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

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	AY2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1 Semester 2
Course Author * Faculty proposing/revising the course	Cheong Kang Hao
Course Author Email	kanghao.cheong@ntu.edu.sg
Course Title	Mathematics II
Course Code	MH2811
Academic Units	3
Contact Hours	38
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH1810
Co-requisites	MH1810
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This course prepares students for the solution and interpretation of practical problems encountered in engineering disciplines with emphasis given to strengthening their problem- solving abilities. This course is targeted at the second year MSE students and aims at equipping MSE students with the necessary mathematical knowledge in Materials Science and Engineering applications.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Apply the methods taught to find the Fourier series of a given periodic function and use the series for approximation and decomposition/synthesis of functions.
ILO 2	Find the Fourier integral of a given non-periodic function on the whole line.
ILO 3	Describe the use of the partial derivative and relate it to slopes and gradients, and the use of the directional derivative.
ILO 4	Apply the chain rule to find the partial derivative of functions with multiple levels of dependent parameters.
ILO 5	Describe the formal definition of the double integral.
ILO 6	Calculate volumes via the double integral.
ILO 7	Demonstrate the ability to reverse the order of a given double integral.
ILO 8	Solve first order ordinary differential equations of the separable, linear and exact types, and use substitution to convert ODEs into these types.
ILO 9	Apply the linear theory of second order linear ordinary differential equations and use it to solve such ODEs with constant coefficients.
ILO 10	Perform the method of separation of variables to derive the solution to a given partial differential equation.
ILO 11	Provide the solution for a given heat or wave equation.
ILO 12	Calculate the gradient, divergence and curl of a scalar or vector-valued function.
ILO 13	Describe the motion of a particle on a parametric curve and derive the parametric form of a curve.
ILO 14	Calculate the line integral of a given scalar or vector field and use Green's formula to calculate work done.
ILO 15	Calculate the surface integral of a given scalar function, and a given vector field.
ILO 16	Provide interpretations of the line integral and the surface integral of a given function.
ILO 17	Apply conservation of a vector field to find the line.

Course Content

Fourier series

Fourier integrals

Partial differentiation

The chain rule for partial derivatives

Double integrals

Reversing the order of integration

Ordinary differential equations

Partial differential equations, wave and heat equations

Vector fields, curl, divergence

Line integrals and surface integrals

Parameterizing a surface or line curve

Green's Theorem

Conserved vector fields

Reading and References (if applicable)

Advanced Engineering Mathematics, by Kreysgiz E, 9th or 10th edition, John Wiley & Sons. ISBN: 978-0470646137

Calculus, by Thomas, Weir and Hass, published by Pearson. 13th edition. ISBN: 9780321878960

NOTE: The above readings comprise the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Fourier series	1	Kreysgiz Chapter 11	In-person	*Quiz dates will be made known to the students ahead of time. Information will be given during the lecture and broadcast over NTULearn.
2	Fourier integrals	2	Kreysgiz Chapter 11	In-person	
3	Partial differentiation	3	Thomas Chapter 14	In-person	
4	The chain rule for partial derivatives	4	Thomas Chapter 14	In-person	
5	Double integrals	5, 6, 7	Thomas Chapter 15	In-person	
6	Ordinary differential equations	8	Kreysgiz Chapter 1	In-person	
7	Ordinary differential equations	9	Kreysgiz Chapter 1	In-person	
8	Partial differential equations, wave and heat equations	10, 11	Kreysgiz Chapter 12	In-person	

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
9	Partial differential equations, wave and heat equations	10, 11	Kreysgiz Chapter 12	In-person	
10	Vector Calculus	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16	In-person	
11	Vector Calculus	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16	In-person	
12	Vector Calculus	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16	In-person	
13	Review	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16	In-person	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Present the key ideas behind mathematical concepts. Present important steps used to solve different types of problems.
Tutorials	Develop proficiency in problem solving skills. Reinforce concepts already covered in the lectures. Gives an opportunity for weaker or more reserved students to clarify doubts.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Quiz 1 (MCQ +Short Answer Questions))	1,2	a, b, g, h, i, k	14	Individual	Analytic	Extended Abstract
2	Continuous Assessment (CA): Test/Quiz(Quiz 2 (MCQ +Short Answer Questions))	3,4	a, b, g, h, i, k	14	Individual	Analytic	Extended Abstract
3	Continuous Assessment (CA): Test/Quiz(Quiz 3 (MCQ +Short Answer Questions))	5,6,7,8,9	a, b, g, h, i, k	14	Individual	Analytic	Extended Abstract
4	Summative Assessment (EXAM): Final exam(Examination - Short Answer Questions)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	a, b, g, h, i, k	58	Individual	Analytic	Extended Abstract

Description of Assessment Components (if applicable)

No Component Weightage (%)

