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INTRODUCTION

Welcome to AP Calculus AB! This course will likely be your first taste of post-secondary level mathematics and the topics we cover will be discussed at the same level as it would be in Differential Calculus courses in college or university (typically called Calc I). Normally this class is already accelerated and now we are going to finish it in about 9 weeks. As such, it should go without saying that **this is a very intense course** and requires a lot of discipline and self-care. To give you some context, the average precalculus 12 grade of students taking Calc I at UBC a few years ago was 90%. The average grade for that calc class was 68%. The content is a bit challenging, but what really makes this class difficult is the pace. You will need to give yourself at least 60 minutes each day to practice and understand the material and likely more than 60 minutes to fully understand it.

BASIC EXPECTATIONS

In person:

- Respect everyone's space. We will define how comfortable we are working in small groups, but you need to be mindful that people are in different circumstances and have different people living at home.
- Build comfort doing math collaboratively. Again, this is something we will need to work out how to do in a safe manner, but your skills will improve much faster if you are working with someone else.
- Take risks when offering ideas in class discussions. We will spend about 20 minutes per class working on vertical surfaces to solve problems and build communication skills.
- Use mistakes as opportunities to advance learning. Once you understand what not to do or why something is wrong, you are not going to make that mistake again and the mistake will often highlight what you should do instead.
- Phones and other devices are NOT allowed out for any reason. I have a zero-tolerance policy for using distracting devices and you will be asked to leave the classroom if you use it during class time. **This is a One-Strike Policy. You will not be given a warning.**
- If you miss a class, you are responsible for catching up work and keeping up to date. I will provide copies of the notes on the website and Teams so you can keep up online. Please contact me as soon as you know you will be missing a class.
- There are two tests in this class. My usual policy is that missing a test will result in a mark of 0. Exceptions may be granted only with my prior consent, and with official documentation from your parent or guardian supporting your reason for missing the test. With COVID I need to be notified within 48 hours of the missed test and be emailed/called by a guardian so we can talk about how to make up the test securely. Make-up tests will not be provided, but there will be an extra credit project you can complete to improve your test score.

Online:

- Keep up with the material online. There will be videos posted on Teams and sections in the textbook that you will need to watch and read regularly.
- Use the appropriate channels on Teams to ask and answer questions. I will be available during the flex time for questions and tutorial; however, as many of you will be travelling home or to school in the flex time, I will not have live meetings.
- Complete assignments honestly. Work submitted with a partner requires both partners to write a 300-word paragraph describing how the other person helped.

MATERIALS

- Students will be issued a copy of *Calculus: Graphical, Numerical, Algebraic* by Finney et al. Lost or unreturned textbooks means $95
- Students have the option to purchase the AP Calculus workbook for $35 (strongly recommend)
- Coiled/bound notebook to complete practice problems in and to write additional notes.
- Three-ringed binder to hold handouts and notes.
- A good set of highlighters
- **If you are writing the AP exam,** a graphing calculator (as recommended by the CollegeBoard). The complete list of approved calculators on the CollegeBoard website.
  https://apcentral.collegeboard.org/ap-coordinators/on-exam-day/calculator-policy
  Your calculator must be able to do the following:
  1. Plot the graph of a function within an arbitrary viewing window
  2. Find the zeros of functions (solve equations numerically)
  3. Numerically calculate the derivative of a function
  4. Numerically calculate the value of a definite integral

  The TI-84 is the current industry standard and will not disappoint, but it is a bit expensive ($130). The Casio FX-9750 is a much cheaper option ($65 on amazon with prime) and has the same capabilities. Check the approved list before buying!

  Note: Both of my exams will only allow a scientific calculator. I will ask you to submit assignments that require technology, but these can be completed using Desmos or Geogebra online.

ASSESSMENT & EVALUATION

Understanding will be assessed though a combination of tests, quizzes and work done online. Everything will be marked cumulatively.

