Open Course Library Project

Washington State Board of Community and Technical Colleges

Dale Hoffman
David Lippman
Melonie Rasmussen

Gates Foundation

State Legislature

Washington State Board of Community and Technical Colleges

Open Course Library Project

To create open-source digital courseware for the 81 most heavily enrolled CC courses

- Beginning & Intermediate Algebra
- Statistics
- Business Calculus
- **Math in Society**
- **Precalculus and Trig**
- **Calculus I, II, III**

OCL Course Creation Process

- Faculty submitted course proposals
- Faculty/team selected for each course
- Development support team created for each course
  - eLearning design specialist
  - Librarian
- Standards
  - Learning Outcomes
  - Assessments
  - Accessibility
  - Cultural awareness

Faculty Course Creation Process

- Write/Assemble/Create
- Reviewed by at least two outside instructors
- Class tested
- Revised
- Posted free (Creative Commons)
  - -- PDF (easy to download)
  - -- MS WORD (easy to modify)
- Printed versions
  - -- Personal printer (B&W or color)
  - -- lulu.com (less than $20)

OCL Mathematics Courses

- Beginning & Intermediate Algebra

  Tyler Wallace (Big Bend Community College)
- Statistics

  Fredrico Marchetti (Shoreline Community College)
- Business Calculus – *under development*

  Shana Calaway (Shoreline Community College)

- Math in Society

  David Lippman (Pierce college)
- Precalculus I and II

  David Lippman & Melonie Rasmussen (Pierce College)
- Calculus I, II, and III

  Dale Hoffman (Bellevue College)

Beginning and Intermediate Algebra

Tyler Wallace

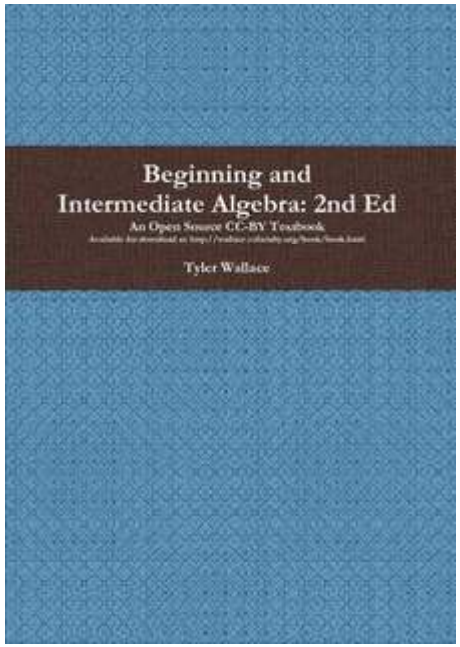
The entire package:

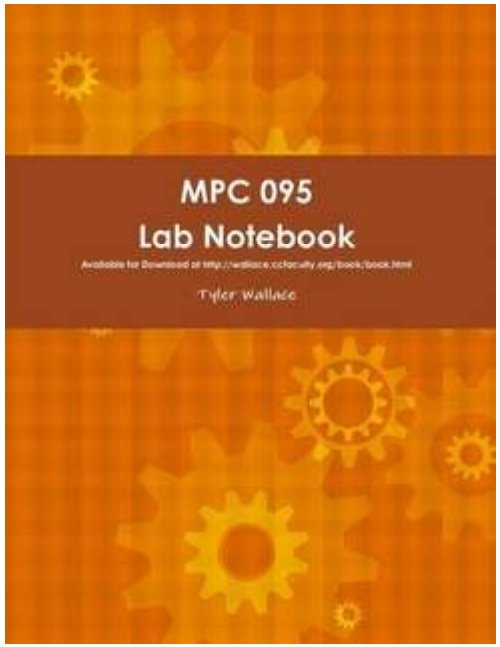
- Open Textbook
- Open Student Solutions Manual
- Open Workbook
- Online Homework (WAMAP)
- Videos online by topic

All Resources Available for “Free”

wamap.org

Washington Mathematics Assessment and Placement





YouTube

Learn math by doing math…

- Five minute video per topic
- On their own: 2 problems
- After 4-5 related videos, do homework
- After 6 homework assignments, do review
- After review, test

What it looks like (topics)

Order of Operations - Simple

No time limit

100% Required

Total Points Possible: 20

Questions

- Q 1 (0/10)
- Q 2 (0/10)

Grade: 0/20

Find: $4+5(6-1)$

Points possible: 10
This is attempt 1 of 3.

What it looks like (homework)

Order of Operations - Homework

No time limit

Practice

80% required.

For extra practice see textbook section 0.3 Order of Operations

Total Points Possible: 150

Questions

- Q 1 (0/10)
- Q 2 (0/10)
- Q 3 (0/10)
- Q 4 (0/10)
- Q 5 (0/10)
- Q 6 (0/10)
- Q 7 (0/10)
- Q 8 (0/10)
- Q 9 (0/10)
- Q 10 (0/10)
- Q 11 (0/10)
- Q 12 (0/10)
- Q 13 (0/10)
- Q 14 (0/10)
- Q 15 (0/10)

Grade: 0/150

Print Version

Use the order of operations to simplify:

$2(-2+1)^2-4(1-4)^2$ =

Points possible: 10
This is attempt 1 of 3.

Submit

Link to download related textbook section

Use

- Project Kaleidoscope did experiment with 9 sections, 236 students. Most saw success rates rise 8-30 percentage points, and even higher gains for low-income students.

