COURSE OUTLINE: MH1802

Course Title	**Calculus for the Sciences**	
Course Code	**MH1802**	
Offered	Study Year 1, Semester 1	
Course Coordinator	Yang Bo (Asst Prof)	YANG.BO@ntu.edu.sg
Pre-requisites	None	
AU	4	
Contact hours	Lectures: 39, Tutorials: 13	
Approved for delivery from	AY 2022/23 semester 1	
Last revised	27 Nov 2022, 19:26	

Course Aims

This course aims to equip you with
• mathematical knowledge and analytical skills so that they are able to apply techniques of calculus (along with your existing mathematical skills) to solve scientific problems whenever applicable;
• mathematical reading skills so that you can read and understand related mathematical content in the basic and popular scientific and engineering literature; and
• mathematical communication skills so that you can effectively and rigorously present your mathematical ideas to mathematicians, scientists and engineers.

Intended Learning Outcomes

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

1. Explain the common terms used in the discussion of different types of numbers and functions
2. Cite examples of the applications of polynomial, trigonometric, logarithmic and exponential functions in Science and conversely identify the appropriate functions that best describe given scientific phenomena or experiments
3. Apply basic algebraic (including Binomial theorem), trigonometric, inverse trigonometric, logarithmic and exponential identities to prove identities in general
4. Apply basic concepts in complex numbers (including Euler's formula and de Moivre's theorem) to solve related problems
5. Explain the meaning of different types of limits of a function and evaluate them
6. Explain the concept of continuity of a function and apply it to estimate root of a function (Intermediate Value Theorem).
7. Apply the concept of limits of a function to solve related problems and derive formulas for the derivative of algebraic, trigonometric, inverse trigonometric, logarithmic and exponential functions
8. Apply the appropriate techniques to solve derivatives and higher order derivatives in general
9. Provide a graphical interpretation of derivatives, classify critical points and apply the appropriate techniques for curve sketching
10. Apply the appropriate techniques in solving single variable optimization and mean value problems
11. Compute and apply Taylor series of functions such as algebraic, trigonometric, inverse trigonometric, logarithmic and exponential functions
12. Cite examples of the applications of derivatives in Science (such as in kinematics and chemical kinetics) and conversely formulate descriptions of relevant scientific phenomena or experiments using derivatives

13. Apply derivatives to numerical approximations (such as Newton's method, linear approximations and differentials)
14. Apply differentiation to L'hospital rule
15. Compute numerical derivatives
16. Apply the concept of Riemann sum, fundamental theorem of calculus and use them to determine integrals
17. Apply the appropriate techniques (such as substitution, integration by parts, using partial fractions, using complex numbers) to solve integrals
18. Apply integration to compute area under graph, arc lengths, volume of revolution, mean values
19. Cite examples of the applications of integrals in Science (such as in kinematics, determining center of mass) and conversely formulate descriptions of relevant scientific phenomena or experiments using integrals
20. Apply numerical methods to make approximation of integrals
21. Perform simple classification of differential equations
22. Apply the appropriate techniques (such as separation of variables, use of integrating factors) to solve basic first order ordinary differential equations
23. Identify and apply techniques to solve second order linear ordinary differential equations with constant coefficients (homogeneous and nonhomogeneous)
24. Cite examples of the applications of differential equations in Science (such as in mechanics, chemical kinetics) and conversely formulate descriptions of relevant scientific phenomena or experiments using differential equations
25. Recognise that power series can be used in solving of general differential equations

Course Content

Types of Numbers; Functions and Graphs

Algebraic, trigonometric, logarithmic and exponential functions and identities

Basic Complex Numbers

Limits & Continuity

Derivatives & Techniques of Differentiation

Applications of Differentiation; Numerical Approximation of differentiation

Indefinite Integrals and Definite Integral, Fundamental Theorem of Calculus, Techniques of Integration 1

Techniques of Integration 2; Applications of Integration

Applications of Integration in Science; Numerical Approximation of integration

Introduction to Differential Equations; First Order Ordinary Differential Equations

Second Order Linear Differential Equations with constant coefficients

Power Series Method

Revision

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Tutorials					
Homework	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	**1.** a, b, c, d	20	individual	See Appendix for rubric
Mid-semester Quiz					
Common Test 1	1, 2, 3, 4, 5, 6, 7, 8	**1.** a, b, c **3.** a	20	individual	See Appendix for rubric
Common Test 2	7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18	**1.** a, b, c **3.** a	20	individual	See Appendix for rubric
Examination (2 hours)					
Final Examination	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	**1.** a, b, c **3.** a	40	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

3. Communication

a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience

Formative Feedback

Formative feedback is given through discussion within tutorial lessons and lectures. It is also given after each common test on the common mistakes and level of difficulty of the problems.

