Some Strategies for Organizing Teaching

New Course (standard lecture course without laboratories or projects)

Upon being assigned the course (usually months in advance of the first class)

- read the Calendar description and any proposed course outline
- check with colleagues to
  - see how the course fits with other courses in that term
  - see how prerequisite courses prepare students for this course
  - assess what relevant skills and knowledge students will have upon entering this course
- draft a sequence of major topics and an approximate timeline for them
- refine the outline with more detailed objectives
- see if material from previous teaching can be adapted to this course
- prepare draft lecture notes, but with flexibility for change as lectures proceed (therefore do *not* use Powerpoint)
- draft a timetable for what should be covered by the end of each week
- choose an evaluation scheme (assignments vs. problem sets; quizzes + 1 test vs. 2 or 3 tests, policies on calculators and formula sheets in tests, etc.)
- decide how to employ teaching assistants in the course

For a course that has been offered before, also consult with previous instructors of the course. Past tests and exams can be a strong indication of the content and style of the course.

Closer to the first day of classes

- check with colleagues / department head(s) that the plan for teaching is sound
- prepare the first few evaluations (problem sets, assignments, quizzes, first test, etc.)
- prepare the first-day handout (template at `www.mun.ca/engineering/about/facultystaff/instructors/index.php`)
- construct a web site for the course (and/or set up a D2L shell)
- prepare a spreadsheet file to record student marks (or use D2L)

During the semester

- create amended complete lecture notes as soon as possible after each lecture
- keep a log of what was taught in each and every class (including references to exact page numbers in lecture notes)
- keep a log after each class on what worked and what changes are needed in subsequent semesters
- prepare future evaluations 2 to 3 weeks ahead of each deadline (it may be difficult to predict what topics will have been covered by a date more than 3 weeks in advance)
- talk frequently to colleagues teaching courses to the same students - this may spark some ideas to vary some of the content or delivery style
- seek ongoing feedback from students, directly and via class reps
- check each week that the course web site (and/or D2L site) is up to date

When composing tests and the final examination

- review what topics are in the scope of the test
- check the lecture notes, problem sets, assignments, etc. as a reminder of the style of questions and solutions that the students have encountered
- ensure a reasonable and balanced coverage in the test of the relevant topics
- try the test yourself - the time allowance for students should be at least double the time that it takes for you to answer the questions fully
- ask a colleague for an opinion on the draft test
- compose a complete solution set with marking scheme (sometimes errors in the questions do not become apparent until this stage)
- try to anticipate some incorrect solution paths that students may take and decide a marking scheme for such solutions
- leave the test for a few days then scrutinize it again with a fresh pair of eyes

Marking of assignments, quizzes and tests

- If teaching assistants are to do the marking, then set aside an hour or so to go through four or five sample papers together, to establish and refine the marking scheme and to ensure that the teaching assistants understand your intentions for the allocation of marks for incorrect solutions.
- for work that is returned to students, no scores should appear on the front page, due to the requirement to respect the privacy of students. The total mark should be written on the back of the cover page or on an inside page.

After grades have been submitted

- review the log of what worked and what changes are needed and prepare a plan for revisions to the course

Grade analysis

- from the marks spreadsheet extract some summary statistics:
  - mean, standard deviation, median and quartiles for test and exam scores and for grades (Minitab can do this much more efficiently than Excel)
  - number and percentage of letter grades (A, B, C, D, F)
  - where a course is offered to more than one major, break these statistics out by major also (copy into a new tab, sort by major, etc.).

After the CEQ is released

- read through student comments and revise the course as appropriate
- report any recommendations back to the department head(s)

Test Design

Strive for a range of questions that

- cover the relevant topics in a balanced manner
- contain a spectrum of difficulty from straightforward to challenging
- can be completed by an average student in the allotted time

Where there are multiple parts to a question, design the question so that an inability to solve an earlier part does not prevent the student from attempting subsequent parts of the question at all.

Example:

ENGI 4430 "Advanced Calculus for Engineering" Final Examination 2010

Among the learning objectives are
1.07 Find the Cartesian equation and surface area of a surface of revolution.
3.01 Use the trapezoidal and Simpson's rules for the estimation of definite integrals.
5.04 Use the gradient vector to find the normal line and tangent plane to surfaces.
The following question tested these three objectives from very different parts of the course. It also reinforced integration techniques and coordinate geometry from earlier courses.

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3. The upper half ($y > 0$) of the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ is rotated once about the x-axis to generate a surface of revolution (an ellipsoid).

(a) Show that the curved surface area A of the ellipsoid is [6]

$$A = \frac{8\pi}{9}\int_0^3 \sqrt{81-5x^2}\,dx$$

(b) Use Simpson's rule with four intervals to estimate the value of A, correct to four significant figures. [6]

(c) The Cartesian equation of the ellipsoid is $\frac{x^2}{9}+\frac{y^2}{4}+\frac{z^2}{4}=1$. Find the Cartesian equation of the tangent plane to the ellipsoid at the point $\left(\frac{3\sqrt{2}}{2}, -1, 1\right)$. [6]

(d) Find the exact value of A. You may quote the standard integral [6]

$$\int \sqrt{a^2-u^2}\,du = \frac{1}{2}\left(u\sqrt{a^2-u^2} + a^2\sin^{-1}\left(\frac{u}{a}\right)\right) + C$$

Any one of the four parts of this question could be attempted (even part (d)), whether or not the student was able to solve the other three parts.

