DIVISION of NUCLEAR and RADIOCHEMISTRY

Application for the label
"EuroMaster in Nuclear and Radiochemistry"
(NRC EuroMaster)

"DNRC accreditation"

Date:	22nd April 2015
Place:	Prague

INTRODUCTION

EuroMaster in Nuclear and Radiochemistry (NRC EuroMaster) system was developed by CINCH (Cooperation in Nuclear Chemistry Education and Training in Europe) EU projects 2010-2016. The aim of the NRC EuroMaster system is to promote and harmonize NRC education in Europe and to promote and organize collaboration of European universities and student exchange. NRC EuroMaster system has two major components:

- Universities fulfilling minimum requirements are entitled to grant NRC EuroMaster label to their students.
- Universities having right to grant NRC EuroMaster label form a network to promote NRC education in Europe, mutual collaboration and student exchange.

The NRC EuroMaster label is granted to the universities by the Division of Nuclear and Radiochemistry of the European Association for Chemical and Molecular Sciences (DNRC EuCheMS). Based on the information given in this package by the candidate university the Division will evaluate the university's NRC curricula by comparing it to the minimum requirements defined in CINCH II project (Attachment 1). If the NRC curriculum fulfils the requirements by having at least 60 ECTS credit units workload in NRC and by covering at least 90% of the required compulsory topics the university will be given the right to grant NRC EuroMaster label to their NRC students and the university will become a member in the NRC EuroMaster Network.

The minimum requirements define that the master's program should contain at least 60 ECTS credit units (50% in case of 120 ECTS cu master's program) studies in nuclear and radiochemistry in the following way:

BSc in chemistry		180 cu
Compulsory studies in nuclear and radiochemistry (of which at least 10 cu exercises)	minimum	25 cu
Optional studies in nuclear and radiochemistry	minimum	5 cu
Project work and master's thesis in nuclear and radiochemistry	minimum	30 cu
Elective studies		rest
In total		300 cu

For master's programs using other than ECTS credit unit system the workload of nuclear and radiochemistry studies should be equivalent to at least 60 ECTS credit units (1500 hours of students' work).

1 UNIVERSITY INFORMATION

Table 1: Information on the candidate university and NRC unit

University	Czech Technical University in Prague	
NRC unit (department, division, laboratory…)	Department of Nuclear Chemistry, Faculty of Nuclear Sciences and Physical Engineering	
Address	Břehová 7, Prague 1, 115 19 Czech Republic	
Home page	www.jaderna-chemie.cz, www.fjfi.cvut.cz, www.cvut.cz	
Phone number	+420 224 358 228	
Head of the NRC unit	Prof. Jan John	
Number of employees (NRC unit)	Persons	Full time job equivalent
Professors	3	2.7
Associate professors or equivalent	5	3.5
Other Academic	9	7.1
Researchers	11	5.5
Technical	10	6.9
Total	38	
Number of external teachers	7/18	
Average annual number of NRC master students	10	
Actual number of doctoral students	Full-time	Part-time
	15	17

Comments:

External teachers teach mostly the optional courses:

- 7 teach or participate in teaching of NRC related courses
- 11 teach other topics

2 STRUCTURE OF THE MASTER'S PROGRAM

The official title of your master's degree, such as Master in Chemistry, Master in Nuclear Chemistry, Master in Chemistry (specialization in radiochemistry) etc.:

Master in Nuclear Chemistry

Is your program accredited by any institution? Please, provide brief details.

Accredited (YES/NO)	**YES**
Institution	Accreditation Commission of the Czech Republic
Address	Secretariat of the Accreditation Commission, Ministry of Education, Youth and Sports, Karmelitská 7, CZ - 118 12 Prague 1. http://www.akreditacnikomise.cz/en/
Accredited for period	2010-2015
Periodicity of re-accreditation	5 years
First accreditation	1992
Programme running since	1955

If your university uses crediting system other than ECTS, please provide basic specification and its relation to the ECTS in the table below. Please, make the specification also in case that your bachelor and master's program have different credit volumes than those given in the introductory part (180, 120, and 300 cu).

Table 2: Specification of the crediting system used (fill only if ECTS is not used)

Specification:	
Required minimum number of credits defined above	
Bachelor programme	
Master programme	

Use the following tables to describe the contents of your NRC education both at bachelor and master's level. Modules are any study units (lecture course, laboratory course, thesis, seminar, examination, internship etc.) which have been defined in curricula and for which the number of credit units has been defined individually.

