COURSE CONTENT

Academic Year	AY2018/19	**Semester**	2
Course Coordinator			
Course Code	CV2015		
Course Title	Hydraulic		
Pre-requisites	Nil		
No of AUs	3		
Contact Hours	Lecture: 26 hrs; Tutorial: 13 hr; Lab: 0 hr.		
Proposal Date	23 May 2019		

Course Aims

To introduce the basic principles of the hydraulics of open channel flows, which are essential fundamentals for the design of water resources related projects.

Intended Learning Outcomes (ILO)

After the successful completion of the course, the students should be able to:

1. Describe the fundamental knowledge of open channel hydraulics, including the concept of boundary layer, velocity distributions in turbulent flow;
2. Apply boundary layer concept to describe and calculate forces on immersed body;
3. Apply the knowledge on boundary layer theory to solve practical engineering problems relating to the planning and design of water resources projects;
4. Perform resistance type equations to solve open channel flow problems under uniform flow conditions;
5. Calculate changes of the water surface profiles subjected to transition problems using specific energy diagram;
6. Sketch and compute water surface profiles related to gradually varied flows;
7. Evaluate hydraulics jumps using the momentum equation.

Course Content

S/N	Topic	Lecture Hrs	Tutorial Hrs
1.	Concept of boundary layer: velocity distribution in turbulent flow	3	1
2.	Steady uniform flow: resistance to flow; Chezy and Manning's equations. Most efficient channel cross-section.	5	3
3.	Specific energy diagram; critical flow condition. Froude number. Channel transitions and controls: humps and contractions, weirs, sluice gates	6	3
4.	Steady non-uniform flow: characteristics and classification of gradually varied flow profiles, control sections.	5	2
5.	Computation of water surface profiles; The Direct Step method.	4	2
6.	Momentum equation and hydraulic jump.	3	2
	Total:	26	13

Assessment (includes both continuous and summative assessment)

Component	Course ILO Tested	Related Programme SLO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
1. Final Examination	1, 2, 3, 4, 5, 6, 7	CVE SLOs (2018) a, c, e, g, j	60%	Individual	
2. Continuous Assessment 1 (CA1) : Quiz 1	1, 2, 3, 4	CVE SLOs (2018) a, c, e, g, j	20%	Individual	
2. Continuous Assessment 2 (CA2): Quiz 2	5, 6, 7	CVE SLOs (2018) a, c, e, g, j	20%	Individual	
Total			100%		

CVE SLOs (2018)

a) **Engineering Knowledge**: Apply the knowledge of mathematics, natural science, engineering fundamentals, and civil engineering specialisation to the solution of complex civil engineering problems.

b) **Problem Analysis**: Identify, formulate, research literature, and analyse complex civil engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) **Design/development of Solutions**: Design solutions for complex civil engineering problems and design system components or processes 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 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 civil 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 the need for the sustainable development.

h) **Ethics**: Apply ethical principles and commit to professional and moral responsibilities in the civil 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 civil engineering activities with the engineering community and with society at large, be able to comprehend and write effective reports and design documentation, and make effective presentations.

k) **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to work, as a member and leader in a multidisciplinary team.

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 evolution.

Formative feedback

The instructor(s) will provide feedback on your performance on the CA. Guidance will also be provided through active interactions during tutorial sessions and consultation meetings.

Learning and Teaching approach

Class meets three times per week in lecture (2 hours) and tutorial (1 hour) format.

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Formal lectures on the topics with in-class discussion
Tutorial	This helps you to achieve one or more of the outcomes as you would need to work on tutorial questions using the concepts and principles taught in lectures. (The class is split into groups for tutorials so that the instructor-student interaction can be more effective.)

Reading and References

Textbooks:

1. Franzini, J.B. and Finnemore, E.J., “Fluid Mechanics with Engineering Applications”, 10th Edition, McGraw-Hill, 2002.

References:

1. Sturm, T. W., “Open Channel Hydraulics”. International Edition, 2nd Edition, McGraw-Hill, 2010.

2. Henderson, F.M. “Open Channel Flow” Macmillan Co, 1966 (Classical text).
3. Chow, V.T. “Open Channel Hydraulics” McGraw Hill, New York, 1981 (Classical text).

Course Policies and Student Responsibilities

You are advised to go through the class material and related texts before the lecture. You are also encouraged to share and deliberate on the challenges and difficulties of the tutorial exercises during the tutorials.

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
Professor Chiew Yee Meng	N1-01b-53	6790 5256	cymchiew@ntu.edu.sg
A/P Lim Siow Yong	N1-01a-15	6790 5287	csylim@ntu.edu.sg

Planned Weekly Schedule

Week	Topics	Course ILO	Activities
1-2	Boundary Layer Theory and Velocity Profile State the meaning of boundary layer; explain the importance of boundary layer in fluid flow; determine the shear stress in turbulent flows; describe smooth and rough pipe regime; state the equations used to describe velocity distribution in pipe and open channel flows; calculate discharge theoretically.	1	3 lecture and 1 tutorial on Concept of Boundary Layer
2-3	Forces on Immersed Bodies Discuss fluid phenomena encountered in incompressible flow or in low-velocity compressible flow where the effect of compressibility is negligible; explain the origin of	1, 2	2 lectures and 1 tutorial on Forces on Immersed Bodies

	lift and drag forces for flow around an immersed body; classify the types of drag; describe the variation of lift and drag coefficients with variations in flow; describe the characteristics of drag coefficient (C_D) vs. Reynold's number (Re) diagram.		
3 - 4	<u>Uniform Flow in Open Channels</u> Describe uniform open channel flow; explain the different conditions for uniform flow; state the Manning formula; solve uniform open channel flow using the Manning Formula; solve problems involving velocity of distribution in open channel and efficient cross sections	3, 4	3 lectures and 2 tutorial on Uniform Flows in Open Channels and most Efficient Sections
5 - 7	<u>Specific Energy and Transition Problems</u> Define specific energy; describe the characteristics of specific energy diagram; state the formula in finding minimum specific energy for a given flow rate per unit width, *q* and maximum *q* for a given *E;* distinguish between subcritical and supercritical flow; discuss critical depth in non-rectangular channels; explain critical hump and its associated flow conditions; choking ponding conditions; solve problems involving humps, depression, and contraction	5	6 lectures and 3 tutorial on Specific Energy and solving problems relating to Transition Problems.
7	Quiz – CA 1		
7 - 8	<u>Momentum Equations and Hydraulic Jumps</u> Apply Newton's 2nd Law of Motion for open channel flow applications; derive relevant equations for use in open channel flow; describe a hydraulic jump and the techniques in solving problems that involve a hydraulic jump; Solve problems involving hydraulic jumps	7	3 lectures and 2 tutorials on Momentum equation and Hydraulic Jumps
9 – 11	<u>Gradually Varied Flows</u> Distinguish between uniform flow and non-uniform flow; discuss control points; derive the gradually varied flow equation; differentiate the types of flow profiles; perform backwater synthesis; sketch water surface profiles	6	5 lectures 2 tutorial on Gradually Varied Flow
12	Quiz – CA 2		
12 and 13	<u>Computation of Gradually Varied Flows</u> Perform numerical analysis to compute water surface profiles	6	4 lectures 2 tutorial on Computation of Gradually Varied Flow