<table>
<thead>
<tr>
<th><strong>Programme title:</strong></th>
<th>MSc Nanotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Final award (BSc, MA etc):</strong></td>
<td>MSc</td>
</tr>
<tr>
<td>(where stopping off points exist they should be detailed here and defined later in the document)</td>
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<tr>
<td><strong>UCAS code:</strong></td>
<td>N/A</td>
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<tr>
<td>(where applicable)</td>
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<tr>
<td><strong>Cohort(s) to which this programme specification is applicable:</strong></td>
<td>From 2008/09 Entry</td>
</tr>
<tr>
<td>(e.g. from 2008 intake onwards)</td>
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<tr>
<td><strong>Awarding institution/body:</strong></td>
<td>University College London</td>
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<tr>
<td><strong>Teaching institution:</strong></td>
<td>University College London</td>
</tr>
<tr>
<td><strong>Faculty:</strong></td>
<td>Engineering Sciences</td>
</tr>
<tr>
<td><strong>Parent Department:</strong></td>
<td>Electronic and Electrical Engineering</td>
</tr>
<tr>
<td>(the department responsible for the administration of the programme)</td>
<td></td>
</tr>
<tr>
<td><strong>Departmental web page address:</strong></td>
<td><a href="http://www.ee.ucl.ac.uk/masters">www.ee.ucl.ac.uk/masters</a></td>
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<tr>
<td>(if applicable)</td>
<td></td>
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<tr>
<td><strong>Method of study:</strong></td>
<td>Full Time or Part Time</td>
</tr>
<tr>
<td>Full-time/Part-time/Other</td>
<td></td>
</tr>
<tr>
<td><strong>Criteria for admission to the programme:</strong></td>
<td>Please see:</td>
</tr>
<tr>
<td>Minimum of 2:i UK degree or equivalent in Electronic Engineering or related subject.</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.ucl.ac.uk/prospective-students/graduate/apply/taught/entry-requirements">http://www.ucl.ac.uk/prospective-students/graduate/apply/taught/entry-requirements</a></td>
<td></td>
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<tr>
<td><strong>Length of the programme:</strong></td>
<td>One calendar year full-time, or two calendar years part-time</td>
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<tr>
<td>(please note any periods spent away from UCL, such as study abroad or placements in industry)</td>
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<tr>
<td><strong>Level on Framework for Higher Education Qualifications (FHEQ)</strong></td>
<td>7</td>
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<tr>
<td>(see Guidance notes)</td>
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</table>
Engineering in Nanotechnology is concerned with developing, providing and maintaining infrastructure, products, processes and services for society. Engineering in Nanotechnology addresses the complete life-cycle of a product, process or service in the field of Nanotechnology, from conception, through design and manufacture, to decommissioning and disposal, within the constraints imposed by economic, legal, social, cultural and environmental considerations. Engineering in Nanotechnology relies on three core elements, namely scientific principles, mathematics and 'realisation'. Scientific principles clearly underpin all engineering, while mathematics is the language used to communicate parameters, model and optimise solutions. Realisation encapsulates the whole range of creative abilities which distinguish the engineer from the scientist; to conceive, make and actually bring to fruition something which has never existed before. This creativity and innovation to develop economically viable and ethically sound sustainable solutions is an essential and distinguishing characteristic of engineering, shared by the many diverse, established and emerging disciplines within engineering.

The UK Standard for Professional Engineering Competence (2010) sets out five main areas of competence expected for Chartered Engineers, each covering a number of different aspects:

A Use of general and specialist engineering knowledge and understanding
B Application of appropriate theoretical and practical methods
C Technical and commercial leadership and management
D Effective interpersonal and communication skills
E Commitment to professional standards and recognition of obligations to society, the profession and the environment.
All students will take 6 compulsory modules and then select 3 optional modules which could be from any of our programmes although some restrictions will apply.

- **6 Compulsory Modules**
  - Physical Science for Nanotechnology (15 Credits EXAM 2 hours)
  - Nanoscale Processing and Characterisation for Advanced Devices (15 Credits EXAM 2 hours)
  - Instrumentation and Physical Techniques in the Life Sciences (7.5 Credits EXAM 1.5 hours)
  - Experimental Techniques for Nanotechnology (15 Credits 3 x reports <5,000 words)
  - Nanotechnology and Society (7.5 Credits Assignment <5,000 words)
  - Nanotechnology in Healthcare (15 Credits EXAM 2 hours)

- **3 Options from the following (although these may be extended)**
  - Molecular Biophysics (15 Credits EXAM 2 ½ hours)
  - Molecular Physics (15 Credits EXAM 2 ½ hours)
  - Entrepreneurship: Theory and Practice (15 Credits EXAM 2 ½ hours, group course work, and individual course work)
  - Innovation Practices (15 Credits, group project including individual and group components)
  - Nanoelectronic Devices (15 Credits EXAM 2 hours)
  - Order and Excitations in Condensed Matter (15 Credits EXAM 2 ½ hours)
  - Plastic and Molecular Electronics (15 Credits EXAM 2 ½ hours)
  - Quantum Computation and Communication (15 Credits EXAM 2 ½ hours)
  - Physics and Optics of Nano Structures (15 Credits EXAM 2 hours)

