

**UCC/UGC/ECCC**

Proposal for New Course

***Please attach proposed Syllabus in*** [***approved university format***](http://www4.nau.edu/avpaa/UCCForms/syllabus.doc)***.***

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| --- | --- | --- | --- |
| 1. Course subject and number: | MAT 220 | 2. Units: | 3 |

[**See upper and lower division undergraduate course definitions.**](http://www4.nau.edu/avpaa/UCCPolicy/Uplow.doc)

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| --- | --- | --- | --- |
| 3. College: | Engineering, Forestry & Natural Sciences | 4. Academic Unit: | Mathematics & Statistics |

5**.** Student Learning Outcomes of the new course. *(*[*Resources & Examples for Developing Course Learning Outcomes*](http://www4.nau.edu/avpaa/Assessment/CourseLearningOutcomesPDF_090712.pdf)*)*

Upon successful completion of the course, the student will be able to:

1. Solve multi-step, complex problems in elementary areas of mathematics using common problem solving strategies;
2. Judge what constitutes a solid mathematical argument;
3. Write readable and concise solutions using correct English with some mathematical notation.

6. Justification for new course, including how the course contributes to degree program outcomes, or other university requirements / student learning outcomes. *(*[*Resources, Examples & Tools for Developing Effective Program Student Learning Outcomes*](http://www4.nau.edu/avpaa/Assessment/ProgramLearningOutcomesPDF_090712.pdf)*).*

MAT 220 is being introduced in part because of assessment reports identifying weaknesses in communication and reasoning of senior mathematics majors. Instructors of key courses (e.g., MAT 320 Foundations) indicate similar issues at the junior level. This course is focused on reasoning and communication through problem solving and written mathematical arguments in order to provide students with more experience and training early in their university studies. In addition, problem solving of the type in the course – problems in elementary areas with little background required that make use of multi-step, complex solutions – is a fundamental component of mathematics that receives little focused attention elsewhere in our program. Decisions about whether to require the course and how it will serve as a prerequisite will be made during the current academic year.

The course directly addresses program outcomes and student learning outcomes in the areas of reasoning and communication as well as providing additional background for central courses in our major and minor programs.

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| 7. Effective **BEGINNING** of what term and year? | Spring 2014 |  |
| [**See effective dates calendar**](http://www4.nau.edu/avpaa/timelines/1314Effective.xls)**.** |  |  |

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| --- | --- |
| 8.  Long course title: | Introduction to Mathematical Reasoning |
| *(max 100 characters including spaces)* | |

|  |  |
| --- | --- |
| 9. Short course title: | Intro Mathematical Reasoning |
| *(max. 30 characters including spaces)* | |

10. Catalog course description *(max. 60 words, excluding requisites):*

Mathematical reasoning in multi-step problems across different areas of mathematics. Focuses on problem solving and solution writing.

11. Will this course be part of any plan (major, minor or certificate) or sub plan (emphasis)?

                                                                                                                                    Yes  No

If yes, include the appropriate plan proposal.

Mathematics BS (elective), Mathematics-Secondary Education BSEd (elective, , Mathematics Education Minor

12. Does this course duplicate content of existing courses? Yes  No

If yes, list the courses with duplicate material. If the duplication is greater than 20%, explain why NAU should establish this course.

The course will be unique on our course list. To some extent it replaces and extends a 1 hour course (no longer being offered) in problem solving, but the proposed course is more extensive, more rigorous, with broader expectations.

13. Will this course impact any other academic unit’s enrollment or plan(s)?              Yes  No

      If yes, describe the impact. If applicable, include evidence of notification to and/or response from

each impacted academic unit

14. Grading option:      Letter grade Pass/Fail Both

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| 15. Co-convened with: |  | 14a. UGC approval date\*: |  |
| (For example: ESE 450 and ESE 550) [See co-convening policy](http://www4.nau.edu/avpaa/UCCPolicy/crosslist.doc).  \*Must be approved by UGC before UCC submission, and both course syllabi must be presented. | | | |

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| 16. Cross-listed with: |  | | |  | | | | |
| (For example: ES 450 and DIS 450) [See cross listing policy](http://www4.nau.edu/avpaa/UCCPolicy/crosslist.doc).        Please submit a single cross-listed syllabus that will be used for all cross-listed courses. | | | | | | | | |
| 17. May course be repeated for additional units? | | |  | | | Yes     No | | |
| 16a. If yes, maximum units allowed? | |  | | |  | | | |
| 16b. If yes, may course be repeated for additional units in the same term? | | | | | | |  | Yes     No |

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| 18. Prerequisites: | MAT 136 with a grade of C or better |  |

If prerequisites, include the rationale for the prerequisites.

