MATH 123 — Multivariate calculus

Description
This is an advanced calculus course, meant as a sequel to a standard calculus course such as MATH 121. Students should be familiar with the notions of functions, continuity, derivatives, integrals, and all the associated techniques: product rule, chain rule, integration by parts, integration by substitution, and so on.

The goal of this course is to introduce two essentially independent topics. The first is sequences and series. The second is indeed multivariate calculus. These are both fundamental tools in math, but also physics, chemistry, economics, and more generally to anyone who uses any sort of math. We will mostly focus on understanding the concepts and how to make computations, as there is only little time to give rigorous proofs.

Objectives

- **Sequences and series**: prove the convergence or divergence of sequences, use various tests and criteria to study the convergence of series. Know the power series of usual functions, compute other power series, apply power series to the approximation of functions or to computing limits.

- **Geometry of space**: master and understand the notions of vectors, dot product, cross product. Applications to writing line and plane equations.

- **Multivariate functions**: be able to compute limits and partial derivatives, apply the chain rule. Use these concepts to study tangent planes or extrema.

- **Multiple integrals**: understand the definition, computation via Fubini's theorem, change of coordinates. Apply more general change of variables. Application to computing surfaces or volumes.

- **Vector calculus**: understand the definition of line integrals and the fundamental theorem. Use Green's theorem. Be able to use curl and divergence, and use Stokes' theorem and the divergence theorem for computations.

Information

**Room**: TBD (please check online before the first class)

**Time**: Monday and Wednesday 2:40pm - 4pm (classes),
Friday 2:40pm – 4pm (recitations)
Staff

Instructor: Raoul Normand

Office: TBD (see during the first class)

Email: raoul.normand@nyu.edu

Office hours: TBD (discussed during the first class)

Material


We will essentially follow the book, Chapters 11, 12, 14, 15, 16. The solution manual gives solution to the odd-numbered exercises in the book, so it is a good way to check your results when you work on your own. If the student manual is not available, the instructor manual provides solution to all the exercises and could just as well be used.

Grading

The grading will consist of weekly quizzes and homeworks, a midterm, and a final exam.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Time</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Quiz</td>
<td>Weekly</td>
<td>Friday 2:40 – 2:50</td>
<td>15%</td>
</tr>
<tr>
<td>Homework</td>
<td>4 during the term</td>
<td>Given Wednesday, to hand in Monday 12 days later</td>
<td>20%</td>
</tr>
<tr>
<td>Midterm</td>
<td>1</td>
<td>After about 8 weeks</td>
<td>25%</td>
</tr>
<tr>
<td>Final</td>
<td>1</td>
<td>Final exam period (12/15 – 12/21)</td>
<td>40%</td>
</tr>
</tbody>
</table>

- **Quizzes** will be given weekly during the first 10 or 15 minutes of the recitations. They will cover what is done during the two precious classes. Only the 11 (out of 13) best grades will be kept and averaged. They could be any type of exercise: multiple choice questions, true or false, open questions... The marking scheme will be indicated on each specific quiz.

- **Homework assignments** will be given after about 2, 5, 9, and 12 weeks, after the Wednesday class, and should be handed in at the beginning of the Monday lecture 12 days later. You are more than encouraged to work in groups, but each
student should hand in their own work in their own words. You can give handwritten assignments, or assignments typed up in LaTeX. This is mostly for those who wish to train to use LaTeX, since it is clearly shorter to write math by hand. Please refrain from using Word or other typesetting software which are not meant for scientific typesetting. Each assignment is worth 5% of the final grade.

- The midterm will occur after about 8 weeks, and should cover the two first parts of the course, namely series and sequences, and vectors in space. It will be one hour and twenty minutes long and will take place during one of the regular hours. The precise date will be fixed later.

- The final exam will be 3 hours long and take place during the dedicated exam week, so some time between December 15 and December 21. You will be notified by the registrar and myself when the date is known. It will cover everything that was done during the term.

The goal of quizzes is to make you review the material studied during the week, before the recitation, so they will be fairly easy. Homework assignments will be more advanced, and always contain an exercise regarding earlier material.

