WINONA STATE UNIVERSITY
REQUIRED CHECKLIST FOR ALL CURRICULAR PROPOSALS

Course or Program  MATH 330

This checklist enables A2C2 representatives to endorse that their departments have accurately followed the Process for Accomplishing Curricular Change. For each course or program proposal submitted to A2C2, this checklist must be completed, signed by the submitting department's A2C2 representative, and included with the proposal when forwarded for approval. Peer review of proposals is also strongly advised, e.g., departments should discuss and vote on the proposals as submitted to A2C2, rather than on just the ideas proposed or drafts of proposals.

If a proposal fails to follow or complete any aspect of the process, the Course and Program Proposal Subcommittee will postpone consideration of the proposal and return it to the department's A2C2 representative for completion and resubmission. Resubmitted proposals have the same status as newly submitted proposals.

Note: This form need not be completed for notifications.

1. The appropriate forms and the “Approval Form” have been completed in full for this proposal. All necessary or relevant descriptions, rationales, and notifications have been provided.
   ______ Completed

2a. The “Financial and Staffing Data Sheet” has been completed and is enclosed in this proposal, if applicable.
   ______ Completed    ______ NA

2b. For departments that have claimed that “existing staff” would be teaching the course proposed, an explanation has been enclosed in this proposal as to how existing staff will do this, e.g., what enrollment limits can be accommodated by existing staff. If no such explanation is enclosed, the department's representative is prepared to address A2C2's questions on this matter.
   ______ Completed    ______ NA

3. Arrangements have been made so that a department representative knowledgeable of this proposal will be attending both the Course and Program Proposal Subcommittee meeting and the full A2C2 meeting at which this proposal is considered.
   ______ Completed

   Name and office phone number of proposal's representative: ______________________

4. Reasonable attempts have been made to notify and reach agreements with all university units affected by this proposal. Units still opposing a proposal must submit their objections in writing before or during the Course and Program Proposal Subcommittee meeting at which this proposal is considered.
   ______ Completed    ______ NA

5. The course name and number is listed for each prerequisite involved in this proposal.
   ______ Completed    ______ NA

6. In this proposal for a new or revised program (major, minor, concentration, etc.), the list of prerequisites provided includes all the prerequisites of any proposed prerequisites. All such prerequisites of prerequisites are included in the total credit hour calculations.
   ______ Completed    ______ NA

7. In this proposal for a new or revised program, the following information for each required or elective course is provided:
   a. The course name and number.
   b. A brief course description.
   c. A brief statement explaining why the program should include the course.
   ______ Completed    ______ NA

8. This course or program revision proposal:
   a. Clearly identifies each proposed change.
   b. Displays the current requirements next to the proposed new requirements, for clear, easy comparison.
   ______ Completed    ______ NA

9. This course proposal provides publication dates for all works listed as course textbooks or references using a standard form of citation. Accessibility of the cited publications for use in this proposed course has been confirmed.
   ______ Completed    ______ NA

__________________________________________________
Department's A2C2 Representative or Alternate     Date

[Revised 9-05]
## Course or Program Approval Form

Routing form for new and revised courses and programs.

### Department Recommendation

<table>
<thead>
<tr>
<th>Department Chair</th>
<th>Date</th>
<th>e-mail address</th>
</tr>
</thead>
</table>

### Dean’s Recommendation

- Yes
- No*

<table>
<thead>
<tr>
<th>Dean of College</th>
<th>Date</th>
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*The dean shall forward their recommendation to the chair of the department, the chair of A2C2, and the Vice President for Academic Affairs.

