**Application for the label**

**“EuroMaster in Nuclear and Radiochemistry”**

**(NRC EuroMaster)**

**“DNRC evaluation”**



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| --- | --- |
| Date: |  |
| Place: |  |

# 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 (first cycle) |  | 180–240 cu[[1]](#footnote-1) |
| 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 Masters thesis in nuclear and radiochemistry | minimum | 30 cu |
| Elective studies – rest up to the total due for the second cycle |  | rest |
| In total (second cycle) |  | 90–120 cu[[2]](#footnote-2) |
| In total |  | 270–360 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).

# UNIVERSITY INFORMATION

**Table 1: Information on the candidate university and NRC unit**

|  |  |  |
| --- | --- | --- |
| University |  | |
| NRC unit  (department, division, laboratory…) |  | |
| Address |  | |
| Home page |  | |
| Phone number |  | |
| Head of the NRC unit |  | |
| Number of employees (NRC unit) | Persons | Full time job equivalent |
| Professors |  |  |
| Associate professors or equivalent |  |  |
| Other Academic |  |  |
| Researchers |  |  |
| Technical |  |  |
| Total |  |  |
| Number of external teachers |  | |
| Average annual number of NRC master students |  | |
| Actual number of doctoral students | Full-time | Part-time |
|  |  |

**Comments:**

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# 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.:

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

|  |  |
| --- | --- |
| Accredited (YES/NO) |  |
| Institution |  |
| Address |  |
| Accredited for period |  |
| Periodicity of re-accreditation |  |
| First accreditation |  |
| Programme running since |  |

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. The syllabi should follow the ECTS specifications (Appendix III to the Guidelines for Applications).
* 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*** |  |  |
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|  |  |  |  |
| ***Optional studies in nuclear and radiochemistry*** | ***Sum*** |  |  |
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**Comments:**

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**Table 3b. NRC contents of your MSc programs.**

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| --- | --- | --- | --- |
| **Content** | **No.** | **Extent (cu)** | **Extent (?)** |
| ***Curriculum at MSc level*** | ***Total*** | ***120*** | ***or xx*** |
| ***Compulsory studies in nuclear and radiochemistry*** | ***Sum*** |  |  |
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| ***Optional studies in nuclear and radiochemistry*** | ***Sum*** | ***50*** |  |
| *How many courses or credits are required? (Courses/Credits/Your unit)* | (??) | | |
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**Comments:**

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**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** |  | ***or xx*** |
|  |  |  |  |
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**Comments:**

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# 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 |  |
| nuclides, radionuclides, isotopes, isobars |  |
| types and origin of radionuclides |  |
| factors affecting stability of nuclei |  |
| modes of radioactive decay (fission, alpha decay, beta decay, internal transition) |  |
| rate of radioactive decay, half-life, activity units, determination of half‑lives |  |
| activity concentrations vs. specific activity, activity vs. count rate |  |
| equilibria in successive decay processes |  |
| isotopic exchange - isotope effects |  |

**Comments:**

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| --- | --- |
| **TOTAL EXTENT (estimate in credit units)** |  |
| - (estimated) extent in the lectures |  |
| - (estimated) extent in the calculation exercises |  |
| - (estimated) extent in the laboratory exercises |  |
| - (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 |  |
| radiation safety measures and their units |  |
| effects of radiation on DNA in cells |  |
| health effects of radiation |  |
| principles of radiation safety (justification, optimization, protection of individuals) |  |
| radiation safety organizations and their recommendations and regulations |  |
| estimation and measurement of radiation doses |  |
| radiation safety practices, safe working habits in radionuclide laboratories and with radiation sources |  |
| safe handling and disposal of radioactive waste from radionuclide laboratories |  |
| measures during/after exceptional events |  |

**Comments:**

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|  |  |
| --- | --- |
| **TOTAL EXTENT (estimate in credit units)** |  |
| - (estimated) extent in the lectures |  |
| - (estimated) extent in the calculation exercises |  |
| - (estimated) extent in the laboratory exercises |  |
| - (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 |  |
| basic instrumentation in radiation measurements |  |
| pulse counting vs. spectrometry |  |
| pulse rate, counting efficiency, activity |  |
| factors affecting counting efficiency |  |
| energy resolution |  |
| detectors for radiation measurement |  |
| statistics and uncertainty calculations in radiometric measurements |  |
| interpretation of gamma, alpha, beta and X-ray spectra |  |
| energy and efficiency calibrations |  |
| liquid scintillation counting |  |
| radiation imaging |  |
| background formation and subtraction |  |
| quality control in radiation measurements |  |
| mass spectrometric measurement of radionuclides |  |