Precalculus 1 and 2

- Free online book, printed for $15
- Sample syllabus with outcomes
- Sample assessments (quizzes and tests)
- All materials are available in Word or text format if you want to modify or customize at a section or sentence level

Precalculus 1 and 2

- Instructor guide, detailing the contents
- Discussion forums to promote interaction
- Additional online resources, including links to other textbooks, video sites, and technology tools

Approach

- Focus on the story of functions
- Contextual motivation
- “Rule of four” integrated throughout
- Stepping stone in level of thinking
- Integrated circle/triangle trig approach
- Distributed approach to trig identities and solving trig equations

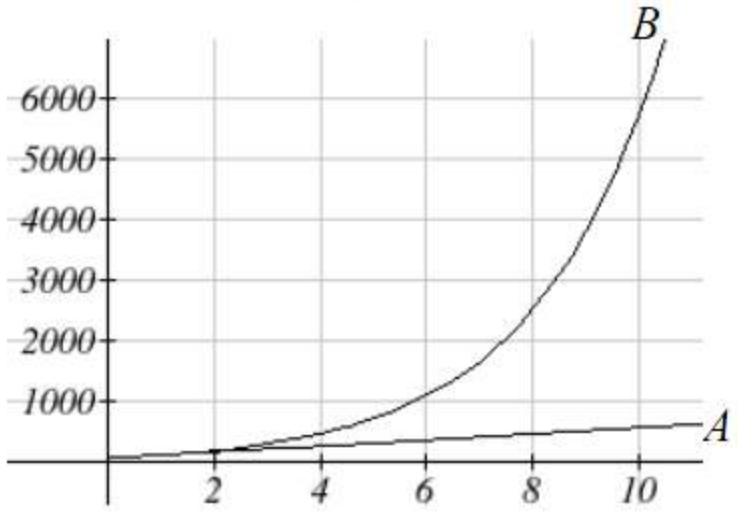
Open Textbook

Section 4.1 Exponential Functions

India is the second most populous country in the world, with a population in 2008 of about 1.14 billion people. The population is growing by about 1.34% each year[1]. We might ask if we can find a formula to model the population, P, as a function of time, t, in years after 2008, if the population continues to grow at this rate.

To see more clearly the difference between exponential and linear growth, compare the two tables and graphs below, which illustrate the growth of company A and B described above over a longer time frame if the growth patterns were to continue

years	Company A	Company B
2	200	225
4	300	506
6	400	1139
8	500	2563
10	600	5767



Definition

An **exponential growth or decay function** is a function that grows or shrinks at a constant percent growth rate. The equation can be written in the form

$f(x) = a(1+r)^x$ or $f(x) = ab^x$ where $b = 1+r$

Where

a is the initial or starting value of the function

r is the percent growth or decay rate, written as a decimal

b is the growth factor or growth multiplier. Since powers of negative numbers behave strangely, we limit b to positive values.

Example 1

Write an exponential function for India's population, and use it to predict the population in 2020.

At the beginning of the chapter we were given India's population of 1.14 billion in the year 2008 and a percent growth rate of 1.34%. Using 2008 as our starting time ($t = 0$), our initial population will be 1.14 billion. Since the percent growth rate was 1.34%, our value for $r = 0.0134$.

Using the basic formula for exponential growth $f(x) = a(1+r)^x$ we can write the formula, $f(t) = 1.14(1+0.0134)^t$

To estimate the population in 2020, we evaluate the function at $t = 12$, since 2020 is 12

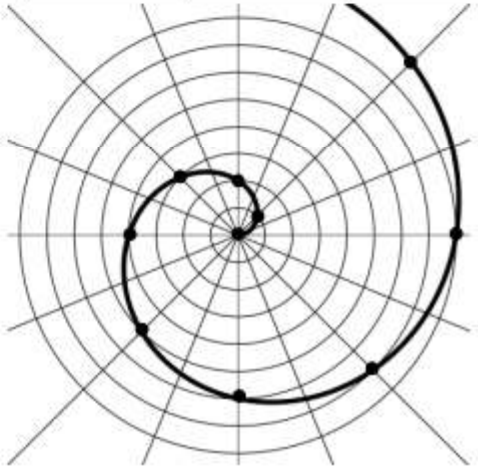
Example 5

Sketch a graph of the polar equation $r = \theta$

The equation $r = \theta$ describes all the points for which the radius r is equal to the angle. To visualize this relationship, we can create a table of values.

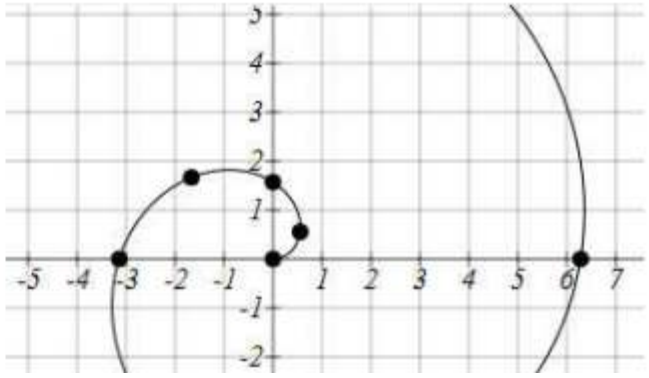
θ	0	$\pi/4$	$\pi/2$	$3\pi/4$	π	$5\pi/4$	$3\pi/2$	$7\pi/4$	2π
r	0	$\pi/4$	$\pi/2$	$3\pi/4$	π	$5\pi/4$	$3\pi/2$	$7\pi/4$	2π

We can plot these points on the plane, and then sketch a curve that fits the points. The resulting graph is a spiral.



