NTEC

Nuclear Technology Education Consortium

Nuclear Technology Education Consortium
M.Sc. in Nuclear Science & Technology
Programme Handbook

CONTACT DETAILS

Manchester University

Professor Jon Billowes
Academic Course Director
T: 0161 275 4104 • E: jon.billowes@manchester.ac.uk

Mrs Mel McLoughlin
Manager of Nuclear Programmes
T: 0161 275 4575 • F: 0161 275 4372 • E: mel.young@manchester.ac.uk

Miss Jo Chesters
Postgraduate Nuclear Programmes Administrator
T: 0161 275 4267 • F: 0161 275 4372 • E: jo.chesters@manchester.ac.uk

Mr Ishty Hussain
e-Learning Technologist
T: 0161 275 4389 • F: 0161 275 4372 • E: ishty.hussain@manchester.ac.uk

Dr John Roberts
NTEC Nuclear Fellow
M: 0161 275 4312 • E: j.w.roberts@manchester.ac.uk

School of Physics & Astronomy • Room 3.51 / 3.52 • Schuster Building •
University of Manchester • Brunswick Street • Manchester M13 9PL
www.ntec.ac.uk

Liverpool University, Department of Physics, Liverpool, L69 7ZE

Professor Paul Nolan
Academic Course Director
T: 0151 794 3377 • E: pjn@ns.ph.liv.ac.uk

Mrs Janet Watson
Course Administrator
T: 0151 794 3713 • E: jmk@liverpool.ac.uk

Sheffield University, Department of Materials Science and Engineering, Mappin St, Sheffield, S1 3JD

Dr Karl Whittle
Academic Course Director
T: 0114 222 5484 • E: k.r.whittle@sheffield.ac.uk

Karen Burton
Course Administrator
T: 0114 222 5941 • E: k.a.burton@sheffield.ac.uk

Nuclear Technology Education Consortium

MSc, Diploma & Certificate in NUCLEAR SCIENCE & TECHNOLOGY

PROGRAMME HANDBOOK

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INTRODUCTION

The purpose of this handbook is to provide information to students undertaking the postgraduate programme in Nuclear Science & Technology being delivered by the Nuclear Technology Education Consortium (NTEC).

NTEC is a consortium of UK universities and research institutes formed specifically to deliver postgraduate taught programmes in Nuclear Science & Technology.

The structure and content of the programme, which leads to qualifications up to Master's level in Nuclear Science & Technology, was established following extensive consultations with the UK nuclear sector, including industry, regulators, MoD, NDA, Government Departments and the Cogent Skills Council.

The programme is based upon a modular structure, the core of each topic within the programme being delivered in one week's intensive teaching at the relevant institution or via distance learning modules taken over 4 months. This allows the M.Sc. qualification to be obtained over three years on a part-time basis, or in one year full-time. A Postgraduate Certificate or Postgraduate Diploma in Nuclear Science & Technology may also be obtained.

NTEC comprises the Universities of Birmingham, Central Lancashire, City University London, Defence Academy College of Management and Technology, Imperial College London, Lancaster, Leeds, Liverpool, Manchester and Sheffield. Together these institutions represent more than 90% of the nuclear postgraduate teaching expertise residing in the UK's universities and research institutes. Further information is given in Appendix 4.

Each Consortium member delivers one or more modules within the syllabus according to its areas of specialisation. Modules will generally be delivered on the campus of the providing institution. Students seeking a postgraduate qualification will register at either, Liverpool, Manchester or Sheffield University. The programme is coordinated by the Nuclear Programmes office at the University of Manchester.

Students can register at either, Liverpool, Manchester or Sheffield University, which is then responsible for overall academic supervision of the student, including supervision of the Master's project & dissertation. The registering institution will also award any degree. NTEC itself does not make awards.

This handbook is provided to address Consortium-wide issues and will be supplemented by the specific student handbook provided to students by their registering university. It is however the clear responsibility of the student to ensure that s/he is fully informed about all aspects of their course.

Access to the internet is assumed. This will be used principally for access to the pre-course preparation material, dissemination of course news and the distance learning modules.

Student Office / NTEC Suite

Desk space and access to computers and a printer are provided in the NTEC Suite on the third floor of the Schuster Building. The area should be respected as a work environment. Tea, coffee and water are provided free of charge and is available to all students registered on the NTEC programme.

COURSE STRUCTURE

The qualifications offered are available on a taught full-time/part-time or part time distance learning basis and lead to an M.Sc. in Nuclear Science & Technology. Intermediate qualifications, a Postgraduate Diploma or Postgraduate Certificate, are also attainable. Qualifications are awarded by the university with which the student has registered and which is therefore responsible for the student's overall academic supervision.

Students who register for, and satisfactorily complete an intermediate qualification may apply for a transfer to a higher qualification.

The programme elements are 'short fat' modules, each of which accrues 15 credits. 180 credits are required for the award of an M.Sc.

The overall philosophy governing the programme structure is that students take four 'core' modules designed to give a basic grounding in either nuclear technology or decommissioning. Students undertaking a Postgraduate Diploma or M.Sc. will then take four elective modules aligned to their particular interests. It is recognised that students will come from a variety of different backgrounds and disciplines and, as far as possible, the pre-course material will be designed to ensure all students commence each module sufficiently prepared to obtain full benefit from it.

Students seeking an M.Sc. will undertake a project and dissertation. Wherever possible this will be an industrially-based project designed to be of benefit to both the student and the sponsoring company.

Typical timescales are:

Part-time taught or distance learning M.Sc. taken over 3 years:

Year 1 — 4 Suggested modules (60 credits)
(Successful completion attains Postgraduate Certificate in Nuclear Science & Technology)

Year 2 — 4 Elective modules (60 credits)
(Successful completion attains Postgraduate Diploma in Nuclear Science & Technology)

Year 3 — Project & Dissertation (60 credits)

The maximum period for completion of a part-time course is a matter for agreement between the student and the university with which s/he has registered.

Full-time M.Sc. taken over 1 year:

4 suggested and 4 elective modules are taken over a period of approximately 9 months. The project and dissertation then follows.

