Washington State University
MAJOR CURRICULAR CHANGE FORM -- COURSE
(Submit original signed form and ten copies to the Registrar’s Office, zip 1035.)

Future Effective Date: 01/01/2015
(Effective date cannot be retroactive)
☐ New course ☐ Temporary course ☐ Drop service course
☐ There is a course fee associated with this course (see instructions)

☐ Variable credit
☐ Increase credit (former credit ________)
☐ Number (former number ________)
☐ Crosslisting (between WSU departments) (Must have both departmental signatures)
☐ Conjoint listing (400/500)
☐ Request to meet Writing in the Major [M] requirement (Must have All-University Writing Committee Approval)
☐ Request to meet GER in ________ (Must have GenEd Committee Approval)
☐ Professional course (Pharmacy & Vet Med only)
☐ Graduate credit (professional programs only)
☐ Other (please list request) Remove the conjoint listing for Math 432 & Math 532 & title change for Math 532

Math 432/532
Advanced Mathematical Thinking
Course prefix: Math 432/532
Course no.: 532
Title: Advanced Mathematical Thinking
Credit: 3
Lecture hrs per week: 3
Lab hrs per week: 0
Studio hrs per week: 0
Graduate standing in mathematics or permission of the instructor
Prerequisite:

Description (20 words or less) Current theories about how humans learn to think mathematically at the advanced level.

Instructor: Libby Knott
Phone number: (509) 335-4122
Email: lknott@wsu.edu

Contact: Sandy Cooper
Phone number: (509) 335-8652
Email: scooper@math.wsu.edu

Campus Zip Code: 3113

- Please attach rationale for your request, a current and complete syllabus, and explain how this impacts other units in Pullman and other branches (if applicable).
- Secure all required signatures and provide 10 copies to the Registrar’s Office.

Chair/Date: 2/18/14
Dean/Date: 2/18/14
General Education Com/Date:

Chair (if crosslisted/interdisciplinary)*: Charles Moore
Dean (if crosslisted/interdisciplinary)*: Carol S. Swindell
Graduate Studies Com/Date:

All-University Writing Com/Date: Academic Affairs Com/Date: Senate/Date:

*If the proposed change impacts or involves collaboration with other units, use the additional signature lines provided for each impacted unit and college.
Rationale for separating the conjoint courses Math 432 and Math 532

Math 432 is being proposed as a UCORE capstone course for Secondary Mathematics Education majors, so we are requesting that Math 532 be separated from Math 432. Math 532 is a requirement for mathematics graduate students pursuing either a master’s in Mathematics with Teaching Emphasis or doctoral degree in Mathematics with Emphasis in Mathematics Education. Math 532 will only be taught every other year in odd numbered spring semesters, while Math 432 will continue to be taught every spring semester. Math 532 will be more appropriate for graduate students than the former conjoint Math 532 because the focus will be on current theories about how humans learn to think mathematically at the advanced level and students will be required to become experts in one line of research in this area.
Syllabus for Spring 2016
Math 532 Advanced Mathematical Thinking

Instructor: Libby Knott
Office: Neill 301
E-mail: iknott@wsu.edu

Office Hours: TTH 1-2 pm
Or by appointment in case of time conflict

Class Times and Location: TuTh 10:35-11:50

Credits: 3 credits
Prerequisites: Graduate standing in mathematics or permission of the instructor

Required Texts: Advanced Mathematical Thinking, edited by David O. Tall and published by Kluwer, and How Humans Learn to Think Mathematically: Exploring the Three Worlds of Mathematics by David O. Tall and published by Cambridge University Press. The first text will be available on reserve or on-line through WSU Libraries and the second can be purchased at the Bookie, ordered on-line, or downloaded onto a Kindle.

Course Description: This course offers an opportunity to explore various theories about how humans learn to think mathematically, with an emphasis on the learning of mathematics at the advanced level. We will build on the ideas of David Tall (and others), with readings from Advanced Mathematical Thinking (AMT), and How Humans Learn to Think Mathematically (HHL), and from other contributors to the field. This will include a focus on the current research in learning about limits, functions, infinity, calculus, and proof.

Learning Outcomes: At the end of this course, you should be able to do the following:
- Understand and describe cognitive aspects of advanced mathematical learning
- Have a familiarity with and ability to cite and locate current research in advanced mathematical thinking
- Describe the trajectory of the research in a particular area such as proof writing, limits, function, etc.
- Develop graduate level writing and oral presentation skills through course assignments
- Synthesize research in one chosen area of advanced mathematical thinking

These outcomes will be assessed through reading summaries and reflections, the responsibility for leading class discussions, a midterm exam, and a final project that will include both a poster presentation and paper. In particular, the final project will be used to assess all five learning outcomes; the reading summaries will be used to assess the first, second, and fourth learning outcome; leading a class discussion will be used to assess the first and fourth learning outcomes; and the midterm will be used to assess the first, second, and fourth learning outcomes.

Grading Criteria:
- Summaries and reflections: 30%
- Leading Class Discussions: 10%
- Midterm: 20%
- Final Project: 40% (Poster- 15%, Paper-20%, and Presentation-5%)

Summaries and Reflections Please write a brief summary of each chapter you read and include a reflection on what you have read. The summary should bring out the key points made in the chapter or article and the reflection should include your interpretation of the reading, whether you agree or not with the author's claims and why, and implications for your own research and/or teaching. This should be typed and turned in prior to class the day it is scheduled to be discussed. No late summaries of required readings will be accepted.