Notice that while y is not a function of x, r is a function of θ. Polar functions allow us a functional representation for many relationships in which y is not a function of x.

Although it is nice to see polar equations on polar grids, it is more common for polar graphs to be graphed on the Cartesian coordinate system, and so, the remainder of the polar equations will be graphed accordingly.



Day by Day guide showing suggested lecture pace, and how handouts, activities, and assessments fit in the course structure

Day-by-Day Course Guide

This Day-by-Day gives a suggested pacing of the course material and included activities and assessments in a 50 hour face-to-face course.

Lecture outlines with examples are available in each chapter's Readings and Outcomes folder

DAY	SECTION	ACTIVITY
1	Syllabus 1.1	Introduce course Introduce WAMAP Start 1.1
2	1.1	Lecture 1.1 / more examples
3	1.2 / 1.3	Lecture 1.2 Start Tool kit worksheet
4	1.3	Quiz #1 Lecture 1.3 finish toolkit worksheet w/ domain info

Lecture outlines, with examples

Teacher Notes

4.1

Motivate exponentials through an example: Compare two job offers: $40,000 start with 1) $1500/yr raises, vs 2) 3.5%/year raises. Calculate out several years.

Derive the $f(x) = a(1+r)^x = ab^x$ form of an exponential through percent growth rate

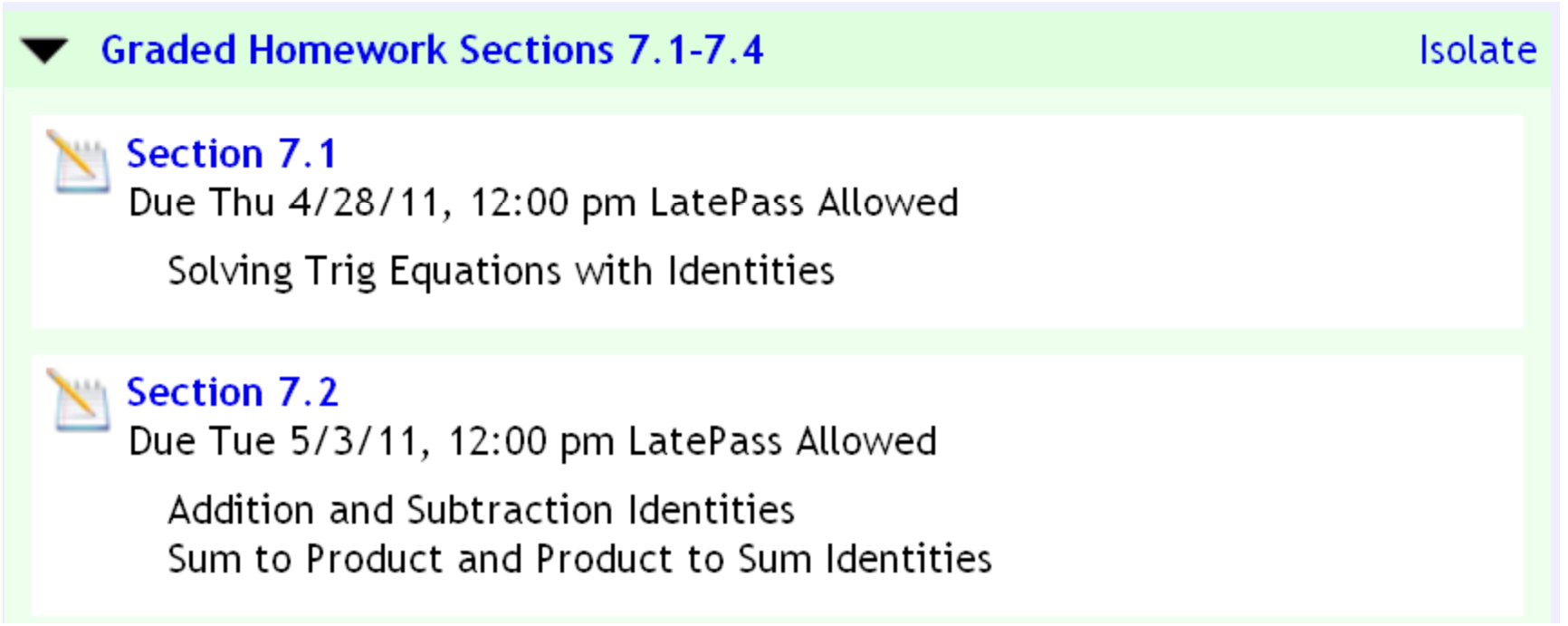
Example: Tuition is currently $1050. If tuition has been increasing by 7%/year, predict the tuition in 5 years

Example: Interpret the equation $P(t) = 1000(0.83)^t$

Discuss finding an equation of an exponential through two points.

