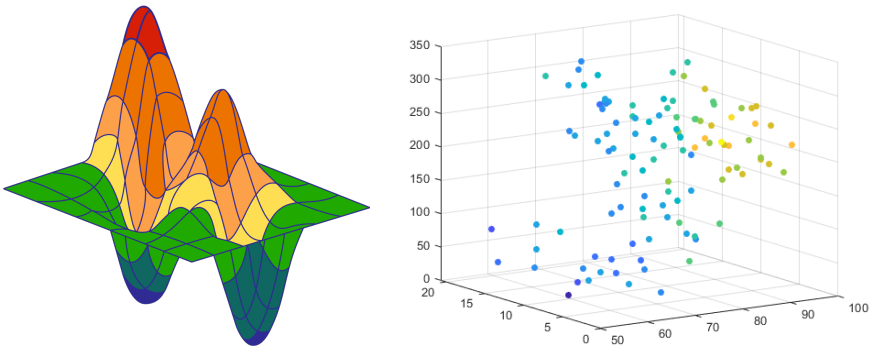
Syllabus 2025-26
MAT 237 Multivariable Calculus with Proofs
University of Toronto

Can an ant walking on the Earth tell if it's a sphere? What patterns can we find in massive data sets? How can we maximize our company's revenue subject to so many cost constraints? Which direction should we walk to rapidly ascend a mountain? How does wind flow over an airplane wing? Why can we only see one side of the moon? How does heat transfer across a surface? Where can we expect to find an electron in a hydrogen orbital? How can we describe the relationship between electricity and magnetism? Why do complex numbers arise in the theory of sound and music? Which path will a rubber duck take as it floats along the river? How do algorithms in artificial intelligence learn from evolving data? What is the shape of the universe?

Multivariable calculus is the language used to explore all of these questions and many more. We will explore this mathematical theory and touch on some of these fascinating questions.



Course Objectives

The MAT237 teaching team has three objectives for your growth and development. We want you to:

1. **Learn more independently.** You will be trained to actively read a textbook with quantitative theory and generate critical questions. You will evaluate sophisticated arguments and measure their validity. You will build connections between ideas within a rich and growing framework.

2. **Apply advanced calculus tools and problem-solving techniques.** You will select and apply appropriate tools from multivariable calculus using a modern perspective informed by linear algebra. You will analyze familiar and novel situations, both theoretical and applied. You will experiment with computer software to perform routine calculations and explore problems.

3. **Communicate mathematics rigorously and intuitively.** You will write complex multi-step proofs and translate between plain and technical language to convey ideas. You will interpret informative computer graphics of multidimensional situations. You will collaborate with classmates and articulate your thought process.

We are excited to support your learning experience, so please come talk to us at any time!

Created by Maryam Khaqan. Last updated September 2, 2025 at 19:56:03.

Contents

Contact

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course email admin237@math.utoronto.ca

teaching team See Quercus for a complete list of the teaching team including TAs and office hours

email policy Emails that do not come from an official **@mail.utoronto.ca** account and don't follow basic email etiquette will be automatically deleted. Email is reserved for administrative questions. Please follow the steps in the next section before sending an email.

Have a question? Is it about:

mathematics Post on Piazza, or talk to teaching staff during office hours.

course administration
- First, read this syllabus carefully.
- Second, search the announcements on Quercus.
- Third, read the frequently updated Policies and FAQ page on Quercus.

If you have searched these sources and cannot find the answer, please email admin237@math.utoronto.ca.

course advice Post on Piazza or email your instructor.

accessibility The University of Toronto is committed to accessibility. If you require any additional academic accommodations, please get in touch with Accessibility Services (`studentlife.utoronto.ca/as`) as soon as possible.

university life Please contact your college registrar for almost any aspect of your university life, especially if you are experiencing any academic, personal, or financial struggles.

health and wellness The Health and Wellness Centre provides a range of services for your physical and mental health, wellness programs, and information to help support you in achieving your personal and academic goals. We encourage you to explore their offerings and build healthy habits.

confidential support If you are searching for immediate and/or ongoing *confidential* support for any school, health, or general life concern, then please call U of T Health Student Support at 1-844-451-9700 (or 001-416-380-6578 for outside North America). This service is free and available 24 hours a day in many languages.