### A2C2 Recommendation

- Approved
- Disapproved

<table>
<thead>
<tr>
<th>Chair of A2C2</th>
<th>Date</th>
</tr>
</thead>
</table>

### Graduate Council Recommendation (if applicable)

- Approved
- Disapproved

<table>
<thead>
<tr>
<th>Chair of Graduate Council</th>
<th>Date</th>
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</table>

<table>
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<tr>
<th>Director of Graduate Studies</th>
<th>Date</th>
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</thead>
</table>

### Faculty Senate Recommendation

- Approved
- Disapproved

<table>
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<tr>
<th>President of Faculty Senate</th>
<th>Date</th>
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</table>

### Academic Vice President Recommendation

- Approved
- Disapproved

<table>
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<tr>
<th>Academic Vice President</th>
<th>Date</th>
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</table>

### Decision of President

- Approved
- Disapproved

<table>
<thead>
<tr>
<th>President</th>
<th>Date</th>
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</table>

Please forward to Registrar.

<table>
<thead>
<tr>
<th>Registrar</th>
<th>Date entered</th>
</tr>
</thead>
</table>

Please notify department chair via e-mail that curricular change has been recorded.

[Revised 9-1-10]
If proposed course change requires A2C2 and/or graduate Council approval, i.e., not considered a notification, complete and submit this form with the appropriate number of copies. Refer to Regulation 3-4, Policy for Changing the Curriculum, for complete information on submitting proposals for curricular changes.

### Current Course Information

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 330</td>
<td>Advanced Calculus I</td>
<td>4</td>
</tr>
</tbody>
</table>

This Proposal is for a(n) _X_ Undergraduate Course  _____ Graduate Course

Applies to: _X_ Required  _X_ Minor  _X_ University Studies  _X_ Not for USP

____ Elective  _X_ Elective

Prerequisites  MATH 210 AND 260

Grading  _X_ Grade only  _____ P/NC only  _____ Grade and P/NC Option

Frequency of offering  Each Fall Semester

### Proposed Course Information. (Please indicate only proposed changes below.)

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

This Proposal is for a(n)  _____ Undergraduate Course  _____ Graduate Course

Applies to  _____ Major  _____ Minor  _____ University Studies

_____ Required  _____ Required  _____ Not for USP

_____ Elective  _____ Elective

Prerequisites

Grading  _____ Grade only  _____ P/NC only  _____ Grade and P/NC Option

Frequency of offering

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A. Changes in the course description.  [SEE ATTACHED]

1. Catalog description (include a display of current and proposed course requirements).
2. Course outline of the major topics and subtopics (minimum of two-level outline).
3.a. Instructional delivery methods utilized: (Please check all that apply).

<table>
<thead>
<tr>
<th>Lecture: Auditorium</th>
<th>ITV</th>
<th>Online</th>
<th>Web Enhanced</th>
<th>Web Supplemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture: Classroom</td>
<td>Service Learning</td>
<td>Travel Study</td>
<td>Laboratory</td>
<td>Internship/Practicum</td>
</tr>
</tbody>
</table>

Other: (Please indicate)

3.b. MnSCU Course media codes: (Please check all that apply).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. CD Rom 5. Broadcast TV</td>
<td>8. ITV Receiving</td>
<td></td>
</tr>
</tbody>
</table>

4. Course requirements (papers, lab work, projects, etc.) and means of evaluation.

B. Rationale for each of the changes proposed.

C. Impact of this Course on other Departments, Programs, Majors, or Minors

1. Does this course increase or decrease the total credits required by a major or minor of any other department? If so, which department(s)?
2. List the department(s), if any, which have been consulted about this proposal.

D. Describe impacts of this proposal on the University Studies Program.
Definitions:

01- Satellite:

02- CD Rom:

03- Internet: Predominately = where all, or nearly all, course activity occurs in an online environment. One to two activities may occur face-to-face in a classroom, with the maximum being two activities.

04 – ITV Sending: a course in which students are in the classroom with the instructor, other students join via interactive television technology from other geographically separate locations

05 – Broadcast TV:

06 – Independent Study: a course in which the teacher develops specialized curriculum for the student(s) based on department guidelines in the University course catalog

07 – Taped: a course in which the teacher records the lessons for playback at a later date

08 – ITV Receiving: a course in which students are not in the classroom with the teacher, other students join via interactive television technology from other geographically separate locations

09 – Web Enhanced- Limited Seat Time: For a course in which students are geographically separate from the teacher and other students for a majority of required activities. However, some on-site attendance is required. The course includes synchronous and/or asynchronous instruction.