Example: Find an equation for an exponential passing through $(0,3)$ and $(3,18)$

Online algorithmically generated homework for each section, in addition to book homework



Many have video help, thanks to James Sousa

Questions

- Q 1 (0/1)
- Q 2 (0/1)
- Q 3 (0/1)
- Q 4 (0/1)
- Q 5 (0/1)
- Q 6 (0/1)
- Q 7 (0/1)
- Q 8 (0/1)
- Q 9 (0/1)
- Q 10 (0/1)

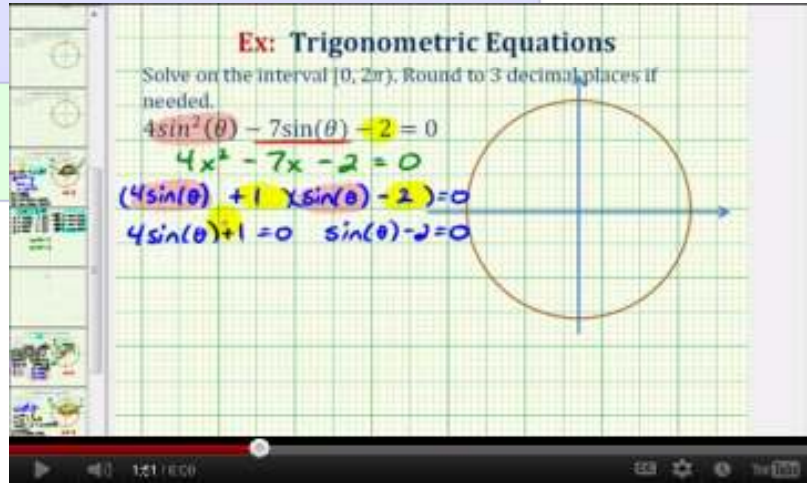
Solve $6\sin^2(t) - \sin(t) - 2 = 0$ for all solutions $0 \le t < 2\pi$

$t =$ Preview

Give your answers accurate to 2 decimal places, as a list separated by commas

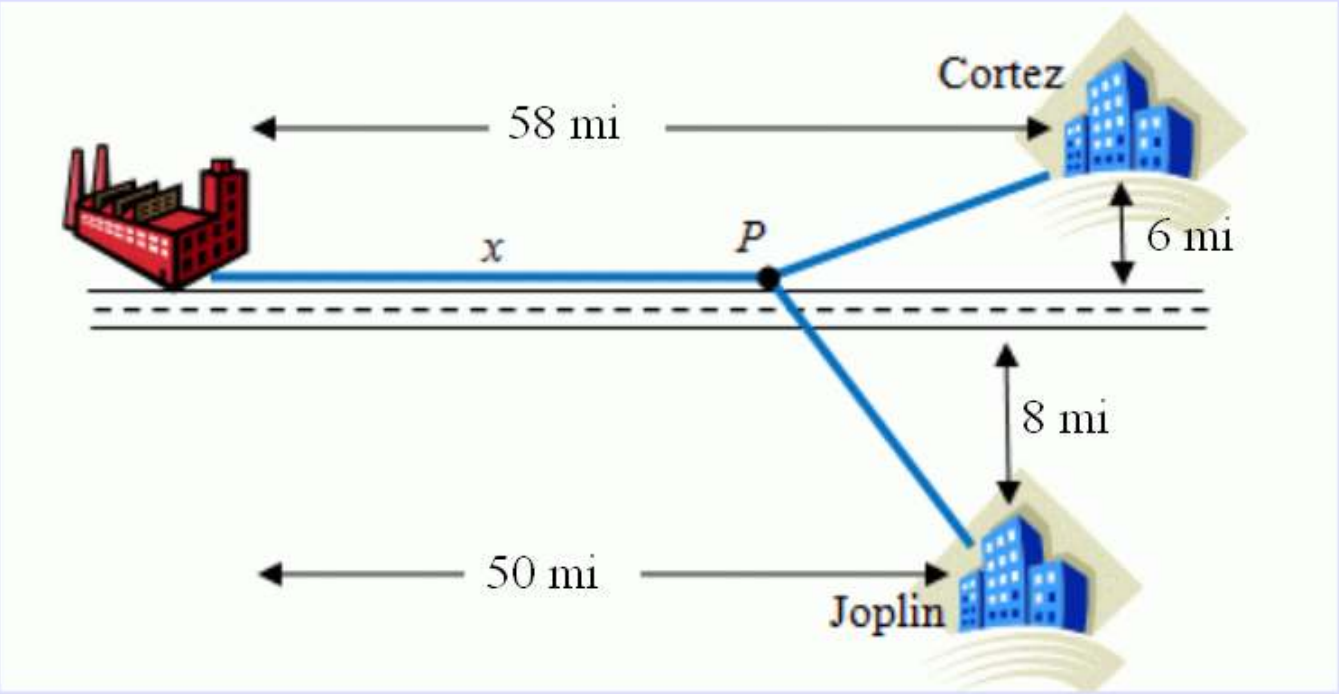
Get help: Video

Points possible: 1
This is attempt 1 of 2.



You are working for a power plant that is located on a highway that runs east to west. The town of Cortez is located 58 miles east of the power plant, and 6 miles north of the freeway. The town of Joplin is located 50 miles east of the power plant, and 8 miles south of the freeway.

To connect power to the two towns, the power plant wants to build one junction station along the freeway then run power out to the two cities from the junction station. The picture below shows the general layout (not to scale), where x is the length of power line run along the freeway (the length from the power plant to the junction at point P). Your boss has asked you to determine where the junction station should be built.



Class Assignments & Handouts

Polynomial Graphs Classwork

Practice on 3.3

Rational Graphs Worksheet

Practice on 3.4

Rational function - help

Guidelines for taking an equation & graphing it.

Chapter 3 Review Problems

Past Due Date. Showing as Review

This assessment is in review mode - no scores will be saved

A non-comprehensive set of online review problems. These problems are optional, and are not part of your homework grade.

Exam 3 Practice Problems

A non-comprehensive set of additional practice problems for Exam

MAA Review by Mike Kenyon, Green River Community College, 10/15/2012

We considered about two dozen texts in our adoption process […] Once the finalists were selected, it became clear that the Lippman/Rasmussen text was equal or superior to the others in quality and far outpaced them in cost. The vote of our full-time faculty was, in fact, unanimous.