Course Information

course website `https://q.utoronto.ca/courses/402509`
You are responsible for checking this webpage regularly.

course code MAT237Y1Y

sections LEC0101, LEC0201, LEC0301, LEC5101

prerequisites See the FAS calendar for details.

description This course is an introduction to multivariable calculus with an emphasis on rigorous proofs. Topics include limits, continuity, partial derivatives, optimization, multiple integrals, vector calculus, and fundamental theorems.

Platforms

Quercus is your MAT237 homepage. It will have all announcements, logistics, pre-class essentials, course materials, and deadlines. Surveys and pre-class quiz grades will be posted on Quercus. However, grades for problem sets and tests can only be viewed on Gradescope; these will not be synced with Quercus.

Socrative is your MAT237 lecture activity app. It is free for you and can be opened in your browser. Download the app before your first lecture. You will explore questions collaboratively and get instant feedback. No account is needed, and none of these activities are graded.

Gradescope is your MAT237 grading and submission software for problem sets and tests. Login to the **Canadian** server only (www.gradescope.ca). Do not use the .com server. Your @mail.utoronto.ca account* will be automatically signed up for a free account when you are assigned your first problem set. Browse their help centre for technical support.

Piazza is your MAT237 discussion forum. It is free for you. Your @mail.utoronto.ca account will be automatically signed up for a free account. You can post questions, find teammates, and help each other. Instructors and TAs will moderate the forum.

Zoom is your MAT237 platform for online learning, if required. For example, some office hours might be held remotely. Sign up for a free Zoom account at utoronto.zoom.us using your UTorID login. We strongly recommend that you install the Zoom desktop client or app.

Resources

Required

Textbook

There is no official textbook for the course. We will instead provide free custom course notes. We will also share a detailed list of readings and resources on Quercus organized lecture-by-lecture.

Suggested

Notes

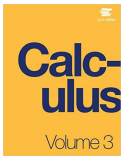
R. Jerrard MAT237 online notes, revised by Z. Wolske (2020)

T. Holden MAT237 lecture notes (2016)

These freely available notes were created by two previous coordinators. Read one if you are looking for an alternate explanation. Be careful, as they sometimes approach things differently than us.

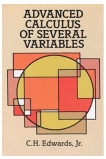
*This email should be the same as the one for Quercus (https://q.utoronto.ca/profile/settings).

Textbooks



G. Strang, E. Herman, Calculus Volume 3, OpenStax (2020)
ISBN-13: 978-1-938168-07-9

This textbook is better suited for a less theoretical course like MAT235. Nonetheless, its many examples and informal explanations can be helpful. You can freely download a PDF or view it online. Be careful, as the definitions are often non-rigorous or do not match our version.

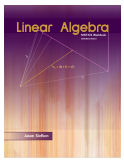


C.H. Edwards, Advanced calculus of several variables, Dover Publications (1995)
ISBN-13: 978-0-486-68336-2

This was the 2020–21 textbook, but it is not required this year. It is a good alternative resource for the first term, but not the second term. Be careful, as definitions and theorems may vary.

G.B. Folland, Advanced calculus, Pearson (2002)
ISBN-13: 978-0-130-65265-2

This was the textbook before 2020, but it is not required this year. It is a good alternative resource for both terms. Be careful, as definitions and theorems may vary.



J. Siefken, Linear Algebra (2022)

This is the official MAT223 Linear Algebra textbook. Use it to refresh your linear algebra.

Videos

MAT137 YouTube channel created by Alfonso Gracia-Saz is an excellent resource for prerequisite review of single variable calculus and how to write proofs.

Khan Academy has a nice set of videos with many computational and motivational examples. The visuals are especially helpful. However, there is little discussion of theory or proofs.

Software

Computer software is an outstanding way to experiment and produce graphs that would otherwise be really hard to create by hand. Here are some online calculators that are easy to use.

Math3D.org is a basic free online tool for plotting 3D objects using equations. If you want to play around with anything in three dimensions, this is a good choice.

Desmos is a basic free online tool for plotting 2D objects using equations. If you want to play around with contour plots, vector fields, or curves in a plane, this is a good choice.

WolframAlpha is a basic free online calculator for all kinds of calculations. If you want to play around with simple computations, this is a good choice.