The course will not require any mathematics beyond one semester of calculus. In fact most features (problems to solve) will not require calculus, but calculus represents the level of mathematical maturity expected of students.

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| 19. Co requisites: |  |  |

If co requisites, include the rationale for the co requisites.

20. Does this course include combined lecture and lab components?                   Yes  No

If yes, include the units specific to each component in the course description above.

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| 21. Names of the current faculty qualified to teach this course: | Nandor Sieben, Dana Ernst, Jeffrey Rushall, James Swift, Terence Blows, and others |

22. Classes scheduled before the regular term begins and/or after the regular term ends may require

additional action.  Review “see description” and “see impacts” for “Classes Starting/Ending

Outside Regular Term” under the heading “Forms”

<http://nau.edu/Registrar/Faculty-Resources/Schedule-of-Classes-Maintenance/>.

Do you anticipate this course will be scheduled outside the regular term?   Yes  No

**Answer 22-23 for UCC/ECCC only:**

23. Is this course being proposed for Liberal Studies designation?             Yes  No

       If yes, include a [Liberal Studies proposal](http://www2.nau.edu/~d-ugstdy/_source/docs/LS_Proposal_form.doc) and syllabus with this proposal.

24. Is this course being proposed for Diversity designation?Yes    No

       If yes, include a [Diversity proposal](http://www4.nau.edu/avpaa/EthDiv/Divform2010.doc) and syllabus with this proposal.

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| **FLAGSTAFF MOUNTAIN CAMPUS** |  |
| **Scott Galland** | **12/10/2013** |
| Reviewed by Curriculum Process Associate | Date |
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| **Approvals**: |  |
|  |  |
| Department Chair/Unit Head (if appropriate) | Date |
|  |  |
| Chair of college curriculum committee | Date |
|  |  |
| Dean of college | Date |
|  |  |
| **For Committee use only:** |  |
|  |  |
| UCC/UGC Approval | Date |

Approved as submitted: Yes  No

Approved as modified: Yes  No

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| **EXTENDED CAMPUSES** |  |
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| Reviewed by Curriculum Process Associate | Date |
|  |  |
| **Approvals:** |  |
|  | |
| Academic Unit Head | Date |
|  | |
| Division Curriculum Committee (Yuma, Yavapai, or Personalized Learning) | Date |
|  | |
| Division Administrator in Extended Campuses (Yuma, Yavapai, or Personalized Learning) | Date |
|  | |
| Faculty Chair of Extended Campuses Curriculum Committee (Yuma, Yavapai, or Personalized Learning) | Date |
|  | |
| Chief Academic Officer; Extended Campuses (or Designee) | Date |
|  |  |

Approved as submitted: Yes  No

Approved as modified: Yes  No



**Department of Mathematics & Statistics**

SYLLABUS AND COURSE INFORMATION

**MAT220 Introduction to Mathematical Reasoning**

### General Information

**Title:** MAT220: Introduction to Mathematical Reasoning

**Semester:** Spring 2014

**Credits:** 3

**Section:** 1

**Time:** 11:30-12:20

**Location:** AMB 162

# Instructor Information

**Instructor:** Dr. Dana C. Ernst

**Office:** AMB 119

**Office Phone:** 928.523.6852

**Email:** <mailto:dana.ernst@nau.edu>

**Office Hours:** MWF at 10:00-11:30AM (or by appointment)

**Webpage:** <http://danaernst.com>

### Course Information and Policies

**Prerequisites:** MAT136 with a grade greater than or equal to C.

**Catalog Description:** Introduction to Mathematical Reasoning (3) Mathematical reasoning in multi-step problems across different areas of mathematics. Focuses on problem solving and solution writing.