Dissertation (60 Credits <12,000 words)

<table>
<thead>
<tr>
<th>Board of Examiners:</th>
<th>i) Name of Board of Examiners:</th>
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<tr>
<td></td>
<td><strong>MSc Nanotechnology Programmes Board</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Professional body accreditation (if applicable):</th>
<th>Institution of Engineering and Technology (IET)</th>
<th>Date of next scheduled accreditation visit: 2018</th>
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</table>
EDUCATIONAL AIMS OF THE PROGRAMME:

1. To provide students with advanced knowledge and understanding of the key principles in nanotechnology, their analysis and design techniques and of details of new concepts and technologies relevant to the area.
2. To provide thorough coverage of research methods based on the underlying scientific and engineering principles of nanotechnology.
3. To equip the students with the scientific and intellectual tools required to define and formulate research problems, and to detail the methodologies needed to address them.
4. To equip the students with the scientific and intellectual tools required to design and analyse key physics and engineering processes related to nanotechnology.
5. To provide a wide range of intellectual, practical and transferable skills that will allow students to develop careers in nanotechnology research, industry and other professional areas of the economy.
6. To develop awareness of the trends of technology developments of nanotechnology.
7. To develop deep knowledge of nanotechnology applications in society and especially in healthcare.
8. To provide detailed knowledge of new and upcoming technologies related to nanotechnology industries and standards.
9. To get exposed to industrial designs and processes and to innovations in the nanotechnology industry.
10. To develop deep knowledge of standards and the nanotechnology commercial environments and standardisation processes and to be able to contribute to such processes through appreciation of their contexts, economic and regulatory drivers and limitations.
11. To provide knowledge and skills to allow for independent learning, individually and/or within a group.
12. To provide knowledge and skills required for critical assessment of research work (of self and others).
13. To provide a wide range of intellectual, practical and transferable skills that will allow students to develop careers in industry or academia.
INTENDED LEARNING OUTCOMES:

The MSc in Nanotechnology programme is designed to give specialization in the field of Nanotechnology for an enhanced preparation for an industrial career or further specialized studies in the field, e.g. PhD work or work in an R&D laboratory in the sector. It includes substantially increased breadth and depth of study beyond that of a corresponding BEng (Hons), and an increased emphasis on industrial relevance. The dissertation project within the MSc in Nanotechnology programme includes an individual research/design project with strong industrial relevance and involvement. The programme provides opportunities for students to develop and demonstrate knowledge and understanding, skills, qualities and other attributes in the following areas.

Knowledge and understanding - Graduates will be able to

- Use knowledge of underlying principles, physics and mathematics on which nanotechnology materials and devices are based, including semiconductor physics, nanoscale processing and characterization, and optics, nano-electronics to tackle a wide range of tasks, including analysis and design of materials, devices and systems.
- Understand and apply the fundamental principles that underpin nanotechnology materials and devices, including Ohm’s Law, quantum physics, molecular physics.
- Analyse and design complex nano-electronic systems e.g. device and integrated circuit fabrication in nanometre scale, advanced characterization in nanometre materials and devices.
- Draw on materials from a range of courses in electronic and electrical engineering and related disciplines in order to solve problems in the field of Nanotechnology including demonstrating depth and breadth to their learning.
- Apply business and management techniques that are relevant to Nanotechnology.
- Explain the role of Nanotechnology in society and the constraints within which their engineering judgement will be exercised.
- Understand the professional and ethical responsibilities Nanotechnology engineers.
- Appreciate the national and international role of the Nanotechnology engineer and the impact of engineering solutions in a global context.
- Demonstrate a systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of their academic discipline, field of study or area of professional practice.

Skills and other attributes – Graduates will be able to

- Deal with complex issues both systematically and creatively, make sound judgments in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences.
- Demonstrate self-direction and originality in tackling and solving problems and act autonomously in planning and implementing tasks at a professional or equivalent level.
- Continue to advance their knowledge and understanding, and to develop new skills to a high level.
- Have the qualities and transferrable skills necessary for employment in circumstances requiring the independent learning ability required for continuing professional development, the exercise of initiative and personal responsibility, and decision-making and sound judgment in complex and unpredictable situations.
- Use a combination of general and specialist engineering knowledge and understanding to optimise the application of existing and emerging technology.
- Apply appropriate theoretical and practical methods to the analysis and solution of engineering problems.
- Use software necessary for Nanotechnology analysis and design, such as the use of computational and modelling tools.
- Demonstrate practical transferrable engineering skills in nanotechnology such as the imaging, nanomanipulation and fabrication techniques for nanotechnology.
- Undertake a large-scale supervised research project in academia or industry and present the results of this work in a written report and oral presentation to peers and staff.
- Work effectively in nanotechnology-based projects.
- Explain in depth the managerial and economic factors facing a professional engineer.
- Interpret specifications and document their solutions to nanotechnology problems so that others can follow and validate their work.
Intellectual skills – Graduates will be able to