Policy on Calculators in Quizzes, Tests and Examinations

During the design of the course, before the first week of classes, decide this policy.

Options are:

- No calculators at all
- Only simple scientific calculators (no capabilities for graphics, programming, communication or algebraic computation)
- A calculator from a specific list of calculators (be careful of cost to students)
- Any calculator (other than iPhones and similar devices that have communications capabilities)

A short quiz may consist of a question such that no calculator is needed.
Longer tests can be divided into a no-calculator part and a graphing calculator part.
The calculator policy should be reconsidered every semester.

Policy on Formula Sheets in Quizzes, Tests and Examinations

During the design of the course, before the first week of classes, decide this policy.

Options are:

1. No formula sheets at all (traditional closed-book test)
2. A formula sheet that you design and supply with the question paper
3. A formula sheet that each student designs, subject to constraints
4. A formula sheet that each student designs, with no constraints other than number and size of sheet(s)
5. A totally open-book test

Options (1) and (2) are the easiest to implement. They allow recall of basic information to be tested. If you supply a formula sheet, then post it on the course web site (or D2L site) well in advance of the test. However, a restriction on calculators should accompany options (1) or (2).

Experience in this faculty has shown that option (3), (student-designed formula sheets subject to constraints), has been troublesome. The instructor must make any restrictions on the content of formula sheets crystal clear to students well in advance of the test. It is difficult to check such formula sheets for compliance with the restrictions during a test. Penalties for unauthorised content also need to be decided and advertised in advance. I avoid option (3) altogether.

Options (4) and (5) require more effort in the design of test questions. They prevent the testing of low-level recall of items, because students may be able to just look them up on their formula sheets. For the same reason, questions from past tests, assignments, problem sets and lecture notes cannot be re-used. I use option (4), because the sound design of a useful formula sheet is an excellent revision exercise for a diligent student.

Deferred Evaluations

Often you will find that a student has good cause (illness, bereavement, varsity sports travel, etc.) for missing a scheduled evaluation (quiz, test, laboratory test, project presentation, other term evaluation or final examination). The Faculty has a policy to govern this situation, at

" http://www.mun.ca/engineering/undergrad/policies/DeferredEval.pdf "

The Undergraduate Office handles student requests regarding absences from final examinations. It is a wise precaution when designing final examinations to also design a second examination for use as a deferred final examination, if needed. If a deferred examination is not needed in one semester, then it may be possible to re-use most or all of it in a subsequent semester.

A deferred final examination should have a similar structure, with a similar coverage of material and a similar range of difficulty among questions as the main final examination. However, individual questions on the deferred final examination should not be identical to any questions on the original final examination.

When an item of term work is missed for good cause, there are two main options:

- schedule a deferred evaluation at a later date
- replace the missing mark by a mark based on other term work and/or the final exam

No tests (not even deferred tests) may take place in the final two weeks of classes.
It is sometimes difficult for instructor and student alike to find a time when a deferred evaluation can take place. A project presentation or laboratory test that forms a major part of the course should normally be replaced by a deferred evaluation.

The second option is easier for a missing quiz or test. Because the level of difficulty of different items of evaluation often varies for the class as a whole, it may not be fair to simply replace the missing mark by a mark based on the average of the student's other marks in the course. For example, in a course with two term tests, base the mark for the missing test on the student's rank in the other test. If the student has the tenth-best mark in Test 1 and is absent for good cause from Test 2, then award to that student whatever the tenth-best mark in Test 2 is for the other students.

In many courses the average final examination mark is well below the average term mark. Moving the weight for a missing term test onto the final examination might not be fair and could increase student anxiety about the final examination.

Re-examinations

A student who earns the required promotion average of 60.0 across the technical courses in the term, but fails one or more of those courses, earns a probationary promotion that can be cleared by passing a re-examination (normally during the first week of classes in the following academic term, about four months later). Passing re-examinations keeps the student on track to graduate with his/her classmates. The other way to clear probationary status is to repeat the failed course(s) successfully, which usually delays graduation.

A re-examination is evaluated on a pass/fail grade only, without a numeric grade. It is meant to provide a second chance for a student to demonstrate minimally acceptable mastery of the concepts of the failed course. Term work does not factor into the re-examination result, which is based on the re-examination only. The re-examination should not, therefore, be just a second final examination.

One strategy in the design of a re-examination is:

- develop a bank of questions for use in re-examinations only
- review the term work and final examination of the re-examinee
- identify the weaknesses that the student showed in the course
- select questions relevant to those weaknesses, for placement in the re-examination

Re-examinations can therefore contain fewer questions than the original final examination, yet with the original time allocation (to give the student more time per question to demonstrate what s/he has learned).