Any module may be taken as a short course for Continuing Professional Development purposes. Students will be given an appropriate certificate but will not achieve a formal qualification from the institution delivering the module.

TAUGHT MODULE FORMAT

Modules are designed to require approximately 150 hours application by the student. The key element of the module is one week of direct teaching on the campus of one of the Consortium members.

Modules will typically contain the following elements:

1. Prior to the concentrated week of teaching, students will undertake approximately 20 hours of pre-module preparation. This may include pre-reading, research and exercises and students may be asked to prepare a short presentation for delivery at the beginning of the taught week. The purpose of this element is to enhance the effectiveness of the taught week by bringing students, who may be from varying backgrounds and disciplines, up to the same basic level of knowledge. This information will be emailed to the student 4 weeks prior to the direct taught week.

2. One week's direct teaching by the institution delivering the module: this may include some group exercises which require the students to work together, undertake research and make a presentation to the module leader and the rest of the cohort. These activities may be subject to assessment. A module review is conducted at the end of the taught week. A mandatory requirement of each module is that students complete a feedback form, which is emailed to all students after completion of the module. Feedback should then be emailed back to the E-Learning Technologist (Ishty Hussain) within one week of completion of the module.

3. A post-module assignment based upon the subject delivered during the taught week and undertaken at the student's place of work or home. The assignment is designed to require approximately 70 hours' input by the student and will be assessed and marked. Students will be required to submit a professionally written report in response to a detailed project brief, to be delivered about 8 weeks after completion of the taught week on a date set by the module leader. The post module assignment subject will be confirmed during the week and date for submission is stated on the NTEC timetable on the website. It is expected that all assignments will be typewritten. If this requirement presents a problem to any student it should be referred in the first instance to the Course Administrator.

   ALL ASSESSMENTS MUST BE EMAILED TO JO CHESTERS

4. If a module examination is incorporated, this will be taken some weeks after the taught section of module to allow students time for assimilation and revision. If an examination is not incorporated, an additional form of assessment may be introduced, such as an additional assignment.

TAUGHT MODULE DELIVERY (Part time & Full time)

All modules are taught by direct teaching, with selected modules being available in both the direct teaching and distance learning formats. Individual module delivery is subject to a minimum number of students registering for that module.

Structure of the taught week

Direct teaching modules are delivered by a number of the Consortium members. Unless otherwise notified, teaching will commence at 9 a.m. on the Monday of the given week.

It is the responsibility of the student to arrange and pay for their own travel to the modules, we only allow travel by train and you must travel down on the Sunday. Accommodation information will be emailed to you along with the pre-course material/timetable 4 weeks prior to the module start date again it is your responsibility to book and pay for this.

(FOR FULL TIME STUDENTS TRAVEL, ACCOMMODATION & FOOD EXPENSES CAN ONLY BE CLAIMED BACK AFTER YOU HAVE ATTENDED THE MODULE AND CAN TAKE UP TO EIGHT WEEKS TO BE REFUNDED). Train tickets should also be booked as far in advance as possible.

At the beginning of the majority of modules students will be given a folder containing the course material to be delivered. If modules incorporate laboratory work or site visits which require particular preparation or documentation, students will be notified in advance.

DISTANCE LEARNING MODULE DELIVERY (Part time)

The following 10 modules are available in distance learning format. Students must complete 8 of the 10 modules to complete the MSc. Each module contains the same syllabus as its counterpart delivered by direct teaching, has the same learning outcomes and is delivered once per annum at a fixed time in order to facilitate the concept of a 'virtual classroom'. The modules are available online for students to study for a period of 4 months.

Semester One (September - January)
N01 Reactor Physics, Criticality & Design
N02 Nuclear Fuel Cycle
N03 Radiation & Radiological Protection
N04 Decommissioning / Waste / Environmental Management
N12 Reactor Thermal Hydraulics

Semester Two (February - June)
N07 Nuclear Safety Case Development
N10 Processing, Storage and Disposal of Nuclear Wastes
N13 Criticality Safety Management
N29 Decommissioning Technology & Robotics
N31 Management of the Decommissioning Process

The distance learning platform is Blackboard, a web-based Virtual Learning Environment, accessible anywhere, anytime and includes course handbooks, course content, timetables, course news, discussion groups, video clips and email. We will be lecture capturing the taught modules from 2014 and these will then be added to the DL modules above.

Key features:

- Content (textual/video/audio based)
- Multimedia (animation/audio/video)
- Communication Tools (discussion boards/blogs/email)
- Assessment (quizzes/self-tests)
- Course Management (student tracking/online grade book)

The teaching material is not simply pages of text or reproductions of PowerPoint slides but is created specifically for this form of delivery. It includes video (presentations with voice over), individual self-tests, e-papers, downloadable material and other related resources.

Access to the internet is essential. For some of the modules, delegates also receive a CD/DVD version of the course which allows study (but not interactive exercises) to be undertaken on a lap top whilst e.g. travelling.

Unless a module contains a compulsory residential session for laboratory work, students may undertake an entire module remotely from the university campus. However an optional one day residential programme is delivered during certain taught modules, allowing delegates to meet the course leader and their fellow attendees and have the opportunity for discussions on key aspects of the module. As with the direct taught version, a significant individual assignment is incorporated as well as an examination. The latter is also taken remotely from the university campus, at a location convenient for the delegate and acceptable to NTEC, and will be sat simultaneously by attendees from the direct taught and distance learning version of each module.

Distance learning programme structure

In order to permit part-time students to complete four modules in a year, modules are delivered in parallel. An illustration of the distance learning programme structure and timetable is shown below. Students should select 2 modules per semester.

September	N01, N02, N03, N04, N12
October	
November	
December	
January	**Examinations & Assignments**
February	N07, N10, N13, N29, N31
March	
April	
May	
June	**Examinations & Assignments**

- ***Note students can mix and match the taught and distance learning modules***

Post-module assignment

Post-module assignments will be set during the taught week and the completion date confirmed. It is the responsibility of the students to ensure they know these dates. Assignments are to be typewritten and students should always retain an electronic copy of their assignments in case of mishap.

