

Exponential Functions

Math 102 Section 102

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Midterm lesson

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Math 102 Midterm

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r/UBC · Posted by u/Backyardz 1 day ago **Screenshot taken at 10:22 pm, Aug 25**

Math 102 Midterm

The midterm for this class is tomorrow, and I was wondering if there are things I should consider/think about.

Also, does anyone know where I can find answer keys to the sample exams? Not sure why we don't have access to em in the first place but if not I guess I have to improvise.

Any and all thoughts help folks! Thanks for your time in advance!

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JoeyMossy [Science](#) 7 points · 1 day ago
Consider optimizing your study time modelled by the function: $M(x) = 100x/(k+x)$, where x is the time until exam. (I love osh)

If by sample exam you mean the final exams posted, it should be in the midterm info look for something like "answers written by graduate students"

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Maniah00333 2 points · 1 day ago
Lol but actually review your osh. I took the course a few back and the last question was really similar to an osh q

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JoeyMossy [Science](#) 1 point · 1 day ago
102 no longer has quizzes and osh only - did that apply when you took it?

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Maniah00333 1 point · 1 day ago
We had both quizzes and osh.

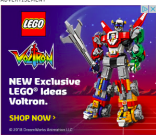
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JoeyMossy [Science](#) 2 points · 1 day ago
Osh has become agonizing pain this year haha

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Don't forget

Assignment 7 is due tonight at 9:00.

Where are we going next?

- ▶ Recall: predator and prey.
 - ▶ Prey population: x
 - ▶ Prey reproduction rate: rx
 - ▶ Predation rate: $\frac{Kx}{a+x}$
- ▶ A new type of equation.

$$\frac{dx}{dt} = rx - \frac{Kx}{a+x}$$

- ▶ A **differential equation** relates one or more derivatives of a function to the function itself.
- ▶ Goal for the following three weeks:
 - ▶ solve them;
 - ▶ understand the structure of their solutions without solving them.

Today: learning goals

We are going to do some preparation before going into differential equations.

1. Identify exponential functions
2. Calculate derivatives of exponential functions
3. Define the number e

Exponential functions

Q1. Which of the following is an exponential function?

- A. x^n power function
- B. 2^x variable in the exponent!
- C. e^2 this is a constant
- D. $\ln(x)$ Inverse of exp. function

Exponential growth

Q2. The number of the bacteria *E. coli* in a culture doubles every twenty minutes. Starting with one *E. coli* cell, find the size of the population after 3 hours and 20 minutes.

- A. 32
- B. 64
- C. 1024
- D. 2048

3 hours and 20 minutes \Rightarrow 10 generations \Rightarrow size is $2^{10} = 1024$

Exponential growth

Q3. Following the previous question, how big is the population after one day?

- A. 2048
- B. 2^{24}
- C. 2^{36}
- D. 2^{72}

1 day $\Rightarrow 3 \times 24 = 72$ generations \Rightarrow size is 2^{72}

Mass of one *E. coli* cell: 10^{-12} kg. 2^{72} cells weigh 4.7 million tons.

In two days of time, the total mass of the cells will be more than 1 million planets of Earth.

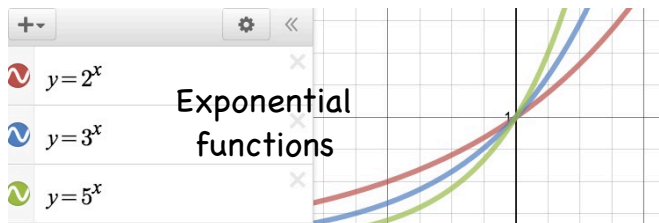
Exponential functions

Q4. Exponential functions a^x , where $a > 1$...

- A. All go through the point $(1, 1)$
- B. All go through the point $(1, 0)$
- C. If $a < b$, then $a^x < b^x$ for all $x > 0$ and $a^x > b^x$ for all $x < 0$
- D. If $a < b$, then $a^x < b^x$ for all $x > 1$ and $a^x > b^x$ for all $x < 1$
- E. None of the above

Exponential functions

If $a < b$, then $a^x < b^x$ for all $x > 0$ and $a^x > b^x$ for all $x < 0$.



Exponential functions

Q5. The derivative of $f(x) = a^x$ is

A. $f'(x) = xa^{x-1}$

B. $f'(x) = ax^{a-1}$

C. $f'(x) = \frac{a^{x+h} - a^x}{h}$

D. $f'(x) = a^x$

E. $f'(x) = Ca^x$

Document camera

- ▶ Derivative of $f(x) = a^x$
- ▶ Why e^x ?

Definition (e)

The number e is defined as

$$e = \lim_{h \rightarrow 0} (1 + h)^{\frac{1}{h}}$$

or equivalently

$$e = \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n$$

Remark: e is defined such that the derivative of the exponential function $f(x) = e^x$ is itself.

Example (document camera)

Calculate

$$\frac{d}{dx} e^{kx}$$

Summary

- ▶ Exponential functions — different from power functions
- ▶ Exponential growth (e.g. bacterial cultures)
- ▶ If $f(x) = a^x$, then $f'(x) = C_a a^x$
- ▶ e^x is a special exponential function such that $\frac{d}{dx}e^x = e^x$

Answers

1. B
2. C
3. D
4. C
5. E

Related Exam Problem

1. Sketch the graph of the function $y = x^2 e^{-x}$