Marked Assignments vs. Unmarked Problem Sets

Assignments and problem sets give students a chance to develop their skills and consolidate their mastery of the content of a course with more extended problems than can be assigned in a 50-minute test. They also allow more collaborative work between students that can improve their understanding. In many courses there are essential skills that cannot be evaluated by traditional written tests and examinations.

However, there are temptations for students who are feeling the stress of too much work to do in too little time:

- if unmarked problem sets are provided, these students may ignore the problem sets in favour of work that is graded directly
- if marked assignments are provided, a group effort may be submitted or worse, the effort of the strongest student is copied mindlessly and submitted by other students

Either way, such students lose the benefit of the practice that these extended questions can provide.

The lure of marks does improve the chances that these students will at least look at the questions and make some attempt on their own to arrive at a solution.

However, the "free marks" from assignments can inflate grades and can lead to a false sense of security. These students will not be as well prepared for tests and examinations and will not achieve the level of mastery of which they are capable. Instructors may feel obliged to set more challenging tests and exams in order to compensate for the high assignment marks.

I have found that a combination of longer unmarked problem sets and frequent short in-class marked quizzes improves student preparation for tests and exams and avoids the problem of weaker students riding on the coattails of stronger classmates in marked assignments.

In ENGI 3424 and 4430 the marking scheme is

5 quizzes (each is one question in the last 15 minutes of a lecture class)	25%
1 mid term test	25%
1 final examination	50%

with the best four of the five quizzes counting towards the quiz component of the grade.

I also use an alternative in ENGI 4421:

1 computer lab assignment	5%
2 term tests (first at 20%, second at 25%)	45%
1 final examination	50%

The assignment covers skills (using the Minitab program) that cannot be tested readily in any other way.

In both cases, the course web site contains many problem sets with complete solutions.

Marks spreadsheet:

Models depend on the marking scheme.

For ENGI 4421 in 2014 Spring:
One spreadsheet for term marks, with assignment / 5, test 1 / 20 and test 2 /25 :

Set aside rows 1 to 3 for column headers.
The column headers should state clearly the maximum mark for each item.

Column	Contents
A	number (1 for first student, 2 for second student in the list, etc.)
B	student name (imported from Banner)
C	student ID number (imported from Banner)
D	student major (unless the course is taken by one major only)
E	assignment score (= column J / 6)
F	test 1 score (sum of columns K to N) / 2
G	test 2 score (sum of columns O to S) / 2
H	term total (sum of columns E, F, G) out of 50
I	term total as a percentage (column H * 2)
J	assignment score as an integer mark out of 30
K-N	marks for each question individually in test 1
O-S	marks for each question individually in test 2
T	comments (reasons for absence, etc.)

The final two rows contain the mean and standard deviation for each marks column

Here is a tip that works for me:

When recording test scores I record the marks for each individual question directly from each page of the test script. This is tedious and time-consuming, but it has two major advantages:

- Addition errors are more likely to be detected and corrected by comparing the manually calculated total mark written on the paper with the total mark calculated by the spreadsheet
- In subsequent years one can review past tests and see which questions provided greater or lesser challenges for students.

Marks spreadsheet (continued)

After the last term evaluation is complete (usually in the penultimate week of classes), copy the marks spreadsheet into other tabs.

- In one tab (Term Ranks), sort on the term total, from highest score to lowest.
- In another tab (byNum1) insert a new column whose entries are MOD(column C, 10000), which extracts the last four digits of the student ID number, then sort on that new column. Also adjust the cell format in that column to display leading zeroes (so that 1234 and 34 display as 1234 and 0034). It is rare for two students in the same class to share the same last four digits of an ID number.
- Copy this tab into another tab (byNum2).
- Set the print area of tab byNum2 to show just the four-digit ID number, the assignment and total test scores and term total. This can be posted for students to verify that your record of their term marks is correct. Print tab byNum1 for you only, so that you can match a four-digit ID number to a student name quickly.

Between the end of classes and the final exam, copy the term marks spreadsheet into a new spreadsheet but retain only the term marks and term ranks tabs.

- In the marks tab insert a new column immediately to the left of the student name column. This will contain the overall grade (= raw grade rounded to an integer).
- After the term total (%) column insert (n+3) new columns (where n is the number of questions in the final exam) for
  - final exam (/50) = sum of (columns for marks for individual questions)
  - final exam (%) = 2 * previous column
  - raw grade (%) = (term total out of 50) + (exam out of 50) - this can be adjusted as the marking scheme dictates.
  - n columns for the marks in each of the n questions

In my courses the final examination is comprehensive (covers the entire course). It is a summative measure of mastery of the concepts throughout the course. A few students struggle earlier in the course but put it all together by the time of the final examination. Therefore I increase the weight of the final examination where it is to an individual student's advantage. Provided that the final examination is fair and provides an appropriate level of challenge, I assign a raw grade as the better of [(term total out of 50) + (exam out of 50)] and (exam as %).

After the grades have been finalised,

- copy the grades tab into another tab (Final Ranks) and sort it in decreasing order of grade

This helps at departmental marks meetings when the cases of marginal students are discussed. The term ranks and final ranks provide clear evidence of how these students fared in your course compared to their classmates.

Versions for courses containing **laboratories** and/or **projects** need to be added!