Formative: During each class you will have the opportunity to practice the content and receive feedback from me and your peers. We will end the class with a few AP styled multiple choice questions that relate to the current topic. Online I will post a daily question you should be able to answer and I will post a detailed solution at the end of the day you can self asses yourself with.

Summative:

- **70% Midterm and Final**. Both will be 35%. The midterm will cover differential calculus while the final will cover integral calculus. Dates are October 16th and November 10th.
- **15% Quizzes**. We will have a short assessment to start the class every day typically one or two written questions we discussed last class or were in the assigned practice problems. I will omit approximately the bottom 25% of your quizzes apart from a few topics that cannot be dropped.
- **15% Online Assignments**. There will be 4 online assignments for the 4 weeks of online class we have. The first 2 weeks have 2 assignments on basic derivative rules and complex derivative rules. The final 2 weeks online will have 2 assignments on antiderivatives and accumulation of change. These can be completed with a partner if each partner writes a 300-word paragraph describing how the other person helped.
- **Extra credit**. There will be two extra credit projects available to replace some of the midterm or final. The derivative topic will be on the precise definition of the limit using ε and δ. The integral topic will be designing a program in Desmos or Geogebra to approximate the area under a curve using rectangles and trapezoids.
  ** If you would prefer to do a different project it needs my approval first

CURRICULAR COMPETENCIES

These are my goals for you to become a competent problem solver and mathematician

COMPETENCY 1: THINKING & UNDERSTANDING

This is how familiar you are with the tools at your disposal and the methodology of problem solving. A house needs to be built and I want you to organize a thoughtful plan to get the job done. A thoughtful plan means you are aware of limitations and why certain steps should be taken to solve a problem. You have safety checks in place so while you may not know why you made a mistake, you should be able to estimate and realize when something is not right and flexible enough to try something else.

Guiding Questions:

- Do you know what is necessary to solve a problem?
- Are you capable of setting up problems you have not seen before?
- Does your work seem reasonable?
- Do you know why something is true or something is done in a specific way?

Examples:

- Proving something for yourself
- Asking yourself “What if…” to break conditions and test case situations

Non-example:

- Reciting formulas

COMPETENCY 2: COMMUNICATION & REPRESENTING

This is how well your ideas are explained and where math and English have a lot of overlap. Good communication begins with clarity, which comes from organization and effectively using mathematical vocabulary and language. The second part of communication is being able represent your ideas for their intended meanings. You should be able to communicate in pictorial (graphs and figures), symbolic (mathematical notation), written and verbal (complete sentences), and concrete (case examples) forms. Finally, good communication should not be restricted because it is believed to be incorrect. You should feel comfortable making mistakes. Good math happens through collaboration. If other people understand you, they will understand your mistakes and can help improve the argument.

Guiding Questions:

- Can I understand where your mistakes came from?
- Are you saying what you intended to say?
- Can I understand you by glancing at your work?
- Can you communicate your ideas to a collaborative group?

Examples:

- Using your voice to explain your ideas to your group without writing anything down
- Using full sentences in your work and labeling your diagrams

Non-example:

- Writing your ideas on the board while your group watches you

COMPETENCY 3: MODELING & SOLVING

This is the meat and potatoes of mathematics. In general, good thinking and communication practices are essential for effective models and correct solutions. Modelling means being able to use mathematical ideas in situational contexts by transforming a problem in an application to an abstract mathematical formulation. These formulations may provide insight into the original application and can help guide future decisions by making strong predictions or accurate solutions based on the behaviour of the system. Mathematical modelling will often use computers to aid in the formulations (in this class those will range from basic calculators to intermediate programs such as Desmos, Geogebra, or Excel).

Guiding Questions:

- Can you create equations and relationships for real problems?
- Can you recognize the significance of your solution, or can you show insight to the application?
- Are you able to use your model to make accurate predictions?
- Can you use technology effectively?

