

GENERAL GUIDELINES FOR FORMING A SINGLE CURVE
FOR MULTI-SECTION AND MULTI-INSTRUCTOR COURSES

1. The course will have unique syllabus. This implies that all lectures will be carried out with same time schedule, same material from same textbook. Moreover, assessment will contain same items with same percentiles. The following material uses a grading of [midterm (25%), final (35%), quiz (15%), lab(15), participation (5%), attendance (5%)] for demonstration purposes.
2. The course material including lecture slides, notes, textbook and reference books will be the same as far as the lectures are concerned.
3. All of the sections will take the same midterms and final exam.
4. A faculty will be assigned as a course coordinator.
5. Coordinator and other instructors will devise a mechanism to obtain objective grading of midterms and final exam. For example, answers to a particular question could be assessed by the same person for all of the sections so that bias arising from different people's assessment can be eliminated. Another way to eliminate bias could be to craft very detailed grading policy itemizing marks for a particular question. In this latter case, even if different people grade the same question, since detailed policy is applied, bias could be minimized.
6. Let $i=1,...,k$ be indexing the sections with k being the total number of sections and let $ij, i=1,...,k, j=1,...,n_i$ be indexing students with n_i being the number of students in section i .
7. After completing the midterm and final grading, the **objective portion of the semester grade** of student j of section i will be obtained by $Obj_{ij} = (c_m * M_{ij} + c_f * F_{ij}) / (c_m + c_f)$ where c_m and c_f are the percentiles of midterm grade and final grade announced in the syllabus (0.25 and 0.35 respectively in our example) and M_{ij} and F_{ij} are the actual respective midterm and final grades of student j of section i .
8. Define $1 \leq r \leq k \ni n_r = \max(n_i, i=1,...,k)$. We will call r as the **reference section**.
9. Define m_i^{obj} and s_i^{obj} as the sample mean and sample standard deviation of $\{Obj_{ij}, j=1,...,n_i\}$ for $i=1,...,k$ as

$$m_i^{obj} = \frac{1}{n_i} \sum_{j=1}^{n_i} Obj_{ij}$$

$$s_i^{obj} = \sqrt{\frac{1}{n_i-1} \sum_{j=1}^{n_i} (Obj_{ij} - m_i^{obj})^2}.$$
10. For $i \neq r$ carry out 95% confidence interval pair-wise t-tests [1] to see if there is any difference between the means in the objective grades of reference section and all the other sections.
 - i) Compute $v_i = \frac{(\frac{s_i^{obj2}}{n_i} + \frac{s_r^{obj2}}{n_r})^2}{\left[\frac{(\frac{s_i^{obj2}}{n_i})^2}{(n_i-1)} + \frac{(\frac{s_r^{obj2}}{n_r})^2}{(n_r-1)} \right]}$ (1)
 - ii) Find the corresponding t_i from Table 1.
 - iii) Compute $(m_i^{obj} - m_r^{obj}) \pm t_i \sqrt{\frac{s_i^{obj2}}{n_i} + \frac{s_r^{obj2}}{n_r}}$ (2)
 - iv) If the above interval contains 0 then the **objective bias** $ob_i = 0$
Else $ob_i = m_i^{obj} - m_r^{obj}, i=1,...,k, i \neq r$.
11. The individual instructors are free to carry out other items in the assessment such as quizzes, labs, attendance and participation. However, their percentiles should be unique as indicated in the syllabus. Even though there might be some discrepancies, it is recommended that the assessments should be carried out in comparable criteria leading to similar statistics, for if otherwise, problems in the statistical standardization process might occur.
12. As an example, after completing the lab, quiz, attendance and participation grading, the **subjective portion of the semester grade** of student j of section i will be obtained by $Sub_{ij} = (c_l * L_{ij} + c_q * Q_{ij} + c_a * A_{ij} + c_p * P_{ij}) / (c_l +$

$c_l + c_q + c_a + c_p$) where c_l , c_q , c_a and c_p (0.15, 0.15, 0.5 and 0.5 respectively in our example) are the percentiles of lab grade L_i , quiz grade Q_i , attendance grade A_i and participation grade P_i of student j of section i respectively.