The main goal of the course is to learn new concepts and many techniques to solve related problems. This cannot be mastered without trying one’s hand at many exercises so as to get familiar with the concepts. For instance, you learned derivatives, and should be able to compute them effortlessly. But you should also remember that it took you a long time and a huge number of exercises to be able to do so, and then move on to more complicated / interesting / realistic / applied problems. This is just as true for this course. The homework is meant to further cement your knowledge.

I will do my best to hand back the different tests the class right after they are handed in, but please acknowledge that I have other duties and I might be delayed.

The final grade will be computed as indicated above and rounded up, then turned into a letter grade from A to D (or F) according to the university policy.

**Guidelines for assignments and tests**

Please use a blue or black pen for your assignments and tests. Red ink is my prerogative. Do not forget to write your English name and your student number, and number your pages and total number of pages, such as 1/3, 2/3, 3/3.

When I hand back your assignments, please check your marks immediately and notify me at the end of the class if there is any issue. You have until the next class to raise any issues regarding the grading, and later complaints won’t be accepted.

No documents are allowed during tests. If I deem it necessary, I will provide a reference sheet for formulas. No calculators or electronic devices are allowed either.
Lateness policy

If, for whatever reason, you cannot attend the Monday class and hand in your assignment, ask one of your classmates to give it to me, or make sure that I get it anytime before the class (e.g. give it to me during an earlier class, bring it to my office, or put it in my mailbox).

Assignments given later, up to the beginning of the Wednesday class, will take 50% off. Later assignments won’t be graded. The homework is mandatory and two assignments not returned will mean 0% out of the whole 20%.

Class rules and behavior

You are naturally expected to attend every class, and be there on time. Late students disturb the class, and do not do themselves any benefit: you will miss much more than a couple minutes if you have to catch up on everything that was said or written when you were not there. If things get out of control, I might have to close the door and not allow late students in, but I hope that we will not come down to that.

In particular, do not be late for quizzes. They will start at 2pm sharp, you will not get extra time if you show up late.

Attendance to classes is of course expected. I will not call the roll, but I trust your good sense. Even though we will mostly follow the book, you cannot expect to learn as much by yourself. Moreover, I will add or skip certain topics, and I will show you what things really matter, how to use different techniques, how to write precise and concise math, and so on, so that you will gain a lot by attending classes.

Unless you have special needs (in which case, tell me beforehand), do not use your phones or laptops during the class. Even if you like to type up your notes, please use a pen and paper during the lectures. You cannot expect to follow the course and type up equations at the same time, not to mention that the noise would be distracting for everyone. More generally, remain quiet and attentive, do not chat, eat, run to the washroom, etc. All in all, respect your classmates and your instructor, as you expect them and myself to respect you.

Illness

If you are ill for a quiz, it will automatically be counted as a zero (and thus canceled, as one of the two lowest grades).

If you are ill for the midterm or for the final exam, notify me ASAP and get a note from your doctor. We will then discuss the modalities of a make-up exam.
## Calendar

<table>
<thead>
<tr>
<th>Week</th>
<th>Section in the book</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2, 3, 4, 5, 6, 7</td>
<td>Warm-up (derivatives, integrals...)</td>
</tr>
<tr>
<td>2-6</td>
<td>11-1 – 11-11</td>
<td>Sequences and series</td>
</tr>
<tr>
<td>7</td>
<td>12-1 – 12-5</td>
<td>Vectors and geometry of space</td>
</tr>
<tr>
<td>8-9</td>
<td>14-1 – 14-7 (14-8*)</td>
<td>Partial derivatives</td>
</tr>
<tr>
<td>12-13</td>
<td>16-1*, 16-2 – 16-5, 16-6*, 16-7 – 16-9</td>
<td>Vector calculus</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Catching up, reviewing</td>
</tr>
</tbody>
</table>

This is just a tentative schedule, which might be adapted depending on how the class goes. Specifically, we might spend less or more time on some topics, and those with a * might be skipped. Depending on the students' needs, I will add a couple reviews / crash courses during the term.