**457.309 Hydraulics and Lab.**

Instructor: Seo, Il Won

Department of Civil and Environmental Engineering

Tel: +82-2-880-7345; e-mail: seoilwon@snu.ac.kr; Web: ehlab.snu.ac.kr

**Description:**

This course studies fundamental theories of water motion and dynamics to be the basis of the design and analysis of the social infrastructures (river and hydraulic structures, water supply system, dam, power plant, bridges, etc). Further, in this course, students will learn all the capabilities necessary for the acquisition, analysis, and interpretation of the science and engineering data by on-hand experiments and numerical simulations of rivers and water resource structures. In the first part of this course, equipment and methodology for the measurement of fluid and water are introduced. Then, dynamics of water flowing in the pipe are discussed, and then methodologies for the analysis of the complex flow in the pipe networks are to be introduced. Main part of this course will be focused on the derivations of flow equations of uniform and non-uniform flow in the open channels. Methods for the analysis of practical problems in the open channels will also be treated in depth.

**Text:**

Seo, I.W., Lecture Note of Hydraulics and Lab., Seoul National University, 2019,
Web: ehlab.snu.ac.kr

**Reference:**

1. Street, R.L., Watters, G.Z., and Vennard, J.K., 1996, Elementary Fluid Mechanics, 7th ed., J. Wiley & Sons, New York, N.Y.
2. Munson, B.R., Okiishi, T.H., Huebsch, W.W., and Rothmayer, A.P., 2013, Fluid Mechanics, 7th ed., J. Wiley & Sons, New York, N.Y.

**Prerequisites:**

Elementary Fluid Mechanics and Lab.

**Contents:**

1. Introduction
2. Fluid Measurements
3. Error Analysis
4. Steady Flow in Pipes
5. Pipe Problems
6. Unsteady Flow in Pipes
7. Uniform Flow in Open Channels
8. Varied Flow in Open Channels
9. Lift and Drag in Incompressible Flow

**Grade:**

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| Class Participation | 5% |
| Homework Assignments | 20% |
| Lab. Report | 15% |
| Mid-Term Exam | 30% |
| Final Exam. | 30% |

**Weekly plan:**

| Week | Chapter | Lecture Title | Contents | Pages |
|---|---|---|---|---|
| 1 | Ch. 1 | Introduction | Course description and motivation | 32 |
| 2 | Ch. 2 | Fluid measurements | Measuring fluid and water motions | 59 |
| 3 | Ch. 3 | Error analysis | Errors in measurements | 23 |
| 4 | Ch. 4-1 | Fundamentals | Fundamental equations and laminar flow in pipes | 30 |
| 5 | Ch. 4-2 | Turbulent flow in pipes | Velocity and friction of turbulent flows | 42 |
| 6 | Ch. 4-3 | Friction factors | Evaluating pipe friction factors | 57 |
| 7 | Ch. 5-1 | Pipe problems-single pipe | Single pipes and pumped pipeline | 40 |
| 8 | Ch. 5-2 | Pipe problems-multiple pipe | Hardy Cross method to solve pipe network problems | 41 |

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| 9 | Ch. 6 | Unsteady pipe flow | Water hammer theory | 47 |
| 10 | Ch. 7-1 | Uniform flow in open channels-Fundamentals | Open channels and momentum equations | 25 |
| 11 | Ch. 7-2 | Uniform flow equation | Chezy and Manning equations, channel efficiency | 40 |
| 12 | Ch. 8-1 | Concept of non-uniform flows | Concepts of Non-uniform flow, specific energy and hydraulic jump | 49 |
| 13 | Ch. 8-2 | Gradually varied flows | Gradually varied flow equation | 31 |
| 14 | Ch. 8-3 | Numerical methods | Solution of GVF problems | 40 |
| 15 | Ch. 9 | Lift and drag in incompressible flow | Forces on submerged objects | 27 |

**Lab. Experiment:**

(1) Measurement of velocity profile in the open channel

(2) Measurement of bottom shear stress using Preston-static tube in the open channel

(3) Measurement of energy losses in pipes

(4) Experiment of hydraulic jump in open the channel

**Numerical Experiment:**

(1) Numerical analysis of pipe network problem

(2) Numerical analysis of the gradually varied flow in the open channel