

COURSE OUTLINE: MH1805

Course Title	Calculus		
Course Code	MH1805		
Offered	Study Year 1, Semester 1		
Course Coordinator	Anders Gustavsson (Dr)	erik@ntu.edu.sg	6513 7450
Pre-requisites	None		
Mutually exclusive	CY1601, MH1100, MH1101, MH1802, RE1011		
AU	4		
Contact hours	Technology-enhanced Learning: 26, Tutorials: 24		
Approved for delivery from	AY 2020/21 semester 1		
Last revised	20 Jul 2020, 09:02		

Course Aims

This course aims to equip you with the subject knowledge, logical reasoning and analytical skills so that you are able to apply the concepts and techniques of calculus of one variable to solve problems encountered in science.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Independently process and interpret concepts and methodologies related to differentiation, integration, power series and ordinary differential equations, and apply them to problems occurring in science.
2. Critically assess the applicability of mathematical tools in the workplace.
3. Critically assess the validity of a mathematical argument involving concepts from the course content.
4. Present mathematical ideas logically and coherently at the appropriate level for the intended audience.

Course Content

Sets and functions

Limits and continuity, one-to-one and inverse functions

Differentiation and optimization

Definition of Riemann Integral, Fundamental Theorem of Calculus, applications of integration.

Methods of integration

Series, Power Series, Taylor Series

Elementary theory, and methods of Ordinary Differential Equations

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Technology-enhanced Learning					
Peer evaluation	1, 2, 3, 4	1. a, b, c, d 2. a, b, c 3. a, b	15	individual	See Appendix for rubric
Application Exercises	1, 2, 3, 4	1. a, b, c, d 2. a, b, c 3. a, b 4. a	10	team	See Appendix for rubric
Tutorials					
Individual Readiness Assessments (IRA)	1, 2, 3, 4	1. a, b, c 2. a 3. a	15	individual	See Appendix for rubric
Team Readiness Assessments (TRA)	1, 2, 3, 4	1. a, b, c 2. a 3. a, b	10	team	See Appendix for rubric
Examination (2.5 hours)					
Final Exam	1, 2, 3, 4	1. a, b, c 2. a, b, c 3. a	50	individual	See Appendix for rubric
Total			100%		

These are the relevant SPMS-MAS Graduate Attributes.

1. Competence

- a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
- b. Formulate mathematical statements precisely using rigorous mathematical language
- c. Discover patterns by abstraction from examples
- d. Use computer technology to solve problems, and to communicate mathematical ideas

2. Creativity

- a. Critically assess the applicability of mathematical tools in the workplace
- b. Build on the connection between subfields of mathematics to tackle new problems
- c. Develop new applications of existing techniques

3. Communication

- a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience
- b. Work in teams on complicated projects that require applications of mathematics, and communicate the results verbally and in written form

4. Civic-mindedness

- a. Develop and communicate mathematical ideas and concepts relevant in everyday life for the benefits of society

Formative Feedback

Immediate feedback (correct/incorrect) is given when you submit a Team Readiness Assessment (TRA) or Application Exercise (AE).

Upon submission of these assessments, your team can also submit questions that will be addressed either directly in a clarifying lecture (for TRA) or in a follow up FAQ (for AE). This

feedback will also address other common errors or any clarification deemed appropriate.

You will also be given general feedback on the Final Exam, in the form of an Examiner's report.

The feedback addresses all intended learning outcomes.

Learning and Teaching Approach

Technology-enhanced Learning (26 hours)	Lectures are delivered as a collection of short concise video clips, 5--10 min each on a particular topic or example. Keeping the videos short helps prevent fatigue and allows you to easily revisit a particular topic for revision or clarification. In your Application Exercises (part of your Continual Assessment), you explore a few particular topics on a level slightly beyond what you learned in lectures. This will involve some programming and some collaboration with teammates. All Intended Learning Outcomes are addressed.
Tutorials (24 hours)	Tutorials are dedicated to two types of activities: - "Traditional" textbook type problem solving. - Individual and Team Readiness Assessments (IRAs and TRAs), explained below: IRAs are short multiple choice quizzes, taken individually, where you are asked questions on the fundamental concepts of the course. These quizzes serve two main purposes: - Ensure that your grasp of the fundamental concepts is sufficient for you to proceed with further topics or applications. - Practice your logical reasoning skill. Each IRA is followed by a TRA where you take exactly the same quiz again, but this time you can collaborate with your team and your team will have to agree on the correct answer. This trains both your ability to clearly explain your own reasoning, as well as assessing the validity of your teammates' reasoning.

