Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Wang Zhongjian
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Course Title	ORDINARY DIFFERENTIAL EQUATIONS
Course Code	MH3110
Academic Units	4
Contact Hours	51
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH2100 OR CY1602
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

The course builds on Calculus and Linear Algebra. It aims to equip you with useful solution methods for solving various types of ordinary differential equations (ODEs), introduce the fundamental theory of ODEs, and develop skills for modeling real phenomena by ODEs.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Solve several types of first-order ODEs including separable equations, first-order linear equations, exact or non-exact equations with integrating factors, and some other equations transformable to the above classes of solvable ODEs through suitable substitutions.
ILO 2	Demonstrate mastery of the linear theory of linear ODEs and appreciate the beauty and rigor through the hierarchical structure of the theory. Solve the second- and higher-order homogeneous equations using the linear theory. Solve nonhomogeneous linear ODEs by using method of undetermined coefficients and variation of parameters. Apply concepts and methods in linear second-order ODEs in the modelling of physical systems.
ILO 3	Demonstrate understanding of the first integral transform method, i.e., the Laplace transform, and explain its profound importance in mathematics. Solve initial value problems using Laplace Transform.
ILO 4	Solve systems of linear equations using the matrix algebra. Extend the methods of undetermined coefficients and variation of parameters for nonhomogeneous linear equations to solve systems of nonhomogeneous linear equations.

Course Content

The couse includes the following contents:

- Solution methods for first-order ODEs including separable equations, first-order linear equations, exact DEs, Non-exact DEs with integrating factors, homogeneous DEs, Bernoulli's equation and substitution techniques for ODEs.
- Linear theory and solutions of linear ODEs: Linear theory: principle of superposition, Wronskian, Linear dependence/independence, Abel's formula etc.. Solution techniques for linear homogeneous equations with constant coefficients, Cauchy-Euler equation and linear nonhomogeneous equations via method of undetermined coefficients and methods of variation-of-parameters.
- Laplace transform: properties of Laplace transform and solution of initial value problems using Laplace transform.
- Systems of Linear ODEs: eigen-value method for linear systems of equations and methods of undetermined coefficients and variation-of-parameter methods for nonhomogeneous systems.
- Basic skills in modeling by ODEs.

Reading and References (if applicable)

Textbook: Boyce, William E., Richard C. DiPrima, and Douglas B. Meade. Elementary differential equations and boundary value problems. Vol. 11. New York: Wiley, 2018. ISBN: 978- 1-119-50397-2.

Reference Book: Vladimir Dobrushkin, Applied Differential Equations with Boundary Value Problems, Chapman and Hall/CRC 2017, ISBN 9781498733656.

NOTE: The above reading comprises the foundational readings for the course and more up-to-date relevant readings (including a textbook which summarizes learning materials during the course) will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Concept of ODE. Solvable First-Order ODEs: Separable DEs, First-order Linear DEs, Exact DEs.	1	In-person	introduction	Chapter 1 of the textbook
2	Non-exact DEs with integrating factors; Substitution techniques: homogeneous DEs and Bernoulli's equation	1	In-person	lectures and tutorials	Chapter 1 of the textbook & Exercises from the reference books
3	Theory on existence and modelling with 1st order ODE. Introduction to Linear theory	1, 2	In-person	lectures and tutorials	Chapters 1-2 of the textbook & Exercises from the reference books
4	Linear theory: principle of superposition, Linear dependence/independence, Abel's formula.	2	In-person	lectures and tutorials	Chapter 2 of the textbook & Exercises from the reference books
5	Linear theory (Continued), Solutions of second-order linear ODEs: constant coefficients and Cauchy-Euler equations	2	In-person	lectures and tutorials	Chapter 2 of the textbook & Exercises from the reference books
6	Solutions of nonhomogeneous DEs: method of undetermined coefficients	2	In-person	lectures and tutorials	Chapter 2 of the textbook & Exercises from the reference books

