Concordia Faculty of Arts and Science

SFYX Math 205/53 Winter 2021

Course Outline

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Office hours: By appointment using the ZOOM teleconferencing format

Although Math SFYX-Math 205/53 is a sequel to SFYX-Math 203/53, the courses can be taken independently. However, a successfully completed course on differential calculus, equivalent to Math 203, is required for admission.

This course is taught interactively using Zoom and requires Mathematica for participation.

What is SFYX?

The Faculty of Arts and Science of the university puts it this way:

First-year students pursuing a Bachelor of Science at Concordia will have the unique opportunity to engage in interdisciplinary, research-based approaches to the foundational sciences (chemistry, biology, physics) and mathematics. You'll gain a well-rounded understanding of a variety of science disciplines, see how they're connected, and explore how they impact society.

Targeted audience

SFYX Math 205 /53 is primarily intended as a course in integral calculus for first year science students not intending to pursue advanced studies in mathematics and statistics.. The program is sponsored by the Faculty of Arts and Science and offered within the course options of the Department of Mathematics and Statistics.

The mathematical topics in this course follow the standard topics in an introduction to integral calculus and require knowledge gained in a first-year course on differential calculus such as SFYX Math 203.

The difference between a regular Math 205 course and its SFYX version is the balance between manual practice and technological techniques used and the emphasis is on applications of calculus in science, technology, and scientific aspects of engineering.

The theoretical aspects of calculus are introduced and explored with numerous examples in the SFYX Math 205 tutorials. The lectures review and deepen the understanding of the concepts introduced in the tutorials. This pedagogical approach to learning is also referred to as “flipped classroom teaching.”

Students who are not in the SFYX program and who prefer the usual manipulative learning of calculus should consider enrolling in a regular section of Math 205.

Learning objective

The “functions” constructed and studied in calculus with the help of “limit” of sequences of numbers, simpler functions, and other mathematical objects are models for many diverse problems arising in science, engineering, and related fields. The operations of addition (+), subtraction (-), multiplication (×), division (÷), extraction of roots ($\sqrt{\blacksquare}$), the exponentiation $(\blacksquare)^n$, the composition of two function f[g[■]], and so on are the tools for constructing the pool of functions for study.

In “differential calculus,” the basic idea is to use “limits” of slopes to build tangents to the curves of functions. In “integral calculus” (this course), one of the basic ideas is to use “limits” of sequences of measures of length, area, and volumes obtained with basic formulas for length, area, and volume in geometry to define and calculate lengths, areas and volumes of wide range of objects in the plane and space.

What kinds of problems can we solve (model) with differential and integral calculus?

- Differentiation of f[x] is studied and applied in Math 203.

$$f[x] \to f'[x] = \text{Limit}\left[\frac{f[x+h]-f[x]}{h}, h \to 0\right]$$

- Integration of f[x] is studied and applied in Math 205. What do we mean by the following operation?

$$f[x] \to \int f[x]\, dx$$

The outcome is called an “indefinite” integral. It is a family of “antiderivatives” of f[x]. Indefinite, because there are infinitely many functions whose derivatives are f[x].

The definite integrals

$$\int_a^b f[x]\, dx$$

are numbers with several interpretation such as the area between the x-axis and the graph of f[x], measured on the interval [a, b].

The connection between two integrals

$$\int f[x]\, dx \text{ and } \int_a^b g[x]\, dx$$

arises if the derivative of g[x] is an antiderivative of f[x]. The “fundamental theorem of calculus” explains the connection.

Another application of limits to sequences of functional values arises if we want to find numerical values of “transcendental” functions constructed with trigonometric functions such as the sine and cosine functions, and exponential and logarithmic functions. In most cases, computers and calculators can only find “approximate” values by finding the values of polynomials:

In[∘]:=
```
infiniteSeries = Series[Sin[x], {x, 0, 10}]
```

Out[∘]=
$$x-\frac{x^3}{6}+\frac{x^5}{120}-\frac{x^7}{5040}+\frac{x^9}{362\,880}+O[x]^{11}$$

In[∘]:=
```
polynomial = Normal[Series[Sin[x], {x, 0, 10}]]
```

Out[∘]=
$$x-\frac{x^3}{6}+\frac{x^5}{120}-\frac{x^7}{5040}+\frac{x^9}{362\,880}$$

In[∘]:=
```
N[Sin[x] /. x → 2]
```

Out[∘]= 0.909297

In[∘]:=
```
N[polynomial /. x → 2]
```

Out[∘]= 0.909347

In[∘]:=
```
Manipulate[Normal[Series[Sin[x], {x, 0, 10 + a}]], {a, 0, 5, 1}]
```

Out[∘]=

a

$$x-\frac{x^3}{6}+\frac{x^5}{120}-\frac{x^7}{5040}+\frac{x^9}{362\,880}-\frac{x^{11}}{39\,916\,800}+\frac{x^{13}}{6\,227\,020\,800}-\frac{x^{15}}{1\,307\,674\,368\,000}$$

In[∘]:=
```
Normal[Series[Sin[x], {x, 0, 10 + 5}]] /. x → 2
```

Out[∘]=
$$\frac{580\,598\,114}{638\,512\,875}$$

In[∘]:=
```
N[%]
```

Out[∘]= 0.909297

As the calculations show, we can “improve” the approximate value of Sin[2] by working with more terms of a polynomial that approximates the sine function. A closer look at these polynomials shows that they are very simple functions constructed using addition, subtraction, division and exponentiation.

