Fall 2018 Math 111 Project Instructions

1. **Group formation: due Wednesday, October 10 (3 points)**

   - Your project for Math 111 must be done in groups of three or four students. (Two is too small, and five is too large). If you have already turned this in, your group can be found in Canvas.
   - **On Tuesday, October 9**, you should turn in one full-size (not scrap) sheet of paper per group that lists all group members names.
   - Your group will be assigned a number. This number must be included in your final write-up.

   Late penalty: 1 point per day

2. **Project write-up: due in class Friday, November 16 (100 points)**

   The report consists of the following three things:

   A. A **cover page**. This must include every group member's full name and your group's name or number, and "MA 111 Fall 2018." Otherwise you can be creative. (2 points)

   B. Your responses to all of the questions in the project handout (95 points). Your group should work through the content, work out the problems, and neatly and clearly write up your solutions. Ideally, much of your work should be **typed**. It is okay to include computations written by hand, but they should be clearly labeled and included in the flow of your project, not scratch work tacked on the end.

   C. An equitability statement (3 points). The best projects are done by students who work together on all components, instead of trying to split the work for individuals. You have two options here. No matter which you choose, **all of your group members must sign below the statement**.

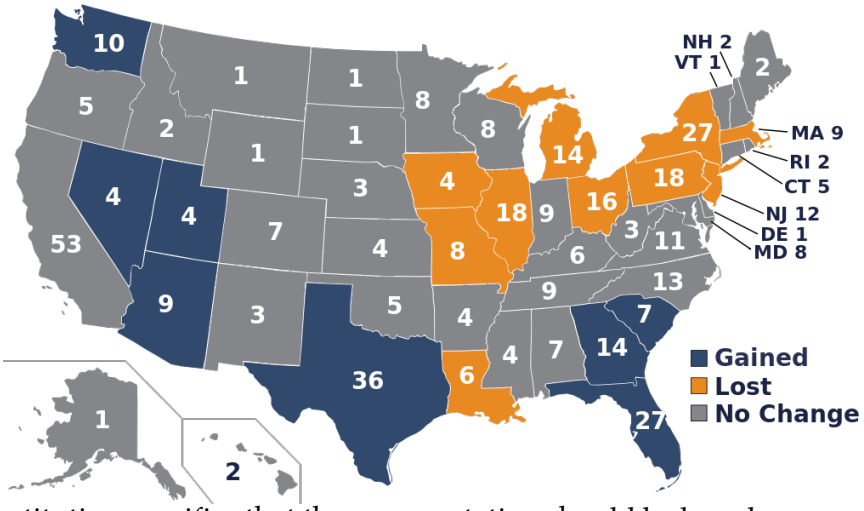
      Option 1 (most groups): Have a statement like the following: *"Each member of our group contributed a fair share, and we should all earn the same grade."*
      Option 2: If, for whatever reason, there was significant difference in contribution of the group members, you can choose to give the relative percentages of contribution. The total must add to 100%. *(For example, in a fictional group of four people, Dominic did way more than his share of the work, so they might turn in: Dominic 40%, Annie 20%, Eddie 20%, Barclay 20%.)* If you choose this option, your grades will be based on a pooled point system.

   Two or more additional points may be awarded for style, entertainment value, creativity, and thoughtfulness.
   Your report must be turned in as a paper copy in class. The paper copy will be graded. It should ALSO be uploaded to Canvas (more details later) to satisfy the UK Core requirement.

   Late penalty for report submission:
   - 1 point bonus on Friday November 16th (official deadline).
   - Full credit on Monday November 19th.
   - 7 points off per day for each day after November 19th.

I. Introduction

You may remember that the U.S. House of Representatives has 435 seats, with the most populous states having more representatives (such as California's 53 seats) and smaller states having fewer, such as Delaware with 1 seat. The state of Kentucky has 6 representatives. The following image, from the United States Census 2010, modified by Adam Lenhardt, was taken from Wikipedia:



The constitution specifies that the representation should be based on our population, but it doesn't specify *how* this should be done. It turns out it is not as obvious as we might expect. There are also other situations in which we have a specific number of things and want to award them proportionally.

To begin this topic, you should read the Apportionment Chapter in the free online text Math in Society by David Lippman, pages 75-92. When reading mathematics it helps to read slowly and carefully; take time to **work through the examples** and take notes on the terms and how they are used.

As you read and work through the chapter, look for the following terms. **For each term below, briefly explain the term in your own words**. (18 points)

1. Divisor (standard divisor)
2. Quota
3. Lower Quota
4. Quota Rule
5. Alabama Paradox
6. New States Paradox
7. Population Paradox
8. Balinski-Young Impossibility Theorem

II. Computations

1. Choose **one** of problems 1, 3, or 7 on page 91. Clearly write up your solution for parts a, b, c, and d. You do not need to do part e. Your write-up should have both computations and sentences that explain the steps. (12 points)

2. Every group is now a country, and each group member is a governor of one of the states. The population of your state is equal to the last four digits of your student number, plus 1000. (For example, if your student number ends in 5678, your state has population 5678 + 1000 = 6678.). (35 points)

    a. Clearly write the names of your states, your names as governors, and the population of each.

    b. If your new government has 45 seats, find the apportionment using
        i. Hamilton's method.
        ii. Jefferson's method.

    c. Now the number of seats is increased to 46. Find the apportionment again using both Hamilton's method and Jefferson's method.

    d. Now suppose your country adds a new state, which has a population of your group number times 100. (For example, if your group number is 35, the state has population 35*100 = 3500.) Your country decides that the government should have 45 seats to share among all the states. Reapportion these 45 seats using Jefferson's method.

    e. Did your computations in parts b, c and d happen to demonstrate the Alabama Paradox? Did they demonstrate the New States Paradox? Explain why or why not for each.

Important note on what to turn in for questions 2, 3, and 4: All methods begin with the standard divisor. Sometimes the standard divisor produces the correct apportionment; other times you might need several adjustments to the divisor until you find the apportionment that works. In the case where the standard divisor does not work, the paper you turn in should show one divisor that does not work (with all computations), the list of other divisors you tried (without the computations), and the final divisor that does work (with all computations). Even if you manage to guess the correct divisor on the first try, you must still go back and show computations for one that did not quite work.

3. Solve **one** problem from exercises 9, 10, or 11 (pages 91-92). State the question, clearly show all steps, and include sentences in your answers to each part of the question. (12 points)

4. Suppose a country has six states with the populations given below. Determine an apportionment of 250 representatives using: (18 points)
   a. Webster's method, and
   b. Adams's method (read problem 17 on page 92).

State	***Population***
Saturn	1,646,000
Jupiter	6,936,000
Pluto	154,000
Neptune	2,091,000
Mercury	685,000
Mars	988,000
Total	***12,500,000***