All students are required to return their post module assignments on time to the Nuclear Programmes Administrator by email. Assignments will be put through Turn-It-In before being passed to the module leader for marking. Assignments received after the due date will be assigned a mark of zero. Only if mitigating circumstances arise, such as unforeseeable or unpreventable circumstances, may a full time student be granted an extension in such cases, the student should make a request to the Nuclear Programmes Office as soon as reasonably possible. Any request will be dealt with on a case by case basis. Part time students will be permitted extensions and requests need to be emailed to Mel Mcloughlin.

M.Sc. PROJECT

Students registered for an M.Sc. will undertake a substantial project/dissertation. Wherever possible this will be an industrially sponsored project which will be designed to be of interest to the student as well as of intrinsic value to the sponsoring organisation. The project should be designed to require approximately 600 hours of application by the student.

Full time students will undertake the bulk of the project from May to September on completion of the taught modules. Part-time students will normally undertake the project in their third year. The project will be supervised entirely by the institution with which the student has registered and students are strongly advised to make early contact with their academic supervisor to establish the appropriate timescales for undertaking their project. As a general guide, full-time students should establish the subject of their project within the first three months of study, and part-time students mid-way through the second year.

Instructions regarding thesis preparation and presentation will be given by the student's registering university.

CANCELLATIONS

For direct teaching and distance learning, fees are payable at the start of each academic year. If a student wishes to withdraw part way through an academic year, the individual module fee for any modules undertaken in that year would be applicable at the individual module rate for that year.

If a student withdraws mid-module, the full module fee applies.

EXAMINATIONS

Examinations will be taken on the dates given in the NTEC Timetable. The location for full time students will be at one of the three registering universities and for part time taught & distance learning students examinations can be sat in your work place or a local education facility (arrangements must be made through the Nuclear Programmes Office). Students must notify the office of their location preference at least 8 weeks in advance of the examination.

Students will be informed in advance by the module leader whether an examination is 'open' or 'closed' book. The general policy within NTEC regarding the use of calculators is specified in Appendix 7.

Arrangements for any re-sits required will be undertaken on a case-by-case basis.

Student discipline

The principles governing student discipline, where modules are being taken away from the student's registering university, are given in Appendix 5.

Plagiarism

Plagiarism is a serious academic offence and the consequences are severe. It is the un-referenced use of other authors' material in assignments and dissertations. Please carefully read through the information provided and ensure that you understand it before submitting any assignments.

Fuller advice is given in Appendix 6. If further guidance is necessary, contact your academic tutor.

Data Protection

The Nuclear Programmes Office which is hosted by The University of Manchester, operates in accordance with the requirements and provisions of the latter in respect of the Data Protection Act 1998.

MODULE ASSESSMENT

In general each module will comprise three assessment elements, an in-module assignment, a post-module assignment and an examination. The contribution to the overall module marks from each element may typically be:

In-module assignment - 10%; Post-module assignment - 50%; Examination - 40%;

However this will be identified for each module on the pre-course material and students should ensure they obtain this information.

Pass marks

1. The pass mark for all modules is 50% and is the same for all levels of qualification. The marks for all assessed elements of a module are summated to derive the overall module mark.

2. By agreement with the student's Programme Director, a maximum of one re-submission of a post-module assignment (by rewriting the topic) and one re-sit of the examination will be permitted per module on a maximum of 2 occasions.

3. Students should be aware however that module examination re-sits and assignment resubmissions are not an automatic right. The School of Physics & Astronomy Committee of Examiners has the right to refuse an individual student a re-sit/resubmission opportunity if there is documented evidence that work and/or attendance have been unsatisfactory and if the student has received a formal warning and has not subsequently shown significant improvement.

4. Students may be awarded a compensated pass for a Masters degree when they fail no more than 15 credits and receive a mark between 40 and 49% for those failed credits. The student must also have gained an overall average for all taught credits of 50% or more in order to be granted the compensated pass.

5. Students may be awarded a compensated pass for a Postgraduate Diploma programme when they fail no more than 15 credits and receive a mark between 40 and 49% for those failed credits. The student must also have gained an overall average for all taught credits of 50% or more in order to be granted the compensated pass.

6. Students may be awarded a compensated pass for a Postgraduate Certificate programme when they fail no more than 15 credits and receive a mark between 40 and 49% for those failed credits. The student must also have gained an overall average for all taught credits of 50% or more in order to be granted the compensated pass.

7. The maximum mark that can be credited for a module which has been failed at the first attempt will be 50%.

8. Students who fail a re-sit or resubmission on any module will be considered to have failed that element of the course in its entirety.

9. Students seeking a formal qualification who obtain an average module mark of 50%-59% will be awarded a Pass. Students seeking a formal qualification who obtain an

average module mark of 60%-69% (and 60% on their dissertation if applicable) will be awarded a Merit. Students seeking a formal qualification who obtain an average module mark of 70% or more, (and 70% on their dissertation if applicable) will be awarded a Pass with Distinction.

10. Students seeking a formal qualification who have failed any module at a first attempt will not be eligible for consideration for their qualification to be awarded a Distinction.

Students will be notified of their provisional module marks by the Nuclear Programmes Administrator. Final marks will be notified following the annual meeting of the Examining Board, which usually takes place in October/November.

Appeals

In the event that a student is dissatisfied with marks for an assignment or examination, s/he should in the first instance address this with the Nuclear Programmes Office.

REGISTRATION & STUDENT SUPPORT

Following acceptance onto the programme, students will be given joining instructions by their university. Although direct teaching may not commence in the week when students register, all full time students must attend registration and Introduction to Nuclear Energy course.

Students must ensure that they take the opportunity on registration day to acquire all the information they need to undertake the course. They should pay particular attention to establishing contact with their personal tutor and project supervisor (if applicable). Arrangements for the method and frequency of contact with the tutor/supervisor should be confirmed.