**Course Description:** MAT220 is an introductory course in mathematical reasoning in multi-step problems across different areas of mathematics. The goal is to use elementary mathematical tools to solve more complex problems in already familiar areas of study such as precalculus, basic number theory, geometry, and discrete mathematics, instead of teaching new mathematical tools that are used in straightforward one-step exercises. The focus is on problem solving and solution writing.

**What is this course really about?** In most of our courses, we focus on content and hope that you as a student will pick up process skills along the way. In this course, we will focus explicitly on the process skills. In some sense the content is irrelevant. The goal is for the students to work on interesting yet challenging multi-step problems that require almost zero background knowledge. Along the way you will develop (or at least move in the direction of) the habits of mind of a mathematician. In addition, students typically enter college not really having a sense of what mathematics is all about and have not been trained to think hard about a problem for more than a few minutes. One goal of this course is to remedy this.

**Course Content:** The content of the course includes, but is not limited to:

* Problem solving strategies such as: use of figures and diagrams, use of variables, considering simpler cases, recognizing patterns, conjectures, counterexamples, breaking up into sub-problems, working backwards, case analysis, considering an extreme case, contradiction, induction, pigeon hole principle, symmetry, algorithms, coding, persistence;
* Writing solutions such as: communicating a solution, planning, organization, lemmas, naming, figures, concise vs. detailed, proofreading;
* Mathematical thinking such as: generalization, converse, hidden connections, new problem construction, open ended problems, ill-defined problems.

**Course Structure and Approach:** Class meetings will consist of discussion of problems, student-led presentations, and group work focused on problems selected by the instructor. A typical class session may include:

* Informal student presentations of progress on previously assigned homework problems;
* Summary of major steps and techniques of the solution of a finished problem;
* Exploration of alternative approaches, possible generalizations, consequences, special cases, converse;
* Discussion of relationships to previously assigned or solved problems;
* Assignment of new problems;
* Explanation of unfamiliar mathematical concepts as needed.

**Course Notes:** We will not be using a textbook this semester, but rather a problem-sequence titled *MAT220 Problem Collection*, Department of Mathematics and Statistics, NAU. The problem collection will be available on the course webpage. We will not be covering every detail of the notes and the only way to achieve a sufficient understanding of the material is to be digesting the reading in a meaningful way. You should be seeking clarification about the content of the notes whenever necessary by asking questions in class or posting questions to the course forum.

**Recommended optional materials/references:** Other possible resources include:

* *The Art and Craft of Problem Solving* by Paul Zeitz
* *The Contest Problem Book*, MAA
* *Mathematical Discovery* by George Polya

**Course Outline:** We will work through the problem-sequence as the semester progresses. The pace at which we cover the material depends largely on how quickly the class can digest the material in a meaningful way. In general, the difficulty of the problems will increase as the course progresses. Activities, assignments, and class discussions will be designed to introduce you to a variety of problem solving strategies. At the beginning, students will work in small groups most of the time, but the course will gradually become more individualized as you gain confidence and experience.

**Student Learning Expectations/Outcomes:** Upon successful completion of the course, you will be able to:

* Solve multi-step, complex problems in elementary areas of mathematics using common problem solving strategies;
* Judge what constitutes a solid mathematical argument;
* Write readable and concise solutions using correct English with some mathematical notation.

**Assessment of Student Learning Outcomes:** Student assessment will be based on regular class attendance, participation during class meetings, consistent progress on assigned problems, quizzes, 2 midterm examinations, and a comprehensive final examination. Written work will be submitted regularly and revised for resubmission. Homework may include newly assigned problems, as well as formal write-ups of previously explored problems. In addition, some assignments may require students to write simple computer programs.

**Exams:** There will be two midterm exams and a cumulative final exam. Each exam will be worth 15% of your overall grade and may consist of both an in-class portion and a take-home portion. The in-class portions of the midterm exams are tentatively scheduled for **Friday, February 22** and **Friday, April 19**, and the in-class portion of the final exam will be on **Wednesday, May 8 at 10:00AM–12:00PM**. Make-up exams will only be given under extreme circumstances, as judged by me. In general, it will be best to communicate conflicts ahead of time.