Examples:

- Using variables until the very end so the problem becomes generalized
- Using technology to further understand and illustrate a problem

Non-example:

- Solutions given on their own without context

COURSE CONTENT

BIG IDEA 1: CHANGE

Using derivatives to describe rates of change of one variable with respect to another or using definite integrals to describe the net change in one variable over an interval of another allows students to understand change in a variety of contexts. It is critical that students grasp the relationship between integration and differentiation as expressed in the Fundamental Theorem of Calculus—a central idea in AP Calculus.

BIG IDEA 2: LIMITS

Beginning with a discrete model and then considering the consequences of a limiting case allows us to model real-world behavior and to discover and understand important ideas, definitions, formulas, and theorems in calculus: for example, continuity, differentiation, integration, and series bc only.

BIG IDEA 3: ANALYSIS OF FUNCTIONS

Calculus allows us to analyze the behaviors of functions by relating limits to differentiation, integration, and infinite series and relating each of these concepts to the others.

AP CALCULUS AB **COURSE OUTLINE**

Legend:

- In person classes are highlighted yellow
- Online classes are highlighted red
- Topics that are italicized **cannot** have their daily quiz replaced
- Topics are that are highlighted blue are covered in one day as are the topics sandwiched between them.

<table>
<tr><th>Topic</th><th>Main Topics</th><th># of Days</th></tr>
<tr><td colspan="3">Week 1: IN PERSON September 14th – 18th</td></tr>
<tr><td rowspan="2">LIMITS & CONTINUITY

Textbook: Chapter 2 plus 3.1 and 3.2

Workbook: Chapter 2 and part of Chapter 3 (page 37 – 99)</td><td>• Defining the limit and limit notation
• Determining limit values from graphs and tables
• Determining limit values algebraically
• Squeeze/Sandwich Theorem
• Limits with infinity
• Types of discontinuities
• Definition of continuity at a point and on an interval
• Intermediate Value Theorem
• Rates of change at an instant
• Defining the derivative at a point and in general
• Differentiability and continuity</td><td rowspan="2">5</td></tr>
<tr><td>COMPETENCIES:
Thinking & Understanding: Do you understand why differentiability implies continuity? Can you prove IVT?
Communication: Can you use the definitions of continuity and differentiability to show functions either are or are not continuous/differentiable? Can you illustrate squeeze theorem? Can you explain the concept of a limit?

BIG IDEAS:
Change: Can change occur at an instant?
Limits: How does knowing the value of a limit, or that a limit does not exist, help you to make sense of interesting features of functions and their graphs?
Functions: How do we close loopholes so that a conclusion about a function is always true regarding differentiability and continuity?</td></tr>
<tr><td colspan="3">Week 2 and 3: ONLINE September 21st – October 2nd</td></tr>
<tr><td rowspan="2">DERIVATIVES

Textbook: Chapter 3 (excluding motion 3.4)

Workbook: Chapter 3 (page 100 – 176)</td><td>• Power rule
• Constant, sum, and difference rule
• Product and quotient rule
• Higher order derivatives
• Derivatives of trig functions
• Chain rule
• Implicit differentiation
• Derivative of inverse functions
• Derivative of exponential and log functions</td><td rowspan="2">9</td></tr>
<tr><td>COMPETENCIES:
Thinking & Understanding: Do you understand how the derivative of inverse functions is determined? Do you understand the logic behind chain rule?
Communication: Can you use limit rules and illustrations to explain the basic derivative rules (constant/sum/product/quotient)?</td></tr>
</table>

