NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2024/2025	**Semester**	1
Course Coordinator	Assoc Prof. Raymond Lau Wai Man / Asst Prof. Dang Thuy Tram		
Course Code	CH2103		
Course Title	Fluids Systems		
Pre-requisites	CH1117/CB1117 Engineering Mathematics CH1104 Materials and Energy Balance		
No of AUs	3		
Contact Hours	26 hours of lectures, 12 hours of tutorials.		
Proposal Date	21 Feb 2022		

Course Aims

At the end of the course, you will be able to apply fluid flow principles in specific applications involved in chemical reactors, heat exchangers, and separation equipment such as distillation column, fluidized bed and filter bed.

Intended Learning Outcomes (ILO)

Students will be able to:

1. Identify the properties of fluids and the state of fluids at rest and during motion.
2. Determine unknown fluid flow information in a system by applying mass, energy and momentum balances with the use of appropriate mathematical tools.
3. Interpret fluid flow properties based on specific location and time in a system.

Course Content

Key topics taught

1) Introduction, fluid properties and forces
2) Mass and Energy Balances
3) Momentum Balances
4) Fluid flow in pipes
5) Flow in non-circular duct and compressible flow
6) Pipe and fittings
7) Dimensional analysis
8) Pumps and compressors
9) Fluid drag
10) Microscopic balances. Exact solutions to Navier-Stokes equations.
11) Non-dimensionalization. Inviscid flow. Non-Newtonian fluid flows
12) Advanced topics. Boundary layer approximation.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
1. Final Examination (2 hr duration, open book)	1, 2, 3	EAB SLO* a, b, c	60%	Individual	Appendix 1i, ii, iii

2. Continuous Assessment 1 (CA1): Quiz (50 min duration, open book)	1, 2	EAB SLO* a, b, c	20%	Individual	Appendix 1i, ii
3. CA2: Continuous Assessment 2 (CA2): Quiz (50 min duration, open book)	1, 2, 3	EAB SLO* a, b, c	20%	Individual	Appendix 1ii, iii
Total			100%		

Formative feedback

After each CA, the problems will be discussed during tutorials. Common mistakes and misunderstanding in concepts will also be addressed.

Learning and Teaching approach

Approach	**How does this approach support students in achieving the learning outcomes?**
Lecture	Lectures are mainly focusing on the principles and concepts of fluid mechanics in chemical engineering.
Tutorial	Tutorial problems are direct applications of the principles and concepts introduced in lectures. Industrial based applications are also introduced as in-class exercises where students are encouraged to discuss with each other in a collaborative manner.

Reading and References

1) James O. Wilkes, Fluid Mechanics for Chemical Engineers with Microfluidics & CFD, 2nd Edition, Pearson, 2006.
2) Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Introduction to Fluid Mechanics, 7th Edition, John Wiley & Sons, 2008.

Course Policies and Student Responsibilities

You are responsible for meeting all course requirements, observing all deadlines, examination times, and other course procedures.

You will be awarded ZERO mark for being absence from quizzes unless it is due to the following reasons:

- Illness (valid medical certificate is required, not from Chinese doctor)
- Passing away of immediate family member (parents, siblings or grandparents)
- Participate in an activity representing NTU (support letter from participating organization)

There will be no makeup given for missed quizzes. Final grade will be determined based on the participated quiz and final examination.

You are responsible for following the university regulations for final examination as indicated here:
http://www.ntu.edu.sg/Students/Undergraduate/AcademicServices/Examination/Pages/Instructionstoexamcand.aspx

You are responsible for being on time for all lectures and tutorials. Sufficient efforts should be put into solving or attempting the tutorial problems prior to attending the respective tutorial classes.

You might be award an "F" for a component or expelled from the university if you are caught cheating.

You are responsible for seeking academic help in a timely fashion.

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
Lau Wai Man	N1.2-B2-32	6316 8830	wmlau@ntu.edu.sg
Dang Thuy Tram	N1.3-B3-09	6790 4257	ttdang@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction, fluid properties and forces	1	Wilkes CH1.1-1.5
2	Mass and energy balances	1,2	Wilkes CH1.6-2.3
3	Momentum balance	1,2	Wilkes CH2.4-2.5
4	Applications of mass, energy and momentum balances in chemical engineering	1,2	Wilkes CH2.6-2.7
5	Fluid flow in pipes	1,2	Wilkes CH3.1-3.3

6	Flow in non-circular duct and compressible flow	1,2	Wilkes CH3.5-3.6
7	Fluid Drag	1,2	Wilkes CH4.3
8	Pump and Compressors, Dimensional Analysis	1	Wilkes CH4.1-4.2
9,10	Intro to microscopic fluids, velocity field, forces, generalized continuity and momentum equations,	3	Wilkes CH5 (all)
11	Exact solution for viscous flows	2,3	Wilkes CH6 (all except 6.6)
12,13	Inviscid flows, stream function, velocity potential, elementary plane flows	2,3	Wilkes CH7 (all except 7.6)

Appendix 1: CH2103 Fluids Systems Evaluation Rubric

ASSESSMENT FORM (Course Coordinator: Lau Wai Man)

Criteria	Unsatisfactory: 1	Borderline: 2	Satisfactory: 3	Very good: 4	Exemplary: 5
i. Identify the properties of fluids and the state of fluids at rest and during motion.	Unable to visualize a problem and do not know how to apply the concepts of pressure and force acting on fluids	Able to visualize the problem and know what pressure and/or force are present but cannot identify the related equations correctly or solve mathematically	Able to visualize the problem, know what pressure and/or force are present, able to identify the related equations correct and solve mathematically for simple systems	Good understanding of the concepts of pressure and force acting on fluids, able to identify the related equations and solve the problem mathematically for standard systems	Excellent understanding of the concepts of pressure and force acting on fluids, able to identify the related equations and solve the problem mathematically for complex systems
ii. Determine unknown fluid flow information in a system by applying mass, energy and momentum balances with the use of appropriate mathematical tools.	Unable to visualize a problem and do not know how to apply the correct balances to solve the problem	Able to visualize the problem and know what balances to use but cannot write the governing equations correctly or solve mathematically	Able to visualize the problem, setup an individual balance correctly and solve the equation mathematically	Good understanding of the problem, ale to setup a combination of two balances and solve mathematically	Excellent understanding of the problem, able to setup a combination of at least 3 or more balances and solve mathematically
iii. Interpret fluid flow properties based on specific location and time in a system.	Unable to identify the correct Navier Stokes equation relating to a flow problem	Able to identify the correct Navier Stokes equation and but not able to reduce the equation based on the flow conditions and boundary conditions	Able to identify the correct Navier Stokes equation and reduce the equation correctly based on the flow conditions but unable to identify the correct boundary conditions	Able to identify the correct Navier Stokes equation, reduce the equation correctly based on the flow conditions and able to solve the problem by identifying the correct boundary conditions	Excellent understanding of the Navier Stokes equation and solve complex fluid problems using simultaneously equations and multiple boundary conditions correctly

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