Support

All lectures, tutorials, and office hours are planned to be held in person. Some office hours may be held online. For further details on the supports described below, see the Policies and FAQ on Quercus.

Lectures

Lectures are designed to help you achieve a key course objective: to learn independently.

before lecture you must complete the pre-class essentials. For each hour of lecture, this includes a guided reading and a short graded quiz, which are assigned on Quercus.

during lecture you will practice this new material for the first time with our support via a lecture worksheet. Activities will directly connect to your readings and test your initial understanding. You will answer polls, practice individually, and frequently discuss in groups.

recording class activities is strictly prohibited without your instructor's consent; this includes pictures and audio. In-person lectures will not be recorded. Course videos and materials belong to your instructor, the University, and/or other sources, depending on the specific facts of each situation and are protected by copyright. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor.

Office hours

All office hours are drop-in and open to everyone. In other words, you can attend any instructor's or TA's office hours without an appointment. An office hour calendar will be posted on Quercus. We are here to support you with any aspect of the course. Remember, we will give hints, not answers. Visit us to chit-chat, study with peers, or listen to other questions. We are always happy to talk.

Tutorials

TAs will host tutorials roughly every week on Tuesdays. You will practice mathematical communication and collaborate with your peers in small groups. Some tutorials may be focused on last week's lectures, and some may be focused on an upcoming problem set or test. TAs will circulate between groups, provide hints, and give feedback on your preliminary ideas. Further details can be found on Quercus. Tutorials begin the week of September 15. See the course calendar for tentative dates.

Assessments

In this course, there are two types of assessments: formative and summative.

formative assessments are designed to help you achieve learning objectives, so they are lower stakes and more frequent; scores are not intended to measure your mastery, but the feedback is key to your learning.

summative assessments are designed to evaluate your achievement of learning objectives, so they are higher stakes and less frequent; scores are a measure of your mastery, and the feedback will continue to help you learn.

Formative

pre-class quizzes There will be a total of 72 pre-class quizzes (1 per lecture hour) on Quercus.

tutorial worksheets There will be 20 tutorial worksheets (1 per tutorial) that you submit on Gradescope. These focus on collaboration and writing quality.

WeBWorK There will be 10 WeBWorK assignments that are assigned roughly every two weeks on Quercus. These provide foundational practice with computations and concepts before starting the problem set. WeBWorK is a free online homework platform integrated with Quercus. These questions are low stakes, give instant feedback, and provide multiple attempts.

surveys There will be 3 surveys to reflect on your learning experience. Each counts toward your final grade.

Summative

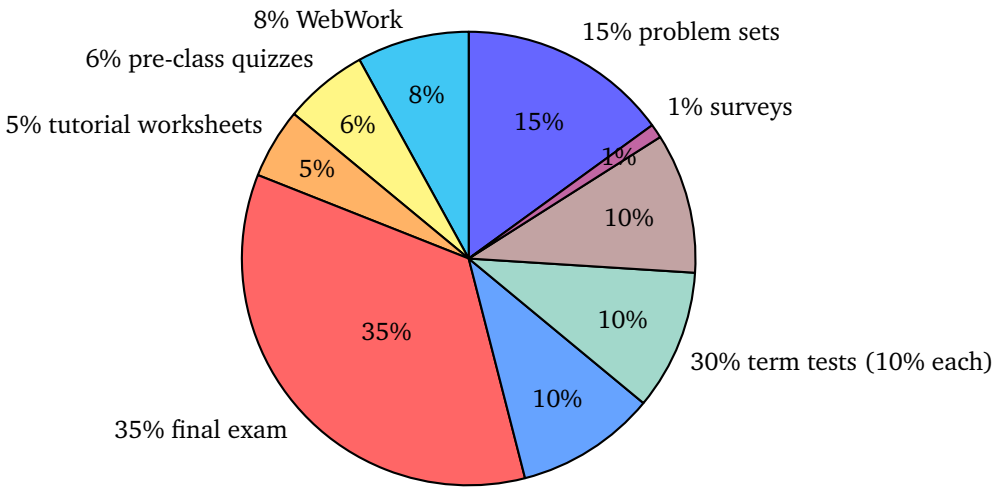
problem sets There will be 7 problem sets that you submit on Gradescope. These are your deep practice with a focus on writing quality and problem-solving. Your best 5 of 7 will count towards your final grade.

term tests There will be 3 term tests, which are in-person and tentatively planned to be at the following times:

- Term Test 1 on **Friday, October 24, 2025** from 19:00–21:00 ET
- Term Test 2 on **Friday, January 16, 2025** from 17:00–19:00 ET
- Term Test 3 on **Friday, February 27, 2025** from 17:00–19:00 ET

final exam The final exam will be held in-person in April 2026. Details will be shared near the end of Winter 2026.

