

## II. WRITING AND GRADING EXAMINATIONS

Many points in last quarter's discussion of quizzes apply equally well midterm and even final examinations. In particular, there are no differences in how you and the students should conduct yourselves inside the classroom or examination site. This includes suggestions on preventing cheating.

### **Recapitulation**

Here is a summary of last quarter's discussion of quizzes and examinations.

- *Designing quizzes.* Students will generally take at least twice as much time to work problems than you will. Quizzes should be similar to homework problems, and even slight variations can be confusing to students; avoid these unless you are trying to test the students' ability to adjust to such variations. Know what you are trying to test the students on in each problem, and do not try to test too much in any single problem.
- *Preventing cheating.* Remember that prevention is better than trying to catch students in the act. Watch out for clothing or other articles that could be used to store notes. Watch the class, make it clear by your actions that you are watching someone closely if you suspect him or her of cheating, but avoid open confrontations. Report all instances to the appropriate faculty member and be aware of any course policies about cheating if these exist.
- *Grading.* Mark papers clearly with objective, non-condescending comments on the nature of the mistakes. Mark the papers in such a way that students cannot cheat after papers are returned. Before you begin to grade examinations, write up an answer key indicating partial credit; keep the grading key and don't deviate from it. It is likely that at least some student responses will not conform to your key, but having a key in advance provides a basis for making further judgments as needed.
- *Significance of various letter grades.* Here is a recapitulation of some commonly accepted standards for letter grades. The grade **A** should represent a high level of achievement and an excellent understanding of the subject, with the ability to apply it reliably at many levels. The grade **B** should represent an above average level of achievement and a good understanding of the subject with the ability to apply it at some levels. The grade **C** should represent an average, adequate level of achievement and at least a marginal grasp of the subject, possibly with more skills in test taking than in learning. Often this grade represents a lack of interest, motivation or time rather than a real lack of ability. The grade **D** represents a low level of achievement and an understanding of the subject that is close to the minimum standard, with possibly little or no interest in learning more. This grade may also indicate a problem with learning or study skills, in which case the student should be referred to the Learning Center. The grade **F** represents a level of achievement for which there is little or no evidence that the student was ever exposed to the subject matter. Once again, there is probably a combined lack of interest and motivation and/or skills at the root of the problem.

### **Some additional general comments**

In writing a test, you should begin by identifying the skills and knowledge you want to measure, and the problems on the test should fit these objectives. The students should be informed about the things you feel are most important, and for the most part the questions should be fairly routine. For elementary courses, difficult questions on marginal topics or trick questions are usually not advisable. To use an analogy from baseball, it is necessary to focus on hitting fastballs before worrying about curveballs or knuckleballs. Verbally stated problems should be chosen carefully. Many students may not have the literacy level needed to translate these into mathematics, and if the problems draw on knowledge from another subject (for example, physics) it is quite likely that the students will be confused by the input from the other subject even if they have the mathematical skill that are meant to be tested. In conclusion, since a test is meant to measure the skills and knowledge of the students, a successful exam is one that accurately measures these rather than one that neatly distributes the students into five letter grades.

### **Complaints and appeals regarding grading**

Most of us have probably done this at least once in an undergraduate mathematics course, and there probably will be complaints as long as there are grades. Unlike an upscale department store, in the education business the customer is not always right, and small concessions to students can easily lead to demands for larger concessions. Therefore it is important to stick with the predetermined grading scheme, discouraging appeals unless there is a grading mistake or an error in the addition of points.

One way of handling appeals without getting into endless arguments with students is to require that requests for regrading be submitted in writing. *This is very strongly recommended.*

Record keeping. Don't forget to record the maximum possible numbers of points in a conspicuous place. Make sure that you put scores into the correct places on the answer sheets. If you keep records on a computer, make hard copies regularly as a safeguard against disk failures.

