

**Project 1: Global Warming and Greenland**

Greenland (Greenlandic: “Kalaallit Nunaat”), is a self-governing Danish province located between the Arctic and Atlantic Oceans. Though geographically and ethnically an Arctic island nation associated with the continent of North America, Greenland is closely tied to Europe, specifically Iceland, Norway and Denmark. It is the largest island in the world that is not also considered a continent.

Most of Greenland is covered by an ice sheet. The total area covered by ice is about 1.7 million square kilometers. The average thickness of ice on Greenland is about 1600 meters. In the summertime Greenland loses part of its ice sheet.

“On Aug. 8 2012, the Greenland ice sheet shattered a seasonal record, with more cumulative melting since record-keeping began more than three decades ago, new research finds. Greenland's melting season usually begins in June, when the first puddles of meltwater emerge, and lasts through early September, when temperatures begin to cool. This year, a full four weeks before the end of the melt season, the ice sheet had shed more water than the record reached during the full season in 2010. "With more yet to come in August, this year's overall melting will fall way above the old records. That's a Goliath year — the greatest melt since satellite recording began in 1979," said study researcher Marco Tedesco, assistant professor of Earth and atmospheric sciences at The City College of New York.”

Your job on this project is to use the information above to determine the following

- The total volume of the ice sheet in Greenland
- What volume (in gallons) of liquid water would this represent? When glacier ice melts, the resulting volume of water is about 90% of the original volume of ice.
- Assuming all of this water melted and flowed into the world's oceans and assume the oceans stay in the same basin rather than spread out over the continents, how much would sea level rise? Give your answer in kilometer, meters and feet. Also report how much of a percentage increase this would be in total volume of the world's oceans.
- There are many different models that try to estimate how long (under current conditions) it would take before Greenland was ice free. Many estimates come in around 1000 years. Assuming that the Greenland ice sheet is melting at a constant rate and will be gone in 1000 years, if you owned a home that was on the coast 2.4 meters above current sea level, how long would it take before the water reached your doorstep?

Write up your findings in a well written report. You should include an introduction to the problem, show and explain all of your calculations as well as cite your sources. Make sure you include answers to each of the questions and an overall conclusion.

### **Washington's Wind Power**

If you have ever driven through the Palouse or down the Columbia River you might have noticed a large number of “wind farms”. Why does Washington seem to have so many wind farms? One reason might be Washington Initiative 937. This initiative passed in 2006 by 52% of Washington Voters is summarized as follows:

The initiative requires large utilities to obtain 15% of their electricity from new renewable resources such as solar and wind (but excluding hydro) by 2020 with incremental steps of 3% by 2012 and 9% by 2016. It also requires that utilities undertake all cost-effective energy conservation

At the end of 2014, Washington wind farms had capacity to generate 3075 Mega-watts (MW) of electricity in one year.

1. Since it is not windy all the time, let's assume wind farms typically generate 35% of their capacity. How much energy in Kilowatt hours can the Washington Wind Farms generate?
2. Given that an average household uses about 10000 kilowatt-hours of energy each year, how many households can be powered by these wind farms?
3. The 2010 U.S. Census states that in Washington State there are 2,855,677 housing units. What percentage of homes can be powered by these wind farms?
4. One advantage of wind power is that it does not produce the carbon dioxide emissions that contribute to global warming. On average energy produced from fossil fuels generates 1.5 pounds of carbon dioxide for every kilowatt hour of energy. How much more carbon dioxide would be entering the atmosphere each year if Washington did not have these wind farms and used a carbon based energy source instead?

### Financing your new car!

In this problem you are to write up a written report comparing different methods for financing your new car. The first thing you need to do is choose a NEW car (no used cars for you!) to finance. I suggest going to the Kelley Blue Book car site on the internet ([www.KBB.com](http://www.KBB.com)) and selecting a new car model. Make note of the new car models price and the options you decide to include. Suppose you have the money to make a 10% down payment on the car and you will have to finance the rest. You go to a lending institution and decide to investigate loans. Your lending institution offers loans for new cars for 3 year, 4 years or 5 years. As you know the type of interest rate you will receive depends on your credit rating. Your lending institution give you the following table giving the APR you will receive depending on the loan term (3, 4 or 5 years) and your credit rating (good, very good or excellent)

