GINA CODY SCHOOL OF ENGINEERING AND COMPUTER SCIENCE

Course number	Course Title	Term
AERO455	Computational Fluid Dynamics for Aerospace Applications	WINTER 2022

Course Instructor	Office	E-Mail	Office Hours
Dr. Ziad Boutanios	TBD	ziad.boutanios@concordia.ca	Thursday 13:00 – 14:15

CLASS, LAB AND TUTORIAL SCHEDULE

Section	Day	Time	Location	Instructor	E-mail
Lecture	T-TH	10:15-11:30	FB-S133	Dr. Ziad Boutanios	ziad.boutanios@concordia.ca
Labs					Lab Start Date
Lab AI	W	9:45-11:35	TBD	Ms. Christina Kolokotronis	Week 2
Lab BI	W	9:45-11:35	TBD	Ms. Christina Kolokotronis	Week 3

COURSE CALENDAR DESCRIPTION

Introduction to computational methods in fluid dynamics using commercial and opensource CFD codes; aspects of geometry modelling, structured and unstructured grid generation, solution strategy, and post-processing; conversion of CAD to CFD models; an overview of basic numerical methods for the Navier-Stokes equations with emphasis on accuracy evaluation and efficiency. Elements of turbulence closure modelling. User-defined function for customized physical models into commercial CFD codes. Lectures: three hours per week. Laboratory: three hours per week, alternate weeks.

PREREQUISITES

ENGR 311, 391; MECH 361.

TEXTBOOK AND ADDITIONAL COURSE MATERIALS

- *Required textbook(s): Computational Fluid Dynamics, An Open Source Approach. By Vermeire, Pereira and Karbasian (freely available at https://users.encs.concordia.ca/~bvermeir/books.html).*
- *Suggested Textbook: Computational Fluid Dynamics, The Basics With Applications. By John D. Anderson.*
- *Instructor's lecture notes: will be posted in Moodle course management site*

- *Software Use:* ANSYS Fluent, StarCCM+, OpenFOAM, python, C++, any CAD software with STL capabilities

GRADING POLICY	
Evaluation Tool	**Weight**
Midterm	25
Labs	20
Assignments	15
Project + Presentation: Attendance is mandatory	40
Bonus personal project + presentation (at instructor's discretion)	2x5
Total	110

Passing Criteria:

- In order to pass the class, you must score above 50% on every component.

GRADUATE ATTRIBUTES: SKILLS TO LEARN AND/OR UTILIZE	
Graduate Attribute	**Indicators**
(KB) A knowledge base for engineering: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.	Knowledge-base for specific engineering field
(PA) Problem analysis: An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions	Problem identification and formulation
	Modelling
	Problem solving
(Inv.) Investigation: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions.	Investigation
	Analysis
	Synthesis
(Tools) Use of engineering tools: An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.	Use of engineering tools
(Team) Individual and teamwork: An ability to work effectively as a member and	Individual and teamwork
	Leadership

leader in teams, preferably in a multi-disciplinary setting.	
(Comm.) Communication skills: An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.	Communication skills Effectively giving and responding to clear communication

COURSE LEARNING OUTCOMES (CLOS)
By the end of this course students will be able to:

Course Learning Outcome	**Relationship to Graduate Attributes**
A. Determine optimal formulations for each flow type	PA
B. Create and repair CAD and computational mesh	PA, Tools
C. Numerically solve flow, investigate and analyze it	PA, Inv., Tools
D. Effectively present results	Comm.
E. Work in a team	Team
F. Research problems and acquire knowledge	KB, PA

TENTATIVE COURSE OUTLINE

Topics	**Week**
Introduction and review of fluid dynamics	1, 2
Discretization and the method of weighted residuals	3
The finite volume method	4
CAD and meshing (structured and unstructured)	5
Aerodynamic simulations and **midterm**	6, 7
Turbulence and heat transfer simulations	7, 8
Supersonic/hypersonic flow	9
Rotating components and turbo-machinery	10
Fluid-structure interaction (FSI)	11

Multiphysics	12, 13

TERM PROJECT

Topic: the term project will be assigned after the midterm break. It will be a group project with approximately 5 students per group. The projects will mimic typical workflows from industry as taught in the lectures of weeks 6 to 13. Degrees of difficulty will be assigned to each project depending on the work to do and the software used.