Posting grades. There are severe restrictions on the manner in which grades may be posted. Complete details are given in the quarterly schedule of classes and the general catalog as well as the papers inserted with the sheets for reporting final grades, and the main points are summarized in a memo from the Registrar that is sent at the end of each quarter. The main point is that it is illegal to post grades in any way that allows someone other than the individual student to identify his or her grade, even if students indicate that they have no objection to such postings. Clearly this excludes posting grades by student names or initials, but it also includes posting by means of the entire Social Security numbers or the last four numbers unless students give consent in writing. Currently University policy is that grades can be posted using identification keys distributed to the students by the instructor or TA, where these keys are constructed so that the students' anonymity is preserved (by implication the preceding examples do not fit this requirement); in the near future the University plans to adopt student identification numbers that are unrelated to Social Security numbers, and these might be appropriate for posting grades. It is very understandable if an instructor or TA feels that the current policy is so difficult to implement that he or she is unwilling or unable to post any grades.

There are some acceptable methods for communicating information about individual student grades informally. Giving them over the telephone is fine (but leaving them on an answering

machine should probably be avoided for privacy reasons), filling out postcards submitted by the students is also acceptable, and electronic mail messages upon student request also work well while preserving privacy (but it is the student's responsibility to provide a reasonable e-mail address, preferably in writing or by e-mail).

Complaints and appeals. Stick with the original grading scheme, discouraging appeals unless there is a clerical or procedural error. Changes should not be made on the basis of reassessment of the quality of a student's work. To expedite the process it is recommended that all appeals be submitted in writing with a minimum of words. Deadlines for the submission of appeals are strongly recommended. If a student is still dissatisfied, he or she should be directed to the Department office unless you are teaching a discussion section and the instructor was involved in the grading process (for example, if the problem involves an exam whose grading was supervised by the instructor rather than a quiz).

### **Preparing students for examinations**

Since the amount of material covered in a quiz is relatively limited, it is fair to assume that the students know what will be expected of them. On the other hand, an examination covers several times the amount of material in a quiz, so it is good for both the students and the instructor if the expectations are explained clearly. For example, the class lessons and textbook sections covered by the examination should be given explicitly, and the format of the exam should be described (how much consists of homework-type problems, how much is multiple choice or true—false, *etc.*). It is natural for students to ask if specific types of problems — for example, a word problem on maxima and minima — will be on the exam. My way of anticipating such questions is to mention more types of problems than one could cover on an hour examination. For example, I might say that such a problem could appear on the exam, and the exam might also or instead have, say, a maxima and minima problem for a function  $y = f(x)$  defined implicitly by an equation  $F(x, y) = 0$ . My inclination is to provide a generous amount of information but to stop short of saying exactly what sorts of problems are on the test. I also think it is a good idea to tell the students they are responsible for significantly more material than you will actually include in the test.

Comments about the content of examinations should not go beyond the wishes of the primary instructor or common sense. In particular, giving away essentially the entire content of an examination is a potentially serious violation of professional ethics that undermines the purpose of the examination itself and can lead to severe consequences.

A little should be said about practice exams. These are often a good idea, especially for final examinations, but instructors should not feel obligated to do this. If such practice examinations are prepared, it is suggested that they be at least twice as long as the examination itself to avoid situations where students can focus their attention on too narrow a range of material or they feel misled because the actual exam has little overlap with the practice exam. It is well known that some students, especially in fraternities and sororities, have access to extensive files of previous tests, and one curious argument that has been advanced in favor of practice exams is that it partially offsets this advantage.

Some instructors believe strongly in review sessions, but there are also reasons for not having them or limiting them. For one thing, they are time consuming and they should not cut significantly into time needed for other matters such as studying for the courses you are taking. Also, some instructors feel that such sessions promote the idea that an examination requires

extraordinary preparation; to a great extent tests should be viewed as a natural extension of the rest of the course.

### Testing at the appropriate level

Your expectations for student performance should determine what and how you test just as they dictate what and how you teach. Generally, tests are supposed to deal with thinking skills. Although a graduate student uses these all the time, often they are so ingrained that they are not recognized explicitly. Here are several levels of skills that are relevant, listed roughly in order of sophistication.

1. *Memorization* — Basic ability to recall or recognize information.
2. *Comprehension* — Understanding of definitions and symbols.
3. *Application* — Using the preceding in new or different situations.
4. *Analysis* — Ability to reduce a problem to the basic issues and to understand the relationships between various parts of a problem.
5. *Synthesis* — Ability to create correct new relationships from previously unrelated items.
6. *Evaluation* — Formulation of critical judgments using insights derived from all of the preceding.