MAA Review by Mike Kenyon, Green River Community College, 10/15/2012

The text had a positive effect on the classroom instructional atmosphere from the very beginning. Many students came to class on the first day with a positive attitude borne of having been to the bookstore and found that their textbook would cost $20 rather than over $100, and even spending that much was optional. Moreover, the vast majority of students had the textbook in one form or another from the outset and so didn't face the prospect of falling behind because they couldn't get it until a financial aid check came in.

Paige Green, Lecturer, UCLA

Everything is going so well with your book and the MyOpenMath component. I am so pleased with the material.

[…]

So far, I find the homework sections so complete and the application problems really give the students a challenge.

James Gray, Tacoma Community College

It’s be very easy to use. The content flows great. I’ve learned new ways to explain concepts. Overall it’s been a very positive experience and I’m very impressed with the textbook, the online questions, tests, and quizzes!

Student Success Data

458 students at Pierce College have used our text (over the last 2 years), vs. 1169 using Stewart (over the last 5 years) showed no significant difference in success.

Math 107 Math in Society

Survey of contemporary mathematical topics, most non-algebraic. Application focus.

a.k.a. Math for Liberal Arts Majors

a.k.a. Quantitative Literacy/Reasoning

Book Topics

- Problem Solving / Quantitative Reasoning
- Voting Theory
- Weighted Voting
- Apportionment
- Fair Division
- Graph Theory
- Scheduling
- Growth Models

Book Topics

- Finance
- Statistics (collecting and descriptive stats)
- Probability
- Sets
- Historical Counting
- Fractals
- Cryptography

Math 107 Math in Society

- Free book online (~$15 B&W printed)
- Video playlist for each chapter
- Full course shell for a fully online course
- Online and paper exercises
- Online and paper quizzes
- Written assignments / discussion questions

Math 107 Math in Society

- Book has been used for 5 years in a fully-online class with good success.
- Small (but not significant) increase in average grade.
- Students regularly rate the readability of the text very high.

Contemporary Calculus
I, II, and III

Limits to Double Integrals

Dale Hoffman
Bellevue College
Bellevue, Washington

All of the materials

- 300 page text for each course
- WAMAP online practice problems (with answers)
- Example quizzes and tests
- Example syllabus

are available free on the web.

Web access

Contemporary Calculus I -- Chapters 0 to
Contemporary Calculus II -- Chapters 4 t
Contemporary Calculus III -- Chapters 9

- How to Succeed in Calculus
- Advice from successful calculus students

Contemporary Calculus -- section I

Chapter 0 -- Review and Preview

- Chapter 0 Learning Outcomes
- 0.1 Preview
- 0.2 Lines
- 0.3 Functions
- 0.4 Combinations of Functions
- 0.5 Mathematical Language
- Chapter 0: Odd Answers

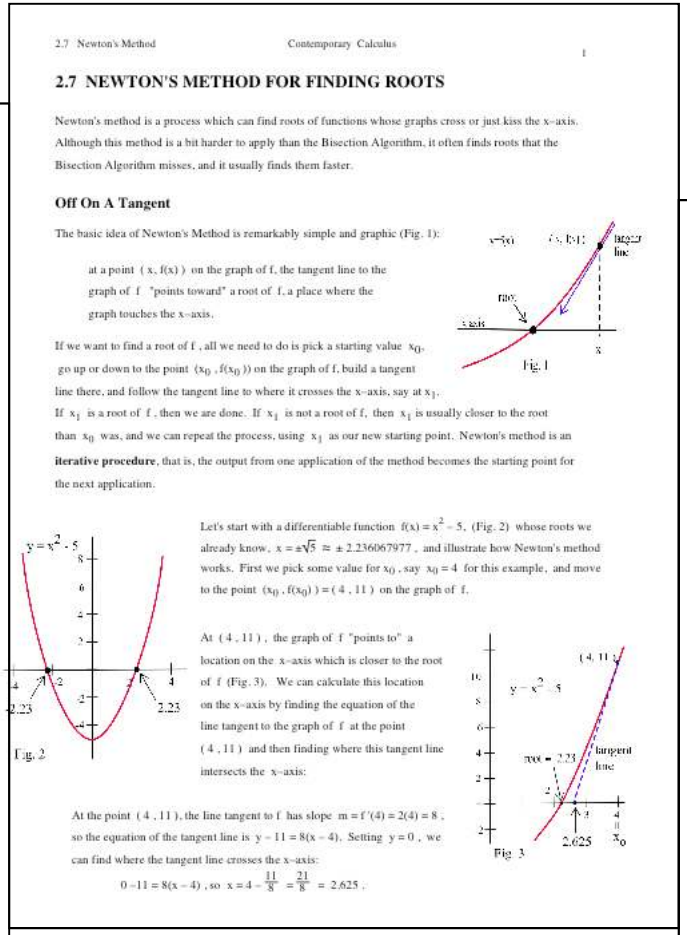
Chapter 1 -- Functions, Graphs, Limits and Co

- Chapter 1 Learning Outcomes
- 1.0 Slopes & Velocities
- 1.1 Limit of a Function
- 1.2 Limit Properties
- 1.3 Continuous Functions
- 1.4 Formal Definition of Limit
- Chapter 1: Odd Answers

Chapter 2 -- The Derivative

- Chapter 2 Learning Outcomes
- 2.0 Slope of a Tangent Line
- 2.1 Definition of Derivative
- 2.2 Differentiation Formulas
- 2.3 More Differentiation Patterns
- 2.4 Chain Rule (!!!)
- 2.5 Using the Chain Rule
- 2.6 Related Rates
- 2.7 Newton's Method
- 2.8 Linear Approximation
- 2.9 Implicit Differentiation
- Chapter 2: Odd Answers

Chapter 3 -- Derivatives and Graphs



2.7 Newton's Method Contemporary Calculus 1

2.7 NEWTON'S METHOD FOR FINDING ROOTS

Newton's method is a process which can find roots of functions whose graphs cross or just kiss the x–axis. Although this method is a bit harder to apply than the Bisection Algorithm, it often finds roots that the Bisection Algorithm misses, and it usually finds them faster.