13. The subjective portion of the grade will be standardized as follows: The reference section will not be modified at all. Let m_r^{sub} and s_r^{sub} be the mean and standard deviation of the subjective grades of the reference section and m_i^{sub} and s_i^{sub} be the mean and standard deviation of the subjective grades of section i . Then, the **standardized subjective grade of student j of section i** is computed as $SSub_{ij} =$

$$(Sub_{ij} - m_i^{sub}) \times \frac{s_r^{sub}}{s_i^{sub}} + m_r^{sub} + ob_i$$

14. The **unified final grade** of student j of section i is computed by

$$F_{ij} = (c_m + c_f) \times Obj_{ij} + (c_l + c_q + c_a + c_p) \times SSub_{ij}.$$

15. For the whole course, unique curve will be drawn by using F_{ij} , $i = 1, \dots, k$. This document does not intend to specify the guidelines of determining letter grades. It is presumed that the reader is familiar with dealing with that task.
16. During entering grades to OASIS, all the midterm and final grades of sections will be entered as usual, the subjective portion of the reference section grades will not be modified, and subjective portion of the non-reference section, $SSub_{ij}$, will be entered as a single column with heading such as "lab+quiz+attendance+participation" with percentile being $c_l + c_q + c_a + c_p$.
17. If the non-reference section i instructor wishes to enter individual lab, quiz, attendance and participation grades to OASIS with their individual percentiles, then the normalized grades nL_{ij} , nQ_{ij} , nA_{ij} and nP_{ij} can be entered as follows:

$$nL_{ij} = L_{ij} + s_i$$

$$nQ_{ij} = Q_{ij} + s_i$$

$$nA_{ij} = A_{ij} + s_i$$

$$nP_{ij} = P_{ij} + s_i$$

$$\text{where } s_i = SSub_{ij} - Sub_{ij}$$

18. The standardization process defined in 13 can be carried out individually for each of lab, quiz, attendance and participation instead of the weighted average. There are two handicaps: First, there is additional computational burden. Second, if means and standard deviations have huge gaps, one can end up with negative numbers or saturated marks (above 100). Therefore, it is advised that, if this latter method is to be used, marking standards should be carefully crafted in advance.
19. **EXAMPLE:** PLEASE SEE THE ATTACHED EXCEL SHEET CONTAINING GRADES FROM DATABASE COURSE OF SPRING 10 SEMESTER

From the excel table, we have the following values:

$$m_r^{obj} = 46.241$$

$$m_i^{obj} = 46.858$$

$$s_r^{obj} = 17.188$$

$$s_i^{obj} = 13.286$$

$$n_r = 54$$

$$n_i = 43$$

Substituting the above values to (1), we obtain $v_i \cong 48$.

From Table 1, we obtain $t_i \cong 2.009$

Using (2), we compute the confidence interval as (-5.6, 6.834)

Since the confidence interval contains 0, we conclude that the objective bias is zero.

The rest of the computation and grades can be examined from the excel table.

v	t
1	12.710
2	4.303
3	3.182
4	2.776
5	2.571
6	2.447
7	2.365
8	2.306
9	2.262
10	2.228
11	2.201
12	2.179
13	2.160
14	2.145
15	2.131
16	2.120
17	2.110
18	2.101
19	2.093
20	2.086
21	2.080
22	2.074
23	2.069
24	2.064
25	2.060
26	2.056
27	2.052
28	2.048
29	2.045
30	2.042
40	2.021
50	2.009
60	2.000
80	1.990
100	1.984
1000	1.962
∞	1.960

Table 1: t values

- [1] Walpole, Myers, Myers and Ye, “Probability & Statistics For Engineers and Scientists” Prentice-Hall, 2007. (pg. 293)