Learning and Teaching Approach

Lectures (39 hours)	Train you to be independent learners who are able to derive ideas/concepts from first principles and take ownership of your own learning. Help you understand the motivation behind mathematical theorems, definitions and formulae. Develop the train of thoughts in problem solving and presentation skills in presenting mathematical ideas and solutions. Develop competence in solving calculus related problems. Develop communication skills and competence in mathematics, particularly calculus. You also have an opportunity to work with your peers.
Tutorials (13 hours)	Train you to be independent learners who are able to derive ideas/concepts from first principles and take ownership of your own learning. Help you understand the motivation behind mathematical theorems, definitions and formulae. Develop the train of thoughts in problem solving and presentation skills in presenting mathematical ideas and solutions. Develop competence in solving calculus related problems. Develop communication skills and competence in mathematics, particularly calculus. You also have an opportunity to work with your peers.

Reading and References

Text Books:

Thomas, GB Jr., Weir MD, Hass J and Giordano FR , Thomas' Calculus, Pearson-Addison-Wesley, 13th Edition in SI Units , 2016. ISBN-13 978-1-292-08979-9.

James Stewart: Calculus (International Student Edition, Metric Version), 7th Edition, Thomson, Brooks/Cole, Cengage Learning. 2016. ISBN-13: 978-0538497817.

Other References:
K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering: A Comprehensive Guide, Cambridge University Press, 3rd edition (March 13, 2006). ISBN 0521861535.

Serge Lang, A First Course in Calculus, Addison-Wesley Pub Co, 3rd edition (January 1973). ISBN-13: 978-0201042238.

Donald Trim, Calculus for Engineering, Prentice Hall Canada, 2nd edition (March 7, 2001). ISBN-13: 978-0130856036.

Tom M Apostol, Calculus (Vol 1 and 2) Wiley 2nd edition (2016 and 2007). ISBN-13: 978-0471000051 (Vol 1), ISBN-13: 978-8126515202 (Vol 2).

Course Policies and Student Responsibilities

Absence Due to Medical or Other Reasons
If you are sick and unable to attend your class (particularly the mid-terms), you have to:
1. Send an email to the instructor regarding the absence.
2. Submit the original Medical Certificate* to administrator.

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

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
Yang Bo (Asst Prof)	SPMS-PAP-04-09		YANG.BO@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Types of Numbers; Functions and Graphs	1, 2	Reading assigned pre-lecture notes and relevant book chapters
2	Algebraic, trigonometric, logarithmic and exponential functions and identities	2, 3, 4	Reading assigned pre-lecture notes and relevant book chapters
3	Basic Complex Numbers	5	Reading assigned pre-lecture notes and relevant book chapters
4	Limits & Continuity	6, 7, 8	Reading assigned pre-lecture notes and relevant book chapters
5	Derivatives & Techniques of Differentiation	8, 9	Reading assigned pre-lecture notes and relevant book chapters; First Midterm test.
6	Applications of Differentiation; Numerical Approximation of differentiation	9, 10, 11, 12	Reading assigned pre-lecture notes and relevant book chapters
7	Indefinite Integrals and Definite Integral, Fundamental Theorem of Calculus, Techniques of Integration 1	13, 14	Reading assigned pre-lecture notes and relevant book chapters
8	Techniques of Integration 2; Applications of Integration	15	Reading assigned pre-lecture notes and relevant book chapters
9	Applications of Integration in Science; Numerical Approximation of integration	16, 17, 18	Reading assigned pre-lecture notes and relevant book chapters; Second Midterm test.
10	Introduction to Differential Equations; First Order Ordinary Differential Equations	19, 20	Reading assigned pre-lecture notes and relevant book chapters
11	Second Order Linear Differential Equations with constant coefficients	21, 22	Reading assigned pre-lecture notes and relevant book chapters
12	Power Series Method	23, 24	Reading assigned pre-lecture notes and relevant book chapters
13	Revision	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	Reading assigned pre-lecture notes and relevant book chapters

Appendix 1: Assessment Rubrics

Rubric for Tutorials: Homework (20%)

The students complete homeworks (weekly and biweekly) either on their own or by forming self-organised study groups.

Most of the homework questions will be MCQs from MyMath Lab or short answers. The answers will be graded by MyMath Lab.

Rubric for Mid-semester Quiz: Common Test 1 (20%)

Point-based marking (not rubrics based).

Rubric for Mid-semester Quiz: Common Test 2 (20%)
Point-based marking (not rubrics based).

Rubric for Examination: Final Examination (40%)
Point-based marking (not rubrics based).