When filling the following tables, please use the instructions bellow:

- List all your bachelor- and master-level NRC modules here.
- In case you have a specific NRC bachelor program, mention it in the Table 3a and give a detailed description as an attachment
- Use the full names of the modules, as stated in your curricula (in English).
- Number your modules in the order of listing from 0 to *n* and use the respective abbreviations for your modules **B** – bachelor, **OB** – optional in bachelor, **C** – compulsory, **O** – optional, and **W** – project work as it is shown in the example.
- Please, create hypertext link for your module names to the English syllabi of the module. If it is not possible, please attach PDF of your syllabi to the application.
- Feel free to add rows to cover all your relevant modules
- If you use a non-ECTS crediting system or system with different credit volumes, replace "?" in the header of the last column by your unit defined in Table 2 and use this column.

Table 3a. NRC contents of your BSc programs.

Content	No.	Extent (cu)	Extent (?)
Curriculum at BSc level	***Total***	***180***	***or xx***
Compulsory studies in nuclear and radiochemistry	***Sum***	***35***	
Nuclear chemistry 1	B1	2	
Nuclear chemistry 2	B2	5	
Detection of Ionizing Radiation	B3	2	
Nuclear Power Plants Design and Operation	B4	3	
Practical Exercises in Detection of Ionizing Radiation	B5	3	
Practical Exercises in Radiochemical Technology	B6	2	
Dosimetry and Radiation Protection	B7	3	
Bachelor thesis 1	B8	5	
Bachelor thesis 2	B9	10	
Optional studies in nuclear and radiochemistry	***Sum***	***17***	
Nuclear physics	OB1	6	
Quantum physics	OB2	3	
Introduction to Elementary Particle Physics	OB3	2	
Transport of Ionizing Radiation and Monte Carlo Method	OB4	4	
Exact Methods in Research of Historic Monuments	OB5	2	

Comments:

(1) These courses form a compulsory NRC part of the “Bachelor in Nuclear Chemistry” study programme preceding the CTU “Master in Nuclear Chemistry” programme. For more details on this bachelor programme, see the attachment.

Table 3b. NRC contents of your MSc programs.

Content	No.	Extent (cu)	Extent (?)
Curriculum at MSc level	***Total***	***120***	***or xx***
Compulsory studies in nuclear and radiochemistry	***Sum***	***30***	
Separation Methods in Nuclear Chemistry 1	C1	3	
Trace radiochemistry	C2	3	
Radiation chemistry	C3	3	
Environment Chemistry and Radioecology	C4	2	
Radioanalytical methods	C5	3	
Practical Exercises in Nuclear Chemistry	C6	4	
Practical Exercises in Radiation Chemistry	C7	3	
Practical Exercises in Separation Methods	C8	3	
Radionuclide Production	C9	2	
Internship	C10	4	
Optional studies in nuclear and radiochemistry	***Sum***	***50***	
How many courses or credits are required? (Courses/Credits/Your unit)	(??)[1]		
Technology of Fuel Cycles of Nuclear Power Stations	O1	2	
Application of Radionuclides 1	O2	2	
Separation Methods in Nuclear Chemistry 2	O3	2	
The Chemistry of Operation of Nuclear Power Plants	O4	2	
Application of radiation methods	O5	2	
Radiation methods in biology and medicine	O6	2	
Chemistry of radioactive elements	O7	2	
Nuclear Materials Technology	O8	2	
Radiobiology	O9	2	
Radiation protection	O10	4	
Determination of radionuclides in the environment	O11	2	
Radiopharmaceuticals 1	O12	2	
Radiopharmaceuticals 2	O13	2	
Application of radionuclides 2	O14	2	
Practical Exercises in Radiation Methods in Biology and Medicine	O15	4	
Practical Exercises in Radioanalytical Methods	O16	4	
Protection of environment	O17	2	
Introduction to Photochemistry and Photobiology	O18	2	
Modelling of Migration Processes in Environment	O19	2	

Instrumental Methods 2	O21	2	
Numerical Simulation of Complex Environmental Processes	O22	2	
Theoretical Foundations of Radiation Chemistry	O23	2	

Comments:

(1) Various options of selection of the optional courses at CTU are described in the section 5 - NRC Topics covered in your curricula – optional studies. The total volume of compulsory NRC courses is 86 cu. The students choose the 34 cu remaining to the required of minimum 120 cu from the offer of the optional NRC courses recommended for each specialization as listed in Table 9 and additional non-NRC courses.

Table 3c. NRC project works of your MSc programs.

Content	**No.**	**Extent (cu)**	**Extent (?)**
Project work and master's thesis in nuclear and radiochemistry	**Sum**	**44**	***or xx***
Research Project 1	W1	6	
Research Project 2	W2	8	
Master Thesis 1	W3	10	
Master Thesis 2	W4	20	

Comments:

(2) Exams are supposed to be a part of the course and do not have any additional credit value.