During the induction period students should receive information on such topics as:

- An introduction to the programme
- The roles of NTEC and the registering university, including staff members
- What is expected of the student
- Advice on completing assignments
- Plagiarism
- The examination processes
- Student support
- The university library
- University internet resources
- Teaching and computing facilities
- Health and Safety

Students will receive copies of both their university handbook and the NTEC student handbook.

At least 4 weeks prior to registration, students should have agreed with their university the modules they will be taking during the academic year. This should be confirmed during registration. Modules have been grouped in streams to align with the anticipated interests of students (Appendix 2). It is NTEC's intention that students elect to take one or other of the two suggested sets of modules in its entirety. However if a student wishes to take an alternative mix of suggested modules, this is permitted with the agreement of his/her tutor and if the timetable allows.

Although staff from both the student's university and NTEC will make every effort to ensure that all necessary information and guidance is provided to the student, it is the student's responsibility to ensure that s/he has all the information required to undertake the course.

Contact details are given in Appendix 1. As a general rule, issues associated with personal academic progress and direction should be addressed to the student's registering university, and programme administrators. If in doubt, ask.

In the event of illness which may affect student's ability to attend taught weeks or examinations, or impact upon the timely submission of a post-module assignment, notify the Course Administrator immediately to agree alternative arrangements. Appropriate support documentation may be required such as a doctor's sick note.

NTEC Accreditation & requirements

The NTEC MSc is accredited by:

- The Institution of Engineering and Technology (IET)
- The Institution of Mechanical Engineers (IMechE)
- The Energy Institute (EI)
- The Institute of Materials Minerals and Mining (IoM3)

For students who wish to be accredited by the IET the following requirements must be obtained:

Where a module comprises of coursework and exam elements, successful completion of the module should require a minimum mark of 40% in each element if the element contributes more than 30% to the module mark.

In order for a student to graduate with an IET accredited qualification they will need to pass the final project at the first attempt.

- **APPENDIX 1**

NTEC CONTACTS – Steering Group and Nuclear Programmes Office

Name	Institution	Email
Steering Committee		
Professor Jon Billowes	University of Manchester	j.billowes@manester.ac.uk
Dr Peter Storey	UCLan	PStorey1@uclan.ac.uk
Dr Steve Monk	Lancaster University	s.monk@lancaster.ac.uk
Professor Paul Nolan	University of Liverpool	pjn@ns.ph.liv.ac.uk **NTEC Chair**
Dr Paul Norman	University of Birmingham	p.i.norman@bham.ac.uk
Prof Claire Scudder	The Defence Academy	
Professor Philip Thomas	City University, London	p.j.thomas@city.ac.uk
Dr Mark Wenman	Imperial College London	m.wenman@imperial.ac.uk
Dr Karl Whittle	University of Sheffield	k.r.whittle@sheffield.ac.uk
Dr Bao Xu	University of Leeds	b.h.xu@leeds.ac.uk
NTEC Administration		
Mrs Karen Burton	University of Sheffield	k.a.burton@sheffield.ac.uk
Miss Jo Chesters	University of Manchester	jo.chesters@manchester.ac.uk
Mr Ishty Hussain	University of Manchester	ishty.hussain@manchester.ac.uk
Mrs Janet Kennedy	University of Liverpool	jmk@liverpool.ac.uk
Mrs Mel McLoughlin	University of Manchester	mel.young@manchester.ac.uk

APPENDIX 1 NTEC CONTACTS - Module leaders

Module	Module leader	Email
N01 Reactor Physics, Criticality & Design	Dr Paul Norman	pin@np.ph.bham.ac.uk paul_i_norman@yahoo.co.uk
N02 Nuclear Fuel Cycle	Ms Alison Robinson	ajrrobinson@uclan.ac.uk
N03 Radiation & Radiological Protection	Professor Jon Billowes	jon.billowes@manchester.ac.uk
N04 Decommissioning / Waste / Environmental Management	Ms Alison Robinson	ajrrobinson@uclan.ac.uk
N05 Water Reactor Performance & Safety	Professor Geoffrey Hewitt	g.hewitt@imperial.ac.uk
N06 Reactor Materials & Lifetime Behaviour	Prof Grace Burke	grace.burke@materials.ox.ac.uk
N07 Nuclear Safety Case Development	Mr Matthew Knott	DEFAC-CMT-ND-SM3@mod.uk
N08 Particle & Colloid Engineering in the Nuclear Industry	Dr Bao Xu	b.h.xu@leeds.ac.uk
N09 Policy, Regulation & Licensing	Professor Lynda Warren	lm.warren@btopenworld.com
N10 Processing, Storage & Disposal of Nuclear Wastes	Dr Karl Whittle	k.r.whittle@sheffield.ac.uk
N11 Radiation Shielding	Dr Andy Boston	a.j.boston@liverpool.ac.uk
N12 Reactor Thermal Hydraulics	Dr Simon Jewer	DEFAC-CMT-ND-RE4@mod.uk

APPENDIX 1 NTEC CONTACTS (continued)

Module	Module leader	Email
N13 Criticality Safety Management	Mr Kirk Atkinson	
N14 Risk Management	Professor Philip Thomas	p.j.thomas@city.ac.uk
N21 Geological Disposal of Radioactive Wastes	Ms Alison Robinson	ajrrobinson@uclan.ac.uk
N23 Radiological Environmental Impact Assessment	Mr John Robertson	DEFAC-CMT-ND-NP1@mod.uk
N29 Decommissioning Technology & Robotics	Dr Stephen Monk	s.monk@lancaster.ac.uk
N30 Design of Safety-Critical Systems	Dr Amos Dexter	a.dexter@lancaster.ac.uk
N31 Management of the Decommissioning Process	Professor Colin Bayliss	colinbayliss50@btinternet.com
N32 Experimental Reactor Physics (PT) (Prague)	Dr Jan Rataj	jan.rataj@fjfi.cvut.cz
N32 Experimental Reactor Physics (FT) (Vienna)	Dr Mario Villa	mvilla@ati.ac.at

