NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2022/2023	**Semester**	2
Course Coordinator	Asst Prof. Tej Salil Choksi / Dr. Pui Tze Sian		
Course Code	CB1117		
Course Title	Engineering Mathematics (Core)		
Pre-requisites	MH1810 Mathematics		
No of AUs	4		
Contact Hours	*39 hours lecture, 13 hours tutorial*		
Proposal Date	*28 Sept 2021*		

Course Aims

This course serves as a foundation course on engineering mathematics. It covers a broad range of fundamental topics, including Differential Equations, Linear Algebra, Multi-variate calculus, and Vector Calculus. These key concepts will be important and useful to those of you who are pursuing Engineering studies, with applications in modelling and solutions of systems.

Intended Learning Outcomes (ILO)

After completing this course, the student will be able to apply the concepts of this course to various engineering disciplines in the following years of study. At the end of this course, you should be able to:

1. Describe and apply ODE models towards simple systems
2. Solve first and second order ODE problems, including Laplace transform or linear algebraic methods
3. Recognise PDE models and integrate functions of several variables over curves and surfaces
4. Understand how to differentiate and integrate multi-variate functions.
5. Learn the basics of vector operations relevant to applications in engineering.

Course Content

1. Model a simple system to obtain a first order ODE.
2. Solve linear and nonlinear first order ODEs as well as the second order linear homogeneous and nonhomogeneous ODE
3. Solve initial value problems using the Laplace transform.
4. Calculate determinant and matrix inverse of higher order matrices.
5. Solve a system of linear algebraic equations using Laplace transform.
6. Calculate eigenvalues and eigenvectors
7. Use eigenvalues and eigenvectors to solve the 1st order linear systems
8. Visualize functions in two and three-dimensions
9. Apply partial derivatives to evaluate directional derivatives, gradient vectors, tangent planes, etc.
10. Determine the extrema of functions of multiple variables and apply it to different practical maximization/minimization problems.
11. Apply multiple integral to evaluate areas, volumes, probability etc.
12. Perform line integral and surface integral over given curves and surfaces.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
1. Quiz 1	1, 2	EAB, SLO, a, b, c	20%	Individual	Refer to appendix 1
2. Quiz 2	4	EAB, SLO, a, b, c	17%	Individual	Refer to appendix 2
3. Class Participation in Weeks 8 to 13	4,5	EAB, SLO, a, b, c, j	3%	Individual	Refer to appendix 3
3. Final exam (2 hrs; Closed Book)	1,2,3,4,5	EAB, SLO, a, b, c	60%	Individual	
Total			100%		

Mapping of Course ILOs to EAB Graduate Attributes

Course Intended Learning Outcomes	Cat	EAB's 12 Graduate Attributes*											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
	Core	●	●	●									
1. Describe and apply ODE models towards simple systems													a,b
2. Solve first and second order ODE problems, including Laplace transform or linear algebraic methods													b, c
3. Recognise PDE models and integrate functions of several variables over curves and surfaces													a, b
4. Describe and apply basic concepts of probability and statistical inference													b, c

Legend:
- ● Fully consistent (contributes to more than 75% of Intended Learning Outcomes)
- ◐ Partially consistent (contributes to about 50% of Intended Learning Outcomes)
- š Weakly consistent (contributes to about 25% of Intended Learning Outcomes)
- Blank Not related to Student Learning Outcomes

Formative feedback

Examination results;
Marker's report on overall examination performance will be uploaded to NTUlearn;
Quiz answers will be discussed in class

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Demonstrate how to carry out a procedure such as working through a problem, use incomplete handouts which enabling students participating in class.
Tutorial	Class room discussion sessions on tutorial questions and related

	topics

Reading and References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, 2010.
2. Thomas, George Brinton, et al. Thomas' Calculus, 14th Edition, Pearson, 2017.

Course Policies and Student Responsibilities

General: Students are expected to complete all online activities and take all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course related announcements. Students are expected to participate in all tutorial discussions and activities.