10 – Web Supplemented- No Reduced Seat Time: For a course utilizing the web for instructional activities. Use of this code may assist your college/university in tracking courses for “smart classrooms” and/or facility usage.

Attach an Approval Form with appropriate signatures.

Department Contact Person for this Proposal:

Barry Peratt 457-5567 bperatt@winona.edu
Name (please print) Phone e-mail address
Include a Financial and Staffing Data Sheet with any proposal for a new course, new program, or revised program.

Please answer the following questions completely. Provide supporting data.

1. Would this course or program be taught with existing staff or with new or additional staff? If this course would be taught by adjunct faculty, include a rationale.
   
   This course would be taught by existing faculty.

2. What impact would approval of this course/program have on current course offerings? Please discuss number of sections of current offerings, dropping of courses, etc.

   As described in the proposal, this revised MATH 330 (3 S.H.) course will replace our current MATH 330 (4 S.H.) course.

3. What effect would approval of this course/program have on the department supplies? Include data to support expenditures for staffing, equipment, supplies, instructional resources, etc.

   The demand for these resources would not change.
A2C2 Proposed Change for MATH 330
Spring 2011

A. Catalog Changes

<table>
<thead>
<tr>
<th>330 - Advanced Calculus I, II (4 S.H. Each)</th>
<th>330 - Advanced Calculus I (3 S.H.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A systematic approach to the theory of differential and integral calculus for functions and transformations in several variables. Prerequisites: MATH 210 and MATH 260.</td>
<td>A systematic approach to the theory of differential and integral calculus for functions and transformations in several variables. Prerequisites: MATH 210 and MATH 260. <a href="#">Offered every Fall semester.</a></td>
</tr>
</tbody>
</table>

The rest of the information for this section is contained in the attached course outline.

B. Rationale for reducing MATH 330 from 4 credits to 3 credits.

The reason for the reduction is that under our proposed B.S. major and revised B.A. major, a second course in either Advanced Calculus or Abstract Algebra will be required of all of our mathematics majors. The overall content and purpose of the course will not substantially change; we will simply cover fewer topics than under the 4 S.H. course by ending our coverage at differentiation and integration rather than moving on to sequences of functions and uniform convergence.

C. The Impact of This Course on Other Departments, Programs, Majors and Minors

The change in this course as well as a similar change in Abstract Algebra, MATH 440, and an increase of 1 S.H. in Linear Algebra, MATH 205, will result in a net decrease of 1 credit hour for the Mathematics Education major.

The change will not affect the number of credit hours in the Statistics major or Math minor.

D. The Impact of This Course Change on the University Studies Program

Currently, MATH 330 satisfies a Writing Flag. The material in this course which qualifies it thus (in particular, the careful exposition of mathematical logic and the writing and re-writing of proofs) does not substantially change; it merely comprises fewer credit hours.
Title: Introductory Real Analysis I

Number of Credits: 3

Course Description: In this proof oriented real analysis course sequence, we take up the rigorous study of functions of a real variable. In doing so, we follow the nineteenth century analysts, led by Cauchy and Weierstrass, who altered the subject by giving precise definitions to the most basic terms like function, limit, and continuity, thus establishing a new standard of rigor for the subject and, by extension, for all of mathematics. In this first course of the sequence, we apply this standard of precision to examine sequences, the Riemann integral, and differentiable functions.

Possible Textbooks:
- Fundamental Ideas of Analysis by Michael Reed.

Topics covered: Numbers in square brackets [ ] indicate the approximate number of class hours that should be spent on the topic.