Loan Term	Credit Rating		
	Good	Very Good	Excellent
3 year	7.5%	5.5%	2.5%
4 year	8.5%	6.5%	3.5%
5 year	9.5%	7.5%	4.5%

So here is what you need to do. Select a credit rating for yourself (good, very good or excellent)

- 1) Create an amortization table for each loan term under your credit rating.
- 2) Now suppose also they have a special offer! If you take a loan out with this lending institution you will receive a 1% discount on interest for the first year of the loan only. (For example suppose you have very good credit and you want a 4 year loan for the first year of your loan you will pay only 5.5% interest while for the last three years you will pay 6.5%.) Create a new amortization table for the loan you chose in part 3 that reflects this special offer.

Type a two page paper that includes the following. You will be grade on how organized your work is; how thorough your work is; how mathematically correct your work is; and the readability of your work (spelling, grammar, logic). Be sure to address (at a minimum)

- An introduction to the problem which states what the problem is about, what car you chose to purchase (and the options) , the new car price of the car, the down payment, the amount financed and your credit rating.
- Make sure you state for each loan option (3,4 or 5 year)—the monthly payment for your loan and the total amount you will pay for the loan if you pay off the loan as scheduled.
- Which loan would you choose? What factors should you consider in making your decision?
- The first four lines for each of the three amortization tables for your credit rating with answers to the required questions. (Copy and paste these into your typed document)
- An explanation of the special offer and the first four lines of the new amortization table. How does this (if at all) affect your monthly payment and total amount of interest paid?

## Paying off Student Loans

*Suppose you have recently graduated college and have started your career. Now that you are in the working world all of the student loans you have taken out for college are due. Looking over the many options for loan repayment plans you narrow your choices to standard repayment, fixed extended repayment and income based repayment. Your task is to explore these options and to determine what you feel is the best repayment option for you.*

*Cost of Tuition and Fees for Washington State Residents as stated on School Websites as of 4/26/16.*

<i>Cost for AA at SFCC at a rate of \$102 per credit hour for 90cr</i>	<i>Cost for BA or BS at EWU at a rate of \$7866/year for 2 years</i>	<i>Cost of BA or BS at Gonzaga at a rate of \$36,535/year for 2 years</i>
<i>\$9,247.50</i>	<i>\$15,732</i>	<i>\$73,070</i>

Tuition and fees aren't the only cost of attending school, there are many other expenses such as textbooks, travel and living expenses. Many students also work while attending school which lowers the amount of money they need to borrow. Lastly, most loans accrue interest while attending school.

In order to simplify this problem, we are going to make several assumptions about student debt. First assume that the average student graduates EWU with a loan debt of \$40,000, an average student graduates Gonzaga with a loan debt of \$45,000 and an average student graduates SFCC with a loan debt of \$25,000. Assume that the loans have an APR of 6.5% (actual APR depends on factors such as credit rating and amount of loan that is subsidized). **Choose what school you will be attending (i.e. choose a loan amount to be repaid).**

*Now let's consider your repayment options.*

1. First consider the Standard Repayment plan. The Standard Repayment plan requires the borrower to make 120 equal payments (1 per month over a course of 10 years). Create an amortization table using Excel for this loan. Make sure you include columns for current loan amount, payment, amount to principle, amount to interest and new balance. Assume the loan is paid off as scheduled.
  - a. What is the monthly payment on the Standard Repayment schedule?
  - b. What is the total you will pay using this repayment plan?
  - c. What is the total amount of interest paid?
2. Now consider the fixed extended repayment plan. Under the fixed extended repayment plan, you will be making 300 equal payments (1 per month over the course of 25 years). Create an amortization table using Excel for this loan. Make sure you include columns for current loan amount, payment, amount to principle, amount to interest and new balance. Assume the loan is paid off as scheduled.
  - a. What is the monthly payment on the fixed extended repayment plan?
  - b. What is the total you will pay using this repayment plan?

- c. What is the total amount of interest paid?

