

BNEN – The Belgian Nuclear higher Education Network. Your way to the European Master of Nuclear Engineering.

Frans Moons

Belgian Nuclear Research Centre SCK•CEN, Mol, Belgium

Abstract

BNEN, the Belgian Nuclear higher Education Network has been created in 2002 by five Belgian universities and the Belgian Nuclear Research Centre (SCK•CEN) as a joint effort to maintain and further develop a high quality programme in nuclear engineering in Belgium.

The master of nuclear engineering is a one year interuniversity programme. The program is taught in English. Its high modularity allows for optimal time management for teachers and students, it facilitates individual participation in selected courses e.g. advanced courses in the context of continuous professional development and it also facilitates foreign students participation in blocs of courses.

The 60 ECTS masters programme goes through subjects like neutron physics (3 ECTS), nuclear safety (3 ECTS) and nuclear thermal hydraulics (6 ECTS), provides the knowledge for neutronic reactor core design (8 ECTS) and plant operation and control (3 ECTS). At a more interdisciplinary level, the programme includes courses on nuclear energy (3 ECTS) and material science (6 ECTS) with a particular interest in the fuel cycle (3 ECTS). Radiation protection (6 ECTS) and a menu of advanced courses (4 ECTS) belong also to the backbone of the programme. The master thesis (15 ECTS) offers opportunities for internship in industry or in a research lab. ECTS credits indicate the average student work load to successfully complete a course. 60 ECTS represents, in term of workload, one year of study.

The Belgian master of nuclear engineering programme is embedded in the European ENEN association, a non-profit international organization of universities and research centers for the preservation and further development of higher nuclear education and expertise. The Belgian master of nuclear engineering programme, where appropriate collaborates with the ANENT, the Asian Network for Education in Nuclear Technology.

1. Introduction

BNEN, the Belgian Nuclear higher Education Network has been created in 2001 by five Belgian universities and the Belgian Nuclear Research Centre (SCK•CEN) as a joint effort to maintain and further develop a high quality programme in nuclear engineering in Belgium. In a country where a substantial part of the electricity generation will remain of nuclear origin for a number of years, there is a need for well educated and well trained engineers in this area. Public authorities, regulators and industry brought their support to this initiative. In the framework of the new architecture of higher education in Europe, the English name for the programme is "Master of Nuclear Engineering".

2. The Belgian Nuclear higher Education Network

The Vrije Universiteit Brussel, the Universiteit Gent, the Katholieke Universiteit Leuven, the Université de Liège, the Université Catholique de Louvain and the Belgian Nuclear Research Centre created in 2001 a consortium called the "Belgian Nuclear higher Education Network", BNEN with the aim to jointly organise the interuniversity post-graduate degree of "**Master of Nuclear Engineering**". Students can enrol at each of the participating universities. The individual universities assume responsibility for the students they register for the interuniversity programme. The home university delivers the degree and the diploma. The diploma mentions the name of the other participating universities.

Teaching assignments for the subjects of the interuniversity study programme are assigned to members of the academic staff of a participating university. Practical exercises and laboratory sessions make full use of the SCK•CEN reactors and laboratories and are supervised by SCK•CEN researchers. The management of the interuniversity programme is vested in the Steering Committee.

The Steering Committee consists of one delegate of each partner of the consortium. Specific "academic matters" are handled by the Teaching Committee i.e. the university members of the Steering Committee.

3. Programme for Master of Nuclear Engineering

The Master Nuclear Engineering is a 60 ECTS "master after master" programme. ECTS credits indicate the average student work load to successfully complete a course. 60 ECTS represents, in terms of workload, one year of study. A 3 ECTS course typically means an estimated work load for the student of 90 hours. These 90 hours might be rated as 20 lecture hours, each lecture hour requiring some 2.5 hours additional study or in total 70 hours, complemented with 20 hours laboratory sessions, exercises and/or independent reading. The "master after master" entails applicants to hold a Belgian university engineering degree or equivalent i.e. a master of engineering with a minimum of 300 ECTS study programme. Other applicants, having gone through a 240 ECTS university or polytechnics programme e.g. chemistry, physics or engineering can be admitted upon evaluation of their application and after having passed an entrance exam, the subject of which covers effectively the material of 30 ECTS focused make-up courses.

The masters programme goes through rather theoretical subjects like neutron physics (3 ECTS), fluid flow and heat transfer modeling (6 ECTS), apply them to neutronic reactor core design (8 ECTS), nuclear safety (3 ECTS), and plant operation and control (3 ECTS). At a more interdisciplinary level, the programme includes chapters on nuclear energy (3 ECTS), material science (6 ECTS) with a particular interest for the fuel cycle (3 ECTS). Radiation protection (6 ECTS) and a menu of advanced courses (4 ECTS) belong also to the backbone of the programme. The final year thesis (15 ECTS) offers opportunities for internship in industry or in a research laboratory.