Off On A Tangent

The basic idea of Newton's Method is remarkably simple and graphic (Fig. 1):

> at a point (x, f(x)) on the graph of f, the tangent line to the graph of f "points toward" a root of f, a place where the graph touches the x–axis.

If we want to find a root of f , all we need to do is pick a starting value x_0, go up or down to the point $(x_0 , f(x_0))$ on the graph of f, build a tangent line there, and follow the tangent line to where it crosses the x–axis, say at x_1. If x_1 is a root of f , then we are done. If x_1 is not a root of f, then x_1 is usually closer to the root than x_0 was, and we can repeat the process, using x_1 as our new starting point. Newton's method is an **iterative procedure**, that is, the output from one application of the method becomes the starting point for the next application.

Fig. 1

Let's start with a differentiable function $f(x) = x^2 - 5$, (Fig. 2) whose roots we already know, $x = \pm\sqrt{5} \approx \pm 2.236067977$, and illustrate how Newton's method works. First we pick some value for x_0 , say $x_0 = 4$ for this example, and move to the point $(x_0 , f(x_0)) = (4 , 11)$ on the graph of f.

Fig. 2

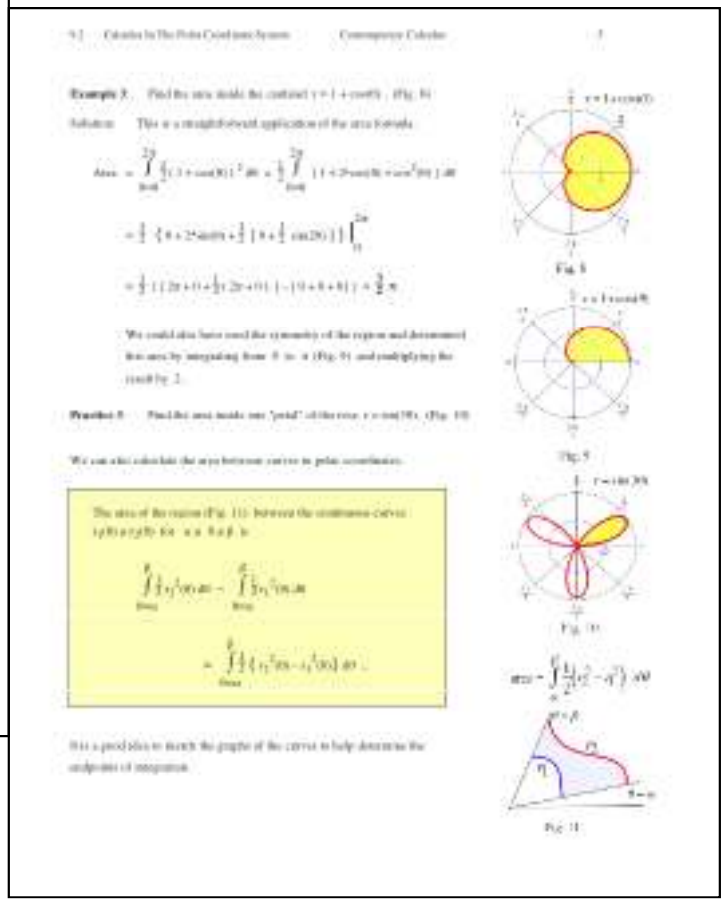
At (4 , 11) , the graph of f "points to" a location on the x–axis which is closer to the root of f (Fig. 3). We can calculate this location on the x–axis by finding the equation of the line tangent to the graph of f at the point (4 , 11) and then finding where this tangent line intersects the x–axis:

Fig. 3

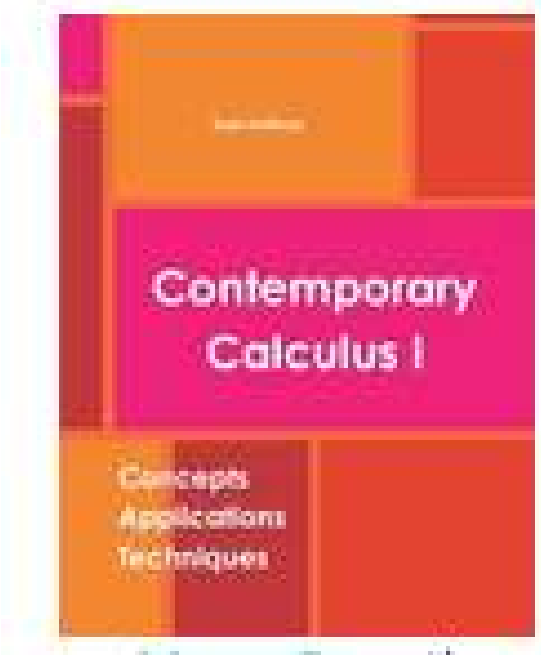
At the point (4 , 11), the line tangent to f has slope $m = f'(4) = 2(4) = 8$, so the equation of the tangent line is $y - 11 = 8(x - 4)$. Setting $y = 0$, we can find where the tangent line crosses the x–axis:

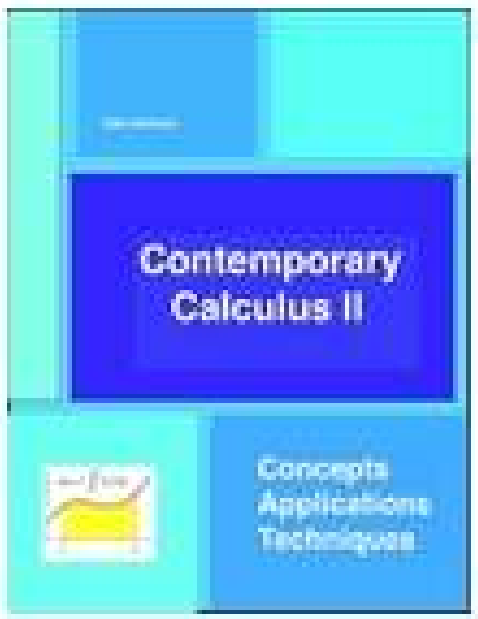
$0 - 11 = 8(x - 4)$, so $x = 4 - \frac{11}{8} = \frac{21}{8} = 2.625$.

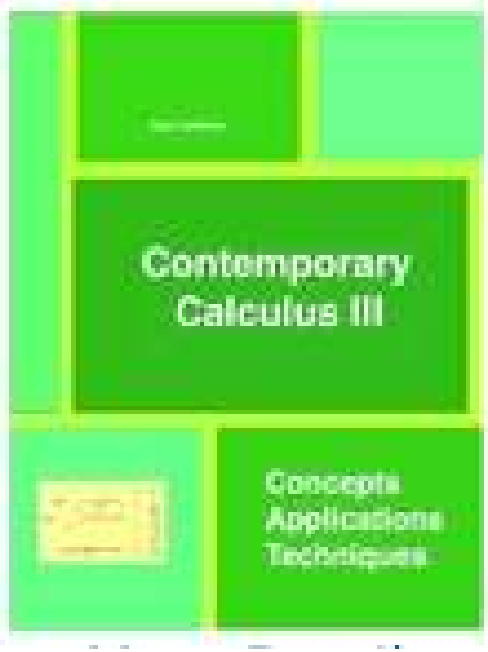
Text pages in color on the web



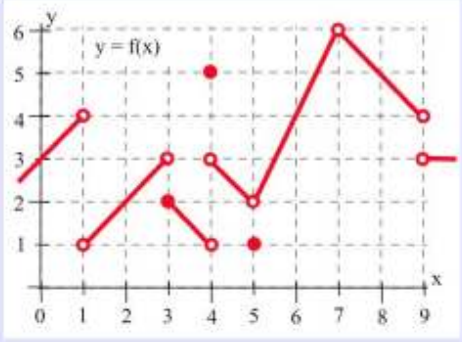
Printed Versions -- B&W, about 300 pages each, less than $20 each







Calculus I Problems from WAMAP



Enter each answer as a whole number (like -4, 0, or 253)

or a fraction (like 1/4, -2/5 or 11/7)

or DNE for Does Not Exist or undefined.

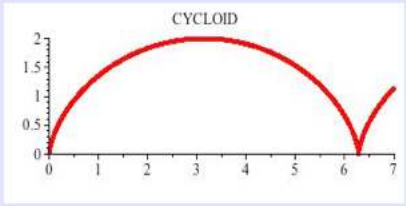
$\lim_{x \to 1^+} \frac{f(x)-3}{f(x+1)-} =$

$\lim_{x \to 3^-} f(f(x)+3) =$

$\lim_{h \to 0} \frac{f(6+h)-f(6)}{h} =$

Let $x(t) = t - \sin(t)$

and $y(t) = 1 - \cos(t)$



All answers should be decimals

rounded to 2 decimal places.

At $t = 2$

$x(t) =$

$y(t) =$

$\frac{dx}{dt} =$

$\frac{dy}{dt} =$

$\frac{dy}{dx}$ = tangent slope =

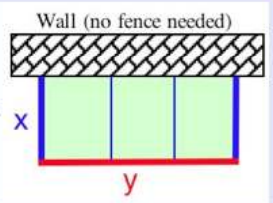
speed =

x	0	1	2	3	4	5	6	7
f(x)	3	2	1	-2	3	4	0	5
f '(x)	-2	-1	2	4	1	0	3	6

x	0	1	2	3	4	5	6	7
g(x)	1	3	5	2	-1	0	-2	4
g '(x)	2	3	-2	0	-3	4	1	5

When x = 2 then $D\left(\frac{f(x)}{g(x)}\right) =$

You have 72 feet of wire to enclose three pens.



One side is a wall that needs no fence.

The outside fencing (thick lines) requires 4 strands of wire.

The inside dividers (thin lines) require 1 strand of wire.

What values for x and y will create a fence that encloses the maximum total area for the pens?

x =

y =

Enter each answer as a whole number or as

a reduced fraction (such as 4/5, 35/4 or 11/2).

Show Answer

Show Answer

To sample

wamap.org

Username: OCL

Password: OCL

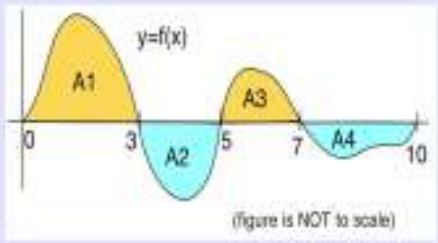
Calculus II Problems from WAMAP

Evaluate the integral below by interpreting

it in terms of areas in the figure.