*Finally, consider the income based repayment plan. The monthly payment for this type of loan is based on a formula that uses Adjusted Gross Income, total indebtedness and family size. The nice thing about the income based repayment plan is that any balance remaining after 25 years is forgiven (Erased). This means that even if you have not paid off all of your debt, after 25 years of paying...it is gone! In order to determine payments under the Income based repayment you must recertify your income each year to show that your income has not change. The calculations vary based on the factors listed above but generally result in 12 percent of your discretionary income, but never more than the 10-year Standard Repayment Plan amount. Unfortunately, only government guaranteed loans qualify so we will assume that all of your loan is back by the government.*

3. With your future career goals in mind, research your estimated future starting salary and report the value as well as your source. Assume that your discretionary income is \$20,000 less than your salary (discretionary income is based upon poverty levels, size of family,...).
4. Create an amortization table using Excel for this loan. Make sure you include columns for current loan amount, payment, amount to principle, amount to interest and new balance. Assume that any remaining balance is forgiven after 25 years and every 5 years into your repayment schedule you get a 3% increase in pay. You stop paying early if your balance is \$0.
  - a. What is your monthly payment for the first 5 years? For years 5-10? 10-15? 15-20? 20-25?
  - b. What is the total you will pay using this repayment plan?
  - c. What is the total amount of interest paid?
  - d. What is the balance (if any) that will be forgiven?
5. Based on this information, your task is to determine the best repayment option for yourself. A complete answer will consider not only the information you have calculated above but also incorporate factors such as how old you will be when your loans are paid off based on each plan, your future goals, as well as consider other living expenses that need to be covered from your monthly income, so if the loan payments are too high, they might not be manageable. With all of this considered plus any other factors that you think are important, choose the best option.

Your work will be graded based on the same rubric as the last project.

## MATH& 107

### Probability Activity #1: Zombie Invasion!

Complete the tables for the problems below. Answer all of the questions in complete sentences with proper grammar and spelling, clearly indicating which part you are answering.

A “zombie” outbreak has infected 1 in 5000 of the 7 Billion people on earth and will turn them into zombies. A “cure” has been developed that will kill any infected zombies and prevent them from infecting anyone else. If the “cure” is given to any humans who are not actually infected, it will kill  $\frac{2}{3}$  of the humans it is given to.

1. Suppose that a test has been developed that will be given to all 7 billion people on earth to determine if each is infected.
  - a. Create a table showing the number of positive and negative test results for a test with
    - i. 99% accuracy (specificity and sensitivity) and
    - ii. 99.9% accuracy
  - b. Under each of the scenarios for the test accuracy, how many humans will die if the cure is administered to everyone who tests positive?
  - c. How much of a difference is there in the number of non-infected humans killed by the two tests, and is the number of humans killed more than the number of zombies?
  - d. What ratio of those treated with the “cure” are not actually infected under each of the above scenarios?
2. Repeat steps a-d above for an infection rate of 1 in 100. If the infection rate is increased to 1 in 100, how does that impact the results above?

## Math& 107

### Statistics Activity - Stop-Question-Frisk

The Stop-question-and-frisk program (SQF), or stop-and-frisk, in New York City, is a practice of the New York City Police Department in which police officers stop and question a pedestrian, then frisk them for weapons and other contraband. About 684,000 people were stopped in 2011 and that number decreased to 45,787 in 2014. The vast majority of the people stopped under the program are African-American or Latino, a disparity which, according to a 2007 study, persists even after controlling for "precinct variability and race-specific estimates of crime participation. When police officers make stops, they fill out a form explaining the situation and details of the stop. After the officer goes off duty, these forms are then entered into a database. This data is available to the public for every year that stop-and-frisk has been in effect.

For the sample provided.

1. Find the mean and median age of
  - a. All individuals stopped.
  - b. All males stopped.
  - c. All females stopped.
  - d. All blacks stopped
  - e. All black Hispanics stopped
  - f. All white Hispanics stopped
  - g. All whites stopped
  - h. All Asian/Pacific Islander stopped
  - i. All Native Americans stopped
2. Discuss the differences you see in the answers for 1, whether or not they are significant, and what else might be worth looking at in the original data.
3. Find the proportion of all suspects stopped by
  - a. gender
  - b. race
4. Discuss the differences you see in the answers for 3, whether or not they are significant, and what else might be worth looking at in the original data.
5. Find the proportion each race who were
  - a. Frisked
  - b. Searched
  - c. Arrested
6. Discuss the differences you see in the answers for 6, whether or not they are significant, and what else might be worth looking at.
7. Pick out two other means, medians, modes, and proportions that you find of interest, then discuss the differences you see in the results, whether or not they are significant, and what else might be worth looking at in the original data.