APPENDIX 2 MODULE STREAMS

SUGGESTED MODULE GROUPS

Decommissioning
- N04 Decommissioning, Radioactive Waste & Environmental Management
- N07 Nuclear Safety Case Development
- N10 Processing, Storage & Disposal of Nuclear Wastes
- N29 Decommissioning Technology & Robotics
- N31 Management of the Decommissioning Process

Reactor Technology
- N01 Reactor Physics, Criticality & Design
- N02 Nuclear Fuel Cycle
- N03 Radiation & Radiological Protection***
- N07 Nuclear Safety Case Development
- N13 Criticality Safety Management

ELECTIVE MODULES – SUGGESTED STREAMS

Decommissioning
- N08 Particle & Colloid Engineering in the Nuclear Industry
- N09 Policy, Regulation & Licensing
- N14 Risk Management
- N21 Geological Disposal of Radioactive Wastes
- N23 Radiological Environmental Impact Assessment
- N30 Design of Safety-critical Systems

Environment & Safety
- N07 Nuclear Safety Case Development
- N09 Policy, Regulation & Licensing
- N10 Processing, Disposal & Storage of Nuclear Wastes
- N14 Risk Management
- N21 Geological Disposal of Radioactive Wastes
- N23 Radiological Environmental Impact Assessment

Reactor Technology
- N05 Water Reactor Performance & Safety *
- N06 Reactor Materials & Lifetime Behaviour
- N09 Policy, Regulation & Licensing
- N11 Radiation Shielding
- N12 Reactor Thermal Hydraulics
- N14 Risk Management
- N30 Design of Safety-Critical Systems
- N32 Experimental Reactor Physics**

NOTE:
* N12 be taken before attendance on the N05 module.
**N01 must have been taken before attendance on the N32 module.
*** N03 must be taken before attendance on the N23 module.

APPENDIX 3 MODULE SUMMARIES

SUGGESTED MODULE GROUPS

Decommissioning

N04 Decommissioning, Radioactive Waste & Environmental Management
Examines and explains the process of decommissioning and considers how the related requirements should be taken into account in plant and equipment design. It establishes the requirements of the decontamination and clean-up process. The principles of the disposal and storage of nuclear waste are identified. The module covers the environmental principles underpinning the management of nuclear waste.

N07 Nuclear Safety Case Development
This module describes the statutory framework that regulates the nuclear industry and the overriding requirement to demonstrate, through an adequate and appropriate safety case, that all hazards associated with operations are effectively managed and controlled. It examines the fundamental building blocks of a 'modern standards safety case' and the supporting processes and methodologies used in developing them.

N10 Processing, Storage & Disposal of Nuclear Wastes
Reviews the basic approaches to nuclear waste management and introduces the fundamental principles of nuclear waste processing, storage and disposal. The main types of waste and schemes for their processing and packaging are discussed highlighting cementation and vitrification immobilisation technologies.

N29 Decommissioning Technology & Robotics
The aim of this module is to provide an ability to design and plan an effective decommissioning programme with an emphasis on immediate demolition using automation and remote handling. Topics covered include strategies for effective decommissioning characterisation, costing and analysis. Techniques for material cutting and waste minimisation, manual techniques, human exposure and protection are included with elements of robotic systems and their integration and control. The module includes a look at the international picture and also an industrial site visit to a live decommissioning project.

N31* Management of the Decommissioning Process
Introduces the importance of making a sound case for a particular project to proceed. It covers both the financial and economic evaluation of projects, drawing the distinction between pure financial parameters and the broader economic cost benefit analysis approach. The course module goes on to cover the management of individual projects using modern proven project management techniques with case studies and real examples.
***** Full-Time students must attend the taught version and Distance Learning attendees must have at least 2 years of industrial experience.

Reactor Technology

N01* Reactor Physics, Criticality & Design
After reviewing the history of the industry, different reactor designs are considered together with an overview of their basic features. Reactor physics are examined in some depth, including nuclear physics, reactor physics, criticality and radioactive decay. Reactor control and safety, accidents and risk assessment, containment and core layout and end of life issues are reviewed, concluding with consideration of advanced reactor design.
***** This module is a prerequisite for the N32 module (Experimental Reactor Physics).

N02 Nuclear Fuel Cycle
The purpose of this module is to describe the nuclear fuel cycle and examine in detail, the technical, economical, safety and environmental issues involved during each stage. The module covers the entire cycle from the extraction of ore to the disposal of waste. The processes involved in reprocessing of fuel are examined and the consequences reprocessing has, in terms of reactor fuel design and waste disposal, are discussed. Each stage is described on an international scale examining global markets and capacities.

N03* Radiation & Radiological Protection
Explains the properties of different types of radiation occurring as a result of nuclear processes and identifies means whereby levels of radiation and dosages can be detected and measured. The principles of radiation protection and shielding are outlined and demonstrated through practical experience with radioactive sources and detection equipment. The module concludes with an overview of ionising radiation regulations and legislation governing the impact of radiation on people and the environment. The safe handling of accidents is illustrated through case studies of real incidents.
***** *This module is a prerequisite for the N23 module (Radiological Environmental Impact Assessment).*

N07 Nuclear Safety Case Development
This module describes the statutory framework that regulates the nuclear industry and the overriding requirement to demonstrate, through an adequate and appropriate safety case, that all hazards associated with operations are effectively managed and controlled. It examines the fundamental building blocks of a 'modern standards safety case' and the supporting processes and methodologies used in developing them.

N13 Criticality Safety Management
Provides a comprehensive introduction to nuclear criticality safety and the management of nuclear criticality safety in facilities, or situations, where fissile materials are encountered outside a nuclear reactor. This module, recently updated to reflect the core competencies specified by the United Kingdom Working Party on Criticality (WPC), consists of a basic nuclear reactor physics and fuel cycle pre-course reading component (mandatory for students who have not yet completed the N01 module) and a one-week taught component which includes a presentation from a visiting lecturer from industry/government, and a crash-course in the use of a Monte-Carlo code (e.g. MONK) for criticality safety analysis. The taught component is followed by a challenging post-course criticality safety assessment that is designed to consolidate knowledge gained during the course and to enable students to join industry with a solid understanding of the criticality safety process.

