Report of the BC Core Calculus Renewal Sub-committee, 2013

The BC Core Calculus came up for renewal at the 2012 BCCUMPS Meeting at Vancouver Community College. Not all members were prepared to discuss or vote on renewal, so a committee was formed to discuss the the matter and report back in 2013.

The sub-committee members were:

- Justin Gray (SFU)
- Costa Karavas, VCC
- Gary MacGillivray (UVic)
- Wayne Negata (UBC)
- Michael Nyenhuis (Kwantlen)

The sub-committee was delegated to select its chair. This did not happen. Instead, all members participated in a collegial way.

The sub-committee met on April 24, 2013, at Vancouver Community College. The main topic of discussion was whether Sequences and Series should be made one of the core topics, how, and what might be removed from the core in order to make room for it. The reason for considering this possible change originated at the 2012 BCCUPMS Meeting, where notice was served by UBC that it intended to include Sequences and Series to all of its first year calculus sequences.

The sub-committee recommends that the BC Core Calculus be renewed for five years, with some changes as indicated below. The balance between core topics and additional topics is not recommended to be changed.

<u>Housekeeping changes to the core curriculum for first year sciences calculus</u>

These changes in wording are not intended to indicate any substantive change to the curriculum.

- Change the reference text to Stewart, Calculus, Early Transcendentals. 7th Ed.
- Amendments of point 5, bullet 5. Delete “tables”
- Change Additional Topics point 2 to "Additional applications of integration".

<u>More substantive changes to the core curriculum for first year sciences calculus</u>

These changes are intended to include some topics from Sequences and Series in the core, and balance that by removing a small amount of numerical integration and differential equations. The wording changes are intended to clearly indicate the level of coverage required for the core topics.

- Amend point 3 "Taylor polynomials and special Taylor series (sin, cos, exp, 1/(1-x))" by adding the words "plus enough sequences and series to understand the radius of convergence; in particular, the concept of series and convergence, the ratio test, and how to find the radius of convergence."
- Clarification of which topics in Sequences and Series are optional by adding "for example, the following tests: integral, comparison, alternating series, root, and limit ratio" to point 1 under "Additional Topics".
- Amend to point 5, bullet 1. Add "and approximate integration" to "Definition of the definite integral".
- Delete point 6. Amend Additional Topics, point 7 by adding "and error bounds".

- Amend point 8 to become "separable differential equations"

With these proposed revisions, the core curriculum would become:

2013 Revised Core Curriculum
First-Year Sciences Calculus

A first year (two-semester) Sciences Calculus course must include all the topics from the **Core Topics** list. It is expected that coverage of this material would constitute three-quarters of the course(s) with the remaining one-quarter chosen from the **Additional Topics** list. For breadth, at least four Additional Topics should be included.

Reference Text: Stewart, *Calculus, Early Transcendentals, Seventh Edition*, Brooks Cole, 2010.

Core Topics (75%)

1. Limits, continuity, intermediate value theorem
2. Differentiation
    - First and second derivatives with geometric and physical interpretations
    - Mean value theorem
    - Derivatives of exp and log functions, exponential growth and decay
    - Derivatives of trigonometric functions and their inverses
    - Differentiation rules (including chain rule, implicit differentiation)
    - Linear approximations and Newton's Method
    - Optimization - local and absolute extrema with applications
3. Taylor polynomials and special Taylor series (sin, cos, exp, 1/(1-x)), plus enough sequences and series to understand the radius of convergence; in particular, the concept of series and convergence, the ratio test, and how to find the radius of convergence.
4. Curve sketching
5. Integration

    Definition of the definite integral and approximate integration
    Areas of plane regions
    Average value of a function
    Fundamental Theorem of Calculus
    Integration techniques: substitution (including trig substitution), parts, partial fractions
    Applications of integration
6. Improper integrals: evaluation and convergence estimates
7. Separable differential equations

Additional Topics (25%)

1. Sequences and series. For example, the following tests: integral, comparison, alternating series, root, and limit ratio.

2. Additional applications of integration
3. Additional differential equations topics
4. Complex numbers
5. Continuous probability density functions
6. Polar coordinates and parametric equations (with calculus applications)
7. Additional numerical methods (eg. Simpson's Rule) and error bounds
8. Related rates
9. L'Hôpital's Rule

The committee recommends that the corresponding wording changes be made to the Social Sciences / Business Calculus. With these changes, it would become:

2013 Revised Core Curriculum
First-Year Social Sciences/Business Calculus

A first year (two-semester) Social Sciences/Business Calculus course must include all the topics from the **Core Topics** list. It is expected that coverage of this material would constitute approximately two-thirds of the course(s) with the remaining one-third chosen from the **Additional Topics** list. For breadth, at least four Additional Topics should be included.

Reference Text: Haeussler and Paul, *Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences*, *Ninth Edition*, Prentice Hall, 1998.

<u>Core Topics</u> (67%)

1. Limits, continuity, intermediate value theorem
2. Differentiation

   First and second derivatives with geometrical and physical interpretations
   Applications to economics, business and social sciences
   Derivatives of exp and log functions, exponential growth and decay with applications
   Derivatives of trigonometric functions
   Differentiation rules (including chain rule, implicit differentiation)
   Linear approximations and Newton's Method
   Optimization - local and absolute extrema with applications
3. Curve sketching
4. Integration

Definition of the definite integral, approximate integration
Areas
Average value of a function
Fundamental Theorem of Calculus
Integration techniques: substitution, parts
Applications of integration

5. Separable differential equations

<u>Additional Topics</u> (33%)

1. Introduction to probability and statistics
2. Partial derivatives and Lagrange multipliers
3. Matrix analysis and Gaussian Elimination
4. Applications of integration
5. Taylor polynomials and special Taylor series (sin, cos, exp, 1/(1-x)), plus enough sequences and series to understand the radius of convergence; in particular, the concept of series and convergence, the ratio test, and how to find the radius of convergence.
6. Additional topics in sequences and series. For example, the following tests: integral, comparison, alternating series, root, and limit ratio.
7. Improper integrals: evaluation and convergence estimates
8. Continuous probability density functions
9. Related rates
10. Derivatives of inverse trigonometric functions
11. Further techniques of integration
12. Additional numerical integration methods and error bounds