University of Macau
Undergraduate Civil Engineering Programme

Coordinating Unit:	Department of Civil and Environmental Engineering, Faculty of Science and Technology		
Supporting Unit(s):	Nil		
Course Code:	CIVL341	Year of Study:	3
Course Title:	Hydraulics II		
Compulsory/Elective:	Compulsory		
Course Prerequisites:	CIVL230 Hydraulics I		
Prerequisite Knowledge:	Entry level fluid mechanics		
Duration:	One semester	Credit Units:	4
Class/Laboratory Schedule:	Three hours of lecture and one hour of tutorial and one hour of laboratory per week.		
Laboratory/Software Usage:	Hydraulics Laboratory		
Course Description:	Application of the basic laws of fluid mechanics to hydraulic problems. Analysis of simple and multiple steady pipe flows: branching pipes, pipes in series and parallel, and pipe network; flow measurement in pipe. Unsteady flow in pressure conduits: establishment of steady flow and water hammer. Analysis of pumps and turbines. Pump and system characteristics. Steady open channel flow: energy and momentum principles; critical and uniform flow development and their computation; best hydraulic section; gradually varied flow and its profile computation; flow measurement in open channel. Introduction to Hydrology.		
Course Objectives:	1. Apply fundamental principles of fluid mechanics for the solution of practical civil engineering problems of water conveyance in pipes, pipe networks, and open channels. 2. Describe the operating characteristics of hydraulic machinery (pumps and turbines), and the factors affecting their operation and specifications, as well as their operation in a system. 3. Describe the principles controlling open channel flows including critical, uniform and gradually varied flows. Design of channel section for uniform flow. 4. Introduce some basic topics of engineering hydrology.		
Learning Outcomes (LO):	Upon completion of this course, students should be able to: 1. apply fundamental knowledge of fluid mechanics in solving problems and making design of pressure-pipe and open-channel hydraulics in civil and environmental engineering. [POs: a,b,c,e,f]; 2. understand the basics of hydraulic machinery and their operation design in water systems. [POs: a,b,c,e,f]; 3. understand the basics of descriptive and quantitative hydrology. [POs: a,f]; 4. conduct experiments (in teams) in flow measurement, hydraulic machinery and open-channel flows and interpreting data from experiments, as well as documenting them in engineering reports. [POs: a,b,d,e,g,k]; 5. understand or become aware of disasters caused by an incorrect analysis in hydraulic engineering system. [POs: a,c,e,f].		
Texts & References: *(* recommended textbook(s))*	1. "Fluid Mechanics" by F. M. White, 6th ed., McGraw-Hill.* 2. "Water-Resources Engineering" by Linsley, Franzini, Freyberg and Tchobanoglous, McGraw-Hill 3. "Hydraulic Engineering" by Roberson, Cassidy and Chandhry, Houghton Mifflin 4. "Open-Channel Hydraulics" by Chow, McGraw-Hill 5. "Fluid Mechanics" by Streeter and Wylie, McGraw-Hill 6. "Fluid Mechanics with Engineering Application" by Daugherty, Franzini and Finnemore, McGraw-Hill 7. "Davi's Handbook of Applied Hydraulics" by Zipparro and Hasen, McGraw-Hill		

Student Assessment:	• Assignments and laboratory reports: 20% • One mid-term examination: 40% • One final examination: 40%
Learning Outcome Assessment:	• Assignments, laboratory reports and examinations • Course evaluation
Pedagogical Methods:	☑ Lecture ☐ Guest speakers ☐ Case study ☐ Role playing ☐ Student presentation ☐ Project ☐ Simulation game ☑ Exercises and problems ☐ Service learning ☐ Internship ☐ Field study ☐ Company visits ☐ e-learning ☑ Independent study ☑ Others: Hydraulics Laboratory.