datestop	timestop	sex	race	age	height	weight	frisked	searched	contrabn	pistol	arstmade		datestop	Date of Stop
9232014	2029	0	1	15	64	160	1	0	0		0		timestop	Time of Stop (24h)
1272014	2145	0	1	21	68	140	0	0	0	0	0		sex	Sex of Suspect 0=female 1=male
6022014	835	1	1	38	64	145	1	0	0	0	0		race	Race of Suspect 1=black, 2= black hispanic,3=white hispanic, 4=white, 5=Asian/Pacific Islander, 6=Native American
3062014	1750	1	1	22	70	150	1	0	0	0	0		age	Age of Suspect
5312014	445	1	1	44	76	270	1	0	0	0	0		height	Height of Suspect (inches)
4092014	1245	1	1	21	76	190	1	1	0	0	0		weight	Weight of Suspect (pounds)
8152014	2215	1	1	17	69	155	1	0	0		0		frisked	Was the suspect frisked 0=no, 1=yes
10122014	20	1	1	20	72	160	1	0	0	0	0		searched	Was the suspect searched 0=no, 1=yes
3282014	20	1	1	19	68	165	0	0	0	0	0		contrabn	Was contraband found on the suspect 0=no, 1=yes
1012014	1640	1	1	43	70	240	1	1	1	0	1		pistol	Was pistol found on the suspect 0=no, 1=yes
8032014	240	1	1	31	72	220	0	0	0		0		arstmade	Was an arrest made 0=no, 1=yes
3032014	245	1	1	37	68	160	1	0	0	0	0			
7242014	1605	1	1	19	69	140	1	1	0		0			
7132014	2200	1	1	26	68	170	0	0	0		0			
11152014	2315	1	1	27	68	180	1	0	0	0	0		<b>Discuss the following in your group. Have one person take notes and turn in one page for the entire group.</b>	
5072014	2150	1	1	23	67	165	0	0	0	0	0		What might be some good questions to consider before working with this sample?	
2182014	2045	1	1	28	77	180	1	0	0	0	0		What can we learn about the population of all stops from this sample?	
4222014	955	1	1	24	64	200	1	0	0	0	0		What can we learn about the population of NYC from this sample?	
3012014	1335	1	1	31	65	180	0	0	1	0	0		What should we know about the population of NYC when working with this sample?	
4212014	1240	1	2	19	62	120	1	1	1	0	0			
3262014	1745	1	2	29	72	200	1	0	0	0	0			
1082014	1600	1	2	30	72	230	1	1	0	0	1			
2272014	1410	0	3	42	61	160	1	0	0	0	0			
11112014	1335	1	3	46	69	180	1	0	0	0	0			
2212014	5	1	3	20	71	160	1	0	0	0	0			
1182014	245	1	3	28	70	230	1	0	0	0	1			
4162014	1235	1	3	28	70	200	1	1	0	0	0			
4162014	1620	1	3	20	66	125	0	0	0	0	0			
1172014	2310	1	3	22	71	150	0	0	0	0	0			
11152014	2035	1	3	18	68	200	1	1	0	0	1			
3162014	1455	1	4	56	72	200	1	0	0	0	0		This sample of 35 data values was taken from the 2014 NYCPD Stop-Question-Frisk (SQF aka Stop and Frisk) dataset which contains 45787 data values.	
8302014	1100	1	4	23	66	160	1	0	0		0			
3102014	820	1	4	17	67	170	0	0	0	0	0			
6102014	2107	1	4	48	72	180	1	1	0	0	0		Source: <a href="http://www.nyc.gov/html/nypd/html/analysis_and_planning/stop_question_and_frisk_report.shtml">http://www.nyc.gov/html/nypd/html/analysis_and_planning/stop_question_and_frisk_report.shtml</a>	
5182014	2055	1	4	15	69	150	0	0	0	0	0			



## Final Math in Society (Math &107) Course Description January 2013

A work group consisting of math faculty representing the public and private baccalaureate institutions in Washington and a representative group of math faculty from the community and technical colleges has created the description below outlining the critical outcomes and core content areas that define a rigorous terminal mathematics course for students in liberal arts and humanities majors. The course provides a solid foundation in the quantitative reasoning, symbolic reasoning, and critical thinking needed for citizenship and builds on the Standards for Mathematical Practice developed as part of the national Common Core State Standards for college readiness in mathematics:

