

EP718
Reactor Heat Transport System Simulation and Analysis
Graduate Studies
Fall/Winter 2021/22
Course Outline

CALENDAR/COURSE DESCRIPTION

Reactor Heat Transport System Simulation and Analysis covers the thermal-hydraulics analysis of reactor heat transport systems. The course presents the underlying physics, fluid flow and heat transfer modelling and analysis of nuclear reactor primary heat transport system.

The course preliminary calendar is shown in the table below:

| Class Date | Teaching Topic |
|-------------|--|
| 10 Jan 2022 | 1. Course Outline |
| | 1b Introduction to TH computer codes |
| 17 Jan 2022 | 2. Two-Phase Flow Fundamentals |
| 24 Jan 2022 | 3. Basic equations for thermal-hydraulic system analysis |
| 31 Jan 2022 | 4. Nodalization |
| 7 Feb 2022 | 5. Equation of state |
| 14 Feb 2022 | 6. The Rate form of equation of state |
| 28 Feb 2022 | 7. Thermal-hydraulic network simulation |
| 7 Mar 2022 | 8. CATHENA TH Network Code |
| 14 Mar 2022 | 9. RELAP5 TH Network Code |
| 21 Mar 2022 | 10. TRACE TH Network Code |
| 28 Mar 2022 | 11. Code Technical Basis |
| | 12. R&D Support |
| 4 Apr 2022 | 13. Code Validation and Assessment |
| 11 Apr 2022 | Project: Student Presentations |
| 25 Apr 2022 | Final Exam - Closed book |

The course will be taught by means of lectures and assignments. **Attendance at the lectures is mandatory.**

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): None
Antirequisite(s): None

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Nik Popov
NRB-B121
npopov@mcmaster.ca
416-566-8233

Office Hours:
Monday – 17:30 – 20:30
Friday – 17:30 – 19:30
By appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

None

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://avenue.mcmaster.ca/>
www.coursewebsite.mcmaster.ca

Dropbox folder that will be shared with the students.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to:

- Understand and apply methods for development of thermal-hydraulic models in reactor heat transport system analysis.
- Understand and critically review thermal-hydraulic computer codes and numerical solution techniques
- Understand and use the latest developments in computer code models for analysis of thermal-hydraulics networks.
- Develop processes and procedures for computer code V&V support.
- Develop and use processes for computer code accuracy assessment and applicability assessment.

MATERIALS AND FEES

Required Texts:

“The Essential CANDU: A Textbook on the CANDU Nuclear Power Plant Technology”, “Chapter 7: Thermohydraulic Analysis”, UNENE/COG, 2017.

Recommended Additional Texts:

CATHENA, RELAP and TRACE Computer Code Manuals.

Calculator:

Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

Other Materials:

Selected journal and conference papers in this area.

Selected website with appropriate information on the course topics.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 3 classroom-based lectures per week
- 1 tutorial per week (2 hours)
- 2 assignments: (1) develop nodalization for selected TH networks, and (2) develop code V&V and model assessment process
- 1 project: assessment of RELAP5 and TRACE models to CANDU TH application
- 1 student presentation on the project
- 1 in-class final exam

COURSE SCHEDULE

| Class Date | Teaching Topic | Readings |
|-------------|--|-------------------------------|
| 10 Jan 2022 | 1. Course Outline | Presentation |
| | 1b Introduction to TH computer codes | Presentation |
| 17 Jan 2022 | 2. Two-Phase Flow Fundamentals | Textbook, Chapter 7 |
| 24 Jan 2022 | 3. Basic equations for thermal-hydraulic system analysis | Textbook, Chapter 7 |
| 31 Jan 2022 | 4. Nodalization | Textbook, Chapter 7 |
| 7 Feb 2022 | 5. Equation of state | Textbook, Chapter 7 |
| 14 Feb 2022 | 6. The Rate form of equation of state | Textbook, Chapter 7 |
| 28 Feb 2022 | 7. Thermal-hydraulic network simulation | Textbook, Chapter 7 |
| 7 Mar 2022 | 8. CATHENA TH Network Code | Code theory manual |
| 14 Mar 2022 | 9. RELAP5 TH Network Code | Code theory manual |
| 21 Mar 2022 | 10. TRACE TH Network Code | Code theory manual |
| 28 Mar 2022 | 11. Code Technical Basis | Presentation, papers |
| | 12. R&D Support | |
| 4 Apr 2022 | 13. Code Validation and Assessment | CSA, CNSC and COG information |
| 11 Apr 2022 | Project: Student Presentations | |
| 25 Apr 2022 | Final Exam - Closed book | |

ASSESSMENT

| Component | Due Date | Weight |
|--------------|----------------|--------|
| Assignment 1 | April 18, 2022 | 15% |
| Assignment 2 | April 18, 2022 | 15% |
| Project | April 18, 2022 | 30% |
| Final Exam | | 40% |
| Total | | 100% |

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Engineering Physics is committed to creating an environment in which students of all genders, cultures, ethnicities, races, religions, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Graduate Chair, Academic Advisor, or to contact the [Equity and Inclusion Office](#).

These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour 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. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](#), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of common 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.

Note that **allowing** another student to copy one's work also falls under academic dishonesty and will be treated in the same way as copying another student's work.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.), or be delivered fully online. Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss them with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

Note that accommodations granted while in the undergraduate program do not transfer automatically to the graduate program.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.