiliar problems of comparable complexity.

E. College definition: Failing.
   Math 103: You have difficulty stating definitions and coming up with examples, do not remember statements of theorems and/or cannot prove them, can do few of the homework exercises, and lack the skills to attach unfamiliar problems of comparable complexity.

Center for Writing Across the Curriculum (CWAC) www.stmarys-ca.edu/center-for-writing-across-the-curriculum offers two options for all students, of all disciplines and levels:
Writing Circles: Students register for the .25 course COMM 190: Writing Circles and then contact CWAC to select a weekly Circle time. Students sign up before or during the first week of the semester. During the small-group workshops, writers discuss their own projects, at all stages of the process.
One-on-one sessions: Students call 925.631.4684 to make appointments or drop in, Dante 202. Online sessions via Skype are available. Fall hours: 4–8 p.m. Sunday; 12–8 p.m. Monday; 12–6 p.m. Tuesday; and 12–8 p.m. Wednesday and Thursday. Writing Advisers guide their peers toward expressing ideas clearly, always weighing audience and purpose. Writers bring their assignment sheets and readings in order to brainstorm ideas, revise drafts, or work on specific aspects of writing, such as grammar, citation, thesis development, organization, critical reading, or research methods. They may discuss any genre, including poetry, science lab reports, argument-driven research, or scholarship application letters.
Library Resources: Reference/Information assistance is available at the Reference Desk, by phone (925) 631-4624, text message at (925) 235-4624 or Chat( IM). Check the Librarys “Ask Us” link for details: http://www.stmarys-ca.edu/library/ask-us. Extended assistance by appointment is also available with your librarian subject specialist. The Mathematics department librarian is Linda Wobbe who can be reached at lwoobbe@stmarys-ca.edu or (925) 631-4232.
<table>
<thead>
<tr>
<th>DATE</th>
<th>TEXT</th>
<th>TOPIC(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed. Sept. 3</td>
<td>Chapter 1</td>
<td>Introduction</td>
</tr>
<tr>
<td>Fri. Sept. 5</td>
<td>Chapter 2</td>
<td>Introduction to Logical Constructions</td>
</tr>
<tr>
<td>Mon. Sept. 8</td>
<td>Chapter 3</td>
<td>Contrapositive and Converse</td>
</tr>
<tr>
<td>Wed. Sept. 10</td>
<td>Chapter 4</td>
<td>Set Notation and Quantifiers</td>
</tr>
<tr>
<td>Fri. Sept. 12</td>
<td>Chapter 5</td>
<td>Proof Techniques</td>
</tr>
<tr>
<td>Mon. Sept. 15</td>
<td>Chapter 6</td>
<td>Sets</td>
</tr>
<tr>
<td>Wed. Sept. 17</td>
<td>Chapter 6</td>
<td>Proof with Sets</td>
</tr>
<tr>
<td>Fri. Sept. 19</td>
<td></td>
<td>\LaTeX</td>
</tr>
<tr>
<td>Mon. Sept. 22</td>
<td>Chapter 7</td>
<td>Operations on Sets</td>
</tr>
<tr>
<td>Wed. Sept. 24</td>
<td>Chapter 9</td>
<td>Power Set</td>
</tr>
<tr>
<td>Fri. Sept. 26</td>
<td></td>
<td>extra</td>
</tr>
<tr>
<td><strong>Mon. Sept. 29</strong></td>
<td></td>
<td>EXAM 1</td>
</tr>
<tr>
<td>Wed. Oct. 1</td>
<td>Chapter 18</td>
<td>Induction</td>
</tr>
<tr>
<td>Fri. Oct. 3</td>
<td>Chapter 18</td>
<td>Induction</td>
</tr>
<tr>
<td>Mon. Oct. 6</td>
<td></td>
<td>Divisors and Division Algorithm</td>
</tr>
<tr>
<td>Wed. Oct. 8</td>
<td></td>
<td>Euclid’s Algorithm</td>
</tr>
<tr>
<td>Fri. Oct. 10</td>
<td></td>
<td>Congruences</td>
</tr>
<tr>
<td>Mon. Oct. 13</td>
<td></td>
<td>Linear Congruences, $\mathbb{Z}_n$</td>
</tr>
<tr>
<td>Wed. Oct. 15</td>
<td>Chapter 14</td>
<td>Functions</td>
</tr>
<tr>
<td>Fri. Oct. 17</td>
<td>Chapter 15</td>
<td>Injective and Surjective</td>
</tr>
<tr>
<td>Mon. Oct. 20</td>
<td>Chapter 16</td>
<td>Inverses</td>
</tr>
<tr>
<td>Wed. Oct. 22</td>
<td></td>
<td>Fermat’s Theorem</td>
</tr>
<tr>
<td>Fri. Oct. 24</td>
<td></td>
<td>No Class</td>
</tr>
<tr>
<td>Mon. Oct. 27</td>
<td>Chapter 2P</td>
<td>Operations</td>
</tr>
<tr>
<td><strong>Wed. Oct. 29</strong></td>
<td></td>
<td>EXAM 2</td>
</tr>
<tr>
<td>Fri. Oct. 3</td>
<td>Chapter 3P</td>
<td>Groups</td>
</tr>
<tr>
<td>Mon. Nov. 3</td>
<td>Chapter 3P</td>
<td>More Examples</td>
</tr>
<tr>
<td>Wed. Nov. 5</td>
<td>Chapter 4P</td>
<td>Elementary Properties</td>
</tr>
<tr>
<td>Fri. Nov. 7</td>
<td>Chapter 5P</td>
<td>Subgroups</td>
</tr>
<tr>
<td>Mon. Nov. 10</td>
<td>Chapter 5P</td>
<td>Subgroups</td>
</tr>
<tr>
<td>Wed. Nov. 12</td>
<td>Chapter 10P</td>
<td>Order of element</td>
</tr>
<tr>
<td>Fri. Nov. 14</td>
<td>Chapter 11P</td>
<td>Cyclic Groups</td>
</tr>
<tr>
<td>Mon. Nov. 17</td>
<td>Chapter 11P</td>
<td>Cyclic Groups</td>
</tr>
<tr>
<td>Wed. Nov 19</td>
<td>Chapter 13P</td>
<td>Counting Coset</td>
</tr>
<tr>
<td>Fri. Nov. 21</td>
<td>Chapter 13P</td>
<td>Lagrange’s Theorem</td>
</tr>
<tr>
<td>Mon. Nov. 24</td>
<td>Chapter 13P</td>
<td>Consequences</td>
</tr>
<tr>
<td>Wed. Nov. 26</td>
<td></td>
<td>No Class</td>
</tr>
<tr>
<td>Fri. Nov. 28</td>
<td></td>
<td>No Class</td>
</tr>
<tr>
<td>Mon. Dec. 1</td>
<td>Chapter 14P</td>
<td>Homomorphism, Kernels</td>
</tr>
<tr>
<td>Wed. Dec. 3</td>
<td>Chapter 14P</td>
<td>Isomorphisms</td>
</tr>
<tr>
<td>Fri. Dec. 5</td>
<td></td>
<td>extra</td>
</tr>
<tr>
<td><strong>Mon. Dec. 8</strong></td>
<td></td>
<td>FINAL EXAM</td>
</tr>
</tbody>
</table>