1. *Make sense of problems and persevere in solving them.*
2. *Reason abstractly and quantitatively.*
3. *Construct viable arguments and critique the reasoning of others.*
4. *Model with mathematics.*
5. *Use appropriate tools strategically.*
6. *Attend to precision.*
7. *Look for and make use of structure*
8. *Look for and express regularity in repeated reasoning.*

**Course Outcomes** – skills and abilities that result from the course:

- [MR] Mathematical Reasoning: Students will read a complex problem requiring quantitative and/or symbolic analysis, use flexibility in selecting a solution strategy, and impose an appropriate mathematical structure or mathematical procedure in solving the problem.
- [MH] Mathematical Habits of Thought: Students will determine the reasonableness and implications of mathematical solutions, and will recognize the limitations of the methods used in context.
- [MDM] Mathematical Decision-Making: Students will apply mathematical processes and solutions in making personal and societal choices.
- [MC] Mathematical Communication: Student will use appropriate representations to effectively communicate, orally and in writing, quantitative results and mathematical processes.
- [MS] Mathematical Symbols, Techniques & Computation: Students will demonstrate proficiency in the skills supporting mathematical understanding.

### Course Core Topics:

1. Proportional reasoning
2. The mathematics of personal finance
3. Probability
4. Descriptive statistics
5. Growth and decay models (linear and exponential)

While the core topics overlap in many ways with content addressed in calculus, statistics, and business pathways, the focus in Math &107 is on the “big ideas” in these areas—the aspects of growth, finance, and statistics that are essential knowledge for an educated citizenry—rather than an extensive emphasis on procedures and details. The intent is to define a rigorous liberal arts quantitative course that provides an important piece of a well-rounded general education, namely, building a student’s ability to reason quantitatively. The list of topics is meant to address this aim through a consistent core focus while still leaving time for additional math topics that can be relevant to a wide range of liberal arts and humanities areas; other topics that might be addressed include, but are not limited to:

- discrete math topics (for example, graph theory, scheduling, voting theory, game theory, fair division)
- geometry/trigonometry
- math in the arts (for example, Fibonacci numbers and the golden ratio)
- symbolic logic supporting probability

## **Additional Clarification for the Math in Society Course Description: Example Outcomes & Prerequisite Skills**

### **Some Example Outcomes within the Core Topics**

The following examples are intended to provide a clearer general sense of the level of performance expectations related to the broad core topics, not to define specific required outcomes. Where noted, the coding abbreviations in parentheses indicate a specific link between a particular example outcome and the broad course outcomes listed for the course: MR=mathematical reasoning; MH=mathematical habits of thought; MD=mathematical decision-making; MC=mathematical communication; and MS=mathematical symbols, techniques and computation.

#### Proportional Reasoning

*[Note: this core content area is often integrated into one or more of the other topics but can also be taught as a stand-alone topic.]*

- Use proportions and ratios to interpret quantities (e.g. per capita, per square mile, national debt as a percentage of GDP).
- Recognize and compare proportional relationships from verbal, graphical, symbolic and numerical scenarios and use these relationships to solve and analyze context-based problems. [MR]
- Apply proportionality to solve and analyze a variety of multi-step contextual problems (examples: similar triangles to determine the height of a tree, using percents to calculate taxes, recipe scaling, determining how many have a disease in a city if has a 1/2000 occurrence rate, working with map scales, balancing a chemical equation, Consumer Price Index, cost of living index, S&P 500, value of a dollar, scaling factors (area and volume), growth and form, etc.) [MS, MR]
- Estimate the relative size of quantities without calculation, utilizing intuition and reasonableness.

#### Personal Finance

- Use given formulas and perform relevant calculations pertaining to personal finance (e.g. the study of future value, present value, compound interest, annuities, financial loans) to solve context-based scenarios.
- Use multiple representations (algebraic, numeric, graphic, verbal) of mathematical models to interpret and analyze scenarios related to personal finance (future value, present value, compound interest, annuities, financial loans).
- Analyze and critique claims related to personal finance (future value, present value, compound interest, annuities, financial loans) to make informed decisions.

