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 2
Course Author * Faculty proposing/revising the course	Pui Tze Sian
Course Author Email	tspui@ntu.edu.sg, Tej.choksi@ntu.edu.sg
Course Title	Engineering Mathematics
Course Code	CB1117
Academic Units	4
Contact Hours	52
Research Experience Components	Not Applicable

Course Requisites (if applicable)

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

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, Vector Calculus, Probability and Mathematical Statistics. 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.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Describe and apply ODE models towards simple systems.
ILO 2	Solve first and second order ODE problems, including Laplace transform or linear algebraic methods.
ILO 3	Recognize PDE models and integrate functions of several variables over curves and surfaces
ILO 4	Understand how to differentiate and integrate multi-variate functions.
ILO 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. Apply partial derivatives to evaluate directional derivatives, gradient vectors, tangent planes, etc. 9. Determine the extrema of functions of multiple variables and apply it to different practical maximization/minimization problems. 10. Apply multiple integral to evaluate areas, volumes, etc. 11. Perform line integral and surface integral over given curves and surfaces. 12. Use Fourier series to represent any periodic function 13. Apply the method of separation of variables to solve 1D heat equations 14. Apply probability theory and basic mathematical statistics

Reading and References (if applicable)

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

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Modelling Linear And Nonlinear 1st Order ODE	1	Reading list [1], [2]	In-person	Face to face lecture
2	2nd Order ODE: Linear Homogeneous And Applications	1,2	Reading list [1], [2]	In-person	Face to face lecture Tutorial 1
3	2nd Order ODE: Linear Nonhomogeneous And Applications	2	Reading list [1], [2]	In-person	Face to face lecture Tutorial 2
4	Laplace Transforms, Heaviside Function	2	Reading list [1], [2]	In-person	Face to face lecture Tutorial 3
5	Laplace Transforms, Heaviside Function	2	Reading list [1], [2]	In-person	Face to face lecture Tutorial 4
6	Linear Algebra And Eigenvalues/Eigenvectors	2	Reading list [1], [2]	In-person	Face to face lecture Tutorial 5
7	System Of The First Order Linear ODE	2	Reading list [1], [2]	In-person	Face to face lecture Tutorial 6
8	Introduction to dimensional coordinate geometry	3	Reading list [1], [2]	In-person	Face to face lecture Tutorial 7
9	Introduction to multivariable functions, partial differential	4	Reading list [1], [2]	In-person	Face to face lecture Tutorial 8

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
10	Directional derivatives, gradients, double integrals	4	Reading list [1], [2]	In-person	Face to face lecture Tutorial 9
11	Area, volume, and probability through multiple integrals	5	Reading list [1], [2]	In-person	Face to face lecture Tutorial 10
12	Line integrals and Vector Fields, potential functions	5	Reading list [1], [2]	In-person	Face to face lecture Tutorial 11
13	Green's theorem, surface area and surface integrals.	5	Reading list [1], [2]	In-person	Face to face lecture Tutorial 12

Learning and Teaching Approach

Approach	How does this approach support you 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

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()	1, 2	EAB, SLO, a, b, c	20	Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Test/Quiz()	4	EAB, SLO, a, b, c	17	Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Class Participation()	4,5	EAB, SLO, a, b, c	3	Individual	Analytic	Multistructural
4	Summative Assessment (EXAM): Final exam()	1,2,3,4,5	EAB, SLO, a, b, c	60	Individual	Analytic	Relational

Description of Assessment Components (if applicable)

Formative Feedback

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

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Creative Thinking	Basic
Curiosity	Intermediate
Problem Solving	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)

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.

Policy (Absenteeism)

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.

Policy (Others, if applicable)

ssments without officially approved leave will result in no marks and affect students' overall course grade.

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Last Updated By: Raymond Lau Wai Man (Assoc Prof)

Appendix : Rubric/Assessment Criteria for Components listed in Assessment Table

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 4: Assessment Criteria Final Exam

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.
Method of approach	• Unable to apply appropriate methods to analyze mathematical problems effectively.	• Can apply some methods to analyze simple mathematical problems.	• Can apply various methods to analyze medium level mathematical problems.	• Can apply advanced methods to analyze complex mathematical problems.	• Can apply advanced methods to analyze all types of mathematical problems proficiently.
Validity of reasoning	• The student's reasoning is logically invalid, leading to incorrect conclusions or solutions.	• The student's reasoning is logically valid but may lack clarity or completeness in some aspects.	• The student's reasoning is logically valid and adequately supports the conclusions or solutions presented.	• The student's reasoning is logically valid and effectively supports the conclusions or solutions presented.	• The student's reasoning is logically valid, precise, and demonstrates exceptional clarity and effectiveness in supporting conclusions or solutions.

Mapping of Course ILOs to EAB Graduate Attributes

Course Code & Title	CB 1117 & Engineering Mathematics
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**
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)	Recognize PDE models and integrate functions of several variables over curves and surfaces	a, b
4)	Understand how to differentiate and integrate multi-variate functions.	b, c
5)	Learn the basics of vector operations relevant to applications in engineering.	b, c
6)		
7)		
8)		
9)		
10)		

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