Syllabus for Math 103: Contemporary Concepts and Applications of Mathematics updated Fall 2007

Text: Excursions in Modern Mathematics, 6th edition by Peter Tannenbaum & Robert Arnold

Course: This course is designed to give students a look at some of the many different ways mathematics is used in the real world. Though this course does *not* involve a ton of algebra and equation solving, the left side of the brain *will* be put to work! This course requires logic, strategy, problem solving techniques, and basic algebra skills.

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The times listed below indicate actual lecture hours spent on each topic. This does *not* include time spent on exams or other in-class activities.

I. The Mathematics of Social Choice----6 hours

Ch1 The Mathematics of Voting: The Paradoxes of Democracy

* Analyze and interpret a preference schedule.
* Rearrange a preference schedule to accommodate the elimination of one or more alternatives.
* Explain the difference between majority rule and the plurality method.
* List and discuss the four voting methods.
* Determine the winner from a preference schedule using each of the 4 voting methods.
* Explain what is meant by a Condorcet Candidate.
*Describe the process of insincere voting.
* List three factors that can affect the outcome of an election.
* List and discuss the four fairness criteria. Understand how a method "violates" a fairness criterion.
*Discuss "Arrow's Impossibility Theorem."

Ch2 Weighted Voting Systems: The Power Game

* Interpret the symbolic notation for a weighted voting system by identifying the quota and the weight of each voter.
*Identify the winning coalitions in a given weighted voting system.
* Determine whether a weighted voting system has a dictator, any dummies, or voters with veto power.
* Calculate the Banzhaf power index for a given weighted voting system.
* List the possible permutations (sequential coalitions) for a three- or four-voter weighted voting system.
* Calculate the Shapley-Shubik index for a three voter weighted voting system.

II. Management Science----7 hours

Ch5 Euler Circuits

* Determine by observation if a graph is connected, and determine the degree of each vertex.
* Construct graphs that model real world situations.
* Define an Euler circuit, and determine whether a graph contains an Euler circuit.
* Find an Euler circuit and identity the circuit by numbering the edges.
* If a graph does not contain an Euler curcuit, "eulerize" the graph by duplicating a minimum number of edges.
* Identify the types of problems whose solutions involve Euler circuits.

Ch6 Hamilton Circuits: The Traveling Salesman Problem (TSP)

* Give the definition of a Hamilton circuit.
* Explain the difference between an Euler circuit and a Hamilton circuit.
* Identify a given application as being an Euler circuit problem or a Hamilton circuit problem.
* Explain what is meant by a complete graph on N vertices.
* Calculate N! for a given value of N.
* Calculate the number of Hamilton circuits and the number of edges in a complete graph with a given number of vertices.
* Define the term algorithm.
* Explain the brute force method for finding the minimum-cost Hamilton circuit.
* Find an approximate solution to the TSP by applying the nearest-neighbor and cheapest-link algorithms.

Ch7 The Mathematics of Networks: Connections!

Omit 7.4-7.5

* Explain the difference between a graph and a tree.
* Explain what is required for a graph to *be* a tree.
* Identify which types of applications are solved by using Euler circuits, Hamilton circuits, or minimum spanning trees.
* Find a minimum-cost spanning tree by applying Kruskal's algorithm.

III. Statistics----12 hours

Ch13 Collecting Statistical Data: Censuses, Surveys & Studies

* Identify the population and sample in a given sampling or experimental situation.
* Explain the difference between a population and a sample.
* Calculate the sample rate and response rate when possible.
* Analyze a sampling example to detect sources of bias.
*Analyze a clinical study to determine what type of study it is, i.e. controlled, randomized, blind, double-blind, etc.
* Describe the placebo effect.
* Determine any confounding variables in a study.

Ch14 Descriptive Statistics: Graphing and Summarizing Data

* Calculate the median, mean, and 1st and 3rd quartiles of a set of data.
* Calculate the range and interquartile range of a given data set
* List the five-number summary for a given data set and construct a box plot.
* Find the standard deviation for a small data set.
* Explain in your own words the meaning of standard deviation.
* Explain the difference between a bar graph and a histogram.
* Construct a bar graph or histogram for a small data set.
* Find the mean, median, and quartiles of data represented by a bar graph or frequency table.
* Analyze a pie chart.

Ch15 Chances and Probability: Measuring Uncertainty

* Describe the sample space for a given random phenomena.
* Explain what is meant by the probability of an outcome.
* List the two laws of probability.
* Apply the laws of probability to determine the validity of a probability space.
* Identify which probability law is not satisfied for a given illegitimate probability space.
* Compute the probability of an event when the probability space of the experiment is given.
*Write the probability space for a given random phenomena.
* Identify the different situations in which permutations or combinations are used.

Ch16 Normal Distributions

* Define statistical inference.
* Explain the difference between a parameter and a statistic.
* Identify both the parameter and the statistic in a simple inferential setting.
* Explain what a random variable is.
* Explain the difference between the honest and dishonest-coin principles.
* Using an appropriate formula, calculate the mean and standard deviation of a given statistic.
* Discuss the effect of an increased sample size on the statistic's sampling error.
* Explain the difference between the population mean and the sample mean.
* Describe a normal curve.
* Locate the mean and standard deviation from a graph of a normal curve.
* Explain the 68-95-99.7 rule and apply it to compute normal probabilities.
* Give the mean and standard deviation of a normally distributed data set, and compute the percent of the population that falls within a given interval.

IV. Topic of Choice-----5 hours

Other topics in the book to choose from are listed below.

Social Choice
Ch3 Fair Division
Ch4 Apportionment
Management Science
Ch8 Scheduling
Growth & Symmetry
Ch9 Spiral Growth in Nature
Ch10 The Mathematics of Population Growth
Ch11 Symmetry
Ch12 Fractal Geometry

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The Math 103 final exam should ideally contain representative questions from each of the main (bold) categories. The criteria upon which the Core Assessment Committee evaluates the Math 103 finals are listed below.

1. Students master problem-solving skills.
2. Students learn to manipulate abstract symbols.
3. Students learn and appreciate the rigorous use of deductive arguments in mathematics.
4. Students learn a broad spectrum of mathematical applications:
(a) Basic statistics
(b) Graph theory and its applications
(c) Probability
(d) Social choice and voting systems
Note: Criterion 2 does not thoroughly apply to Math 131. The amount of abstract symbols used in this course is very little to none. The main emphasis is on real-world applications and the ability of the students to apply the information learned to logically and deductively solve problems.

To that end, a question is chosen from the final exam representing each of these eight criteria and sub-criteria. It has often been the case in the past that one exam question served to cover more than one criterion. It is not our intention to create conditions leading to inordinately long or redundant final exams for the purpose of meeting Core Assessment Committee demands. However, Math 107 instructors should be aware of the criteria while preparing their final exams.