1. Continuous Assessment (CA): Test/Quiz(Quiz 1 (MCQ +Short Answer Questions)): 14%

2. Continuous Assessment (CA): Test/Quiz(Quiz 2 (MCQ +Short Answer Questions)): 14%

3. Continuous Assessment (CA): Test/Quiz(Quiz 3 (MCQ +Short Answer Questions)): 14%

4. Summative Assessment (EXAM): Final exam(Examination - Short Answer Questions): 58%

Rubric for Quizzes (42%)
Point-based marking

Rubric for Examination (58%)
Point-based marking

Formative Feedback

For the CA and final exam, feedback on the common mistakes are given on NTULearn after the grades are announced. This includes the examiner's report which will be released on NTU Learn after the results are announced. Common mistakes are often repeated and addressing this will be important for achieving the learning outcomes 1-17. Solutions to tutorial questions will be discussed during the class.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Communication	Basic
Decision Making	Basic
Problem Solving	Basic
Critical Thinking	Basic

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 tutorial classes punctually and take all scheduled quizzes. You are expected to participate in all tutorial discussions and activities.

Policy (Absenteeism)

Absence from the quizzes 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 CA components.

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 Quizzes (42%)
Point-based marking

Rubric for Examination (58%)
Point-based marking

Mapping of Course ILOs to EAB Graduate Attributes

Course Code & Title	MH2811: Mathematics II
Course Type	Core

Overview											
(a)	●	(b)	●	(c)		(d)		(e)		(f)	
(g)	●	(h)	●	(i)	●	(j)		(k)	●		

Legend:

●	Fully consistent (contributes to more than 75% of Student Learning Outcome)
◐	Partially consistent (contributes to about 50% of Student Learning Outcome)
O	Weakly consistent (contributes to about 25% of Student Learning Outcome)
Blank	Not related to Student Learning Outcome

Course ILOs		**EAB Graduate Attributes**
ILO 1	Apply the methods taught to find the Fourier series of a given periodic function and use the series for approximation and decomposition/synthesis of functions.	a, b, g, h, i, k
ILO 2	Find the Fourier integral of a given non-periodic function on the whole line.	a, b, g, h, i, k
ILO 3	Describe the use of the partial derivative and relate it to slopes and gradients, and the use of the directional derivative.	a, b, g, h, i, k
ILO 4	Apply the chain rule to find the partial derivative of functions with multiple levels of dependent parameters.	a, b, g, h, i, k
ILO 5	Describe the formal definition of the double integral.	a, b, g, h, i, k
ILO 6	Calculate volumes via the double integral.	a, b, g, h, i, k
ILO 7	Demonstrate the ability to reverse the order of a given double integral.	a, b, g, h, i, k
ILO 8	Solve first order ordinary differential equations of the separable, linear and exact types, and use substitution to convert ODEs into these types.	a, b, g, h, i, k

ILO 9	Apply the linear theory of second order linear ordinary differential equations and use it to solve such ODEs with constant coefficients.	a, b, g, h, i, k
ILO 10	Perform the method of separation of variables to derive the solution to a given partial differential equation.	a, b, g, h, i, k
ILO 11	Provide the solution for a given heat or wave equation.	a, b, g, h, i, k
ILO 12	Calculate the gradient, divergence and curl of a scalar or vector-valued function.	a, b, g, h, i, k
ILO 13	Describe the motion of a particle on a parametric curve and derive the parametric form of a curve.	a, b, g, h, i, k
ILO 14	Calculate the line integral of a given scalar or vector eld and use Green's formula to calculate work done.	a, b, g, h, i, k
ILO 15	Calculate the surface integral of a given scalar function, and a given vector eld.	a, b, g, h, i, k
ILO 16	Provide interpretations of the line integral and the surface integral of a given function.	a, b, g, h, i, k
ILO 17	Apply conservation of a vector field to find the line.	a, b, g, h, i, k

EAB Graduate Attributes

a) **Engineering Knowledge**: Apply the knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialisation as specified in WK1 to WK4 respectively to the solution of complex engineering problems.

b) **Problem Analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences with holistic considerations for sustainable development. (WK1 to WK4)

c) **Design / Development of Solutions**: Design creative solutions for complex engineering problems and design systems, components or processes that meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required. (WK5)

d) **Investigation**: Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) **Modern Tool Usage**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering problems, with an understanding of the limitations. (WK2 and WK6)

f) **The Engineer and the World**: When solving complex engineering problems, analyse and evaluate sustainable development impacts to: society, the economy, sustainability, health and safety, legal frameworks and the environment (WK1, WK5, and WK7).

g) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK9).

h) **Individual and Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multidisciplinary, face-to-face, remote and distributed settings (WK9).

i) **Communication**: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions, taking into account cultural, language, and learning differences.

j) **Project Management and Finance**: Demonstrate knowledge and understanding of engineering management principles and economic decision-making, and apply these to one's

own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

k) **Life-long Learning**: Recognise the need for, and have the preparation and ability to (i) engage in independent and life-long learning, and (ii) adapt to new and emerging technologies, and (iii) think critically, in the broadest context of technological change (WK8).

No	Knowledge Profile
WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
WK5	Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts that supports engineering design and operations in a practice area
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues
WK9	Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc with mutual understanding and respect, and of inclusive attitudes

Reference: EAB Accreditation Manual