I. Preliminaries
   a. The Real Numbers [1]
   b. Sets and Functions [1]
   c. Cardinality [1]
   d. Methods of Proof [2]
II. Sequences
   a. Convergence [2]
   b. Limit Theorems [2]
   c. Cauchy Sequences [2]
III. The Riemann Integral
   a. Continuity [2]
   b. Continuous Functions on Closed Intervals [2]
   c. The Riemann Integral [2]
   d. Numerical Methods (lightly)
   e. Discontinuities [2]
   f. Improper Integrals [3]
IV. Differentiation
   a. Differentiable Functions [2]
   b. The Fundamental Theorem of Calculus [2]
   c. Taylor’s Theorem [2]
   d. Newton’s Method (lightly)
   e. Inverse Functions [2]

Remarks:
- It is understood that the topological space in which all topics in the course reside is $\mathbb{R}^n$, and topics in topology should be covered only insomuch as they are needed to provide a context for the proofs in $\mathbb{R}^n$. Instructors are encouraged to motivate the course with some classic pathological examples, whose analysis necessitated the development of rigorous methods of proof. However, the main thrust of the course is for students to
develop and demonstrate the ability to read, write, and understand rigorous mathematical arguments relating to the fundamental topics in real analysis.

- In this course mathematical exposition will be emphasized and solutions to most of the problems will be proofs. Students will be expected to understand and produce proofs. We will expect students to write proofs in complete, well-organized, and grammatically correct sentences (albeit using symbols).

- The Mathematics Subgroup has agreed on the following learning goals for this course:
  - Students will be able to prove convergence and divergence of limits using the \( \epsilon-\delta \) definition.
  - Students will be able to prove basic theorems about the notions of completeness, compactness and connectedness.
  - Students will be able to prove basic facts about derivatives and their properties.
  - Students will be able to prove basic facts about infinite series of functions.
  - Students will be able to write the definition of the Riemann integral and use it to compute a Riemann Integral of a function in elementary cases.
  - Students will demonstrate a rigorous understanding and working knowledge of the main concepts, theorems and techniques of real analysis by using the definitions, theorems, and examples to prove or disprove given statements.

- Additional Instructor References
  - S. Abbott, Understanding Analysis
  - G. Folland, Real Analysis
  - W. Rudin, Real and Complex Analysis
  - H.L. Royden, Real Analysis (2nd Ed.)
  - C. Apostol, Mathematical Analysis (2nd Ed.)
  - R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis

Approximate pace of coverage: 18 required sections in 36 class meetings (after accounting for test days, etc.) \( \rightarrow \) approximately 2 sections per week on average, though some topics will take more and some less time, as reflected in the topics section above.

Method of Instruction: Methods may include lecture, group work, discussion of examples, and must include a significant opportunity for students to improve on their writing of proofs.

Evaluation Procedures: Possible methods include examinations, quizzes, homework problems, and a final examination.

University Studies: Writing Flag

Flagged courses will normally be in the student’s major or minor program. Departments will need to demonstrate to the University Studies Subcommittee that the courses in question merit the flags. All flagged courses must require the relevant basic skills course(s) as prerequisites (e.g., the “College Reading and Writing” Basic Skill course is a prerequisite for Writing Flag courses), although departments and programs may require additional prerequisites for flagged courses. The University Studies Subcommittee recognizes that it cannot veto department designation of flagged courses.

The purpose of the Writing Flag requirement is to reinforce the outcomes specified for the basic skills area of writing. These courses are intended to provide contexts, opportunities, and feedback for students writing with discipline-specific texts, tools, and strategies. These courses should emphasize writing as essential to academic learning and intellectual development.

Courses can merit the Writing Flag by demonstrating that section enrollment will allow for clear guidance, criteria, and feedback for the writing assignments; that the course will require a significant amount of writing to be distributed throughout the semester; that writing will comprise a significant portion of the student’s final course grade; and that students will have opportunities
to incorporate readers’ critiques of their writing.