Unfortunately, few students in elementary courses are prepared to successfully perform tasks involving analysis, synthesis and evaluation. In fact, practice aimed at sharpening thinking skills is one of the main objectives of discussion sections for courses, and examinations provide another means of refining such skills. When preparing an examination, it is important to evaluate the levels of thinking that were used in class and to test to these levels.

Sometimes it is useful to classify exam questions in terms of the level of thinking that is required, so that the relative distribution of thinking levels is better understood. In lower level classes, good examinations contain a mixture of thinking skills (recollection, application, analysis, synthesis). A classification of questions by skills can also be useful for diagnostic purposes and for allocating point values of individual problems.

Here are some typical examples of mathematics questions that involve various thinking skills.

*Memorization.* State the Law of Cosines.

*Comprehension.* Express the area inside the circle  $x^2 + y^2 = 1$  as a definite integral.

*Comprehension, application.* Evaluate the sum  $1 + 3 + \dots + (2n-1)$ .

*Comprehension, analysis.* A 5 foot ladder is leaning against a wall and being moved along the ground (perpendicular to the wall) at a speed of 2 inches per second. How fast is the top of the ladder moving when the bottom of the ladder is 3 feet from the wall?

*Synthesis.* Using the multiple angle formula  $\cos 5\theta = \cos^5\theta - 10\cos^3\theta\sin^2\theta + 5\cos\theta\sin^4\theta$  prove that the cosine of 72 degrees (one fifth of 360 degrees) is a root of the polynomial equation  $4x^4 - 5x^2 + 1 = 0$ . (**Warning:** You are strongly discouraged from using this in any lower level mathematics course!!)

## Choosing problems

As for quizzes it is important to know what you wish to test in a particular problem. If more than one concept is to be tested, decide the relative importance of the parts of the problem that deal with the respective concepts and assign partial credit to reflect your priorities. Long problems should be viewed as sequences of shorter steps, with partial credit of say 3--5 points for each step (*e.g.*, right formula, correct method, correct solution of an appropriate algebraic equation, proper interpretation of the answer). Check for ambiguities that could mislead the students needlessly. If these exist and are difficult to remove, then it is probably best to replace the given question. Make sure that the students have enough time. The primary instructor of a class should be able to work an hour examination in 10 to 12 minutes. Try to anticipate the time and effort that will be needed to grade a question and make adjustments or changes if grading the problem will be too demanding. In particular, it is good to be aware of various approaches students might take in answering or attempting to answer questions. Last but not least, draw upon your previous experience of how well or poorly specific exam problems have worked in the past.

Grading exams is tedious under the best of conditions, but I have found that careful preparation of examinations pays off in making the task far less unpleasant. In particular, extra time spent in preparing an exam generally saves at least an equivalent amount of grading time, and in most cases the grading work itself also becomes much easier.

## Multiple choice questions

One way of speeding up the grading process is to use multiple choice questions for part or all of an examination. This is particularly useful for large classes, it can be used to test comprehension and analytical skills as well as memorization, and it also has considerable diagnostic value. However, one does not get something for nothing. It can be difficult and time consuming to write good questions, students can easily misinterpret the questions, and the whole process can tend to trivialize the subject matter. Many mathematics instructors have very strong feelings against such questions, but others view them as unavoidable. However, they have been used for years or even decades at many highly respectable institutions with no apparent adverse consequences or complaints from other departments.

Before considering whether to include multiple choice questions on an examination, it is necessary to look at specific examples that have worked out reasonably well. The following link contains examples of multiple choice examinations for a wide range of lower level undergraduate courses including precalculus and first year calculus:

<http://www.math.purdue.edu/highSchool/collegePrep/exams-undergrad.php>

Here are some guidelines for constructing multiple choice questions. First, address only one idea or issue per question. Next, make positive statements because even the best students can overlook the word "not" in a question. Make the alternatives brief and similar in phrasing. Scatter the correct choices so that there is no obvious pattern. Avoid implicit hints to the correct answer such as making the correct answer the most elaborate. Use "all/none of the above" sparingly. Keep the notation consistent with the course unless this is to be tested specifically. Finally, use illustrations when appropriate.