The programme structure includes the possibility to spread it over up to four years, especially to accommodate young engineers already working in the nuclear industry. This is of particular importance for the Belgian situation, where the master of science in nuclear engineering is a condition to get the Class I recognition. Operating major nuclear installations requires Class I licensees.

As can be seen in the annex, the programme is highly modular. The high modularity a.o.

- allows for optimal time management for teachers and students
- facilitates individual participation in selected courses e.g. advanced courses in the context of continued education
- facilitates foreign student's participation in blocs of courses in the frame of student exchange, as explained further.

4. Stakeholder contribution

The BNEN programme is also financially supported by the Belgian nuclear stakeholders. The support is mainly used for some 5 students' grants per year as well as to finance teachers and students expenses related to the program i.e. buying books or participation to scientific conferences.

Stakeholders also actively participate in organising advanced courses within the programme or in giving specialised seminars. SCK•CEN is an excellent place to teach nuclear engineering. Not only for the direct access to nuclear laboratories and research infrastructure, but also for benefiting of the presence of a number of doctoral students who help teaching practical exercises and laboratory sessions and supervise master theses. SCK•CEN covers the personnel costs for its teaching staff and for the administrative and lodging support to the programme. Laboratories use is offered in kind or at marginal costs.

5. European Master of nuclear engineering

The basic goal of the European Master of Nuclear Engineering is to guarantee a high quality nuclear education in Europe by means of stimulating student and instructor exchange, through mutual checks of the quality of the programmes offered, by close collaboration with renown nuclear-research groups at universities and laboratories.

BNEN, through its partners in the ENEN association, actively participates in the European master in nuclear engineering.

The ENEN association is a non-profit international organisation of universities and research centers for the preservation and further development of higher nuclear education and expertise.

Based upon a year-long exchange of views between the partners of ENEN, a coherent and practical concept for a European master of nuclear engineering has emerged. A master of nuclear engineering

can only be granted after having obtained a full-time load of ten semesters beyond secondary level or in other words, 300 credits engineering academic level studies. A minimum of two semesters equivalent or 60 credits must be obtained in strictly nuclear subjects composed of a set of core-curriculum courses complemented with nuclear electives and a project work/thesis in a nuclear domain. The ENEN association, on behalf of its members, grants the quality label **European** master of nuclear engineering if a substantial amount (some 20 or 30) of credits have been followed at an ENEN-member institution other than the home institution. Typically, these credits might be obtained by performing "abroad" the project work or master thesis and taking also there some related advanced courses.

BNEN stimulates its students to study abroad, but also hosts foreign students as well for thesis work as for its courses. For the academic year 2004-2005, the BNEN courses Nuclear Reactor Theory, 8 credits, Nuclear Thermal Hydraulics, 6 credits, and Radiation Protection and Nuclear Measurements, 6 credits, are organised in a residential way to facilitate foreign students participation.

To get the 20 to 30 "European" ENEN credits, foreign students might opt:

- to follow the full 2 semester BNEN programme
- to prepare a project work (at least 15 ECTS) and take some advanced/electives course (e.g. some 6 ECTS), organised within BNEN, to get the 20 to 30 "European" ENEN credits
- to follow the above mentioned 3 months/20 ECTS Nuclear Reactor Theory, Nuclear Thermal Hydraulics and Radiation Protection and Nuclear Measurements, in BNEN jargon also called Bloc II.
- to follow the 6 months/33 ECTS of Bloc II and the project work
- to compile a meaningful basket out of the available options.

6. Continued professional development

Although not the primary objective of the BNEN programme, industry acknowledges the BNEN courses in the frame of continued professional development. The BNEN highly modular programme facilitates individual participation in selected courses e.g. advanced courses in the context of continued professional development.

Special training courses such as "special training course on MOX-fuel", "special training course on severe accidents", "special training course on decommissioning of nuclear installations", "special training course on radioisotopes", rejoice a large industry participation.

7. Conclusions

The present-day reflections on development and preservation of nuclear knowledge and the different initiatives taken, definitely catalyse networking in the nuclear education and training domain, as well on inter-academic level as between academia, research centers, regulatory bodies and utilities.

The main question remains: do we more of (the best) students? After three years of operation it is too early to draw hard conclusions. However prudently some trends might be observed: (i) the number of students increases, (ii) the number of "free initiative" students also increases i.e. the first year almost all students were already employed in the nuclear sector, in the previous year, 80% of the students followed the programme out of private interest and (iii) more and more of the graduates continue in the field and apply for doctoral research positions.