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
7	Chapter 2 of the textbook & Exercises from the reference books	2	In-person	lecture, tutorials, midterm revision	Chapters 2-3 of the textbook & Exercises from the reference books
8	Laplace Transform: concept and properties	3	In-person	lectures and tutorials, midterm	Chapter 4 of the textbook
9	Laplace Transform: concept and properties (Continued) and solution of initial value problems.	3	In-person	lectures and tutorials	Chapter 4 of the textbook
10	Systems of 1st linear order ODEs and eigen-methods for homogeneous systems	4	In-person	lectures and tutorials	Chapter 5 of the textbook
11	Systems of 1st linear order ODEs: nonhomogeneous systems	4	In-person	lectures and tutorials	Chapter 5 of the textbook
12	Modeling by ODEs: examples and numerics	1, 2, 3, 4	In-person	lectures and tutorials	Lecture notes
13	Review for final examination and miscellaneous topics	1, 2, 3, 4	In-person	revision	Lecture notes

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	The implementation of learning objectives will be built upon well-designed and prepared course materials and interactive means of conducting lectures. Below are student-centered learning and teaching approaches in the lectures. 1) ODEs are rooted in applications and many are arisen from mathematical modeling of real phenomena. In the lecture, some motivated examples will be given to make students feel this course useful for their future career. 2) This course involves some deep theory, and more insightful examples and practice questions are important and useful for engaging students. 3) In view of the depth of some course contents, it will encourage discussions and critical thinking through properly designed topics and related questions.
Tutorials	To better implement the learning outcomes, the tutorial questions will be designed for three levels of difficulty: i) basic questions related to concepts and definitions; ii) working-out questions on must-known methods and iii) open-ended questions for critical thinking. Moreover, some tutorial questions will be focused on helping student explore/learn some real life applications of ODEs.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Midterm, MCQs and Short answer questions)	1,2		15		Individual	Analytic	Relational
2	Continuous Assessment (CA): Assignment(Solutions of tutorials)	1,2,3,4		20		Individual	Holistic	Relational
3	Summative Assessment (EXAM): Final exam(A 2hr final exam.)	1,2,3,4		60		Individual	Analytic	Relational
4	Continuous Assessment (CA): Class Participation(In class participation)			5		Individual	Analytic	Relational

Description of Assessment Components (if applicable)

There are four assessments in the course:

The Midterm consists of 10 MCQs and 2 short answer question and will last for 1 hour.

During the last week, you are required to submit you sum-up of your solutions to the tutorials. Since the solution will be discussed during the tutorial. You will be graded based on the completeness of this report.

The final exam will last for 2 hours and consists of 5-6 short answer questions.

There is also 5% for in-class participation: 3-5 random quiz with one True/False question. Points will be calculated by 'Correct Anwer' divided by 'Total number of quiz'.

Formative Feedback

The Midterm consists of 10 MCQs and 2 short answer questions and will last for 1 hour. It will provide progressive feedback to students. It also contains an 2-hour final examination. These will not only provide a comprehensive

coverage of the knowledge points, but also encourage students to study constantly and develop the skills consistently.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Adaptability	Intermediate
Curiosity	Intermediate
Self-Management	Intermediate
Critical Thinking	Intermediate

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned pre-class readings and activities, attend all classes punctually and take all scheduled quizzes in due course. You are expected to take responsibility to follow up with course notes and course related announcements.

Policy (Absenteeism)

If you are sick and not able to attend the Midterm test, you must submit the original Medical Certicate* to an administrator. There will be no make up test for the Midterm test, students with valid LOA will have the total course marks rescaled to a based of 100%..
*The Medical Certicate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Appendix 1: Assessment Rubrics

Rubric for Midterm:

MCQs (10%)

Short Answer Questions (5%)

Point-based marking (not rubrics based).

Rubric for Assignment:

Short Answer Questions (25%)

Point-based marking (not rubrics based).

Rubric for Examination: Short Answer Questions (60%)

Point-based marking (not rubrics based).

Rubric for in-class participation: Random test (5%)

Point-based marking (not rubrics based).