COURSE OUTLINE: MH2811

Course Title	**Mathematics II**		
Course Code	**MH2811**		
Offered	Study Year 2, Sem 1 | Study Year 2, Sem 2		
Course Coordinator	Wang Li-Lian (Prof)	lilian@ntu.edu.sg	6513 7465
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Pre-requisites	MH1810		
Co-requisites	MH1810		
AU	3		
Contact hours	Lectures: 26, Tutorials: 12		
Approved for delivery from	AY 2023/24 semester 1		
Last revised	27 Nov 2023		

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.

Intended Learning Outcomes

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

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

Assessment

Component	Course ILOs tested	EAB Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
To be given in Tutorials					
Quiz 1 (MCQ +Short Answer Questions)	1,2	a, b, h, i, j, l	12.5	individual	See Appendix for rubric
Quiz 2 (MCQ +Short Answer Questions)	3,4	a, b, h, i, j, l	12.5	individual	See Appendix for rubric
Quiz 3 (MCQ +Short Answer Questions)	5,6,7,8	a, b, h, i, j, l	12.5	individual	See Appendix for rubric
Quiz 4 (MCQ +Short Answer Questions)	9,10,13	a, b, h, i, j, l	12.5	individual	See Appendix for rubric
Examination (2 hours)					
Short Answer Questions	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	a, b, h, i, j, l	50	individual	See Appendix for rubric
		Total	**100%**		

Mapping of Course Intended Learning Outcomes to Engineering Accreditation Board (EAB) Graduate Attributes

Category	Core				
EAB's 12 Graduate Attributes*					
(a) ●	(b) ●	(c)	(d)	(e)	(f)
(g)	(h) ●	(i) ●	(j) ●	(k)	(l) ●

Overall statement

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

	Course Student Learning Outcomes	**EAB Graduate Attributes**
1	Apply the methods taught to solve for the Fourier series of a given periodic function.	a, b, h, i, j, l
2	Calculate the Fourier integral of a given function	a, b, h, i, j, l
3	Describe the use of the partial derivative and relate it to slopes and gradients, and the use of the directional derivative	a, b, h, i, j, l
4	Apply the chain rule to solve for the partial derivative of functions with multiple levels of dependent parameters	a, b, h, i, j, l
5	Describe the formal definition of the double integral	a, b, h, i, j, l
6	Calculate volumes via the double integral	a, b, h, i, j, l
7	Demonstrate the ability to reverse the order of a given double integral	a, b, h, i, j, l
8	Solve first order ordinary differential equations of the separable, linear and exact types	a, b, h, i, j, l
9	Solve second order linear ordinary differential equations with constant coefficients	a, b, h, i, j, l
10	Perform the method of separation of variables to derive the solution to a given partial differential equation	a, b, h, i, j, l
11	Provide the solution for a given heat or wave equation	a, b, h, i, j, l
12	Derive the different parametric forms of a given line curve or a surface	a, b, h, i, j, l
13	Apply Green's Theorem to solve a given integral	a, b, h, i, j, l
14	Calculate the line integral of a given scalar function, and a given vector field	a, b, h, i, j, l
15	Solve for the surface integral of a given scalar function, and a given vector field	a, b, h, i, j, l
16	Provide interpretations of the line integral and the surface integral of a given function	a, b, h, i, j, l
17	Apply conservation of a vector field to solve for the line integral and explain the meaning in terms of work done	a, b, h, i, j, l

***Legend:**
● Fully consistent (contributes to more than 75% of Student Learning Outcomes)
◐ Partially consistent (contributes to about 50% of Student Learning Outcomes)
○ Weakly consistent (contributes to about 25% of Student Learning Outcomes)
[Blank]Not related to Student Learning Outcomes

The graduate attributes as stipulated by the EAB, are:

a. **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation 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.

c. **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety ,

cultural, societal, and environmental considerations.

d. **Investigation:** Conduct investigations of complex problems using research-based knowledge 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 activities with an understanding of the limitations.
f. **The engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j. **Communication:** Communicate effectively 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.
k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and 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.
l. **Life-long Learning:** Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Formative Feedback

Feedback on the common mistakes is 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.

Learning and Teaching Approach

Lectures (26 hours)	Present the key ideas behind mathematical concepts. Present important steps used to solve different types of problems.
Tutorials (12 hours)	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.

Reading and References

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

Course Policies and Student Responsibilities

(1) 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.

(2) 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.

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.

Use of Generative Artificial Intelligence (GAI) such as ChatGPT is allowed in the course but students need to adhere to NTU's prevailing guideline. i.e. **Give proper citations if you use any AI tool**. Extending the practice of correctly citing references in your work under NTU's policies on citation and plagiarism, the University requires students to **(i) identify any generative AI tools used** and **(ii) declare how the tools are used in submitted work**. Please note that even with acknowledgement, copying of output generated by AI tools (in part or whole) may still be regarded as plagiarism.

Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
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Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Fourier series	1	Kreysgiz Chapter 11
2	Fourier integrals	2	Kreysgiz Chapter 11
3	Partial differentiation	3	Thomas Chapter 14
4	The chain rule for partial derivatives	4	Thomas Chapter 14
5	Double integrals	5, 6, 7	Thomas Chapter 15
6	Ordinary differential equations	8	Kreysgiz Chapter 1
7	Ordinary differential equations	9	Kreysgiz Chapter 1
8	Partial differential equations, wave and heat equations	10, 11	Kreysgiz Chapter 12
9	Partial differential equations, wave and heat equations	10, 11	Kreysgiz Chapter 12
10	Vector Calculus	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16
11	Vector Calculus	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16

12	Vector Calculus	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16
13	Review	12, 13, 14, 15, 16, 17	Thomas Chapters 12-16

*Quiz dates will be made known to the students ahead of time. Information will be given during the lecture and broadcast over NTULearn.

Appendix 1: Assessment Rubrics

Rubric for Quizzes (50%)

Point-based marking

Rubric for Examination (50%)

Point-based marking