NANYANG TECHNOLOGICAL UNIVERSITY

Teaching, Learning and Pedagogy Division

Reg. No. 200604393R

COURSE OUTLINE

Academic Year	2017	**Semester**	1 & 2
Course Coordinator	A/P Yeo Joon Hock (Semester 1) A/P Chan Weng Kong (Semester 2)		
Course Code	MA3006		
Course Title	Fluid Mechanics		
Pre-requisites	MA2003 Introduction to Thermo-fluids		
No of AUs	3		
Contact Hours	Lecture (26 hours), Tutorial (12 hours))		
Proposal Date	6 December 2017		

Course Aims

This course aims to provide you with the fundamental knowledge on *Fluid Flow*. The principles of fluid flow are demonstrated through the applications of the Bernoulli's equation and the conservation laws, i.e., the continuity, momentum and energy equations. You are trained to use the control volume approach for solving physical fluid flow problems in typical engineering environment. Practical topics such as dimensional analysis, internal flow and piping losses, and principles and applications of fluid machines will complete this course on fluid mechanics for mechanical engineering students.

Intended Learning Outcomes (ILO)

By the end of this course, you would be able to:

1. differentiate between system and control volume,
2. apply Bernoulli's equation to fluid flow problems for the determination of unknown variables,
3. apply the continuity and momentum equations to solve physical flow problems,
4. apply the angular momentum equation for applications in water sprinklers,
5. apply the energy equation to solve physical flow problems in pumps, turbines, fans and pipes,
6. select suitable differential pressure flow meters for volume flow rate measurements,
7. obtain dimensionless parameters from a set of variables using dimensionless analysis,
8. carry out similitude studies between models and prototypes using suitable dimensionless groups,
9. distinguish the differences between laminar and turbulent flows along pipes,
10. perform pipe loss calculations using Darcy equation and Moody diagram,
11. compute minor losses in a flow system and sketching of EGL and HGL,
12. describe the applications of fluid machines in a fluid flow system and compute pump characteristics using similarity laws,
13. determine specific speed of a given turbomachine and select the appropriate fluid machine to match the flow system to satisfy flow requirement,

14. determine the operating flow rate, head generated and power requirement of a single pump, 2 pumps in series and 2 pumps in parallel in a flow system.
15. determine the Net Positive Suction Head and select the appropriate fluid machine to avoid cavitation.

Course Content

MOMENTUM AND ENERGY EQUATIONS AND APPLICATIONS (7 hours)
Momentum equation for steady flow. Fixed and moving control volumes. Forces on PIPE bends, deflectors and jet engine. Moment-of-momentum equation. Energy equations for pumps and turbines. Flow meters.

DIMENSIONAL ANALYSIS AND SIMILITUDE (4 hours)
Buckingham Pi theorem. Significance of dimensionless groups. Flow similarity and model studies.

INTERNAL FLOWS AND PIPING SYSTEMS (7 hours)
Laminar and turbulent flows in pipes. Energy concepts in pipe flows. Darcy equation and Moody diagram. Frictional and minor losses. Analysis of pipe network.

PRINCIPLES AND APPLICATIONS OF FLUID MACHINES (8 hours)
Principles of fluid machines. Performance characteristics of pumps and fans. Similarity laws. Specific speed and machine selection. System characteristics and matching. Parallel and series operations of pumps. Cavitation and NPSH.

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 (2.5 hours, Closed book)	1-15	EAB SLO Draft 2017* a, b, d, g	60%	Individual	
2. CA1: Quiz 1	1-5	EAB SLO Draft 2017* a, b, d, g	20%	Individual	
3. CA2: Quiz 2	6-10	EAB SLO Draft 2017* a, b, d, g	20%	Individual	
Total			100%		

* “EAB SLO Draft 2017” stands for the EAB Accreditation Manual Draft Version: Aug 2017

Formative feedback

- The outcome of the quiz will be discussed after the quiz to provide feedback and correct any mistakes/misapplication of concepts made by the class.
- You are encouraged to participate actively in tutorial class. This will help clarify your doubts.

- Feedback will be welcomed through the course, where you could write in to the lecturers for constructive suggestions.