**Homework:** Generally, homework will fall into two categories.

1. **Daily Homework**: Homework will be assigned each class meeting, and you are expected to complete (or try your best to complete) each assignment before walking into the next class period. All assignments should be carefully, clearly, and cleanly written. Among other things, this means your work should include proper grammar, punctuation and spelling. You will almost always write a draft of a given solution before you write down the final argument, so do yourself a favor and get in the habit of differentiating your scratch work from your submitted assignment.   
     
   The Daily Homework will generally consist of solving problems from the problem sequence. Daily Homework will be graded on a ✓-system.  
     
   You are allowed (in fact, encouraged!) to modify your written solution in light of presentations made in class; however, you are required to use the felt-tip pens provided in class. I will provide more guidance with respect to this during the first couple weeks of the semester.
2. **Weekly Homework:** In addition to the Daily Homework, you will also be required to submit two formally written proofs each week. You may choose any two problems marked with \* that were turned in during a given week to submit the following Tuesday by 5PM. For example, you may choose any two problems marked with a \* that were turned in during week 2 for the second Weekly Homework. These problems are due by 5PM on Tuesday in week 3.

Please understand that the purpose of the written assignments is to teach you to solve problems. It is not expected that you started the class with this skill; hence, some low grades are to be expected. However, I expect that everyone will improve dramatically. Improvement over the course of the semester will be taken into consideration when assigning grades.

You are allowed and encouraged to work together on homework. Yet, each student is expected to turn in his or her own work. In general, late homework will not be accepted. However, you are allowed to turn in up to 5 homework assignments (daily or weekly) late with no questions asked. Unless you have made arrangements in advance with me, homework turned in after class will be considered late. Your overall homework grade will be worth 20% of your final grade.

**Class Presentations:** (Adopted from *Chapter Zero Instructor Resource Manual*) Though the atmosphere in this class should be informal and friendly, what we do in the class is serious business. In particular, the presentations made by students are to be taken very seriously since they spearhead the work of the class. Here are some of my expectations:

* In order to make the presentations go smoothly, the presenter needs to have written out the solution in detail and gone over the major ideas and transitions, so that he or she can make clear the path of the proof to others.
* The purpose of class presentations is not to prove to me that the presenter has done the problem. It is to make the ideas of the solution clear to the other students.
* Presenters should explain their reasoning as they go along, not simply write everything down and then turn to explain.
* Fellow students are allowed to ask questions at any point and it is the responsibility of the person making the presentation to answer those questions to the best of his or her ability.
* Since the presentation is directed at the students, the presenter should frequently make eye contact with the students in order to address questions when they arise and also be able to see how well the other students are following the presentation.

Presentations will be graded using the rubric below.

|  |  |
| --- | --- |
| **Grade** | **Criteria** |
| 4 | Completely correct and clear solution. Yay! |
| 3 | Solution has minor technical flaws, some unclear language, or lacking some details. |
| 2 | A partial explanation is provided but a significant gap still exists to reach a full solution. |
| 1 | Minimal progress has been made that includes relevant information & could lead to a solution. |
| 0 | You were completely unprepared. |

**Basis for Evaluation:** Your final grade will be determined by your scores in the following categories.

* Homework: 20%
* Quizzes: 5%
* Midterm Exams: 40% (Each exam is worth 20%)
* Presentations/Participation: 15%
* Final Exam: 20%

**Determination of Course Grade:** In general, you should expect the grades to adhere to the standard letter-grade cutoffs: A 100- 90%, B 80-89%, C 70-79%, D 60-69%, F 0-59%.

**Rules of the Game:** You should not look to resources outside the context of this course for help. That is, you should not be consulting the web, other texts, other faculty, or students outside of our course. On the other hand, you may use each other, the course notes, your own intuition, and me.