Major Assessment Methods: For each Major Assessment Method below, please indicate the specific pedagogical methods involved (by putting a ✓ in the relevant box(es) on the right-hand side).	Case Study	Role Playing	Student Presentation	Individual project/paper	Group project/paper	Simulation Game	Exercises & problems	Service learning	Internship	Field Study	Company visits	Written examination	Oral examination	Others (please specify)
Class Participation/ Discussion (0%)														
Assignment(s) (10%)							✓							
Mid-term Examination (40%)												✓		
Final Examination (40%)												✓		
Others *(please specify)* _Lab Reports_ (10 %)					✓									
Course Web: (if any)														

Course Content: (topic outline)

Week no.	Topics	Assignment no.	LO no.
1	**Review of Fluid Mechanics** Flow classification and kinematics; fluid statics; continuity, momentum and energy equations	1	1
1,2,3	**Steady Flow in Pressure Conduits** Head Loss in Pipes: Darcy-Weisbach Equation vs. Hazen-William Equation; Flow with Negative Pressure: Cavitation; Flow in Branching Pipes; Pipes in Series and Parallel; Pipe networks: The Hardy Cross Method, and The Linear Theory Method; Flow Measurement in Pressure conduit: Bernoulli Obstruction Theory; Flow Meters: Thin Plate Orifice, Flow Nozzle, and Venturi Meter **Laboratory Experiment** Flow Meters in Pipes	2,3,4	1,4,5
4,5	**Unsteady Flow in Pressure Conduits** Unsteady Continuity, Momentum and Energy Equations; Establishment of Steady Flow; Water Hammer due to Instantaneous, Rapid and Slow Closure; Surge Tanks and Hydraulic Ram **Laboratory Experiment** Hydraulic Ram	5	1,4,5
6,7,8	**Hydraulic Machinery** Similarity Laws and Factors for Hydraulic Machines; Elementary Theory for Rotating Machines; Centrifugal, Mixed- and Axial-Flow Pumps; Pump and System Characteristics; Pump in Parallel and Series; Impulse and Reaction Turbines **Laboratory Experiment** Pumps in Parallel and Series	6,7	2,4,5
9,10	**Steady Open Channel Flow** Types of Steady Open Channel Flow; Kinds of Open Channel and Its Geometry; Velocity and Pressure Distribution in a Channel Section; Energy Principle: Specific Energy; Momentum Principle: Specific Force; Hydraulic Jump **Laboratory Experiment** Hydraulic Jump	8	1,4,5
11,12	**Critical and Uniform Flow** Development of Critical Flow and Its Computation ; Flow Control and Flow Measurement; Development of Uniform Flow; Chezy and Manning Equations; Determination of the Manning's Roughness Coefficient; Computation of Normal Depth, Normal Discharge, Normal Slope and Critical Slope; Best Hydraulic Section; Design of Channels for Uniform Flow	9	1,4,5
12,13	**Gradually Varied Flow** Energy Equation for Gradually Varied Flow; Types of Flow Profiles; Profile Computation for Prismatic Channel: The Direct Step Method **Laboratory Experiment** Flow over false floor	10	1,4,5
13,14	**Introduction to Hydrology** Description of Descriptive and Quantitative Hydrology; Unit Hydrograph and Direct Runoff Estimation	11	3,5

Percentage Content of:	Math	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total
	50	0	25	20	5	0	100

Timetabled work in hours per week:	Lecture	Tutorial	Laboratory	Other	Total
	3	1	1	---	5

Contribution to Program Outcomes:

Program Outcomes	Contribution to POs# 5 Significant ----------> 1 Least				
	5	4	3	2	1
(a) Apply knowledge of mathematics, science, and engineering	✓				
(b) Design and conduct experiments, and analyze data	✓				
(c) Design components, systems or processes in presence of constraints		✓			
(d) Function in a multi-disciplinary team			✓		
(e) Engineering problem solving	✓				
(f) Understand professional and ethical responsibility			✓		
(g) Communicate effectively			✓		
(h) Understand the impact of engineering solutions to the society					
(i) Recognize the need and have the ability for lifelong learning					
(j) Have knowledge of contemporary issues					
(k) Apply the skills, techniques, modern engineering tools		✓			
(l) Use the computer/IT tools relevant to the discipline					

 # Note 5: Significant contribution; 4: Supporting contribution; 3: Moderate contribution; 2: Marginal support; 1: Least support

Course Instructor(s):	Prof. K. M. Mok