UN504
Small Modular Reactors

Course Outline **June – August 2026**

INSTRUCTORS:

1. **TBD**
2. **TBD**

COURSE DESCRIPTION:

The course focuses on the design and safety of Small Modular Reactors (SMRs). The course provides an overview of SMRs under recent consideration in Canada, and an overview of SMR types from the IAEA catalog. Most of the course is focused on the GVH BWRX-300 design that is being constructed at OPG's Darlington site in Ontario and for which the LTC and LTO licensing processes are ongoing with the Canadian Nuclear Safety Commission (CNSC). The course covers BWRX-300 safety design, core physics design, core thermal hydraulics design and the fuel and fuel channel design. The course includes fundamentals of physics, thermal hydraulics, fuel and safety that are specific to the BWRX-300 design.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to:

(a) Describe the functionality of a BWRX-300 station and its major Structures, Systems and Components (SSCs).

(b) Understand reactor physics phenomena, including how instrumentation is used to measure reactivity and how it is controlled.

(c) Understand how the fuel is designed, how it performs in-service, and how previous operational experience guides best practices in operation.

(d) Understand fundamentals of thermalhydraulics and heat transport systems, and how they impact reactor design and safety.

(e) Understand the role of various safety systems and describe their functionality.

(f) Unerstanding of the fundamentals of the Deterministic Safety Analysis and Probabilistic Safety Analysis for SMRs, focused on the BWRX-300.

(g) Understand the content and format of the safety report and its evolution from PSAR for construction, POSAR for commissioning, and FSAR for operation.

LITERATURE (essential)

- GE Hitachi Vernova Nuclear Energy, "BWRX-300 Preliminary Safety Analysis Report", NEDO-33950, Rev. 2 (2022). Non-proprietary version publicly available on CNSC web site (click here).

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- GE Vernova Hitachi Nuclear Energy, "BWRX-300 Preliminary Safety Analysis Report", for TVA application to NRC for construction at the Clinch River site in Tennessee (click GEH BWRX-300 | Nuclear Regulatory Commission).
- IAEA Handbook of SMR designs, 2024 (click SMR_catalogue_2024.pdf)

ASSESSMENT

Quizzes	8%
Assignments 1,2,3,4	24%
Midterm exam	25%
Final Exam	43%

FINAL GRADES

Final grades will be assessed according to the McMaster/UNENE standard grading scheme.

SCHEDULE

The schedule below should be viewed as an approximation. There may be slight deviations. All times are in Toronto time (EST).

USE OF ARTIFICIAL INTELLIGENCE

Students may use generative AI for editing/translating/outlining/brainstorming/revising their work throughout the course so long as the use of generative AI is referenced and cited. Use of generative AI outside the stated use of editing/translating/outlining/ brainstorming/revising without citation will constitute academic dishonesty. It is the student's responsibility to be clear on the limitations of use and to be clear on the expectations for citation and reference and to do so appropriately.

COURSE LOGISTICS

Course runs in a hybrid mode, which means lectures are in person and online in parallel, and lectures are recorded. Course venue is at Durham College at Whitby as per schedule provided in this outline. Online attendance is provided by Zoom only for students who join from a location in Canada (online attendance while on travel outside of Canada is blocked by Zoom).

Students can attend lectures in person or online. However, UNENE encourages students to attend as many lectures in person as possible to take advantage of meeting professors and colleagues from various nuclear industry organizations and for networking. There are two days that students need to attend in person: Day V in the schedule below, for in person attendance of the midterm exam and Day IX for in person attendance of the final exam. Students who cannot attend in person these two days need to get approval from the professor at the first day of the course to do these exams by invigilation at another university that is closer to their residence location.

Lecture material, assignments and quizzes are given to students using CANVAS. Students are provided with access to CANVAS and are expected to be familiar with using CANVAS before the course begins.

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Regardless of how students attend lectures (in person or online), students are required to have functioning laptops, audio and video equipment. If attending online, students are required to make appropriate arrangements to have online video on during attendance. During lecture attendance, students are required to be logged into Zoom and CANVAS in parallel.

I. June 20, 2026

1. Introduction and logistics
2. SMRs technologies
3. BWRX-300 technology overview
4. BWR thermal hydraulics fundamentals
5. BWRX-300 thermal hydraulics fundamentals

II. June 21, 2026

6. BWRX reactor core thermal hydraulics
7. BWRX isolation condenser thermal hydraulics
8. BWRX cooling system thermal hydraulics
9. BWRX turbine and condenser thermal hydraulics

III. July 11, 2026

10. Reactor Physics: Refresher
11. Reactor Physics: Specifics to BWRs
12. Reactor Physics: Instrumentation
13. Reactor Physics: Reactor Control

IV. July 12, 2026

14. Reactor Physics: Fission products
15. Reactor Physics: Criticality safety
16. Reactor Physics: Radiation protection and shielding
17. Reactor Physics: Review

V. July 25, 2026

18. Fuel: Overview & Design
19. Fuel: fuel cycles, front end

    MIDTERM EXAM
20. Fuel: fuel cycles, irradiation
21. Fuel: fuel cycles, back end

VI. July 26, 2026

22. Fuel: OPEX (1)
23. Fuel: OPEX (2)
24. Fuel: Fuel Handling
25. Fuel: Review

VII. Aug. 8, 2026

26. Safety principles refresher
27. BWRX safety strategy
28. BWRX means of shutdown
29. BWRX emergency cooling

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VIII. Aug. 9, 2026

30. BWRX means of confinement
31. BWRX Deterministic Safety Analysis (DSA)
32. BWRX Probabilistic Safety Assessment (PSA)
33. BWRX content and format of safety reports
34. BWRX content and format of safety reports

IX. August 22, 2026

FINAL EXAM

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