3 NRC TOPICS COVERED IN YOUR CURRICULA – COMPULSORY STUDIES

Fill the Tables 4-9 to answer how the topics listed in Minimum requirements are covered in your bachelor or master's program. When filling the tables look for details in the Minimum requirements. **If necessary, add numbered comments bellow the tables**.

Table 4. Radioactivity, radionuclides and radiation – principles of nuclear physics to radiochemists. Module number from the list you gave in section 3 (Tables 3a-3c). In case the same topic is taught in more than one module, give numbers of all modules.

TOPIC	INCLUDED IN MODULE No.
structure of atom and nucleus, nucleons	B1, OB1, OB2, OB3
nuclides, radionuclides, isotopes, isobars	B1, OB1
types and origin of radionuclides	B1
factors affecting stability of nuclei	B1, OB1
modes of radioactive decay (fission, alpha decay, beta decay, internal transition)	B1-3, B5-7, OB1, C6
rate of radioactive decay, half-life, activity units, determination of half-lives	B1-3, B5-7, OB1,C6
activity concentrations vs. specific activity, activity vs. count rate	B1-3, B5, B6, C6
equilibria in successive decay processes	B1-3, B5, B6, C6
isotopic exchange - isotope effects	B2, C6, C8 O2, O14

Comments:

(1) For estimation of total extent in credits in the table below, only the compulsory modules are used (B and C codes).

TOTAL EXTENT (estimate in credit units)	**7 cu**
- (estimated) extent in the lectures	2
- (estimated) extent in the calculation exercises	1
- (estimated) extent in the laboratory exercises	4
- (estimated) extent in exams	
- (estimated) extent in seminars	
- (estimated) extent in others	

Table 5. Radiation safety

TOPIC	INCLUDED IN MODULE No.
types of radiation and their absorption processes by matter, range	B1-3, OB1, B5, B7, OB4, C3, C5-7, O5, O6, O10
radiation safety measures and their units	B7, C3, C7, O10
effects of radiation on DNA in cells	B7, C7, O6, O9, O10, O15
health effects of radiation	B7, C7, O6, O9, O10, O12, O13
principles of radiation safety (justification, optimization, protection of individuals)	B6, B7, O10
radiation safety organizations and their recommendations and regulations	B6, B7, O10
estimation and measurement of radiation doses	B6, B7, C7, O10
radiation safety practices, safe working habits in radionuclide laboratories and with radiation sources	B6, B7(*)
safe handling and disposal of radioactive waste from radionuclide laboratories	B6(*)
measures during/after exceptional events	B6, B7, O10

Comments:

(1) For estimation of total extent in credits in the table below, only the compulsory modules are used (B and C codes).

* These requirements are part of the first laboratory exercises in radiochemistry laboratories, when the students get instructions on safety work etc.

TOTAL EXTENT (estimate in credit units)	**4 cu**
- (estimated) extent in the lectures	2
- (estimated) extent in the calculation exercises	1
- (estimated) extent in the laboratory exercises	1
- (estimated) extent in exams	
- (estimated) extent in seminars	
- (estimated) extent in others	

Table 6. Detection and measurement of radiation

TOPIC	INCLUDED IN MODULE No.
interaction processes of radiation with matter	B2, B3, B5, B7, OB4, C3, C7, O5, O6, O10,
basic instrumentation in radiation measurements	B3, B5, B7
pulse counting vs. spectrometry	B3, B5,
pulse rate, counting efficiency, activity	B3, B5,
factors affecting counting efficiency	B3, B5, OB4
energy resolution	B3, B5,
detectors for radiation measurement	B3, B5, OB4
statistics and uncertainty calculations in radiometric measurements	B3, B5,
interpretation of gamma, alpha, beta and X-ray spectra	B3, B5, C5, O11, O16
energy and efficiency calibrations	B3, B5,
liquid scintillation counting	B3, B5,
radiation imaging	B3, O6
background formation and subtraction	B3, B5,
quality control in radiation measurements	O11
mass spectrometric measurement of radionuclides	OB5, O21

Comments:

(1) For estimation of total extent in credits in the table below, only the compulsory modules are used (B and C codes).

TOTAL EXTENT (estimate in credit units)	**6 cu**
- (estimated) extent in the lectures	3
- (estimated) extent in the calculation exercises	
- (estimated) extent in the laboratory exercises	3
- (estimated) extent in exams	
- (estimated) extent in seminars	
- (estimated) extent in others	

Table 7. Chemistry and analysis of radionuclides.