ELECTIVE MODULES – SUGGESTED STREAMS

Decommissioning

N08 Particle & Colloid Engineering in the Nuclear Industry
Knowledge of particle science is important in a number of technology areas of relevance to the nuclear industry. Particles are used and manipulated throughout the whole nuclear fuel cycle; process improvements are therefore strongly dependent on an understanding of particle behaviour under different conditions. This module covers all aspects of particle technology that can be considered relevant for the modern nuclear industry. Examples of where particles are relevant within the nuclear fuel cycle are used to highlight the central importance of this topic area to a nuclear engineer or scientist.

N09 Policy, Regulation & Licensing
The nuclear industry is one of the most heavily regulated industries in the UK. Regulatory issues necessarily impact upon the development of national policy in environmental and energy areas. This module covers the international and national legal frameworks for nuclear power and radioactive waste management including licensing issues covered by the Nuclear Installations Act, discharge authorisations under the Environmental Permitting (England and Wales) Regulations 2010, transport of radioactive material and planning for new build. The roles of the various regulatory bodies and other players are discussed. The module also addresses the role of the Nuclear Decommissioning Authority, decommissioning of nuclear facilities and UK radioactive waste management policies and national strategies. Students are introduced to basic legal principles as applied in the nuclear sector and are shown how to read case law and apply their knowledge to legal problems.

N14 Risk Management
Introduces the concepts of risk management by reference to nuclear and other systems. Describes the mathematical analysis of risk based on probability modelling, which is extended to the case of quality modelling. A case study based on the Chernobyl accident is presented. Comparisons of risk management across industries are presented, including engineering contracting, rail transport, chemical process and pharmaceuticals as well as nuclear.

N21 Geological Disposal of Radioactive Wastes
This module will examine historic and current UK developments in radioactive waste management and will introduce both geology and hydrogeology to the student. Shallow and deep methods of geological disposal and the multi-barrier concept will be investigated using UK and overseas case studies. Techniques of investigating the suitability of sites for geological disposal will be covered together with the correct recording methodology for soil and rock description. For both types of geological disposal the near and far-field processes will be considered; as will geohazards in relation to geological time.

N30 Design of Safety-critical Systems
Provides students with knowledge of the design issues relevant to safety-critical systems. Topics included cover safety standards relevant to the design of engineering systems, and the IEC 61508 Safety Lifecycle and the implementation of the various steps of the process. Hazard identification and analysis techniques such as FMEA, HAZOP, and fault trees are also addressed.

Environment & Safety

N09 Policy, Regulation & Licensing
The nuclear industry is one of the most heavily regulated industries in the UK. Regulatory issues necessarily impact upon the development of national policy in environmental and energy areas. This module covers the international and national legal frameworks for nuclear power and radioactive waste management including licensing issues covered by the Nuclear Installations Act, discharge authorisations under the Environmental Permitting (England and Wales) Regulations 2010, transport of radioactive material and planning for new build. The roles of the various regulatory bodies and other players are discussed. The module also addresses the role of the Nuclear Decommissioning Authority, decommissioning of nuclear facilities and UK radioactive waste management policies and national strategies. Students are introduced to basic legal principles as applied in the nuclear sector and are shown how to read case law and apply their knowledge to legal problems.

N10 Processing, Storage & Disposal of Nuclear Wastes
Reviews the basic approaches to nuclear waste management and introduces the fundamental principles of nuclear waste processing, storage and disposal. The main types of waste and schemes for their processing and packaging are discussed highlighting cementation and vitrification immobilisation technologies.

N14 Risk Management
Introduces the concepts of risk management by reference to nuclear and other systems. Describes the mathematical analysis of risk based on probability modelling, which is extended to the case of quality modelling. A case study based on the Chernobyl accident is presented. Comparisons of risk management across industries are presented, including engineering contracting, rail transport, chemical process and pharmaceuticals as well as nuclear.

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N23*Radiological Environmental Impact Assessment
This module provides knowledge and experience in the application of methodologies used to assess the impact of routine or accidental discharges of radioactive material into the atmosphere or marine environment. The physical, chemical and radiological processes covered include atmospheric and marine dispersion, deposition, the uptake of radioactive material by humans, animals and crops and incorporation into foodstuffs. Methods are developed for assessing individual radiation dose to members of the critical group and for collective dose to the population. In order to provide further context, the module also provides a perspective on actual radioactive discharges from operating plants and discusses the regulatory framework for controlling and monitoring such discharges.
***** *The N03 module (Radiation & Radiological Protection) is a prerequisite for this module.*

Reactor Technology

N05* Water Reactor Performance & Safety

Water reactors are likely to be the main source of nuclear power for the foreseeable future. This module considers such reactors with particular reference to their performance and safety and commences with an understanding of water reactor hydraulics, heat transfer and fuel design. The main codes for predicting reactor safety (RELAP, TRAC, CATHARE, TRACE) will also be described as will CFD methods, the latter in the specific context of the generic commercial code, STARCD. Hands-on experience with codes is given. Finally, accidents beyond the design basis ("severe" accidents) are discussed.
***** *The N12 module (Reactor Thermal Hydraulics) is a prerequisite for this module.*

N06 Reactor Materials & Lifetime Behaviour

This module describes the science and engineering of reactor materials, and the factors that influence the lifetime of these materials, including corrosion, environmentally-assisted fracture, and irradiation embrittlement. Other topics covered in this module include fracture mechanics and structural integrity, non-destructive evaluation techniques, as well as plant monitoring and lifetime issues. Also considered are materials specifications and fabrication processes for materials used in nuclear power systems.

N09 Policy, Regulation & Licensing

The nuclear industry is one of the most heavily regulated industries in the UK. Regulatory issues necessarily impact upon the development of national policy in environmental and energy areas. This module covers the international and national legal frameworks for nuclear power and radioactive waste management including licensing issues covered by the Nuclear Installations Act, discharge authorisations under the Environmental Permitting (England and Wales) Regulations 2010, transport of radioactive material and planning for new build. The roles of the various regulatory bodies and other players are discussed. The module also addresses the role of the Nuclear Decommissioning Authority, decommissioning of nuclear facilities and UK radioactive waste management policies and national strategies. Students are introduced to basic legal principles as applied in the nuclear sector and are shown how to read case law and apply their knowledge to legal problems.