The SFYX version of Math 205 uses Mathematica to allow us to explore the some of the uses and properties of integrals to model and solve problems in mathematics, science, engineering, and other fields.

The course ends with individual projects that allows every student to solve a problem of personal interest using ideas and techniques of integral calculus. This culminating exercise is intended to be a unifying learning objective of the course for each student.

Reflections

The ten reflections (Week 2 to 11) are answers to the following two questions, written by completing reflection templates. Students have fifteen minutes at the end of a lecture to write and post their answers. Reflections must be spontaneous and written in class.

- Question 1

Summarize in words what you have learned from today's lecture and from your participation in the class.

- *Question 2*

Summarize in words how what you have learned today fits into your previous knowledge or how you think you might be able to use it in the future.

Past students have found the writing of reflections an enjoyable and rewarding experience. Reflections also fit well into the goals and style of the SFYX approach to teaching and learning. The students who wrote them in other courses found that the writing of reflections promotes understanding and retention of course material, encourages exploration, and fosters curiosity.

Ten posted reflections count for one mark each towards the final grade and are **confidential to the students who wrote them.**

Requirements

- SOFTWARE
  - **Mathematica,** a free download from your MyConcordia portal. Once installed on your computer (Mac or PC), you need to activate Mathematica. Your Concordia e-mail address is your Activation Key.
- TEXTBOOK
  - Your textbook is the interactive electronic version of **Calculus, Early Transcendentals, 3rd edition, by Briggs, Cochran, Gillett, and Schulz,** published by Pearson. You require a six-month subscription obtained from the Concordia Bookstore.
  - *In this course, the textbook will simply be referred to as "Briggs."*
- MYLAB/MATH

- **All assignments and examinations** are randomized self-grading examinations posted in **MyLab/Math.**
- **Practice examinations** are also posted in MyLab/Math and can be repeated as often as desired.

Learning style and objectives of the SFYX version of Math 205

- Interactivity based on Wolfram Mathematica
- Extensive use of graphic learning tools to deepen understanding
- Introduction to next-gen thinking and computational reasoning
- Making calculus relevant, enjoyable, accessible, and learnable
- All tutorials, lectures, and assignments are based on theMathematica-based interactive electronic version of the textbook "Calculus" by Briggs, Cochran, Gillett, Schulz.

The textbook is included in your 6-month subscription to MyLab/Math and you do not require a printed copy of the textbook.

- The MyLab/Math subscriptions are available from the Concordia University Bookstore.
- The textbook for the regular sections of Math 205 cannot be used in this SFYX section of Math 205.
- If you have bought the textbook for the regular sections of Math 205, please return it to the vendor for a refund.
- If you have been registered in any Math 205 Tutorial other than the tutorials links to SFYX Math 205/53, you need to switch immediately since only the SFYX tutorials count for marks in this course.
- The course projects are written as interactive slide shows in Mathematica. Sample projects written by former students will be provided and templates will be posted.

Grading scheme

1. Tutorials and Assignments - 15%
2. Proctored Midterm 1 (Week 7) based on Weeks 1 to 5 - 30%
3. Proctored Midterm 2 (Week 11) based on Weeks 6 to 10 - 30%
4. Mathematica Calculus Project based on the Assignment "Applications and Examples" - 20%
5. Reflections - 5%

Tutorials

The tutorials for the SFYX version of Math 205 are different from those for the regular section. They provide the technical material required in the Wednesday lectures and are posted as Zoom recordings every Monday. In fact, the lectures assume that you have worked through the tutorials.

You are expected to use Mathematica to work through all computational elements of the tutorials.

In Office Hour meetings, you will be required to use the work in your Mathematica notebook as a basis for discussion.

Lectures

The lectures are interactive. They deal with calculus problems in science and related fields, solved with the tools discussed in the tutorials of associated lectures.

Assignments

The assignments and examinations of the course are MyLab/Math problem sets solved with Mathematica. Each assignment and examination is accompanied by a practice version to ensure that you have the opportunity to do well in the course.

Week 1 - Introduction to Mathematica and MyLab/Math

Week 2 - Briggs Chapter 3 - Derivatives

Week 3 - Briggs Chapter 4 - Applications of the derivative

Week 4 - Briggs - Chapter 5 - Integration

Week 5 - Briggs Chapter 6 - Applications of integration

Week 6 - Briggs Chapter 8 - Techniques of integration

Week 7 - Midterm Examination 1 and Science Applications

Week 8 - Briggs Chapter 10 - Sequences and Infinite series

Week 9 Briggs - Chapter 11 - Power series

Week 10 - Briggs Chapter 11 - Taylor series

Week 11 - Midterm Examination 2 and Sample Projects

Week 12 - Project Topics, Drafts, and Completion Templates

WEEK 13 - Course Completion and Review

End of the Course Outline