TOPIC	INCLUDED IN MODULE No.
chemistry (oxidation states, solubility, complex formation, hydrolysis, compounds) of the most important radionuclides	C1, C2, C5, C8, O1, O3, O7, O11
nuclear characteristics (half-lives, decay modes, emitted radiation) of the most important radionuclides	C1, C6, C8, O3, O7, O11
measurement techniques of the most important radionuclides	C1, C6, C8, O3, O7, O11
special characteristics of the chemistry and separations of radionuclides	C1, C2, C6, C8, O1, O3, O7, O11
needs and principles of radiochemical separations	C1, C6, C8, O1, O3, O7, O11
analytical methods used in radionuclide separations (precipitation, ion exchange, solvent extraction, extraction chromatography)	C1, C6, C8, O3, O7, O11, O16
yield determination and counting source preparations	B6, C1, C6, C8, O3, O7, O11, O15, O16
separation of long-lived radionuclides for mass spectrometric measurement	
sampling and sample pre-treatment methods	O11
speciation analysis of radionuclides	C2, O2
hot-atom chemistry	B2

Comments:

(1) For estimation of total extent in credits in the table below, only the compulsory modules are used (B and C codes).

TOTAL EXTENT (estimate in credit units)	**12 cu**
- (estimated) extent in the lectures	7
- (estimated) extent in the calculation exercises	1
- (estimated) extent in the laboratory exercises	4
- (estimated) extent in exams	
- (estimated) extent in seminars	
- (estimated) extent in others	

Table 8. Nuclear reactions and production of radionuclides.

TOPIC	INCLUDED IN MODULE No.
interaction processes of particles with nuclei	B1, B2, C3, C5, C6, C9, O6, O10, O12, O13
types of nuclear reactions and models	B1, B2
coulombic barrier	B1, B2
energetics of nuclear reactions	B1, B2
kinetics of nuclear reactions	B1, B2
cross-sections	B1, B2, C6, C9
excitation functions	B1, B2, C9
induced fission	B1, B2
types of particle accelerators	C9, O6
production of radionuclides in cyclotrons	C9
production of radionuclides in reactors	B2, B4, C9, O1, O4, O7, O8
radionuclide generators	B2, B6, C6, C9, O6, O12, O13, O15
principles and uses of nuclear power reactors	B4, O1, O4, O8

Comments:

(1) For estimation of total extent in credits in the table below, only the compulsory modules are used (B and C codes).

TOTAL EXTENT (estimate in credit units)	**10 cu**
- (estimated) extent in the lectures	7
- (estimated) extent in the calculation exercises	2
- (estimated) extent in the laboratory exercises	1
- (estimated) extent in exams	
- (estimated) extent in seminars	
- (estimated) extent in others	

Table 8. Topics of NRC exercises.

TOPIC	INCLUDED IN MODULE No.
Calculation exercises	
use of nuclide chart and data bases	B1, B2
calculation of activities based on half-life data	B1, B2
calculation of activities in successive decays (radiochemical equilibria)	B1, B2
calculation of irradiation yields based on cross sections and projectile flux	B1, B2
calculation of irradiation doses	B7, O10
calculation of required shielding for radiation protection	B7, O10
uncertainty calculation in activity measurements	B3
conversion of count rates to activities	B3
Laboratory exercises	
detection of surface contamination for radiation safety	B6
use of radiation dosimeters for radiation safety to measure total dose and dose rates	C7 (*)
measurement of radiation with a simple detector, such as Geiger tube (e.g. dead-time, absorption of beta radiation, counting geometry etc.)	B5, C6
measurement of radiation with a LSC	B5, B6, C6, C8,
measurement of radiation with a gamma spectrometer - energy calibration, interpretation of gamma spectra	B5, O16
separations of radionuclides using various methods, such as precipitation/co-precipitation, ion exchange chromatography, solvent extraction and/or extraction chromatography	B6, C6, C8, O15, O16

Comments:

* Only chemical dosimeters for dose measurement in experiments are used.

TOTAL EXTENT (estimate in credit units)	**16 cu**
- (estimated) extent in the calculation exercises	4
- (estimated) extent in the laboratory exercises	12

4 NRC TOPICS COVERED IN YOUR CURRICULA – OPTIONAL STUDIES

NRC curriculum should also include optional NRC studies in at minimum 5 cu. These course modules may cover various application fields of nuclear- and radiochemistry. Suggested topic areas are described below and detailed course contents in the Minimum requirements.