References

- [1] On the "Belgian Nuclear higher Education Network": <http://www.sckcen.be/BNEN/>
- [2] On the "European Nuclear Education Network": <http://www.enen-assoc.org>

[3] APPENDIX – BNEN academic calendar 2005 - 2006

For each course on the 1st day, the professor and the students agree on the exact dates.

September 30, 2005 October 3, 2005 14.00 – 15.30	UGent Academic session – all public Club-house SCK•CEN Mol Information session for students, professors & SCK staff	Logical scheme if spread	
			Year or semester
October 3 – 15, 2005 Exam: TBD	Nuclear energy: introduction W. D'haeseleer	3 ECTS 4x5h + 10h els	1
October 3 – 15, 2005 Exam: TBD	Introduction to nuclear physics A. Hermanne	3 ECTS 4x5h + 10h els	1
October 17 – 22, 2005 Exam: January 9, 2006	Nuclear Materials I J. Lecomte-Beckers	3 ECTS 4.5x4h + 10h els	3
October 24 – 29, 2005 Exam: TBD	Nuclear fuel cycle and applied radiochemistry P. Mathieu	3 ECTS 5x4h + 10h els	1
November 7 – 19, 2005 Exam: TBD	Nuclear Materials II W. Bogaerts and E. van Walle	3 ECTS 7x3h + 10h els	3
Selection before October 15 Report 10 à 30 p. within 2 weeks	Elective and/or advanced topics (proposal: week 47-48) MOX –fuel, Belgonucleaire, M. Lippens (Nov 22-23) Decommissioning of nuclear facilities, SCK•CEN, V. Massaut (Nov 24-25) Severe accidents, CEA, C.Journeau (Nov 29-Dec 2) Eugene Wigner course Topical Days (SCK•CEN) - http://www.sckcen.be 07-10-05 Life management for current research reactors 08-11-05 Heavy liquid metal technology 07-02-06 Trends in irradiation technology 21-02-06 Improvement of techniques for multiscale modeling 23-02-06 Transport processes in radioactive waste management	4 ECTS 2 ECTS 2 ECTS 3 ECTS 4 ECTS 1 ECTS 1 ECTS 1 ECTS 1 ECTS 1 ECTS	3
January 11 – 28, 2006 Full 3 weeks (all els included) Exam: June 5, 2006	Nuclear reactor theory W. D'haeseleer (2 ECTS) J.-M. Noterdaeme (3 ECTS) E. Mund (3 ECTS)	8 ECTS	1
February 7 – 25, 2006 Full 3 weeks (all els included) Exam: April 17, 2006	Nuclear thermal hydraulics M. Giot	6 ECTS	2
March 1 – 18, 2006 Almost 3 weeks (all els included) Exam: June 7, 2006	Radiation protection and nucl. measurements H. Thierens and K. Bacher (4 ECTS) S. Tavernier (2 ECTS)	6 ECTS	2
March 20 – 25, 2006 Exam: TBD	Operation and control W. Van Hove and G. Janssens-Maenhout	3 ECTS 5x4h + 10h els	4
March 27 – April 1, 2006 Exam: TBD	Reliability and safety A. Poucet	3 ECTS 20h+10h els	4
Intermed. presentation: Feb 2&3, 2006 Delivery: May 31 or July 31, 2006 Oral presentation: June 22 /23, 2006 and Aug. 31/Sept. 01, 2006	Project work and internship Proposal (title & abstract) at end of first semester, preferably earlier 2 ECTS elective(s) on related topics, to be agreed by promoter	15 (13&2) ECTS	3/4
Periods: June 01 till 17, 2006 August 16 till 26, 2006	Examination 1 st session 2 nd session		
Dates: Friday, June 23, 2006 Friday, September 01, 2006	Deliberation / evaluation		
TBD: to be defined els = exercises, lab sessions and seminars		Total (ECTS)	60 ECTS

Bloc I – 19 ECTS

Bloc II (ENEN-I) – 20 ECTS

Bloc III (ENEN-II) – 21 ECTS

Bloc I might have 20 ECTS or more, by additional elective and/or advances topics.

ENEN students might opt for Bloc II (3 months/20 ECTS) or Bloc II and III (6 months/41 ECTS) or
Bloc II + thesis (6 months/35 ECTS)

Corresponding Author:

Frans Moons
SCK•CEN
Boeretang 200
B-2400 Mol
Belgium
T: + 32 14 332596
F: + 32 14 318936
e-mail: frans.moons@sckcen.be