N11 Radiation Shielding

This module gives an introduction to radiation shielding merging practical problems with industry standard transport codes in order to give a good understanding of the requirements for radiation shielding.

N12 Reactor Thermal Hydraulics

This module describes the thermal hydraulic processes involved in the transfer of power from the core to secondary systems of nuclear power plants. Fundamental calculations associated with these processes will be explained, examples set and results discussed.

N14 Risk Management

Introduces the concepts of risk management by reference to nuclear and other systems. Describes the mathematical analysis of risk based on probability modelling, which is extended to the case of quality modelling. A case study based on the Chernobyl accident is presented. Comparisons of risk management across industries are presented, including engineering contracting, rail transport, chemical process and pharmaceuticals as well as nuclear.

N30 Design of Safety-Critical Systems

Provides students with knowledge of the design issues relevant to safety-critical systems. Topics included cover safety standards relevant to the design of engineering systems, and the IEC 61508 Safety Lifecycle and the implementation of the various steps of the process. Hazard identification and analysis techniques such as FMEA, HAZOP, and fault trees are also addressed.

N32* Full-Time Experimental Reactor Physics (Vienna, Austria)

The module is based at the TRIGA low power research reactor facility of the Vienna University of Technology/Atomic Institute in Vienna. Reactor neutronics and dynamics are demonstrated through experimental measurements of neutron fluxes, control rod calibrations, reactivity measurements and reactor power calibrations. An understanding and appreciation of the instrumentation and controls of a reactor are gained during the experiments and through hands-on operating experience at the reactor control panel. Safety aspects of reactor operation and fuel handling and inspection are emphasised.

***** *The N01 module (Reactor Physics, Criticality & Design) is a prerequisite for this module.*

N32* Part-Time Experimental Reactor Physics (Prague, Czech Republic)

The module is held at the training rector VR-1 which is operated by Czech Technical University in Prague. The education and training within the module is oriented to the reactor physics, dosimetry, nuclear safety, and operation of nuclear reactor. The participants actively take part in all experiments, and independently evaluate acquired data. Principles of neutron detection, importance of delayed neutrons and their properties, reactor neutronics and dynamics are studied and demonstrated during various reactor experiments and measurements. An understanding of the reactor I&C and safety aspects of reactor I&C and safety aspects of reactor operation are gained through hands-on reactor control.

***** *The N01 module (Reactor Physics, Criticality & Design) is a prerequisite for this module.*

APPENDIX 4 CONSORTIUM MEMBERS

The University of Birmingham: Birmingham has more than 50 years of experience of teaching postgraduate courses related to the nuclear industry and applied and medical radiation physics. They have for some years liaised closely with industry and the regulators regarding course syllabus and delivery.

The University of Central Lancashire: The University of Central Lancashire offers an extensive range of nuclear education across all levels, including nuclear related technologies, decommissioning, leadership in the nuclear industry, programme controls and management, environment, and governance. Working closely with nuclear employers, these courses are delivered at our Preston and Westlakes campuses and nationally via our partner network. The courses are developed and underpinned by research in UCLan's John Tyndall Institute for Nuclear Research, Lancashire Business School and UCLan Centre for Sustainable Development.

City University, London: City University has a major research programme in risk and reliability in the aerospace, nuclear and medical fields. An emphasis is placed upon an interdisciplinary approach with the aim of supporting rational decision making across a variety of industries and activities. A Risk Management module is taught to students taking the M.Sc. in Energy and Environmental Technology and Economics.

Defence Academy, College of Management and Technology: The primary role of the Defence Academy is to deliver nuclear education and training to all service and civilian personnel appointed to the Defence Academy and to deliver nuclear accident procedure courses to service and civilian personnel associated with the transportation of nuclear material. The Defence Academy will use its full range of academic expertise, from a staff of almost 100, to provide the consortium with core modules on the nuclear fuel cycle and criticality safety management, and an elective module on reactor thermal hydraulics.

Imperial College London: Nuclear Technology and Nuclear Reactor Technology courses have been taught and continuously developed at Imperial over the past two decades. Around 1000 students have attended these courses which involve live reactor training on the UK's sole civilian research reactor. Imperial also offers the only course which teaches reactor technology and fuel production and processing from a chemical engineering viewpoint.

Lancaster University: Lancaster brings expertise in innovative nuclear course design including part-time industry-based schemes in Decommissioning and Safety Engineering involving modules in the Design of Safety-critical Systems and Decommissioning and Robotics Engineering.

University of Leeds : The BNFL-Leeds University Research Alliance in Particle Science and Technology provides a unique opportunity to produce multi-disciplinary teams capable of solving some of the complex problems that can arise in an industry as diverse as nuclear decommissioning or nuclear power generation. The alliance is a major contributor to the Institute of Particle Science and Engineering at Leeds with a large academic research team of 130.

REGISTERING UNIVRSITIES

University of Liverpool: The University of Liverpool runs over 20 masters training programmes in the Faculties of Science, Engineering and Medicine. A number of the programmes have been supported by EPSRC in the past with the development of computer aided learning being an important feature. The masters training programmes are completely integrated into the University quality assurance and are informed by the excellent research carried out within the University.

University of Manchester: The University has nuclear research activities in 10 departments covering aspects of materials, nuclear fuels, radiochemistry, radiation science, nuclear physics, nuclear medicine and environmental science. The university has considerable experience in industrially-focussed modular programmes and e-learning formats. Manchester has also established the Dalton Nuclear Institute to coordinate and grow its nuclear research capacity.

University of Sheffield: The Immobilisation Science Laboratory is a multidisciplinary team of 40 academic staff and researchers studying all aspects of waste immobilisation from waste generation to repository design. Its postgraduate taught courses examine the fundamental materials issues of waste management applied to wasteform processing and durability by vitrification, cementation and ceramication.