*Time management.* When using multiple choice questions in mathematical examinations, it is recommended that you allow at least 24 minutes for each 5 questions.

### **Checking for accuracy and time length**

It is extremely important to check an examination for accuracy several times and to work it out on your own before having it duplicated. This can be extremely tedious and unpleasant, but it is easy for typographical and worse errors to appear in exams, and these can have disastrous consequences, especially in the most elementary courses. At best, minor typographical errors are annoying to the students; at worst, misstated problems can give a highly unfair and distorted picture of the students' achievements, and in extreme cases these can lead to justifiable student grade appeals. As noted above, you should also check to make sure that the students have enough time to complete the examination. You should remember that many innocent looking problems required a great deal more work than anticipated.

### **The mechanics of grading**

Going through examinations is often one of the dreariest parts of teaching. However, careful preparation of an examination can reduce grading time by at least half. Breaking a problem up into small units of partial credit provides a systematic way of deciding how much credit a student's answer deserves. This is not only good for efficient grading of papers, but it is also useful for dealing effectively with the inevitable student complaints about loss of points on problems and for diagnostic studies of students' progress. Elimination of ambiguities should lessen the number of cases where student answers go off in an unexpected direction that requires special consideration. The use of well-written true/false or multiple choice questions for even part of an examination can bring the amount of work down to a more bearable level. Grading one written problem at a time promotes uniformity and allows you to develop an efficient routine. Sometimes it is useful to grade exams together with other instructors for the same course. The positive side is that it can provide help in dealing what to do about borderline cases. On the other hand, these sessions have a tendency to degenerate into conversations that distract everyone's attention or lead into questionable or inappropriate areas like poking fun at standard student mistakes; for example, comments on isolated answers with amusing original mistakes are one thing, but many people find it annoying — or worse — to hear repeated comments ridiculing standard mistakes like saying that  $(a + b)^2$  is equal to  $a^2 + b^2$ . The UCR TA handbook (*The Next Step*) contains a section on grading tips that complements the preceding discussion (pp. 94–100).

## **Determining letter grades**

We have already discussed some of the basic principles for defining letter grades. In addition to these considerations, it is necessary to decide on a standard for assigning grades. One of the most frequently used options is to set absolute cutoff points for various grades. Here is a typical example for illustration purposes only:

- 96–100 points.....**A+**
- 90–95 points.....**A**
- 85–89 points.....**A–**
- 81–84 points.....**B+**
- 73–80 points.....**B**
- 70–72 points.....**B–**
- 68–69 points.....**C+**
- 60–67 points.....**C**
- 50–59 points.....**D**
- 00–49 points.....**F**

Another approach is to grade on a curve, with the percentages of students receiving specific letter grades reflecting appropriate guidelines. At my previous institution the practice was to base these on the average percentages of students receiving the letter grades in question for the analogous courses over the past five years, with additional adjustments to reflect special situations. Incidentally, since the strength of students taking a course one quarter is frequently not the same as that of students taking the course in the previous or subsequent quarter, the latter averages were only done for students who took the course in the same quarter. Figures of this sort are also available for the precalculus and first year calculus courses taught here over the past few years. Usually there must be some flexibility with the exact percentages, but such margins often run in the range of about 5 per cent, and in some cases there may also be absolute upper and lower bounds on the number of low or high grades. Note that grading on the basis of preassigned percentages generally requires large classes, and it is not always fair or accurate for small classes.

It is often helpful to put the cutoff points for letter grades at points where relatively few students will be very close to the borderline, but sometimes this is impossible.

## **Students with disabilities**

Linda Terry is in charge of issues related to this matter. There are strong legal requirements about making special arrangements for students who have been certified by the University as having disabilities. Alternate testing sites and times are two options that must be considered frequently. If a student feels that he or she has a disability problem, it is necessary for this to be certified before there is an obligation to make special arrangements.

## **STUDENT DISHONESTY**

We have already discussed student cheating in connection with quizzes. Cheating is a serious problem, but unfortunately a truly dedicated cheater is probably close to being undetectable. It is generally better to take steps to prevent cheating rather than to spend the time and effort following up on instances of such behavior. One basic recommendation is to create an atmosphere in which cheating is an offense against the majority of honest students; this helps to keep the issue from becoming simply a matter of instructor versus students.