SPECIAL NOTES

The course instructor reserves the right to modify the course outline and grading policy as necessary with prior notice given to students.

Lectures, office hours and labs will be given online initially. Switching to physical instruction in classroom will be determined by the university.

All students are expected to have personal computers with internet connection and a Concordia VPN active so they can access lab sessions.

ON CAMPUS RESOURCES

HEALTH SERVICES An on-campus health clinic and health promotion center with nurses and doctors. SGW 514-848-2424 ext. 3565 LOY 514-848-2424 ext. 3575	**COUNSELLING AND PSYCHOLOGICAL SERVICES** Counsellors (licensed mental health professionals) work with students to address their mental health and wellbeing needs. SGW 514-848-2424 ext. 3545 LOY 514 848-2424 ext. 3555
ACCESS CENTRE FOR STUDENTS WITH DISABILITIES Supports students with a variety of disability conditions (including temporary disabilities arising from illness or injury). Students receive academic support for their educational experience at Concordia. acsdinfo@concordia.ca 514-848-2424 ext. 3525	**SEXUAL ASSAULT RESOURCE CENTRE** Provides confidential and non-judgemental support and services to students, staff and faculty of all genders and orientations affected by sexual violence and/or harassment. Jennifer Drummond, Coordinator jennifer.drummond@concordia.ca sarc@concordia.ca 514-848-2424 ext. 3353
STUDENT SUCCESS CENTRE Support network from first-year to graduation. You'll find one-on-one tutors, study groups, workshops as well as learning and career advisors 514-848-2424, ext. 3921	**DEAN OF STUDENTS** Supports students to enhance their Concordia experience by engaging in student life outside the classroom. Terry Kyle, Manager deanofstudents.office@concordia.ca SGW 514-848-2424 ext. 3517 LOY 514-848-2424 ext. 4239
ABORIGINAL STUDENT RESOURCE CENTRE An on-campus resource for First Nations, Métis and Inuit students that helps them make the most of the many resources available at the university. Orenda Konwawennotion Boucher-Curotte, Coordinator orenda.boucher@concordia.ca 514-848-2424 ext. 7327	**INTERNATIONAL STUDENTS OFFICE** Supporting international students with immigration documents, health insurance, social events, and workshops. iso@concordia.ca 514-848-2424 ext. 3515
STUDENT ADVOCACY OFFICE Advocating for students facing charges under the Academic Code of Conduct or the Code of Rights and Responsibilities. studentadvocates@concordia.ca 514-848-2424, ext. 3992	**MULTI-FAITH & SPIRITUALITY CENTRE** Provides a home for all those wishing to celebrate the human spirit in the widest sense of the word, through programs, events and a quiet space for reflection. Ellie Hummel, Coordinator mfsc@concordia.ca 514-848-2424, ext. 3593
CAMPUS SECURITY Ensures the safety of our members and campus property through prevention, surveillance, intervention, training, and education. Provides emergency medical services. security@concordia.ca 514-848-3717 (dial 1 for urgent situations; dial 2 for non-urgent situations)	**CONCORDIA UNIVERSITY STUDENT PARENTS CENTRE** An accessible space for student parents to study, share interests and develop a support network. Sumaiya Gangat, Coordinator cusp@concordia.ca 514-848-2424, ext. 2431

ACADEMIC HONESTY AND CODE OF CONDUCT

Violation of the Academic Code of Conduct in any form will be severely dealt with. This includes copying (even with modifications) of program segments. You must demonstrate independent thought through your submitted work. The Academic Code of Conduct of Concordia University is available at:
http://www.concordia.ca/students/academic-integrity/offences.html

It is expected that during class discussions and in your written assignments you will communicate constructively and respectfully. Sexist, racist, homophobic, ageist, and ablest expressions will not be tolerated.

