

M111 Mathematics as a Human Pursuit Practice for Exam 3

Sections 5A and 5E

Sections 11A, 11C and 10C, Lab on Sound, and Fractal worksheets, Worksheets on Fibonacci Numbers and Golden Ratio

Section 5A Fundamentals of Statistics

1. List the basic steps in a statistical study.
2. Label the following samples as to whether they represent random, stratified, systematic, or convenience sampling. **Explain** your answer.

_____ a) Core directors want to get a consensus about students opinions about the content of Core 1. The Core directors submit a questionnaire to Dr. White's Core 1 discussion group to rate the content of Core 1 at SJC.

_____ b) On an assembly line for the production of candy, every 100th piece is pulled and checked for weight.

3.
 - a) What is selection bias?
 - b) What is participation bias?
 - c) Which, if any, is demonstrated in the following poll: A survey to determine public opinion in America on the issue of government sponsored health insurance is conducted by surveying the randomly selected patients at public health clinics.
4. Determine whether each of the following studies is observational or experimental. If experimental, are control groups used and if so what is control group, and is it blind, and if so single blind or double blind? If observational is it a case-control study and if so what are the cases and what are the controls? **Justify your answers.**

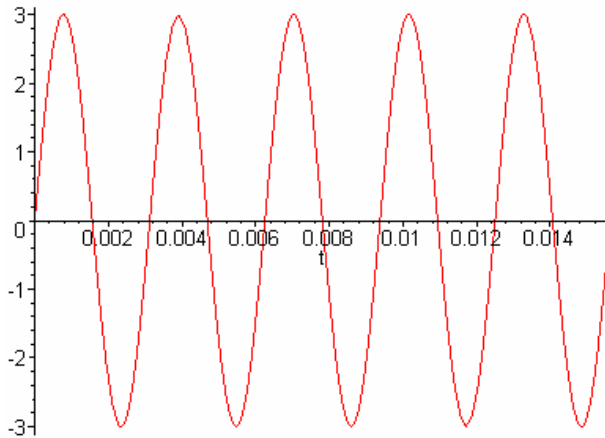
To determine whether a new brand of lotion with bees wax in it will reduce the appearance of wrinkles, a study is conducted. Two groups of people apply lotion to their face for a period of six months. One group receives lotion with the bees wax in it and the other group receives a lotion that does not have the bees wax in it. Dermatologists evaluate the participants each month for reduction in the appearance of wrinkles -- the dermatologists do not know which product the patients are using, nor do the participants.

Unit 5E Correlation and Causality

5. What type of correlation would you expect to see in each of these (weak, moderate, strong positive or negative, or none) – explain your answer.
 - a) The age of a (non-antique) car and its value.
 - b) The average adjustable mortgage rate and the number of home foreclosures.
6. The price of jet fuel and the price of an airline ticket should have what type of correlation.
7. Describe what the data points should look like in a scatter diagram where there is no correlation.
8. A coefficient of correlation between golf handicaps and stock rates of -0.4 is found. What does this indicate?

Sound Lab and Unit 11a Mathematics and Music

9. Suppose that you obtained the following sound wave:



- What is the amplitude of this sound wave?
- What is the period of this sound wave?
- What is the frequency of this sound wave?

10. The standard sine curve is periodic with period = _____.

Consider the function $3 \sin(4x - 2)$

- What is its amplitude?
- What is its period?
- What is its frequency?
- Express the above function as an equivalent cosine function.

11. Assuming a twelve note scale, and given the frequency of Middle C is 256 Hz. What is the frequency of the note that is one octave higher? What is the frequency of the note that is 5 half steps higher?

Unit 11C and Fibonacci Numbers Worksheet

12. Fill in the next five numbers of the Fibonacci sequence:

1, 1, 2, _____, _____, _____, _____

13. Let $F(n)$ denote the n 'th Fibonacci number. We obtained the golden ratio when we took the limit of the ratio of

- $\frac{F(n)}{F(n-1)}$
- $\frac{F(n) * F(n-1)}{F^2(n-1)}$
- $\frac{F^2(n)}{F^2(n-1)}$
- $\frac{F(n+1) - F(n)}{F(n-1) - F(n-2)}$

14. The golden ratio is denoted by which Greek symbol? _____

15. Which of the following is the golden ratio?

- a) $1 - \sqrt{2}$ b) $\frac{1 - \sqrt{2}}{5}$ c) $\frac{1 - \sqrt{5}}{2}$ d) $\frac{1 + \sqrt{5}}{2}$

16 a) Give two examples of the use of the golden ratio in history or art.

b) Define a golden rectangle – sketch a golden rectangle

17. If you are dividing a line of length 4 inches at the ideal point for the golden ratio
The length of the shorter line segment would be _____

And the length of the longer line segment would be _____

18. The line segment above was divided so that the ratio of the length of the longer
portion to the shorter portion was equal to the ratio of

Unit 10C Fractal Geometry

19. A fractal is

- a) an object generated by iterating the equation $x_1 = x_0^2 + c$.
b) an object which is self-similar when examined at different scales.
c) an object with infinite dimension
d) an object that has infinite length.

20. a) Draw what the Snowflake Island (Koch's triangle) would look like after the first
two iterations.

b) Draw what the Sierpinski Triangle would look like after the first two iterations.

21. If you are measuring an object such that when you reduce the ruler length by a factor
of 2, the number of elements increases by a factor of 5. What is the fractal dimension of
this object:

- a) .43068 b) .69897 c) .30103 d) 2.32193

22. If a fractal is created at each iteration by dividing the object into 5 self similar objects
each of which has size equal to $\frac{1}{4}$ the original object what would be the fractal dimension
of this object?

Mandelbrot Worksheet

23. Give the precise definition of the Mandelbrot Set

24. Give the precise definitions of the filled Julia set and the Julia set.

25. Compute the following:

a) $(4 + 3i) + (2 - 8i)$

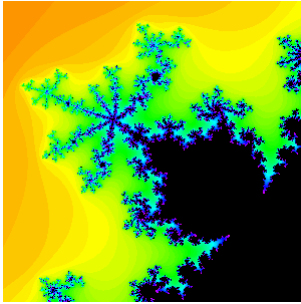
b) $(3 - 2i) * (2 + 4i)$

26. a) Compute the orbit of the seed 0 under the iteration of $x = x^2 + i$.

b) Is i a member of the Mandelbrot set? Justify your answer.

c) What is the orbit of the seed 0 under the iteration of $x = x^2 + 2$?

d) Is 2 a member of the Mandelbrot set? Justify your answer.



e) Determine the period and rotation number of the primary bulb in the Mandelbrot set at left. Justify your answer

f) For the Julia set below corresponding to a c in a primary bulb, what is the period of this primary bulb? What is its rotation number?

