COURSE OUTLINE: MH2810

Course Title	**Mathematics A**		
Course Code	**MH2810**		
Offered	Study Year 2, Semester 1		
Course Coordinator	Ku Cheng Yeaw (Dr)	cyku@ntu.edu.sg	6513 8652
Pre-requisites	None		
Mutually exclusive	EE2090, EE2092		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
Approved for delivery from	AY 2020/21 semester 1		
Last revised	15 Jun 2020, 14:21		

Course Aims

This course aims to provide a mathematical foundation to those who start the B. Eng programme directly from the 2nd year, and to ensure these students have necessary mathematical capability for their study in all other courses in the subsequent semesters.

Intended Learning Outcomes

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

1. Use vectors to solve geometrical problems in two- and three-dimensional space.
2. Evaluate limits of functions using different methods.
3. Evaluate derivatives, and apply Chain Rule and Implicit differentiation and L'Hopital's Rule.
4. Apply differentiation to solve problems related to rate of change and optimization.
5. Evaluate integrals using different techniques, and apply integration to find areas and volumes.
6. Classify and solve Ordinary Differential Equations.
7. Give examples of convergent and divergent sequences and series, and perform various convergence tests for series
8. Describe how a function can be expressed as a power series, determine the radius of convergence of a power series
9. Represent certain functions by manipulating geometric series or by differentiating or integrating known series.
10. Find Taylor/Maclaurin series of a given function using definition.
11. Evaluate partial derivatives, and apply Chain Rule and Implicit Differentiation for functions of more than one variable.
12. Apply the properties of directional derivatives and gradient vectors to solve problems related to rate of change of functions of more than one variable.
13. Interpret the meaning of double integrals, and evaluate double integrals via iterated integrals and change of order.
14. Evaluate double integrals in polar coordinates.

Course Content

1. [Vectors] Vectors in the plane & space. Dot products. Cross products. Applications to lines and planes in Space.

2. [Functions and Limits] Functions and their limits & properties.

3. [Differentiation] Derivative, Differential rules. Applications: rate of change, linearization, differential, local and global extreme values, L' Hopital's Rule

4. [Integration] Indefinite integrals, Definite integrals (Intuitive idea). General rule for integration. Integration of simple functions & Formulae. Techniques of Integration: substitution, by parts, partial fractions. Applications: Area and Volume.

5. [Sequences,& Power Series, Taylor Series] Sequences, series, Function as power series, Taylor and Maclaurin series, Convergence Tests.

6. [Ordinary Differential Equations] Separable differential equations. Linear first-order ODE. Linear- second-order ODE with constant coefficients. Nonhomogeneous equations: Method of undetermined coefficients & Variation of parameters. Applications.

7. [Partial Differentiation] Functions of several variables. Partial derivatives, chain rule, gradient vector, tangent planes, total differential, normal lines, directional derivatives, applications.

8. [Multiple Integrals] Double integrals, regions of integrations, triple integrals, meaning and applications. Polar Integration.

Assessment

Component	Course ILOs tested	EAB Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Technology-enhanced Learning					
Online Quiz 1	1, 2, 3, 4	a, b, j, l	10	individual	See Appendix for rubric
Online Quiz 2	7, 8, 9, 10	a, b, j, l	10	individual	See Appendix for rubric
Mid-semester Quiz					
Midterm Test	1, 2, 3, 4, 5, 6	a, b, j, l	20	individual	See Appendix for rubric
Examination (2 hours)					
Final Exam	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	a, b, j, l	60	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 aims to provide a mathematical foundation to those who start the B. Eng programme directly from the 2nd year, and to ensure these students have necessary mathematical capability for their study in all other courses in the subsequent semesters.	
Course Student Learning Outcomes	**EAB Graduate Attributes**
1 Use vectors to solve geometrical problems in two- and three-dimensional space.	a, b, j, l
2 Evaluate limits of functions using different methods.	a, b, j, l
3 Evaluate derivatives, and apply Chain Rule and Implicit differentiation and L'Hopital's Rule.	a, b, j, l
4 Apply differentiation to solve problems related to rate of change and optimization.	a, b, j, l
5 Evaluate integrals using different techniques, and apply integration to find areas and volumes.	a, b, j, l
6 Classify and solve Ordinary Differential Equations.	a, b, j, l
7 Give examples of convergent and divergent sequences and series, and perform various convergence tests for series	a, b, j, l
8 Describe how a function can be expressed as a power series, determine the radius of convergence of a power series	a, b, j, l
9 Represent certain functions by manipulating geometric series or by differentiating or integrating known series.	a, b, j, l
10 Find Taylor/Maclaurin series of a given function using definition.	a, b, j, l
11 Evaluate partial derivatives, and apply Chain Rule and Implicit Differentiation for functions of more than one variable.	a, b, j, l
12 Apply the properties of directional derivatives and gradient vectors to solve problems related to rate of change of functions of more than one variable.	a, b, j, l
13 Interpret the meaning of double integrals, and evaluate double integrals via iterated integrals and change of order.	a, b, j, l
14 Evaluate double integrals in polar coordinates.	a, b, 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 the 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 envir onments.

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

For the midterm and final exams, 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. For the online quizzes and tutorial problems, the solutions will be discussed during the tutorial session and feedback on common mistakes will be given then.

Learning and Teaching Approach

Lectures (39 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

Calculus 8E, by James Stewart, ISBN: 978-1285740621

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

Course Policies and Student Responsibilities

Absence due to medical or other valid reasons.

If you are sick and unable to attend a midterm test or missed the deadlines for your assignments/quizzes, you must:
1. Send an email to the instructor regarding the absence.
2. Submit the original Medical Certificate* to an administrator.
*The Medical Certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

In this case, a makeup assessment will be arranged. If a make-up test cannot be arranged due to unavailability of venue or other unforeseen circumstances, the weightage of the test will be transferred to the final exam.

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.

Course Instructors

Instructor	Office Location	Phone	Email
Ku Cheng Yeaw (Dr)	MAS-05-11	6513 8652	cyku@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Vectors in the plane & space. Dot products. Cross products. Applications to lines and planes in Space.	3	
2	Functions, Limits, Derivatives, Chain Rule, Implicit Differentiation, Rate of Change, Maximum/minimum	1, 2, 4	
3	L'Hospital Rule, Indefinite and definite integrals, Area, Volumes.	1, 5	
4	Techniques of Integration: Techniques of integrations: Substitution, By-parts, Partial fraction	5	
5	1st order ODE, 2nd order ODE: homogeneous & inhomogenous	6	
6	Sequences and series	7	
7	Divergence Test, Integral Test	7	
8	Absolute Convergence Test, Ratio Test, Root Test, Power Series	7	
9	Manipulating Geometric Series, Term-by-term differentiation and integration of power series, Taylor/Maclaurin Series	8, 9, 10	
10	Functions of two variables, partial derivatives, Chain Rule	11	
11	Implicit differentiation, Directional derivatives, gradient vectors, Double Integrals (definition & meaning)	11, 12	
12	Iterated Integrals, Double Integrals in polar coordinates	13, 14	
13	Review		

Appendix 1: Assessment Rubrics

Rubric for Technology-enhanced Learning: Online Quiz 1 (10%)
Point-based marking

Rubric for Technology-enhanced Learning: Online Quiz 2 (10%)
Point-based marking

Rubric for Mid-semester Quiz: Midterm Test (20%)
Point-based marking

Rubric for Examination: Final Exam (60%)
Point-based marking