Continuous assessments: Students are required to attend all continuous assessments.
Absenteeism: Continuous assessments make up a significant portion of students' course grade. Absence from continuous assessments without officially approved leave will result in no marks and affect students' overall course grade.

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
Tej Salil Choksi	N1.2-B1-18	63168940	tej.choksi@ntu.edu.sg
Alex Pui	N1.3 B2-12	6790 4485	tspui@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/Activities
1	Modelling Linear And Nonlinear 1st Order ODE	1	Face to face lecture
2	2nd Order ODE: Linear Homogeneous And Applications	2	Face to face lecture Tutorial 1
3	2nd Order ODE: Linear Nonhomogeneous And Applications	2	Face to face lecture Tutorial 2
4	Laplace Transforms, Heaviside Function	3	Face to face lecture Tutorial 3
5	Linear Algebra And Eigenvalues/Eigenvectors	2	Face to face lecture Tutorial 4
6	Linear Algebra And Eigenvalues/Eigenvectors	2	Face to face lecture Tutorial 5

7	System Of The First Order Linear ODE	2	Face to face lecture Tutorial 6
8	Introduction to three-dimensional coordinate geometry	4	Face to face lecture Tutorial 7
9	Introduction to multivariable functions, Partial Differentiation	4	Face to face lecture Tutorial 8
10	Directional derivatives, gradients, Double integrals	4	Face to face lecture Tutorial 9
11	Area, volume, and probability through multiple integrals,	4	Face to face lecture Tutorial 10
12	Line integrals and Vector Fields, Potential functions	5	Face to face lecture Tutorial 11
13	Green's theorem, Surface Area and Surface Integrals	5	Face to face lecture Tutorial 12

Appendix 1: Assessment Criteria

Criteria	Unsatisfactory: <40%	Borderline: 40% to 49%	Satisfactory: 50% to 69%	Very good: 70% to 89%	Exemplary: >90%
Knowledge Understanding general vs particular solution	• Lacks understanding of theories, concepts, and terms governing 1st and 2nd ODE.	• Partial understanding of theories, concepts, and terms governing 1st and 2nd ODE	• Good understanding of the theories, concepts, and terms governing 1st and 2nd ODE	Good and comprehensive understanding of the theories, concepts, and terms governing 1st and 2nd ODE	• Very good and comprehensive understanding of theories, concepts, and terms governing 1st and 2nd ODE
Analysis The ability to comprehend 2nd order and higher order ODEs	• Unable to apply the theories and concepts to solve 1st and 2nd ODEs problems	• Can apply the theories and concepts to solve simple 1st and 2nd ODEs problem	• Can apply the theories and concepts to solve medium level 1st and 2nd ODEs problem	• Can apply the theories and concepts to solve complicated 1st and 2nd ODEs problem	• Can apply the theories and concepts to solve 1st, 2nd and higher order ODEs problem.

Appendix 2: Assessment Criteria

Criteria	Unsatisfactory: <40%	Pass: 40% to 69%	High Standard: >70%
Method of approach (40%)	Using methods that are irrelevant or do not apply to the given problem. Applying theorems whose conditions are not satisfied.	Able to identify relevant methods that help solve the problem but unable to arrive at the complete / appropriate solution.	Applying methods and theorems that are relevant and efficiently to solve the entire problem.
Validity of reasoning (40%)	The student's reasoning is logically invalid.	The student's reasoning is logically valid	The student's reasoning is logically valid and effective
Presentation of answer (20%)	The student's argument is poorly explained or not explained at all.	The student's argument is clear, but may contain some gaps.	The student's argument is clear, precise, with no or insignificant gaps.

Appendix 3: Assessment Criteria

Class participation will be gauged by weekly online polls. These polls serve as a self-assessment tool for the student, and help the faculty gauge the pulse of the class in terms of effectiveness of the learning. Points are awarded for participation, regardless of whether the answers are correct/wrong.

Criteria	Grade
Answers 5 or 6 of the 6 polls	3% (Full points)
Answer 3 or 4 of the 6 polls	1% (1/3rd of the points)
Answer 0, 1, or 2 of the 6 polls	0% (0 points)

Appendix 3: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

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 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