Civil Engineering 2O04 – Fluid Mechanics

Fluid properties; hydrostatics; continuity, momentum and energy equations; potential flow; laminar and turbulent flow; flow in closed conduits, transients, open channel flow; hydraulic cross-sections.

Session: Term II, 2017-18 winter

Instructor: Dr Heba Teamah
Office: JHE 316
E-Mail: teamahhm@mcmaster.ca
Office Hours: Monday, Wednesday 12:30-13:20

Teaching Assistants: Shannon Guo fullee1@mcmaster.ca
Erin Fuller guosx@mcmaster.ca
TBA

Lectures: Monday, Wednesday 11:30-12:20 and Friday 13:30-14:20, BSB-B136
Tutorials: Wednesday 14:30-16:20, KTH-B132; 16:30-18:20, BSB-136
Laboratory: Friday 14:30-17:20 JHE-121

The purpose of this course is to help students understand the fundamental principles of mechanics as applied to fluids. These involve conservation of mass, momentum and energy balance. Owing to the difficulties involved in the modelling processes and the solutions to the analytical models, it is necessary to use empirical approaches in many situations. Therefore, in certain parts of the course material, empirical formulae will be introduced with emphasis on the parameters involved and their influences on the flow behaviour.

Course Objectives and Learning Outcomes: The goals are to develop; an understanding of the basic physics of fluid motion; and the ability to analyze flow situations commonly encountered in the discipline of civil engineering.

After completing the course, the learning outcomes are,

- Competence in Specialized Engineering Knowledge in fluid dynamics (1.4)
- Ability to identify reasonable assumptions that could be made before a solution path is proposed (2.1)
- Ability to manage time and processes effectively, prioritizing competing demands to achieve personal and team goals and objectives (6.1)
- Construct effective written arguments (7.3)

Course Content (Tentative)

Part I. Fundamentals of Fluid Mechanics (4 weeks)

1. Physical properties of fluids (viscosity, density, compressibility, vapour pressure, and surface tension)
2. Fluid statics (forces due to pressure field in a still fluid)
3. Pressure forces on surfaces
4. Buoyancy and Stability of submerged and floating bodies

Part II. Fluid-Flow Concepts and Basic Equations (5 weeks)

5. Kinematics and concept of control volume
6. Fluid flow concepts and basic equations (conservation of mass, momentum and energy)
7. Applications of the Bernoulli equation and the linear-momentum equation
8. Hydraulic Jump
9. Potential Theory

Part III. Real Fluid Flow (4 weeks)

10. Dimensional analysis
11. Laminar and Turbulent flow in a circular pipe
12. Friction factors and loss coefficients.
13. Darcy-Weisbach equation; Moody diagram.
14. Types of pipe flow problems – transients
15. Uniform Open Channel Flow - Chezy and Manning equations
16. Hydraulic Radius, Specific Energy


Avenue: [http://avenue.mcmaster.ca/](http://avenue.mcmaster.ca/)
Lecture notes; Additional notes and Assignments will be posted on Avenue. Students are expected to check and read all the materials posted on avenue.

Teaching Approach: The topics in this course will be presented using a traditional lecture format. Students are expected to attend lectures to ensure that they understand what material is the most important. Tutorials will be used to present sample problems. Assignments are intended to help consolidate the understanding of the material presented in lectures as well as extend concepts covered in lectures.

Assignments/Tutorials: During the course of this term, students are expected to work independently and in groups. Students are placed in a group of 3 or 4 to work together for the assignments during tutorial time. For this model to work, every student is expected to come prepared to the tutorials. This means that the students must solve the assignment problems prior to coming to the tutorial. Please note that the TA will check every group at the beginning of the tutorial. The submission is done in group; however, we expect a minimum level of understanding from the whole group. Students relying on the group members to do their work will lose marks.
Six to eight assignments will be given during the term to assist in understanding the course material. One assignment is handed in per group. Please do not forget to write the name and student number of the group members on all submissions.

**Midterm Test:** There will be one midterm test. The date and testing room are still to be confirmed. Given the challenges to book rooms and conflicts with other courses, the tests may be on a Saturday. If the date and time of the midterm conflict with your regular academic schedule, you must inform the instructor by email immediately after the date is announced. When a test is formally deferred, the instructor reserves the right to conduct it orally or in any format.

**Grading Procedure:** Final grades will be converted to the twelve-point letter grade system using the standard conversion scale. Individual components will be weighted as follows:

- Assignments: 20%
- Laboratory Reports: 20%
- Midterm Test: 20%
- Final Exam: 40%

The marks will be converted to final letter grade using the standard conversion scale shown in the McMaster Undergraduate Calendar.

**Important Note:** “The instructor and university reserve the right to modify elements of the course during the term. The university and instructor may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on the changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.”

**Lab Demos (TBA): Starting Day: January 19, 2018**

Part of the course requirement is attending and reporting on lab demos. The lab demos are intended to reinforce the lecture material.

**Laboratory Groups:** Each laboratory group will consist of a maximum of 5 students. The demonstration of the experiments will cover the hydrostatic pressure, the Bernoulli, energy and momentum principles.

- Pressure forces on surfaces (Lab Demo 1)
- The Bernoulli equation (Lab Demo 2)
- Applications of the linear-momentum equation (Lab Demo 3)
- The Hydraulic Jump (Lab Demo 4)

**POLICY REMINDERS**

**Calculators:** Only McMaster Standard Calculator (Casio fx-991) may be used during
assignments, tutorials, midterm test, and final examination.

**Ethics and Dishonesty:** Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at [http://www.mcmaster.ca/senate/academic/ac_integrity.htm](http://www.mcmaster.ca/senate/academic/ac_integrity.htm)

The following illustrates only three forms of academic dishonesty:
1. Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

**Adverse Discrimination:** The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons involved, individuals are reminded that they should contact their Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible.

**Health and Safety:** The Faculty of Engineering is committed to McMaster University’s Workplace and Environmental Health and Safety Policy which states: “Students are required by University policy to comply with all University health, safety and environmental programs”. It is your responsibility to understand McMaster University Workplace and Environmental Health and Safety programs and policies. For information on these programs and policies please refer to McMaster University Environmental and Health Support Services Occupational Safety Risk Management Manual at: [http://www.workingatmcmaster.ca/med/document/Lab-Safety-Handbook-1-36.pdf](http://www.workingatmcmaster.ca/med/document/Lab-Safety-Handbook-1-36.pdf).

It is also your responsibility to follow any specific Standard Operating Procedures (SOPs) provided for some of the experiments and the laboratory equipment. The following rules are to be observed.

1. Glasses or safety glasses/goggles must be worn in the lab.
2. Contact lenses are not to be worn in the lab.
3. No loose clothing allowed.
4. Closed-toed shoes must be worn.
5. Long hair must be tied back.

Students not abiding by these safety requirements will be given one warning. Second offences will result in the student being asked to vacate the laboratory, and receiving a grade of zero for that lab.