### Additional Information

**Additional Comments and Some More Propaganda:** This course will likely be different than any other math class that you have taken before for two main reasons. First, you are used to being asked to do things like: “solve for *x*,” “take the derivative of this function,” “integrate this function,” etc. Accomplishing tasks like these usually amounts to mimicking examples that you have seen in class or in your textbook. Likely for the first time, you will be exposed to what “doing” mathematics is really all about. This will most likely be a shock to your system. Considering the number of math courses that you have taken before you arrived here, one would think that you have some idea what mathematics is all about. You must be prepared to modify your paradigm. The second reason why this course will be different for you is that the method by which the class will run and the expectations I have of you will be different. In a typical course, math or otherwise, you sit and listen to a lecture. (Hopefully) These lectures are polished and well delivered. You may have often been lured into believing that the instructor has opened up your head and is pouring knowledge into it. I absolutely love lecturing and I do believe there is value in it, but I also believe that in reality most students do not learn by simply listening. You must be active in the learning you are doing. I’m sure that each of you has said, “Hmmm, I understood this concept when the professor was going over it, but now that I am alone, I am lost.”

In order to promote a more active participation in your learning, we will incorporate ideas from an educational philosophy called inquiry-based learning (IBL) or discovery-based learning. If you want to learn more about IBL, go [here](http://danaernst.com/resources/inquiry-based-learning/). Much of the course will be devoted to students presenting their ideas on the board and a significant portion of your grade will be determined by how much mathematics you produce. I use the word “produce” because I believe that the best way to learn mathematics is by doing mathematics. Someone cannot master a musical instrument or a martial art by simply watching, and in a similar fashion, you cannot master mathematics by simply watching; you must do mathematics!

Furthermore, it is important to understand that solving problems is difficult and takes time. You shouldn’t expect to complete a single problem in 10 minutes. Sometimes, you might have to stare at the statement for an hour before even understanding how to get started. In fact, solving problems can be a lot like the clip from the *Big Bang Theory* located [here](http://www.youtube.com/watch?v=i5oc-70Fby4&feature=related).

Aside from the obvious goal of wanting you to learn how to solve problems, one of my principal ambitions is to make you independent of me. Nothing else that I teach you will be half so valuable or powerful as the ability to reach conclusions by reasoning logically from first principles and being able to justify those conclusions in clear, persuasive language (either oral or written). Furthermore, I want you to experience the unmistakable feeling that comes when one really understands something thoroughly. Much “classroom knowledge” is fairly superﬁcial, and students often find it hard to judge their own level of understanding. For many of us, the only way we know whether we are “getting it” comes from the grade we make on an exam. I want you to become less reliant on such externals. When you can distinguish between really knowing something and merely knowing about something, you will be on your way to becoming an independent learner.

All of the secondary skills you will develop in this course are highly valued by society. Whether you become a teacher, a lawyer, an engineer, or an artist, what differentiates you from your competition is your ability to think critically at a high level, collaborate professionally, and communicate effectively.

**Attendance:** Regular attendance is expected and is vital to success in this course, but you will not explicitly be graded on attendance. Yet, repeated absences may impact your participation grade (see above). Students can find more information about NAU's attendance policy on the [Academic Policies](http://nau.edu/student-life/) page. Of course, institutional excuses will be honored.

**Class Etiquette:** You are expected to treat each other with respect. You are also expected to promote a healthy learning environment, as well as minimize distracting behaviors. In particular, you should be supportive of other students while they are making presentations. Moreover, every attempt should be made to arrive to class on time. If you must arrive late or leave early, please do not disrupt class. Please turn off the ringer on your cell phone. I do not have a strict policy on the use of laptops, tablets, and cell phones. You are expected to be paying attention and engaging in class discussions. If your cell phone, etc. is interfering with your ability (or that of another student) to do this, then put it away, or I will ask you to put it away.

**Department and University Policies:** You are responsible for knowing and following the Department of Mathematics and Statistics Policies (see attached) and other University policies listed [here](http://www4.nau.edu/avpaa/UCCPolicy/plcystmt.html). More policies can be found in other university documents, especially the [NAU Student Handbook](http://nau.edu/Student-Life/Student-Handbook/) (see appendices) and the website of the [Office of Student Life](http://nau.edu/student-life/).