Reading and References

Besides notes provided in the course, the textbook "Calculus" by Spivak (ISBN 978-0-914098-91-1) covers most of the detail that is omitted in the lectures. Sometimes, chapter or page references to this book are given in the lecture notes.

Course Policies and Student Responsibilities

(1) General

You are expected to complete all assigned pre-class readings and activities, attend all seminar classes (face to face or online) punctually and take all scheduled assignments and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements for seminar sessions they have missed. You are expected to participate in all seminar discussions and activities.

(2) Absenteeism

TBL requires you to be in class or be present at online meetings to contribute to team work. In-class or online activities make up a significant portion of your course grade. Absence from a class or online meeting without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for such activities.

If you miss a seminar session, you must inform your team members and me via email (erik@ntu.edu.sg) prior to the start of the class. Students who miss Continual Assessment activities with valid reasons will be exempted from that activity in score calculations. Students who miss CA activities without a valid reason will get a zero score for that session of absence.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code,

a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

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Course Instructors

Instructor	Office Location	Phone	Email
Anders Gustavsson (Dr)	SPMS-MAS-04-10	6513 7450	erik@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO Readings/ Activities	
1	Introduction		
2	Sets, logic and functions.	1, 2, 3, 4	IRA/TRA
3	Limits.	1, 2, 3, 4	AE
4	Limits, continuity, inverse functions.	1, 2, 3, 4	IRA/TRA
5	Differentiation and optimization.	1, 2, 3, 4	AE
6	The Mean Value Theorem and its consequences. Higher order derivatives and applications.	1, 2, 3, 4	IRA/TRA
7	Definition of the Riemann integral. Fundamental Theorem of Calculus. Applications of integration.	1, 2, 3, 4	
8	Methods of integration.	1, 2, 3, 4	IRA/TRA
9	Differential equations.	1, 2, 3, 4	AE
10	Series. Tests for convergence.	1, 2, 3, 4	IRA/TRA
11	Power series	1, 2, 3, 4	AE
12	Taylor series and their applications.	1, 2, 3, 4	IRA/TRA
13	Revision	1, 2, 3, 4	

Appendix 1: Assessment Rubrics

Rubric for Technology-enhanced Learning: Peer evaluation (15%)

The peer review is conducted by you as a student. You can use these recommended rubrics:

Criteria	Standards		
	Fail standard	Pass standard	High standard
Punctuality	The team member arrives late without a valid reason to TBL sessions on more than one or two occasions.	Except for one or two occasions, the team member arrives on time to TBL sessions, or has a valid reason to be late.	The team member arrives on time to every TBL session, or has a valid reason not to be late.
Valuable contribution	The team members provides no or little valuable input at TBL sessions.	The team member provides some valuable contributions at TBL sessions.	The team member provides creative and useful ideas at TBL sessions.
Facilitates discussion	The team member pays little attention to the rest of the team.	The team member pays attention to ideas from other team members.	The team member recognizes the strengths of individual team members and incorporates the best ideas for the benefit of the team.

Rubric for Technology-enhanced Learning: Application Exercises (10%)

iRA / tRAs and AEs are assessed by multiple choice questions.

Rubric for Tutorials: Individual Readiness Assessments (IRA) (15%)

iRA / tRAs and AEs are assessed by multiple choice questions.

Rubric for Tutorials: Team Readiness Assessments (TRA) (10%)

iRA / tRAs and AEs are assessed by multiple choice questions.

Rubric for Examination: Final Exam (50%)

Criteria	Standards		
	Fail standard	Pass standard	High standard
Method of approach (LOs 1--3)	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant arguments or theorems that help solve the problem. Invoking theorems whose conditions are satisfied.	Using arguments and theorems in logically consistent ways to solve nonstandard problems.
Validity of reasoning (LO 3)	The student's reasoning is logically invalid.	The student's reasoning is logically valid.	The student's reasoning is logically valid and effective.
Clarity of argument (LO 4)	The student's reasoning is poorly explained or not explained at all.	The student's reasoning is clear, but may contain some gaps.	The student's reasoning is clear, precise, with no or insignificant gaps.