Grades



Grading scheme

1% **Surveys:** There are 3 surveys, so each is worth ≈ 0.33%.
5% **Tutorial worksheets:** Only your best 15 of 20 worksheets will be counted, so each is worth 0.3%.
6% **Pre-class quizzes:** Only your best 54 out of 72 quizzes will be counted, so each is worth ≈ 0.1%.
8% **WeBWorK:** Only your best 8 of 10 WeBWorK sets will be counted, so each is worth 1%.
15% **Problem sets:** Only your best 5 out of 7 will be counted, so each is worth ≈ 3%.
30% **Term tests:** There are 3 term tests, so each is worth 10%.
35% **Final exam**: You must pass the final exam in order to pass the course.

Adjustments and curving

We are evaluating you using absolute standards, not relative to your peers. There will be no linear adjustments or "curving" of any kind. Your course grade will be computed as described above. When appropriate, we will round up to the nearest letter grade, but that is all. Please do not ask us for further adjustments or details. There will be none.

Late or missed assessment policies

- Verification of Illness forms (also known as a "doctor's note") are **not** required.
- **Late submissions will not be accepted for surveys, pre-class quizzes, WebWork, or tutorial worksheets**.
- **Late submissions of problem sets are accepted without any penalty for a *combined* total of 8 hours late over the entire year.** In other words, you have a "grace budget" of 8 hours. This should be used to resolve unexpected technical issues during submission near the deadline; do not use this budget to continue to work on the problem set. **If you have already exhausted your grace budget of 8 hours,** then any additional late problem sets will be counted as missed.
- **If you arrive 10 or more minutes late to a tutorial,** then you cannot submit a tutorial worksheet for that tutorial. You may still attend and participate in the discussion, but you cannot join any team submission. Tutorials are collaborative experiences, so you must be part of the entire discussion.
- **If you miss a survey, pre-class quiz, tutorial worksheet, WeBWorK, or problem set** then it will be one of the assessments that are dropped or shifted according to the policies in the grading scheme.
- **If you miss a term test**, then you must submit a short request form on Quercus **within 72 hours of the test**. No exceptions. If your request is approved, you will be informed of your accommodation. Your accommodation will usually be a re-weighting of your assessments; the exact formula is decided by the course coordinators.

Academic integrity

Collaboration on problem sets

Discussing exercises with your other classmates is a useful and mathematically healthy practice. You will have the option to submit problem sets individually or with a partner.

If you submit individual work then, when it comes time to write up your solutions for submission, you must present solutions in your own words. To be certain, work together with other classmates in the discovery phase, but do not work together when you are writing your solutions, never share your solutions with your peers, and never have the solution written by a friend in front of you.

If you submit group work then the same rules above apply except you can write solutions with your partner. However, **do not "split the tasks"**. You must work on all aspects together in both the discovery and writing phase. Both of you should solve problems together and debate the solutions. One of you can write up a draft of a solution, but both of you should understand, review, and edit every solution. Doing otherwise amounts to academic misconduct, and the penalties are severe.

Collaboration on tutorial worksheets

Tutorial worksheets are designed to be collaborative, so all teammates of a tutorial worksheet must be present and active for the entire tutorial. A teammate may be late to a tutorial by a maximum of 10 minutes, and all teammates must participate until the end of the tutorial. **If you submit a tutorial worksheet where *a single* group member is late by more than 10 minutes or leaves the tutorial early,** then this amounts to academic misconduct ***for all group members***, and the penalties are severe.