APPENDIX 5 STUDENT DISCIPLINE

1. The formal disciplinary body will be the student's registering university.

2. The module delivering institution has the authority to take immediate action if appropriate, such as exam cheating or plagiarism, and will advise the student's registering institution of the action taken and the reason.

3. The delivering institution will formally report to the student's registering university any activity which it thinks should be subject to disciplinary proceedings.

4. All such information will be routed to the student's registering institution via the Nuclear Programmes Office to ensure comprehensive student records are maintained.

5. Should a student wish to appeal against disciplinary proceedings, s/he will do so by following the complaints and appeals procedure of his/her registering university. The latter will liaise with the module delivering institution.

6. Students will not be disciplined twice for the same misdemeanour.

7. NTEC as a body has no disciplinary role but has a coordinating role and will oversee equity of student experience.

APPENDIX 6 REFERENCING

Course work and dissertation

Ask module leaders for their preferred referencing system for assignments. There is no preferred format for references in the dissertation but the numerical system is more usual for scientific papers now (see the Harvard and Vancouver descriptions below). In the list of references at the end of the dissertation a journal reference would appear thus:

J.A. Smith, B.A. Brown and C.D. Jones, *Phys. Rev. A* **75** (2004) 39.

where the numbers are **volume number** (year) first page of article.

Books may be referenced thus:

A.B. Author, *Title of Book*, publisher (year).

Alphabetical system (Harvard)

In the Harvard alphabetical system the name of the author appears in the text together with the year of publication, e.g. (Smith 2001) or Smith (2001) (as appropriate). Where there are only two authors both names should be given in the text (Smith and Jones 2001) or Smith and Jones (2001); however, if there are more than two authors only the first name should appear followed by *et al*, (Smith *et al* 2001) or Smith *et al* (2001). If you refer to different works by one author or group of authors in the same year they should be differentiated by including a, b, etc after the date (e.g. 2001a). If you refer to different pages of the same article, the page number may be given in the text, e.g. Smith (2001, p 39). The reference list at the end of your article using this system should be in alphabetical order.

Numerical system (Vancouver)

In the numerical system you should number your references sequentially through the text. The numbers should be given in square brackets and one number can be used to refer to several instances of the same reference. The reference list at the end of the article lists the references in numerical order, not alphabetically.

APPENDIX 7 PLAGIARISM

Plagiarism is the theft or use of someone else's work without proper acknowledgement, presenting the material as if it were one's own. Plagiarism is a serious academic offence and the consequences are severe.

Guidelines:

1. Coursework, dissertations and essays submitted for assessment must be the student's own work, unless in the case of group projects a joint effort is expected and is indicated as such.

2. Unacknowledged direct copying from the work of another person, or the close paraphrasing of somebody else's work, is called plagiarism and is a serious offence, equated with cheating in examinations. This applies to copying both from other students' work and from published sources such as books, reports or journal articles. Plagiarised material may originate from any source. It is as serious to use material from the World Wide Web or from a computer based encyclopaedia or literature archive as it is to use material from a printed source if it is not properly acknowledged.

3. Use of quotations or data from the work of others is entirely acceptable, and is often very valuable provided that the source of the quotation or data is given. Failure to provide a source or put quotation marks around material that is taken from elsewhere gives the appearance that the comments are ostensibly one's own. When quoting word-for-word from the work of another person quotation marks or indenting (setting the quotation in from the margin) must be used and the source of the quoted material must be acknowledged.

4. Paraphrasing, when the original statement is still identifiable and has no acknowledgement, is plagiarism. Taking a piece of text, from whatever source, and substituting words or phrases with other words or phrases is plagiarism. Any paraphrase of another person's work must have an acknowledgement to the source. It is not acceptable to put together unacknowledged passages from the same or from different sources linking these together with a few words or sentences of your own and changing a few words from the original text: this is regarded as over-dependence on other sources, which is a form of plagiarism.

5. Direct quotations from an earlier piece of the student's own work, if unattributed, suggests that the work is original, when in fact it is not. The direct copying of one's own writings qualifies as plagiarism if the fact that the work has been or is to be presented elsewhere is not acknowledged.

6. Sources of quotations used should be listed in full in a bibliography at the end of the piece of work and in a style required by the student's department.

7. Plagiarism is a serious offence and will always result in imposition of a penalty. In deciding upon the penalty the examining institution will take into account factors such as the year of study, the extent and proportion of the work that has been plagiarised and the apparent intent of the student. The penalties that can be imposed range from a minimum of a zero mark for the work (with or without allowing resubmission) through the down grading of degree class, the award of a lesser qualification (e.g. a pass degree rather than honours, a certificate rather than diploma) to disciplinary measures such as suspension or expulsion.

APPENDIX 8 USE OF CALCULATORS IN EXAMINATIONS

1. Electronic calculators may not be used in examinations unless specific authorisation for their use appears on the examination question paper.

2. All calculators must be battery-operated (or solar powered) and silent. Examination candidates are responsible for providing batteries for their calculators.

3. Calculators with facilities for storing and retrieving text are not permitted. Calculators, or other devices capable of acting as a calculator, which have a full range of alphabetic keys (i.e. A-Z) are not permitted; devices with keys in the range A-F for use with hexadecimal numbers are permitted.

4. Portable computers are not permitted.

5. Devices capable of communicating directly with other similar devices are not permitted.

6. Examining institutions may decide that there should be particular restrictions on calculators in individual examinations, or extensions to these provisions, where this is required by the subject matter or method of examination. Where this is the case, specific and clear instructions will be given in the rubric at the head of the examination paper.

7. Any candidate found using an unauthorised calculator in an examination will be reported for suspected cheating. The device will be immediately confiscated and the examining institution will be under no obligation to issue the student with a replacement device for the remainder of the examination

Nuclear Technology Education Consortium

Nuclear Programmes Office
School of Physics & Astronomy • Room 3.51 / 3.52 Schuster Building
University of Manchester • Brunswick Street • Manchester M13 9PL

T: 0161 275 4267 • F: 0161 275 4372 • E: jo.chesters@manchester.ac.uk
www.ntec.ac.uk