These courses must include requirements and learning activities that promote students’ abilities to:

a. practice the processes and procedures for creating and completing successful writing in their fields;
b. understand the main features and uses of writing in their fields;
c. adapt their writing to the general expectations of readers in their fields;
d. make use of the technologies commonly used for research and writing in their fields; and
e. learn the conventions of evidence, format, usage, and documentation in their fields.

Topics below which include such requirements and learning activities are indicated below using lowercase, boldface letters a.-e. corresponding to these requirements.

**Course Outline of the Major Topics and Subtopics:**
- The real number system and an introduction to proof. a., b., c., d., e.
- Elementary Topology—open/closed sets, countability, boundedness, compactness. a., b., c., d., e.
- Functions, Sequences, and Limits. a., b., c., d., e.
- Continuity. a., b., c., d., e.
- Differentiation. a., b., c., d., e.
- Integration. a., b., c., d., e.
- Vectors and Curves. a., b., c., d., e.
- Infinite Series. a., b., c., d., e.

**Additional Information about Writing Assignments:** In accordance with criteria a., b., c., d., and e., this course provides the rigorous underpinnings of proof construction and writing that are expected of students planning to attend graduate school in mathematics. The abstracts and proofs that students write in this course constitute the vast majority of their grade. One such abstract/proof pair is given below as an example of the type of writing required in this course:

**Abstract:** In the following proof, we show that if a function \( f \), from set \( S \) to \( T \), is a bijection, then its inverse must also be a bijection. To accomplish this, we begin by assuming that \( f \) is a bijection and then show that this assumption leads necessarily to the conclusion that \( f^{-1} \) is a bijection. Hence, we begin with the knowledge that \( f \) has the following four properties:

1. It is well-defined,
2. Its domain is all of the set \( S \),
3. It is injective, and
4. It is surjective.

We must then prove that its inverse has the following four qualities:

1. It is well-defined,
2. Its domain is all of the set \( T \),
3. It is injective, and
4. It is surjective.

We note that since \( f \) is injective, this will lead us to the conclusion that its inverse is well-defined, and the fact that \( f \) is well-defined will lead us to the conclusion that \( f^{-1} \) is injective. Likewise, the fact that \( f \) is surjective leads to the conclusion that its inverse has \( T \) as its
domain, and the fact that the domain of $f$ is the set $S$ leads to the conclusion that $f^{-1}$ is surjective.

**Proof:**

Prove that if a function $f : S \rightarrow T$ is a bijection, then $f^{-1} : T \rightarrow S$ is also a bijection.

**Proof:** Assume $f$ is a bijection from $S$ onto $T$. We must show that $f^{-1}$ is a bijection from $T$ onto $S$.

To see that $f^{-1}$ is well-defined, let $(t, s_1)$ and $(t, s_2)$ be in $F^{-1}$. We must show that $s_1 = s_2$. Since $(t, s_1), (t, s_2) \in F^{-1}$, then $(s_1, t), (s_2, t) \in F$. Since $F$ is injective, $s_1 = s_2$.

We now show that $\text{Dom}(f^{-1}) = T$. Since $f$ is surjective, given any $t \in T, \exists s \in S \ni (s, t) \in F$. Therefore, given any $t \in T, \exists s \in S \ni (t, s) \in F^{-1}$, and so $\text{Dom}(f^{-1}) = T$. So, $f^{-1}$ is indeed a function which maps $T$ to $S$.

To show that $f^{-1}$ is injective, let $(t_1, s), (t_2, s) \in F^{-1}$. This implies that $(s, t_1), (s, t_2) \in F$. Since $F$ is well-defined, $t_1 = t_2$.

To show that $f^{-1}$ is surjective, let $s \in S$ be arbitrary. We must show $\exists t \ni (t, s) \in F^{-1}$. But, since $s \in \text{Dom}(f), \exists t \ni (s, t) \in F$. Hence, $(t, s) \in F^{-1}$ by definition.

Prepared by: Math Subgroup  
Date: Spring 2010