Prohibited use of generative AI

The use of generative artificial intelligence (AI) tools is strictly prohibited in all course assessments unless explicitly stated otherwise by the instructor. This includes, but is not limited to, ChatGPT, GitHub Copilot, and open-source models that you have trained and/or deployed yourself. You may not interact with, nor copy, paraphrase, or adapt any content from any generative AI for the purpose of completing assignments in this course. Use of generative AI will be considered use of an unauthorized aid, which is a form of academic misconduct under the Code of Behaviour on Academic Matters.

Code of Behaviour

Familiarize yourself with the University of Toronto's Code of Behaviour on Academic Matters. It is the rule book for academic behaviour at the UofT, and you are expected to know the rules. A simplified version is available here: https://www.academicintegrity.utoronto.ca/perils-and-pitfalls/
The University of Toronto treats cases of academic misconduct very seriously. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the Code. The consequences for academic misconduct can be severe, including a failure in the course and a notation on your transcript. Every year, students get expelled permanently for academic offences.

Schedules

Weekly study schedule

To help you manage your time effectively, here are our expectations for your weekly time commitment.

2–4 h	**Complete pre-class essentials.** This is your foundational knowledge. This time includes watching or reading any assigned material and submitting the pre-class quizzes.
3 h	**Participate in lectures.** This is your first practice with new material and a chance to test your basic understanding. Be active in every lecture. Answer polls and discuss with classmates.
1 h	**Collaborate in tutorial.** This is your second practice to deepen your understanding and communication skills. Collaborate with peers. Practice writing and speaking mathematics.
3–5 h	**Work on your upcoming weekly assessment.** This is your deep practice. It is when most of your learning actually happens! Each week, you should be solving problems for one core assessment: a WeBWork, a problem set, or a term test. The time spent may vary from week to week, but you should always be dedicating at least 3 hours per week.
1 h	**Ask questions on Piazza or at office hours.** This is your opportunity for feedback and reflection. You might be stuck or might not be confident in your approach. Those moments are critical to your growth. We will share feedback on your initial attempts and hints for getting unstuck.

You should therefore spend a total of about 10 to 14 hours per week on MAT237. Full-time university students with 4 to 5 courses will spend about 40 to 55 hours per week on their studies, so this estimate exceeds the average time spent per course. Indeed, MAT237 is a demanding (and hopefully rewarding) course, so we want to be transparent about what you can expect.

Tentative schedule of topics

A more detailed list of modules can be found on Quercus.

Fall 2025

Week	Dates	Topics
0	9/2–9/5	Introduction; Parametric curves
1	9/8–9/12	Real-valued functions; Vector fields; Coordinate systems
2	9/15–9/19	Explicit, parametric, implicit form; Interior, boundary, closure; Sequences
3	9/22–9/26	Open sets & closed sets; Compact sets; Limits
4	9/29–10/3	Continuity; Path-connected sets; Extreme value theorem
5	10/6–10/10	Derivatives of one variable; Partial derivatives
6	10/13–10/17	Directional derivatives; Gradient; Differentials & Jacobians
7	10/20–10/24	Differentiability; Chain rule & mean value; Local extrema & critical points
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8	11/3–11/7	Optimization; Tangent spaces; Smooth manifolds
9	11/10–11/14	Diffeomorphisms; Inverse function theorem; Nonlinear systems
10	11/17–11/21	Implicit function theorem; Implicit manifolds; Lagrange multipliers
11	11/24–11/28	Constrained optimization; Hessians; Higher order partials;
12	12/1–12/4	Taylor polynomials; Classification of critical points

Winter 2026

Week	Dates	Topics
13	1/5–1/9	Partitions; Upper sums and lower sums; Integration over rectangles
14	1/12–1/16	Uniform continuity; Jordan measurable sets; Zero Jordan measure sets
15	1/19–1/23	Integration over non-rectangles; Averages & volume under a graph; Mass
16	1/26–1/30	Probability; Fubini's theorem 2D; Double integrals
17	2/2–2/6	Integrals in polar coordinates; Fubini's theorem 3D; Triple integrals
18	2/9–2/13	Integrals in cylindrical & spherical coordinates; Change of variables
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19	2/23–2/27	Curves; Arc length; Line integrals
20	3/2–3/6	FTLI; Conservative vector fields; 2D circulation & curl
21	3/9–3/13	2D flux & divergence; Green's theorems; Surfaces
22	3/16–3/20	Surface area; Surface orientation & relative boundary; Surface integrals
23	3/23–3/27	3D flux & divergence; Divergence theorem; 3D circulation & curl
24	3/30–4/3	Stokes' theorem; Div, grad, curl

Tentative course calendar

"**PS**" is problem set, "**WW**" is WeBWorK, and "**TT**" is term test. All assessment deadlines are tentative.

