NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2024 /2025	**Semester**	1
Course Coordinator	Assoc Prof. Ni Ran / Dr. Mukta Bansal		
Course Code	BG2211		
Course Title	Introduction to Computational Thinking		
Pre-requisites	MH1810		
No of AUs	3		
Contact Hours	26 Lecture hours and 12 tutorial hours		
Proposal Date	17 May 2018		

Course Aims

Computational thinking (CT) is a problem solving process with the aid of computer; i.e. formulating a problem and expressing its solution in such a way that a computer can effectively carry it out. It includes a number of characteristics, such as breaking a problem into small and repetitive ordered steps, logically ordering and analyzing data and creating solutions that can be effectively implemented as algorithms running on computer. As such, computational thinking is essential not only to the Computer Science discipline, it can also be used to support problem solving across all disciplines, including math, science, engineering, business, finance and humanities.

The aim of this course is hence to take students with no prior experience of thinking in a computational manner to a point where you can derive simple algorithms and code the programs to solve some basic problems in bioengineering domain.

Intended Learning Outcomes (ILO)

At the end of this course, you should be able to:

1. Code basic programs based on the programming language such as MATLAB.
2. Formulate a problem and express its solution in such a way that a computer can effectively carry it out. (i.e. equip you with CT skills)
3. Identify appropriate numerical methods in solving realistic problems in bioengineering using computing language (such as MATLAB).

Course Content

0	**Course Overview and Concepts of Computational Thinking** Solving complex problem using computer **- enables the student to work out exactly what to tell the computer to do.**
1	**Overview of Programming Languages** Graphic programming, high level programming languages (Matlab)
2	**Basic internal operation of computer** Basic computer organization and how a computer execute a program (Machine instructions)
3	**Basic program structure: control constructs and data types** Concepts of data types, variables; Pseude code and flowcharts; Sequences, Selection (if/else), iteration (for/while loop);

4	**CT concept – Abstraction** Problem formulation - reducing something to a set of sub problems which have existing numerical algorithms/methods such as linear/nonlinear equations, optimization, curve fitting, numerical integration/differentiation, numerical differential equations
5	**CT concept - Decomposition** Break a complex problem into smaller and more manageable parts/steps and find the appropriate algorithms/methods for them including the methods for linear/nonlinear equations, optimization, curve fitting, numerical integration/differentiation, numerical differential equations.
6	**CT concept – Pattern recognition** Looking for similarities among and within problems, which also enable re-use knowledge of previous similar problems
7	**CT concept – Algorithm** Reformulating the problem into series of ordered steps through Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.
8	**Limit of computing** Analysis of Algorithm Complexity to determine how much resources (space and time) are needed to execute an Algorithm in order to achieve code optimization.

Component	**Course LO Tested**	**Related Programme LO or Graduate Attributes**	**Weighting**	**Team/Individual**	**Assessment rubrics**
1. Continuous Assessment 1 (CA1 and CA2): Quizzes	1, 2, 3	EAB SLO* a, b, f	80%	Individual	
2. CA3: Assignments	1, 2, 3	EAB SLO* a, b, c, f	20%	Individual	Appendix 1
Total			100%		

Formative feedback

You will get back your quizzes scores and the answers;
You will receive feedback during tutorials based on your performance;
You will also receive feedback on your assignment performance.

Learning and Teaching approach

Approach	**How does this approach support students in achieving the learning outcomes?**
LECTURE	Course materials covering all topics

LAMS Online Lecture	MATLAB Implementation
TUTORIAL	12 classroom discussion sessions on tutorial questions and related topics

Reading and References

TextBook

- √ *S. C. Chapra & R.P. Canale, Numerical Methods for Engineers, 7th Edition, McGraw Hill Education, 2015.*

References

- √ *J. H. Mathews and K. D. Fink, Numerical Methods using Matlab, 4th Ed., Pearson-Prentice Hall, New Jersey, 2004*
- √ *Constantinides and N. Mostoufi, Numerical Methods for Chemical Engineering: Applications in MATLAB, Cambridge University Press, 2006.*

Course Policies and Student Responsibilities

- Completed assignments should be submitted through box labeled BG2111. No late assignments will be accepted.
- There will be no make-up quizzes. Zero points for no show up. Exceptions will be made for official leave of absence (with valid proof). In this case, points will be awarded based on your performance in the final examination.
- Active note taking in the class is encouraged.

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
Mukta Bansal	N1.2-B2-28	6316 8775	mbansal@ntu.edu.sg
Ni Ran	N1.2-B1-12	6790 6737	r.ni@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	**Course Overview and Concepts of Computational Thinking** Simple Mathematical Model, Programming and Software & Approximation & Round-Off Errors	1, 3	
2	**Overview of MATLAB** Taylor Series	1, 3	
3	Error Propagation	1, 2, 3	
4	**Computational Algorithms:** Bracketing Methods & Open Methods	1, 2, 3	
5	**Decomposition & Algorithm** Open Methods & Quiz	1, 3	
6	**Decomposition & Algorithm**	1, 3	
7	**Algorithm** LU Decomposition and Matrix Inversion & Review	1, 3	
8 & 9	**Abstraction** Optimization	1, 2, 3	
10	**Pattern recognition** Curve Fitting	1, 2, 3	
11	**Algorithm** Numerical Integration	1, 2, 3	
12	**Algorithm** Differential Equation	1, 2, 3	
13	Review & Quiz	1, 2, 3	

Appendix 1: Assessment criteria for the assignment

Criteria	Unsatisfactory: 1	Borderline: 2	Satisfactory: 3	Very good: 4	Exemplary: 5
Interpretation (LO 2 and 3)	Interpretation of the problem is not clear	Interpretation of the problem and explanation of the algorithm suggests minimal understanding of the basics	Interpretation of the problem and explanation of the algorithm suggests that there is basic understanding	Interpretation of the problem and explanation of the algorithm suggests that there is clear understanding of the numerical methods.	Interpretation of the problem and explanation of the algorithm suggests a very clear understanding of the numerical methods that is needed for the assignment and provide recommendations
MATLAB implementation (LO 1, 2, 3)	Not able to implement it in MATLAB	Able to do it without having much idea.	Able to understand and implement it in MATLAB	Able to implement it in MATLAB and able to interpret the results.	The MATLAB simulation meets all the requirements and presents the results in a very user friendly/useful way.

Appendix 2: 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