**Comments:**

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| --- | --- |
| **TOTAL EXTENT (estimate in credit units)** |  |
| - (estimated) extent in the lectures |  |
| - (estimated) extent in the calculation exercises |  |
| - (estimated) extent in the laboratory exercises |  |
| - (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 |  |
| nuclear characteristics (half-lives, decay modes, emitted radiation) of the most important radionuclides |  |
| measurement techniques of the most important radionuclides |  |
| special characteristics of the chemistry and separations of radionuclides |  |
| needs and principles of radiochemical separations |  |
| analytical methods used in radionuclide separations (precipitation, ion exchange, solvent extraction, extraction chromatography) |  |
| yield determination and counting source preparations |  |
| separation of long-lived radionuclides for mass spectrometric measurement |  |
| sampling and sample pre-treatment methods |  |
| speciation analysis of radionuclides |  |
| hot-atom chemistry |  |

**Comments:**

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| **TOTAL EXTENT (estimate in credit units)** |  |
| - (estimated) extent in the lectures |  |
| - (estimated) extent in the calculation exercises |  |
| - (estimated) extent in the laboratory exercises |  |
| - (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 |  |
| types of nuclear reactions and models |  |
| coulombic barrier |  |
| energetics of nuclear reactions |  |
| kinetics of nuclear reactions |  |
| cross-sections |  |
| excitation functions |  |
| induced fission |  |
| types of particle accelerators |  |
| production of radionuclides in cyclotrons |  |
| production of radionuclides in reactors |  |
| radionuclide generators |  |
| principles and uses of nuclear power reactors |  |

**Comments:**

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| --- | --- |
| **TOTAL EXTENT (estimate in credit units)** |  |
| - (estimated) extent in the lectures |  |
| - (estimated) extent in the calculation exercises |  |
| - (estimated) extent in the laboratory exercises |  |
| - (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 |  |
| calculation of activities based on half-life data |  |
| calculation of activities in successive decays (radiochemical equilibria) |  |
| calculation of irradiation yields based on cross sections and projectile flux |  |
| calculation of irradiation doses |  |
| calculation of required shielding for radiation protection |  |
| uncertainty calculation in activity measurements |  |
| conversion of count rates to activities |  |
|  |  |
| **Laboratory exercises** |  |
| detection of surface contamination for radiation safety |  |
| use of radiation dosimeters for radiation safety to measure total dose and dose rates |  |
| measurement of radiation with a simple detector, such as Geiger tube (e.g. dead-time, absorption of beta radiation, counting geometry etc.) |  |
| measurement of radiation with a LSC |  |
| measurement of radiation with a gamma spectrometer - energy calibration, interpretation of gamma spectra |  |
| separations of radionuclides using various methods, such as precipitation/co-precipitation, ion exchange chromatography, solvent extraction and/or extraction chromatography |  |

**Comments:**

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| --- | --- |
| **TOTAL EXTENT (estimate in credit units)** |  |
| - (estimated) extent in the calculation exercises |  |
| - (estimated) extent in the laboratory exercises |  |

# 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) |
| --- | --- | --- | --- |
| ***(Name)*** |  |  |  |
|  |  |  |  |
|  |  | **Total** |  |
| ***(Name)*** |  |  |  |
|  |  |  |  |
|  |  | **Total** |  |
| ***(Name)*** |  |  |  |
|  |  |  |  |
|  |  | **Total** |  |
| ***(Name)*** |  |  |  |
|  |  |  |  |
|  |  | **Total** |  |

**Comments:**

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| (Add lines into the previous table, if necessary.) |

# 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 …).

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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.

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

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# 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.

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1. “The framework of qualifications for the European Higher Education Area” adopted at The Bergen Conference of European Ministers Responsible for Higher Education, Bergen, Norway, 19-20 May 2005 [↑](#footnote-ref-1)
2. The Bologna Process - Conference on Master-level Degrees: Conclusions and Recommendations of the Conference. Helsinki, Finland, March 14 - 15, 2003 [↑](#footnote-ref-2)