Fall 2025

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Sep 1	Sep 2 **START**	Sep 3	Sep 4	Sep 5	Sep 6	Sep 7
Sep 8	Sep 9	Sept 10	Sep 11	Sep 12	Sep 13	Sep 14
Sep 15	Sep 16 Tutorial 1	Sep 17	Sep 18	Sep 19	Sep 20	Sep 21
Sep 22 **WW1 due**	Sep 23 Tutorial 2	Sep 24	Sep 25 **PS1 due**	Sep 26	Sep 27	Sep 28
Sep 29	Sep 30 Tutorial 3	Oct 1	Oct 2	Oct 3	Oct 4	Oct 5
Oct 6 **WW2 due**	Oct 7 Tutorial 4	Oct 8	Oct 9 **PS2 due**	Oct 10	Oct 11	Oct 12
Oct 13	Oct 14 Tutorial 5	Oct 15	Oct 16	Oct 17	Oct 18	Oct 19
Oct 20 **WW3 due**	Oct 21 Tutorial 6	Oct 22	Oct 23	Oct 24 **Term Test 1**	Oct 25	Oct 26
Oct 27	Oct 28	Oct 29	Oct 30	Oct 31	Nov 1	Nov 2
Nov 3	Nov 4 Tutorial 7	Nov 5	Nov 6	Nov 7	Nov 8	Nov 9
Nov 10 **WW4 due**	Nov 11 Tutorial 8	Nov 12	Nov 13 **PS3 due**	Nov 14	Nov 15	Nov 16
Nov 17	Nov 18 Tutorial 9	Nov 19	Nov 20	Nov 21	Nov 22	Nov 23
Nov 24 **WW5 due**	Nov 25 Tutorial 10	Nov 26	Nov 27 **PS4 due**	Nov 28	Nov 29	Nov 30
Dec 1	Dec 2 **Make-up Lecture**	Dec 3	Dec 4	Dec 5	Dec 6	Dec 7

Winter 2026

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Jan 5 **START**	Jan 6	Jan 7	Jan 8	Jan 9	Jan 10	Jan 11
Jan 12	Jan 13 Tutorial 11	Jan 14	Jan 15	Jan 16 **Term Test 2**	Jan 17	Jan 18
Jan 19	Jan 20 Tutorial 12	Jan 21	Jan 22	Jan 23	Jan 24	Jan 25
Jan 26 **WW6 due**	Jan 27 Tutorial 13	Jan 28	Jan 29	Jan 30	Jan 31	Feb 1
Feb 2	Feb 3 Tutorial 14	Feb 4	Feb 5 **PS5 due**	Feb 6	Feb 7	Feb 8
Feb 9 **WW7 due**	Feb 10 Tutorial 15	Feb 11	Feb 12	Feb 13	Feb 14	Feb 15
Feb 16 **Drop Deadline**	Feb 17	Feb 18	Feb 19	Feb 20	Feb 21	Feb 22
Feb 23 **WW8 due**	Feb 24 Tutorial 16	Feb 25	Feb 26	Feb 27 **Term Test 3**	Feb 28	Mar 1
Mar 2	Mar 3 Tutorial 17	Mar 4	Mar 5	Mar 6	Mar 7	Mar 8
Mar 9 **WW9 due**	Mar 10 Tutorial 18	Mar 11	Mar 12 **PS6 due**	Mar 13	Mar 14	Mar 15
Mar 16	Mar 17 Tutorial 19	Mar 18	Mar 19	Mar 20	Mar 21	Mar 22
Mar 23 **WW10 due**	Mar 24 Tutorial 19	Mar 25	Mar 26 **PS7 due**	Mar 27	Mar 28	Mar 29
Mar 30	Mar 31 Tutorial 20	Apr 1	Apr 2 END	Apr 3	Apr 4	Apr 5