ADDENDUM

ACADEMIC CONDUCT ISSUES THAT APPLY IN GENERAL
The basic ten rules that make you a good engineer

The B. Eng. program is set to satisfy most of the requirements for your education and prepares you for a professional engineering career that requires dedication and knowledge. What you learn, and how you learn, will be used extensively in your engineering profession for the next 30 to 40 years. Therefore, the four years spent in the engineering program are crucial towards your professional formation. The first step is for you to learn to "think like an engineer" which means:

- accept responsibility for your own learning
- follow up on lecture material and homework
- learn *problem-solving skills,* not just how to solve each specific homework problem
- build a body of knowledge integrated throughout your program
- behave responsibly, ethically and professionally

One of the mainstays of being a professional engineer is a professional code of conduct and as an engineering student this starts with the Academic Code of Conduct (Article 16.3.14 of the undergraduate calendar). However, you may encounter situations that fall outside the norm and in such cases, you use your common sense.

Further, the following issues should be given serious consideration:

1) Attendance at lectures and tutorials are major learning opportunities and should not be missed. The labs represent a unique opportunity for you to acquire practical knowledge that you will need in your career. Class and tutorial attendance is important for you to comprehend the discipline and make the connections between engineering skills. You are strongly encouraged to participate in the class, ask questions and answer the instructor's questions. Tutorials are just extensions of the classes in which application of the concepts presented during the lectures are presented and problems are practically solved.

2) The decision to write tests that are not mandatory is entirely yours. For example, midterm test are often stated in many courses as optional. However, one the objectives of midterms is to check on your

comprehension of the material and allow time for whatever action is necessary (from more study time to discontinuing a course). Plan to attend the class tests even if they are not mandatory. If you pay attention in the lectures, it will take you significantly shorter time to comprehend the material. **Note also** that if you are in the unfortunate position of being unable to write a final exam due to medical reasons and seek a deferral, this may not be possible if the instructor has no information indicating that you have been attending the course and assimilating the material (ie through midterms, quizzes, assignments etc).

3) Homework is usually mandatory and it has some weight in the final grade (such information is given in the course outline). Homework may also be conceived as training material for the class tests. Under all circumstances, it is highly recommended to carry out the home work on time and submit it on the prescribed date. Late submissions are not granted to individual cases regardless of the reason. This is part of the training for being in the workforce where deadlines have to be met. Please, plan your work such that you submit all the assignments and lab reports on time and in the correct place (not in the corridor or on the street!).

4) Office hours with tutors, lab instructors or class instructors are listed in the course outline/website/office doors. Please respect these office hours and in case you have a serious conflict, contact the instructor asking for a special time arrangement.

5) Class tests (midterms, quizzes) are returned to the student. The final exams are not. If you wish to see your exam paper, be aware that most instructors allow only a narrow window of time for that purpose. For the fall term, exams may usually be reviewed in January and May for the spring term.

6) When you see your marked work (assignments, midterms, final exam etc), be aware that you are supposed to review your material and see the type of errors you made and if marks have been added incorrectly. This is not an opportunity to try and "negotiate" a higher grade with the instructor. If you believe that your grade is not right, you may apply for a formal Course Reevaluation through the Birks Student Centre.

7) Writing tests and exams represents a major component of your course work. These tests and exams have rigorous requirements such as:

- **No cell phone or other communication enabling tool is allowed on the student** during the examination period.
- Only **specified faculty calculators** are allowed during tests and exams unless otherwise indicated by the instructor.
- Usually, **no materials** are allowed in the exam unless otherwise announced.

Get used to signing in and out of your exam. Make sure that you leave your exam papers with the invigilator. There are rules concerning general exam issues in the UG Calendar. These requirements are there to eliminate any possible misunderstanding and you are asked to **respect the rules**. Disciplinary measures are taken when the rules are not followed.

8) Respect your colleagues and those that you meet during the class: tutors, instructors, lab instructors, technical personnel, assistants, etc. Use appropriate communication means and language. Be considerate for all human beings. This includes small things such as turning off cell-phones before a class begins. Concordia University is a very diverse group of people and a very large multicultural community.

9) Communication is part of your future profession. Learn how to communicate effectively and efficiently in the shortest time possible. Write short but meaningful e-mails, make effective phone calls, etc. If your instructor accepts emails make sure that your request is clear with the course number and your name in the *Subject* line. Do not ask for special treatment as instructors have to treat all students equitably.

10) Respect all the above and you will get closer to your future profession.