Learning and Teaching approach

Approach	**How does this approach support students in achieving the learning outcomes?**
Lectures	The lectures will cover all the important concepts on fluid flow. To enhance your understanding, examples will be given. These will help you to achieve the learning outcomes 1 to 15.
Tutorials	You are expected to attend and participate actively in the tutorials. Concepts that you have difficulty in understanding will be highlighted and discussed. In addition, tutors will explain the subtleties in some problems in class. All these will further help you to achieve the learning outcomes 1 to 15.

Reading and References

Textbook

1. Munson, BR, Young, DF, Okiishi, TH and Huebsch WW, Fundamentals of Fluid Mechanics, **7th Edition, John Wiley, 2013.**

References

1. Potter, MC, Wiggert, DC and Ramadan BH, Mechanics of Fluids, 5 th Edition, Cengage, **2015.**
2. Fox, RW, McDonald, AT and Pritchard, PJ, Introduction to Fluid Mechanics, 6th Edition, John Wiley, **2003**

Course Policies and Student Responsibilities

(1) General
You are expected to complete all assigned pre-class readings and activities, attend and participate in every tutorial session. You are expected to take responsibility to follow up with course notes and course related announcements.

(2) Quizzes
Note that it is compulsory for you to take both quizzes for this course. In the case of absence due to medical reasons, you must submit a medical certificate to the School not later than two weeks after that quiz, failing which you would be considered to be absent and given 0 mark for that component of the CA. The original medical certificate with the appropriate Leave of Absence form should be endorsed by respective tutor and submitted to the MAE Undergraduate Office with a scanned version emailed to the Course Coordinator and the tutor concerned.

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
Dr Yeo Joon Hock	N3-2b-57	67905500	mjhyeo@ntu.edu.sg
Dr Lua Aik Chong	N3-2b-56	67905535	maclua@ntu.edu.sg
Dr Chan Weng Kong	N3-2c-80	67905497	mwkchan@ntu.edu.sg

Planned Weekly Schedule

	Topic	Course LO	Readings/Activities
1.	Momentum Equation and its Applications.	Differentiate between system and control volume. Apply Bernoulli's equation to fluid flow problems for the determination of unknown variables. Apply the continuity and momentum equations to solve physical flow problems. Specific ILO (1,2,3)	Chapter 5
2.	Angular Momentum Equation and its Applications.	Apply the angular momentum equation for applications in water sprinklers. Specific ILO (4)	Chapter 5
3.	Energy Equation and its Applications.	Apply the energy equation to solve physical flow problems in pumps, turbines, fans and pipes. Specific ILO (5)	Chapter 5
4.	Flow Rate Meters	Select suitable differential pressure flow meters for volume flow rate measurements. Specific ILO (6)	Chapter 8
5.	Dimensional Analysis	To obtain dimensionless	Chapter 7

		parameters from a set of variables using dimensionless analysis. Specific ILO (7)		
6.	Dimensional Analysis and Similitude	To carry out similitude studies between models and prototypes using suitable dimensionless groups. Specific ILO (8)	Chapter 7	
7.	Introduction to Viscous Flow	To distinguish the differences between laminar and turbulent flows along pipes. Specific ILO (9)	Chapter 8	
8.	Viscous Flow and pipe losses	To perform pipe loss calculation using Darcy equation and using of Moody diagram. Specific ILO (10)	Chapter 8	
9	Viscous Flow, minor loss and EGL and HGL	To compute minor losses in a flow system and sketching of EGL and HGL. Specific ILO (11)	Chapter 8	
10	Introduction and Classification of Fluid Machines. Performance characteristics of pumps and fans. Similarity laws.	Describe the applications of fluid machines in a fluid flow system and compute pump characteristics using similarity laws. Specific ILO (12)	Chapter 12	
11	Specific speed and machine selection. Determination of System characteristics.	Determine specific speed of a given turbomachine and select the appropriate fluid machine to match the flow system to satisfy flow requirement. Specific ILO (13)	Chapter 12	
12	System Matching. Parallel and series operations.	Determine the operating flow rate, head generated and power requirement of a single pump, 2 pumps in series and 2 pumps in parallel in a flow system. Specific ILO (14)	Chapter 12	
13	Cavitation and NPSH.	To compute NPSH available at pump inlet and to determine if pump is operating under cavitation. Specific ILO (15)	Chapter 12	