Leading a Class Discussion After the first week, students will be responsible for leading the class discussions on the readings. Depending on the size of the class, each student will be responsible for leading 3-5
discussions over the course of the semester. For the discussion you should be prepared with questions that will bring out key points of the readings and will lead to interesting exchanges.

**Midterm** The midterm will be a take-home essay exam based on the readings for the first half of the semester. You will be expected to support your answers with specific references to the readings which you will be expected to supplement with additional sources beyond the required readings.

**Final Project** The final project will focus on a topic from advanced mathematics that has been researched extensively by mathematics educators. Possible topics include the learning of proof writing, limits, functions, infinity, problem solving, discrete math and combinatorics, probability and statistics, and differential equations, or another topic of choice with your instructor's approval. You will synthesize the research done on this topic and characterize the trajectory of the research. Your findings will be presented in a poster format and written paper. Citations should be given in APA format.

**Grading Scale for Math 532**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93% - 100%</td>
</tr>
<tr>
<td>A-</td>
<td>90% - 92.9%</td>
</tr>
<tr>
<td>B+</td>
<td>87% - 89.9%</td>
</tr>
<tr>
<td>B</td>
<td>83% - 86.9%</td>
</tr>
<tr>
<td>B-</td>
<td>80% - 82.9%</td>
</tr>
<tr>
<td>C+</td>
<td>77% - 79.9%</td>
</tr>
<tr>
<td>C</td>
<td>70% - 76.9%</td>
</tr>
<tr>
<td>D</td>
<td>60% - 69.9%</td>
</tr>
<tr>
<td>F</td>
<td>0% - 59.9%</td>
</tr>
</tbody>
</table>

**Weekly Schedule**

The course readings are from the books *Advanced Mathematical Thinking (AMT), and How Humans Learn to Think Mathematically (HHL).*

<table>
<thead>
<tr>
<th>Week</th>
<th>HHL</th>
<th>Title/topic</th>
<th>AMT</th>
<th>Title/topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Ch. 1</td>
<td>About this book</td>
<td>Ch. 1</td>
<td>Psychology of AMT</td>
</tr>
<tr>
<td>Week 2</td>
<td>Ch. 9</td>
<td>Historical evolution</td>
<td>Ch. 2</td>
<td>AMT processes</td>
</tr>
<tr>
<td>Week 3</td>
<td>Ch. 4</td>
<td>Long-term learning</td>
<td>Ch. 3</td>
<td>Mathematical creativity</td>
</tr>
<tr>
<td>Week 4</td>
<td>Ch. 7</td>
<td>Embodiment &amp; symbolism</td>
<td>Ch. 6</td>
<td>Conceptual entities &amp; symbols</td>
</tr>
<tr>
<td>Week 5</td>
<td>Ch. 2</td>
<td>Foundations of mathematical thinking</td>
<td>Ch. 5 &amp; 7</td>
<td>Role of definition &amp; reflective abstraction</td>
</tr>
<tr>
<td>Week 6</td>
<td>Ch. 14</td>
<td>Math research</td>
<td>Ch. 8</td>
<td>Research in T&amp;L of AMT</td>
</tr>
<tr>
<td>Week 7</td>
<td>Ch. 10</td>
<td>Transition to formal knowledge</td>
<td>Ch. 9 &amp; 10</td>
<td>Functions &amp; limits</td>
</tr>
<tr>
<td>Week 8 &amp; 9</td>
<td>Ch. 11</td>
<td>Blending ideas in calculus</td>
<td>Ch. 11</td>
<td>Analysis</td>
</tr>
<tr>
<td>Week 10</td>
<td>Ch. 13</td>
<td>The infinitely large &amp; small</td>
<td>Ch. 12</td>
<td>Infinity</td>
</tr>
<tr>
<td>Week 11 &amp; 12</td>
<td>Ch. 8</td>
<td>Problem solving &amp; proof</td>
<td>Ch. 4, 13</td>
<td>Proof, research on proof</td>
</tr>
<tr>
<td>Week 13</td>
<td>Student Poster Gallery Walk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 14</td>
<td>Student Presentations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 15</td>
<td>Student Presentations</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Attendance Policy:** Attendance is required and expected. Attendance consists of 1) showing up on time, and 2) participating in class. Repeated tardiness, showing up more than five minutes late, or failing to participate fully will seriously impact your learning and will disrupt the learning of your classmates. Please be conscientious about attendance, get the most out of each class meeting, and respect your classmates by minimizing interruptions.

**Students with Disabilities:** Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please visit or call the Access Center (Washington Building, Room 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist on campus: 509-335-3417, [http://accesscenter.wsu.edu](http://accesscenter.wsu.edu), AccessCenter@wsu.edu.

**WSU Academic Integrity:** Academic integrity is the cornerstone of the university. You assume full responsibility for the content and integrity of the academic work you submit. You may collaborate with classmates on homework assignments. However, your submitted work, and examinations must be your own work. Any student who violates the University's standard of conduct related to academic integrity will be referred to the Office of Student Conduct and may fail the assignment and/or the course. You can learn more about academic integrity at [http://conduct.wsu.edu/academic-integrity-policies-and-resources](http://conduct.wsu.edu/academic-integrity-policies-and-resources). Please use these resources to ensure that you don't inadvertently violate WSU's standard of conduct.

**WSU Safety:** Washington State University is committed to enhancing the safety of the students, faculty, staff, and visitors to the Pullman campus. It is highly recommended that you review the Campus Safety Plan ([http://safetyplan.wsu.edu](http://safetyplan.wsu.edu)) and visit the Office of Emergency Management web site ([http://oem.wsu.edu/](http://oem.wsu.edu/)) for a comprehensive listing of university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.