
THE BELGIAN NUCLEAR HIGHER EDUCATION NETWORK: YOUR WAY TO THE EUROPEAN MASTER IN NUCLEAR ENGINEERING.

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Abstract. 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. More information: <http://www.sckcen.be/BNEN>.

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 Science in 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 Science in 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 individual university delivers the degree and the diploma is signed by the Rector of that university. 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 Science in Nuclear Engineering

The Master of Science in 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 science in 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 focussed make-up courses.

The masters programme goes through highly theoretical subjects like neutron physics (3 ECTS), fluid flow and heat transfer modelling (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 two 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 life-long learning
- facilitates foreign students participation in blocs of courses in the frame of student exchange, as explained further.

4. International outlook

4.1. European master in nuclear engineering

The basic goal of the a European Master of Science in 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 centres for the preservation and further development of higher nuclear education and expertise. For more information, see <http://www.enen-assoc.org>.

Based upon a year-long exchange of views between the partners of ENEN, a coherent and practical concept for a European master in nuclear engineering has emerged. A master in 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 in 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. To demonstrate the feasibility of this exchange, the BNEN courses on Nuclear Thermal Hydraulics, 6 credits and Nuclear Reactor Theory, 8 credits, were respectively organised October 20-31 and November 17-28, 2004 in a residential scheme, to allow participation of "foreign" students. Indeed "foreign" attendance reached 50% of a total of respectively 20 and 10 students.

For the academic year 2004-2005, the BNEN courses Nuclear Reactor Theory, Nuclear Thermal Hydraulics and Radiation Protection and Nuclear Measurements are scheduled respectively in week 2,3,4; week 6,7,8 and week 10 & 11 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.

4.2. Erasmus Mundus

The European Commission has established a new educational programme, called Erasmus Mundus, to attract non-European students and scholars to European Master programmes.

ENEN association partners are applying for these grants. Students have the option to follow the first part at the Belgian Nuclear higher Education Network where the courses are taught in English; or at the Institut National des Sciences et Techniques where the courses are taught in French. The second part is an elective part at a second university of choice: the Technical University of Madrid, the University Ljubljana, the Helsinki University of Technology, the BNEN or the INSTN. During this second part, the students will do their master thesis project, have an internship in a research centre, a nuclear power plant or at the university, and would follow advanced courses and seminars.

Upon approval of the ENEN master courses for the Erasmus Mundus programme and upon approval of the individual dossiers of candidate students: non-European students wishing to attend this master can receive a grant of € 21 000 for one year of study of nuclear engineering. Non-European scholars can receive a grant of € 13 000 for a three-month stay at one of the participating universities. This grant serves to pay, among other things, transport costs, lodging, registration fees of the participating universities, ...

5. 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", could rejoice a large participation.

Annex: BNEN calendar – academic year 2004 – 2005.

Location of the courses: SCK•CEN – Boeretang 200 – 2400 Mol. Always 09.00 – 18.00, except otherwise stated or agreed upon.

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

Date	Course Title	Credits	FT	HT
			semester	
Oct. 4, 2004 (Monday) 14.00 – 15.30 16.00 – 18.00	Club-house SCK•CEN Mol <i>Information session for students, professors & SCK staff</i> <i>Academic session – all public</i>			
Oct. 4 – 9, 2004	<i>Nuclear energy: introduction</i> W. D'haeseleer	3 ECTS 4x5h + 10 h els	1	1
Oct. 11 – 16, 2004	<i>Introduction to nuclear physics</i> A. Hermanne	3 ECTS 4x5h + 10 h els	1	1
Oct. 18 – 23, 2004	<i>Nuclear Materials I</i> J. Lecomte-Beckers	3 ECTS 4.5x4h + 10h els	1	3
Oct. 25 – 30, 2004	<i>Nuclear fuel cycle and applied radiochemistry</i> P. Mathieu	3 ECTS 5x4h + 10h els	1	1
Nov. 8-13 & Nov. 15 – 20, 2004	<i>Nuclear Materials II</i> W. Bogaerts and E. van Walle	3 ECTS 7x3h + 10h els	1	3
15 <i>Selection before Oct. Report 10 à 30 p. within 2 weeks</i>	<i>Elective and/or advanced topics</i> <i>Advanced seminar on accelerators and time of flight experiments – IRMM -</i> W. Mondelaers <i>Radioisotopes – IRE – A. Debauche</i> <i>Advanced fuel – J.-B. Thomas</i> <i>Eugene Wigner course</i> Topical Days (SCK•CEN) - http://www.sckcen.be	4 ECTS 2 ECTS 2 ECTS ? ECTS 4 ECTS 1 ECTS	1	3
Jan. 12 – 29, 2005 Full 3 weeks (all els included)	<i>Nuclear reactor theory</i> W. D'haeseleer (2 ECTS) J.-M. Noterdaeme (3 ECTS) E. Mund (3 ECTS)	8 ECTS also ENEN	1	1
Feb. 8 – 26, 2005 Full 3 weeks (all els included)	<i>Nuclear thermal hydraulics</i> M. Giot	6 ECTS also ENEN	2	2
March 8 – 19, 2005	<i>Radiation protection and nucl. measurements</i> H. Thierens and K. Bacher (4 ECTS) S. Tavernier (2 ECTS)	6 ECTS 40h(10*4) UG/VUB; + els	2	2
March 21 - 26, 2005	<i>Operation and control</i> W. Van Hove and G. Janssens-Maenhout	3 ECTS 5x4hours + 10h els	2	4
Apr. 18 – 23, 2005	<i>Reliability and safety</i> A. Poucet	3 ECTS 20h+10h els	2	4
Delivery: May 31 or August 15, 2005	<i>Project work and internship</i> Proposal (title & abstract) at end of first semester. 2 ECTS on related topics	15 (13&2) ECTS	2	4
Periods: June 01 till 17, 2005 August 16 till 26, 2005	<i>Examination</i> 1 st session 2 nd session			

Dates: Friday, June 24, 2005 Friday, September 02, 2005	<i>Deliberation</i>			
FT: full time – take the programme in one year HT: half time – take the programme in two years els = exercises, lab sessions and seminars	Total (ECTS) First semester (ECTS) Second semester (ECTS) Third semester (ECTS) Fourth semester (ECTS) Advanced courses Project/internship	60	23 18 4 15	17 12 6 6 4 15

Bloc I – 21 ECTS
(ENEN-II) – 19 ECTS

Bloc II (ENEN-I) – 20 ECTS

Bloc III

Bloc III 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/39 ECTS) or Bloc II + thesis (6 months/33 ECTS)