The UCR rules for dealing with academic dishonesty are summarized in a document that was distributed in September of 1996 (*Intolerance of Academic Dishonesty at the University of California, Riverside*). Here are some of the most important points.

- Academic dishonesty is viewed as a serious offense at UCR that is not to be tolerated.
- The UC definition of punishable dishonesty includes all forms of academic misconduct, including but not limited to cheating, fabrication, plagiarism, or facilitating dishonesty; the latter is subject to further elaboration in campus regulations, and the complete policy is published each quarter in the schedule of classes. The statement on academic dishonesty elaborates on situations that are covered under the terms cheating, plagiarism, unauthorized collaboration, and manufacturing of data.

### **Procedures and sanctions**

This is quoted from a memorandum sent to the UCR faculty dated August 30, 1999: “The sanctions for violation of student code 102.01 [concerning academic dishonesty] are clear cut:

“If an instructor suspects a student has cheated or plagiarized, the faculty member will arrange with the student to discuss the circumstances. If the student admits violating section 102.01, then the faculty member will issue the appropriate grade (usually an **F**) and notify the Student Conduct Coordinator (DC) for additional disciplinary action.

“If the student denies that he/she has committed an act of academic dishonesty then the instructor will forward all relevant information to the DC. The DC will review these facts and interview the student, instructor and any witnesses to determine if section 102.01 has been violated.

“If the facts support the charge, the DC will levy an appropriate disciplinary sanction. The student may appeal this decision to the Student Conduct Committee (through the office of the DC). However, if the student does not appeal within one week, the DC will report to the faculty member that the student has not appealed and the faculty member will then notify the Registrar of the appropriate course grade (again usually an **F**) to be posted on the student's grade report.

“If the DC reports that there is insufficient evidence of academic dishonesty and the student does not acknowledge the misconduct, the faculty member also has the right to request a hearing of the case before the Student Conduct Committee for further review and resolution.

“For a second violation of section 102.01, a student will receive an **F** for the course and a one-quarter suspension — effective immediately. A third infraction will result in the student's permanent dismissal from the University.”

The Student Discipline Coordinator is J. Lance Gilmer, whose office is in 234 Costo Hall, and whose office extension is **787-2428**.

Perhaps the most important thing to note is that the primary instructor has responsibility for handling the procedural aspects of such cases and the TA's role is to come to the primary instructor with all the relevant evidence. A more detailed discussion of the TA's responsibilities is given at the end of this unit.



## Reporting academic dishonesty

The memorandum dated August 30, 1999, also contains a form that can be used to report alleged acts of academic dishonesty. The information requested on this form is summarized below:

- Instructor's name, departmental affiliation and telephone extension.
- Student name and ID number.
- Date and type of alleged incident (cheating on exam, plagiarism, unauthorized collaboration, data manufacture, or other [of course, this needs to be explained]).
- Details and documentation if the student denies that the alleged act took place.
- Indication whether the student has admitted or denied the alleged act (as noted before, the rules mandate a meeting of this sort before a case can be brought forward).
- If the student has admitted that the alleged act took place, indication of the grade sanction that has been imposed.
- Additional comments.
- Instructor's signature and the date of submission.

Here are a few common sense guidelines that should be followed if you suspect a student or students of cheating. First, gather as much information as possible. Make written notes immediately and secure the names of witnesses, preferably other staff members. When you are informing students of suspicions regarding cheating, avoid accusations and getting angry.

The problem of preventing cheating is a combined responsibility of the primary instructor as well as the teaching assistant. Individual faculty members vary in their approaches to prevention and sanctions, but the following is a list some suggestions for preventing cheating on examinations that you may wish to discuss with the instructor and use to control the problem:

1. Make up more than one format of the exam so that students seated near each other do not have the same test. Different colors of paper are one way of distinguishing formats. Of course, even if you give the same exam printed on different colors it can deter the students from cheating, but of course this only works once because the students will realize the trick when they get their exams back. A different but more effective trick is to concentrate multiple choice and true–false questions at the bottom of pages where they are harder to copy from.
2. Number the tests and answer sheets correspondingly. Preprinting student names is one possibility if you want to avoid cases where two students put each others' names on the exams so that the poorer student gets the better grade (I remember one incident where the starting fullback on the football team and another student did this so the football player would pass the test — subsequently the player got arrested on criminal charges and kicked off the team, suggesting that maybe there is a little justice sometimes ... ). If problems with “ringers” are an issue, the possibilities of checking student IDs and requiring them to sign in and sign out should be considered. If IDs are to be checked, it is mandatory that students receive ample warning in advance.
3. Consider photocopying the students' exams, either for all students or for randomly selected ones, and let the class know this is being done.
4. Move around the examination room and spend time at the back of the room so that students who might be cheating will need to turn around to see where you are.

5. There should be enough proctors for the number of students. In some cases undergraduate paper graders have been used by the Department to provide enough personnel for large lectures.
6. Do not give the same exam each quarter. Students will figure this out quickly and retrieve copies of previous exams even if the latter are not already in some test file.
7. Sometimes in large classes a student will simply get into the large crowd of students exiting at the end of the exam period, leaving without turning in an exam, and then complaining afterwards that he or she turned in an exam but it must have gotten lost in the rush. There are two things that could be done to avoid this. First, an instructor or TA can be stationed at each exit so that no one can hide in the rush to leave. Alternatively, you can require that students remain seated after finishing the exam, raising their hands if they finish early so that you or a TA can pick up the exam and, if time has expired, simply remaining in their seats until someone does pick up the exam. More generally, exam proctors need to be especially vigilant during the last few minutes of the examination when students are turning in their papers. In any case, do not allow students to rush chaotically to turn in their exams at the end of the class.
8. When giving makeup tests, do not use the same exam after you have gone through the answers with the rest of the class.
9. As noted before, during an examination do not allow the students to wear clothing or keep accessories that could be used for cheating purposes. In any case books and materials should be on the floor, under the chairs, and not on the adjacent seat. In some cases it might be wise to ask that all books and materials be left at the front of the room during the exam.
10. If there are enough seats in the room, the students should be spaced one seat apart (Given the current lack of space here, especially with increased enrollments, this may seem like a quote out of a handbook from another institution, but it actually comes from a TA handbook that was used at UCR just a couple of years ago!!! It was even more surprising to see a version of this suggestion in the memorandum dated August 30, 1999). — The Department does have the power to schedule evening examinations for large lecture classes in future years, and it may be necessary to take this option if student dishonesty continues to increase; it is important to note that primary instructors do not have the authority to schedule evening exams but can ask the office staff to request special exam rooms with more space if this seems necessary.
11. Keep examination materials and class records in a safe place.
12. If calculators are being used, make sure that the memories are cleared.

There is also a section on academic dishonesty in the UCR TA handbook (*The Next Step*) with additional information and a somewhat different format involving questions and answers (pp. 101–111).

### **The teaching assistant's responsibilities**

If you are sure that cheating took place, there are two very important things you must remember to do.

1. *Document everything.* Take detailed notes about what has happened or is happening, specify the time and place, note who is sitting near the student, describe any articles such as crib sheets or notes that might be part of the situation. Ask another TA to serve as a witness and to do the same on a separate sheet if possible. Let the instructor know immediately after the exam if he or she is not present.

2. *Give your evidence to the instructor in charge of the course.* The primary instructor will probably arrange a meeting at which he or she is present and at which you and any other witnesses can present the student with your evidence. Most of the time the problem is resolved at this point. However, after you present the evidence to the instructor it is important to know that the problem is then out of your hands. If the primary instructor decides to pursue the matter you may be called as a witness, but if the matter is not pursued there is nothing that you can do on your own (except mention the matter to the Department Chair if you feel strongly enough). The primary instructor is the person responsible for the student's grade and for reporting the cheating, and he or she is the person who will have to meet with the student and/or other university officials such as the ombudsman. Although a TA has some responsibility for the prevention of cheating, he or she is not responsible for the cure.

The following web sites from other UC campuses also provide relevant information:

<http://sja.ucdavis.edu/SJA/plagiarism/html>

<http://charm.physics.ucsb.edu/people/hnn/disq/html>

<http://www.id.ucsb.edu/ic/resources/teaching/Integrity.html>