	BIG IDEAS: **Change:** How do higher order derivatives relate to change? **Limits:** How do mathematical properties and rules for simplifying and evaluating limits apply to differentiation? **Functions:** How does the derivative describe characteristics of a function?	
Week 4 and 5: IN PERSON October 5th – 16th		
APPLICATIONS of DERIVATIVES **Textbook: Chapter 4 plus 3.4 and 8.1** **Workbook: Chapter 4 (page 177 – 250)**	• Linearization • Behaviour of implicit functions • Extreme Value Theorem and critical points • Mean Value Theorem • Increasing and decreasing functions • First derivative test • Concavity • Second derivative test • Connecting $f, f', \& f''$ • Curve sketching • *Optimization* • *Related rates* • Motion along a line • L'Hôpital's Rule	**7**
	COMPETENCIES: **Thinking & Understanding**: Can you think of different ways the graph of $f, f', \& f''$ might look? Can you think of cases when a function might be increasing on every interval $(a, b) \in D$ but not on D where D is the domain of the function. **Communication**: Can you explain how the first and second derivative test find critical points? Can you explain the MVT? **Modelling**: Can you create models and solve optimization problems? Can you create models and solve related rates problems? BIG IDEAS: **Change:** How is change to different variables related? **Limits:** How can we determine that limit, provided it exists using derivatives and what does linearization mean on the small scales? **Functions:** What additional information is included in a sound mathematical argument about optimization that a simple description of an equivalent answer lacks? How is linearization a good approximation to a function?	
MIDTERM	• Differential Calculus topics (includes a review day) • Friday October 16th	**2**
Week 6 and 7: ONLINE October 19th – October 30th		
ANTIDERIVATIVES & INTEGRATION **Textbook: Chapter 5 (excluding 5.3) plus 6.1, 6.2, and 7.2**	• Antiderivatives • Integration using substitution • Integration using long division and completing the square • Approximating area using RAM and trapezoid • Riemann sums • Area as a limit • Definite integral notation	**9**

<table>
<tr><td>Workbook: Chapter 5 and part of Chapter 6 (page 251 – 326)</td><td>Definite integral properties
Fundamental Theorem of Calculus
Average value
Area between curves
COMPETENCIES:
Thinking & Understanding: Do you understand both parts of the Fundamental Theorem and how they are derived? Do you understand that substitution is a transformation?
Communication: Can you define a discrete integral as a Riemann sum?

BIG IDEAS:
Change: Given information about a rate of change over time, how can we determine the total change over that time?
Limits: How can we use limits to define the definite area under a curve?
Functions: How is integrating to find areas related to differentiating to find slopes? How does the Fundamental Theorem of Calculus relate differentiation to integration?</td><td></td></tr>
<tr><td colspan="3">Week 8 and 9: IN PERSON November 2nd – 10th</td></tr>
<tr><td>DIFFERENTIAL EQUATIONS & APPLICATIONS of INTEGRALS

Textbook: Chapter 6 (excluding 6.3 and 6.6) plus 7.1 and 7.3

Workbook: Chapter 6 (page 327 – 380)</td><td>Integration as net change
Accumulation function applications
Volumes with given cross sections
Volume using discs about x-axis
Volume about non x-axis
Volume using shells
Slope fields
Modelling differential equations
Separation of variables and initial conditions
Modelling exponential growth and decay
COMPETENCIES:
Thinking & Understanding: Can you derive the equation to find volume using discs and shells?
Communication: Can you show the difference when describing the volume after a region has be rotated around a horizontal line vs a vertical line?
Modelling: Can you model problems with an accumulation function? Can you model problems with differential equations and initial conditions?

BIG IDEAS:
Change: Given information about a rate of change over time, how can we determine the total change over that time?
Limits: How can we use limits to define volume and how does the geometry influence our summation?
Functions: How does a differential equation relate to the behaviour of the model?</td><td>5</td></tr>
<tr><td>FINAL</td><td>Integral Calculus topics (includes a review day)
Tuesday November 10th</td><td>2</td></tr>
<tr><td colspan="3">Week 9: ONLINE November 12th – 17th</td></tr>
<tr><td>Outstanding Assignments and Extra Credit Topic</td><td>Various</td><td>4</td></tr>
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