**Closing Remarks:** (Adopted from pages 202-203 of *The Moore Method: A Pathway to Learner-Centered Instruction* by C.A Coppin, W.T. Mahavier, E.L. May, and G.E. Parker) There are two ways to approach this class. The first is to jump right in and start wrestling with the material. The second is to say, “I'll wait and see how this works and then see if I like it and put some problems on the board later in the semester after I catch on.” The second approach isn't such a good idea. If you try every night to do the problems, then either you will get a problem (Shazaam!) and be able to put it on the board with pride or you will struggle with the problem, learn a lot in your struggle, and then watch someone else put it on the board. When this person puts it up you will be able to ask questions that help you and the others understand it, as you say to yourself, “Ahhh, now I see where I went wrong and now I can do this one and a few more for the next class.” If you do not try problems each night, then you will watch the student put the problem on the board, but perhaps will not quite catch all the details and then when you study for the exams or try the next problems you will have only a loose idea of how to tackle such problems. And then the anxiety will build and build and build. So, take a guess what I recommend that you do.

**NORTHERN ARIZONA UNIVERSITY**

**DEPARTMENT OF MATHEMATICS AND STATISTICS**

***UNIVERSITY AND DEPARTMENT POLICIES – SPRING 2012***

**Course Prerequisites and Placement:** Prior to enrollment in a course in the Department of Mathematics and Statistics a student must have completed the course prerequisites or have proper placement for the course. It is the students’ responsibility to check that they are properly enrolled in a course and to drop the course if they are not. Failure to do so could result in not receiving credit for the course. The department may cancel students’ registration in a course in which they are not properly enrolled. However, it is the student’s responsibility to monitor their own enrollment.

**Administrative Drops:** An instructor may administratively drop from a course any student who is absent **one or more times** fromclassduring the first week without contacting the instructor and receiving approval. Students who have not met all prerequisites for a course may be administratively dropped. However, it is the student’s responsibility to monitor their own enrollment.

**Class Attendance:** Students are expected to assume full responsibility for class attendance and are accountable for work missed because of absences. Instructors are under no obligation to make special arrangements for students who have been absent unless such absence has been excused by a formal institutional excuse. Institutional excuses permit a student to be absent from classes to represent the University in athletics and extracurricular or academic activities. Institutional excuses must be hand-delivered to the instructor and arrangements made for the work missed prior to the planned absence from class.

**Dropping/Auditing a Course:** The last day you may drop/delete a course (*without the class appearing on your transcripts*) is **January 26**. The last day you may drop a course (and receive a **W)** is **March 23, 2012**. Academic policy requires that a student who never attended class or stopped attending class receive an **F** should the student fail to officially drop the course. The deadline to change from credit to audit or vice versa is **January 27, 2012**. Once a student has registered and completed a class as an auditor, the audit grade cannot be changed to a credit-earning grade. The grade of **AU** is awarded to auditors for satisfactory attendance. See the most recent *Academic Catalog* for more information at: http://www4.nau.edu/aio/AcademicCatalog/academiccatalogs.htm.

**The Grade of Incomplete:** A grade of **I** is given by an instructor only if a student is unable to finish a course due to extraordinary, unforeseeable circumstances, and the deadline to drop has passed. An incomplete is only given to a student who was passing the course with a grade of **C** or higher at the time the student was forced to stop attending. Before a grade of  **I** can be given the student and instructor must complete the official department form indicating the work to be completed, as well as the date(s) by which the work must be completed. A grade of **I** not removed within a one-year period automatically reverts to a grade of **F**.

**Final Examinations:** Final examinations are required in all classes and must be given at the scheduled times and dates indicated in the university final exam schedule. An exception to the official final examination schedule can be made if a student is scheduled to take more than two examinations in one day. For more information, see the schedule at: http://home.nau.edu/registrar/FinalExam1121.asp.

**Other University Policies**

Students are responsible for the following policies: Safe Environment, Students with Disabilities, Institutional Review Board, Academic Integrity, and Academic Contact Hour. A copy of these policies may be downloaded from the web site http://www2.nau.edu/academicadmin/UCCPolicy/plcystmt.html.