UCLouvain

# lmeca2648

*2018*

# Nuclear thermal-hydraulics (Centre d'étude nucléaire-Mol)

| 5 credits | 40.0 h + 7.5 h | Q1 |
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| Teacher(s) | Bartosiewicz Yann ; |
| Language : | English |
| Place of the course | Louvain-la-Neuve |
| Main themes | • Reactor heat generation<br>• Transport equations (single-phase & two-phase flow)<br>• Thermal analysis of fuel elements<br>• (Single-phase fluid mechanics and heat transfer)'usually already known<br>• Two-phase flow dynamics<br>• Two-phase heat transfer<br>• Single heated channel; steady state analysis<br>• Single heated channel; transient analysis<br>• Flow loops<br>• Utilisation of established codes and introduction to advanced topics (modelling and thermalhydraulics for GEN4 reactors) |
| Aims | 1<br>• To be familiarised with various reactor types and their main design and operational characteristics<br>• To learn how to estimate the volumetric heat generation rate in fission reactor cores under normal operation and shutdown conditions<br>• To learn how to analyse the thermal performance of nuclear fuel elements<br>• To learn the basic fluid mechanics of single phase reactor cooling systems<br>• To learn to calculate pressure drop in reactor systems, including tube bundles, and spacer grids<br>• To learn to analyse the heat transfer characteristics of single phase reactor cooling systems<br>• To learn the basic fluid mechanics of two-phase systems, including flow regime maps, void-quality relations, pressure drop, and critical flow<br>• To learn the fundamentals of boiling heat transfer, and its implications for reactor design<br>• To learn the fundamentals of core thermal design, with attention to design uncertainty analysis and hot channel factors.<br>- - - -<br>*The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".* |
| Evaluation methods | Project (45%): set up a simulation tools to calculate the pressure drop in a boiling channel under different conditions<br>Exam (55%): closed book. 4h. Understanding/theory/exercice |
| Teaching methods | • 30h of ex catedra lectures<br>• 14h of supervised personnal work<br>• 24h of supervised exercice sessions<br><br>The course takes place at the Nuclear Research Centre of Belgium (SCK.CEN) in gthe framework of the BNEN interuniversity programme (see: http://bnen.sckcen.be).<br>Courses taking place at SCK.CEN are condensed over a period of 2 intensive weeks of courses. |
| Content | • Lect. 1: Thermal design principles<br>• Lect. 2: Reactor energy distribution<br>• Lect. 3: Transport eqns. For 1-phase flow: Reminders/summary<br>• Lect. 4: Tranport eqns. For 2-phase flows:basic formulation<br>• Lect. 5: Tranport eqns. For 2-phase flows:equations<br>• Lect. 6: Thermodynamics, cycles: non-flow and steady flow<br>• Lect. 7: Thermodynamics, cycles: non steady flow first law<br>• Lect. 8: Thermal analysis of fuel elements<br>• Lect. 9: 1-phase fluid mechanics/heat transfer: Reminders/summary<br>• Lect. 10: 2-phase fluid mechanics/pressure drops<br>• Lect. 11: 2-phase fluid mechanics/pressure drops<br>• Lect. 12: 2-phase heat transfer (pool boiling)<br>• Lect. 13: 2-phase heat transfer (flow boiling)<br>• Lect. 14: Single-heated channel: steady state analysis<br>• Lect. 15: Flow loops |
| Inline resources | http://bnen.sckcen.be |

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| Bibliography | • Todreas, N.E. and Kazimi, M.S. Nuclear System I: Thermal Hydraulic Fundamentals, CRC Press, 2012.<br>• Todreas, N. E. and Kazimi, M.S. Nuclear Systems II: Elements of Thermal Hydraulic Design, Hemisphere Publishing Corp., New York, 1990.<br><br>**REFERENCE BOOKS ON THE CONTENT**<br><br>• Todreas, N.E. and Kazimi, M.S. Nuclear System I: Thermal Hydraulic Fundamentals, CRC Press, 2012. Mandatory.<br>• Todreas, N. E. and Kazimi, M.S. Nuclear Systems II: Elements of Thermal Hydraulic Design, Hemisphere Publishing Corp., New York, 1990. Advised. |
| Faculty or entity in charge | MECA |

| Programmes containing this learning unit (UE) | | | | |
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| Program title | Acronym | Credits | Prerequisite | Aims |
| Master [120] in Electro-mechanical Engineering | ELME2M | 5 | | |
| Master [120] in Mechanical Engineering | MECA2M | 5 | | |