#### Probability

- Calculate and interpret probabilities, including conditional probabilities, given contextual information contained in a two-way (contingency) table, and use these calculations to make informed decisions.

- Interpret percentages, fractions, and ratios as appropriate probabilities, including conditional probabilities, within an authentic context.
- Analyze and critique statements about probability and risk that appear in the media (including advertisements): e.g., risk and personal health decisions, false positives of medical tests, polls and other estimates of a population parameter, statements involving odds, etc.

### Descriptive Statistics

- Recognize and categorize methods of obtaining data (e.g. sampling, experimental, observational), discuss possible sources of bias, and use this information to make informed decisions.
- Use appropriate tools (e.g. spreadsheets, calculators) and strategies (e.g. verbal, numerical summaries, graphical summaries) to describe and display authentic data.
- Create, interpret, analyze, and critique graphical displays of data (e.g. boxplots, histograms, pie charts, and other more complicated displays which are typically found in the media).
- Calculate, interpret, analyze, and critique numerical summaries of data (including measures of center and spread).
- Compare and contrast two or more samples or populations by comparing numerical and graphical summaries of data.
- Write arguments properly using calculated statistics as supporting evidence [MH, MD, MC]
- Use, analyze, and critique statistical (e.g. regression) models derived from data.

### Growth Models

- Analyze data and/or scenarios to determine if they describe linear or exponential growth [MR]
- Identify growth rates, initial values, or point values expressed verbally, graphically, or numerically, and translate them into a format usable in calculation. [MR]
- Create linear and exponential models for an authentic situation.
- Use, interpret, and analyze linear and exponential models (including describing relevant features of the model, using the model to make predictions, discussing appropriateness and limitations of the model).

### Prerequisite Skills for Math &107 (Math in Society)

In order for students to be successful in a rigorous college level quantitative reasoning course it is essential that they have a firm foundation in basic number sense, the ability to reason algebraically, the ability to read and interpret graphs, and some initial exposure to probability and statistics. The following list of skills is intended to help frame our concept of a college-level quantitative reasoning course and to provide students and instructors with an understanding of the expectations we have for students who enroll in such a course. It is important to realize that students are not expected necessarily to achieve a high level of

proficiency in all of these skills prior to entering Math &107 as many of these skills will continue to be developed and refined at the college level.

The Math&107 (Math in Society) description of skills and outcomes presumes that students entering the course have developed the mathematical skills and habits of mind to be successful in a college-level math class. That skill set includes those listed below; and may be documented through a suitable score on a placement test or achieved by successful completion of the appropriate pre-college level math sequence, to include an appropriate version of intermediate algebra.

*[Note: While many of these skills provide foundational support for multiple core topic areas in Math &107, the coding abbreviations in parentheses where noted suggest a primary link between a particular skill and one of the core content areas listed for the course: PR=proportional reasoning; PF=personal finance; P=probability; DS=descriptive statistics; and GM=growth models.]*

### *Number Sense*

- Use standard order of operations to evaluate expressions (including fractions and exponents)
- Calculate with, and convert between, decimals, fractions, and percents (PR, P)
- Interpret and use scientific notation (PR)
- Use various strategies to perform estimations (products, ratios, relative sizes) (PR)
- Use, and convert between, units (PR)
- Increase or decrease a given value by a given percentage (GM)
- Calculate the relative change (percent) between two quantities (P)

### *Algebraic Reasoning and Modeling*

- Use variables to represent quantities
- Solve linear equations and proportions (GM)
- Create and use linear models in a variety of authentic settings (GM)
- Interpret slope as a rate or ratio as appropriate for the given context (GM)
- Apply exponent rules to simplify expressions with exponents, including negative exponents (PF)
- Recognize and describe the relationship between variables expressed in an algebraic equation or graphical representation (intuitive notion of a function) (GM)
- Use, and convert between, different representations of relationships (verbal, algebraic, numerical, graphical)

### *Graphical Sense*

- Create and use simple graphs: lines, bar charts, pie charts, and histograms (DS)
- Read and interpret graphs, charts, and tables (DS)

### *Statistical Literacy*

- Calculate and interpret means and medians (DS)
- Interpret percents as probabilities or likelihoods (P)