Topic areas for optional NRC courses/course modules suggested in Minimum requirements

Chemistry of the nuclear fuel cycle	TA1
Radiopharmaceutical chemistry	TA2
Environmental radioactivity – radioecology	TA3
Chemistry of actinides and transactinides	TA4
Chemistry of radionuclides in geosphere related to final disposal of spent nuclear fuel or high-level waste	TA5
Radiation chemistry	TA6
Nuclear and radioanalytical methods	TA7

What are the requirements of NRC optional studies in your curricula: how many modules and how many credit units are required?

- Please fill names of your studies including its extent in ECTS cu or your units defined in Table 2.
- When possible provide hyperlink to the syllabi or attach PDF of your syllabi to the application.
- For brief orientation, please use codes defined in the above table.

Table 9: Description and content of optional studies/modules in your curricula.

Name of the study, course, module etc.	Code No	Topic codes	Extent (cu)
Applied nuclear chemistry			
Technology of Fuel Cycles of Nuclear Power Stations	O1	TA1	2
Application of Radionuclides 1	O2	TA2–5,7	2
Application of radionuclides 2	O14	TA2–5,7	2
The Chemistry of Operation of Nuclear Power Plants	O4	TA1	2
Application of radiation methods	O5	TA1	2
Nuclear Materials Technology	O8	TA1	2
Practical Exercises in Radioanalytical Methods	O16	TA3,7	4
Theoretical Foundations of Radiation Chemistry	O23	TA6	2
		Total	**18**
Nuclear chemistry in biology and medicine			
Radiation methods in biology and medicine	O6	TA2	2
Radiobiology	O9	TA2,3,6	2
Radiation protection	O10	TA1–7	4

Radiopharmaceuticals 1	O12	TA2	2
Radiopharmaceuticals 2	O13	TA2	2
Practical Exercises in Radiation Methods in Biology and Medicine	O15	TA2	4
Theoretical Foundations of Radiation Chemistry	O23	TA6	2
		Total	**18**
Chemistry of the environment and radioecology			
Protection of environment	O17	TA3	2
Modelling of Migration Processes in Environment	O19	TA3,5	2
Determination of radionuclides in the environment	O11	TA3,7	2
Numerical Simulation of Complex Environmental Processes	O22	TA3,5	2
		Total	**8**
General NRC courses			
Separation Methods in Nuclear Chemistry 2	O3	TA1	2
Chemistry of radioactive elements	O7	TA1,3,4	2
Instrumental Methods 2	O21	TA7	2
		Total	**6**

Comments:

1. The students of the "Nuclear chemistry" programme can further specialize to: "Applied nuclear chemistry", "Nuclear chemistry in biology and medicine", or "Chemistry of the environment and radioecology". For these specializations, the above listed content is recommended being the part of the final master exams.
2. The General optional NRC courses are available for all the three specializations mentioned above.
3. Topic area "Radiation chemistry", TA6 is a compulsory part of master level in NRC at CTU in Prague.
4. The total volume of compulsory NRC courses is 86 cu. The students choose the 34 cu remaining to the required of minimum 120 cu from
    a. the offer of the optional NRC courses recommended for each specialization as listed above and
    b. additional non-NRC courses.

5 PROJECT WORK AND MASTER'S THESIS

Describe your master's thesis type (for example "Six months project including four months laboratory work and two months for writing the report on both experimental work and the literature" or "Three months laboratory work and report and an individual literature survey (two months)" or …).

Diploma thesis – 30 cu in the last year of study, at least 7 months work including laboratory work and writing the report. In optimum way student each year follows its precedent work: bachelor thesis – research project – master thesis, where bachelor thesis is based mainly on literature survey and basic experiments, research project (14 cu work) consists of laboratory work resulting in a research report with short theoretical introduction.

How many credit unit you grant from project work and master's thesis. If there are several parts (see above) give credit units individually for each.

Research project 6 cu in the first semester, 8 cu in the second, when a report has to be submitted and the results have to be presented and defended (the report and its presentation and defence are graded).
Master thesis 10 cu in the first semester, 20 cu in the second. Thesis defence is then a part of the final master state exam.

Give 4-6 examples of recent topics of projects works and master's thesis.

Master theses:
Determination of americium in operational radioactive waste
Influencing of microorganisms with ionizing and UV radiation at presence of the scavengers
Labelling of bio-degradable triterpenoids
Speciation study of alkaline earth uranyl complexes by TRLFS method

Research projects:

6 OTHER IMPORTANT INFORMATION

Please, provide any other important information about your NRC programme bellow. Also, if it is relevant provide information about accreditation of the programme.

As given in Part 3, the accreditation expires in 2015. At this moment, application for its extension is in the final stages of compilation.