The areas of the labeled regions are

A1= 5, A2=3, A3=2 and A4=1



$$V = \int_{5}^{10} 1 + f(x)\,dx$$

V = ____

Enter your answer as a whole number

Show Answer

Evaluate each integral below by interpreting

it in terms of areas bounded by the integrand function.

$$V = \int_{1}^{9} 3\text{-}x\,dx = \_\_\_\_$$

$$V = \int_{1}^{9} |\,3\text{-}x\,|\,dx = \_\_\_\_$$

Enter each answer as a whole n

a reduced fraction (such as 4/5,

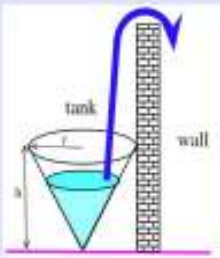
Show Answer

Show Answer

To sample

wamap.org
Username: OCL
Password: OCL

A 14 foot tall wall is next to a conical tank that has a top radius of 4 feet and is 6 feet tall. The tank is full of a liquid that has a density of 55 pounds per cubic foot.



Represent the amount of WORK done to lift (pump) the top 2 feet of liquid to the top of the wall as an integral.

(use "pi" for PI=3.14159)

Work = $\int_{a}^{b}$ ____ Preview dx

a = ____

b = ____

Then evaluate the integral. Work = ____ *foot-pounds*

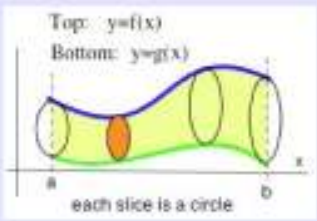
Show Answer

Show Answer

Show Answer

Show Answer

A solid is formed between f(x) and g(x) so each slice (perpendicular to the x-axis) is a circle.



Represent the volume of this solid as a definite integral.

Volume = $\int_{a}^{b}$ ____ Preview dx

Type 3.14 for "pi"

Show Answer

Quality & Student Success

- Profession reviews
- Student success
- Student feedback

Some professional reviews of the Contemporary Calculus manuscript

from a New York CC

Better than any other book I've seen, these problems force students to think about what concepts mean.

I am quite favorably impressed with this text.

Emphasis on geometrical reasoning. **A**

Emphasis on meaning and use of concepts. **A**

Problem sets. **A+**

from a Florida university

Emphasis on geometric reasoning. I think this is very important and it is one of the strengths of this manuscript. A

Problem sets. A

Applications for motivation. A

Stewart/Hoffman Success Comparison

Bellevue College used Stewart (2006-07) and Hoffman (2007-08)

Stewart N=622

Success = "ABC" = 74.4%

Success range: 42 – 90%

Hoffman N=710

Success = "ABC" 74.8%

Success range: 40 – 95%

Five instructors taught multiple sections in 2006-07 using Stewart and then multiple sections in 2007-08 using Hoffman.

The student success numbers for these five instructors were virtually identical using each text, but 4 of the 5 had slightly greater student success using Hoffman

Student Feedback

During Fall 2010 students in my 2 sections of Calculus I evaluated various aspects of the course.

Course Content & Effectiveness

Very satisfied	39	(64%)
Satisfied	22	(36%)
Dissatisfied	0	

Course Materials

Very satisfied	41	(67%)
Satisfied	18	(30%)
Dissatisfied	2	(3%)

Finding the materials on the web

Textbook (as PDF and MS WORD files)

http://scidiv.bellevuecollege.edu/dh/Calculus_all/Calculus_all.html

Or just Google "hoffman calculus"

Class web pages include quizzes, tests and worksheets

- Math& 151: Calculus I

  http://scidiv.bellevuecollege.edu/dh/math151/math151.html

- Math& 152: Calculus II

  http://scidiv.bellevuecollege.edu/dh/math152OCL/math152OCL.html

- Math& 153: Calculus III

  http://scidiv.bellevuecollege.edu/dh/math152OCL/math152OCL.html

Printed version: lulu.com search "Hoffman Calculus"

Top 1000 reasons I created a FREE calculus book

Top 1000 reasons I created a FREE calculus book

8. Our students deserve a cost break

Top 1000 reasons I created a FREE calculus book

8. Our students deserve a cost break

7. I love calculus. It was fun.

Top 1000 reasons I created a FREE calculus book

8. Our students deserve a cost break
7. I love calculus. It was fun.
6. Most of my students are taking calculus for the first time

Top 1000 reasons I created a FREE calculus book

8. Our students deserve a cost break
7. I love calculus. It was fun.
6. Most of my students are taking calculus for the first time
5. I enjoy creating materials to help students learn

Top 1000 reasons I created a FREE calculus book

4. Teachers can modify the text

Top 1000 reasons I created a FREE calculus book

4. Teachers can modify the text

3. I like to share

Top 1000 reasons I created a FREE calculus book

4. Teachers can modify the text
3. I like to share
2. People think I'm crazy so they are nice to me

Top 1000 reasons I created a FREE calculus book

4. Teachers can modify the text
3. I like to share
2. People think I'm crazy so they are nice to me
1. I have enough money

Thank you

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Please contact me if you have any questions or want more information.

Thank you

Bellevue College is hiring 3 tenure track math positions !!

Dale Hoffman

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Questions?

http://www.opencourselibrary.org

http://www.opentextbookstore.com

http://www.myopenmath.com login/password: OCL