- Demonstrate a comprehensive understanding of techniques applicable to their own research or advanced scholarship.
- Demonstrate originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in the discipline.
- Show originality in tackling and solving problems.
- Understand how the boundaries of knowledge are advanced through research.
- Demonstrate a conceptual understanding that enables the student to evaluate critically current research and advanced scholarship in the discipline.
- Demonstrate a conceptual understanding that enables the student to evaluate methodologies and develop critiques of them and, where appropriate, to propose new hypotheses.
- Apply appropriate quantitative mathematical, scientific and engineering tools to the analysis of problems.
- Analyse and solve Nanotechnology problems, applying rigour in any related mathematics.
- Design Nanotechnology materials, devices or process to meet a need.
- Be creative in the solution of problems and in the development of designs.
- Integrate knowledge and understanding of other scientific, mathematical, computational or engineering disciplines in order to support their engineering specialisation.
- Formulate and test hypotheses modifying the hypotheses depending on the data obtained.
- Evaluate designs, processes and products and make improvements.
- Take a holistic approach in solving problems and designing systems, applying professional judgements to balance risks, costs, benefits, safety, reliability, aesthetics and environmental impact.

Characteristics – MSc in Nanotechnology will

- Be rational and pragmatic, interested in the practical steps necessary for a concept to become reality.
- Strive to achieve sustainable solutions to problems and have strategies for being creative, innovative and overcoming difficulties by employing their knowledge in a flexible manner.
- Be numerate and highly computer literate, and capable of attention to detail.
- Be cost and value-conscious, and aware of the social, cultural, environmental, health and safety, and wider professional responsibilities they should display.
- Appreciate the international dimension to engineering, commerce and communication.
- When faced with an ethical issue be able to formulate and operate within appropriate codes of conduct.
- Adopt a professional outlook, capable of team working, effective communicators, and able to exercise responsibility.

PROGRAMME OUTCOMES:

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas:

A: Knowledge and understanding
<table>
<thead>
<tr>
<th>Knowledge and understanding of:</th>
<th>Teaching/learning methods and strategies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key technologies and their underpinning scientific principles in nanotechnology.</td>
<td>The lectures of a core module cover essential topics in physics, electrical and electronic engineering, and biology.</td>
</tr>
<tr>
<td>A range of advanced topics in nanotechnology.</td>
<td>Optional modules allow students to shape their specialization and offer students the opportunity to fill gaps in previous education.</td>
</tr>
<tr>
<td>Laboratory safety and good practice of essential equipments for nanotechnology.</td>
<td>A set of laboratory classes will familiarize students the use of nanotechnology equipment.</td>
</tr>
<tr>
<td>The industrial and regulatory standards and standardisation frameworks.</td>
<td>Research Project: research training through hands-on experience. Students will write a dissertation, placing their research in context through a literature survey, and oral presentation of the above results.</td>
</tr>
<tr>
<td>Theory of nanotechnology.</td>
<td>Lectures are provided to cover the societal aspects of nanotechnology.</td>
</tr>
<tr>
<td>The nanotechnology business and commercial environments and the constraints they place on the commercial aspects of nanotechnology.</td>
<td></td>
</tr>
<tr>
<td>Developing and emerging technologies in nanotechnology.</td>
<td></td>
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<tr>
<td>Societal aspects of nanotechnology.</td>
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</table>

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<thead>
<tr>
<th>Assessment:</th>
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<tbody>
<tr>
<td>Assessment is usually carried out three to four weeks after module teaching.</td>
</tr>
<tr>
<td>Core modules are assessed by unseen written exam.</td>
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<tr>
<td>Assessment methods of optional modules depend on the module taken where assessment is by exam, assignment or a mix of the two.</td>
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</tbody>
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<tr>
<th>B: Skills and other attributes</th>
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<tbody>
<tr>
<td>Intellectual (thinking) skills:</td>
</tr>
<tr>
<td>The course aims to enable the students to:</td>
</tr>
<tr>
<td>Critically evaluate research results (their own and those of others)</td>
</tr>
<tr>
<td>Apply knowledge of research methods to analyse and/or develop new technologies in nanotechnology.</td>
</tr>
<tr>
<td>Apply knowledge of nanotechnology principles to synthesise new concepts and generate research ideas.</td>
</tr>
<tr>
<td>Critical assessment and analysis of current research and research methodologies in nanotechnology.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching/learning methods and strategies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The primary teaching methods will be through lectures, tutorials and seminars within the associated modules.</td>
</tr>
<tr>
<td>Intellectual skills will be reinforced and strengthened significantly throughout the project conducted in the London Centre for Nanotechnology.</td>
</tr>
<tr>
<td>Specific lectures on research methods are given.</td>
</tr>
<tr>
<td>Critical assessment of research literature and methodologies is supported through workshops and seminars (several occasions during the year).</td>
</tr>
<tr>
<td>Laboratory sessions within a number of modules support the development of students’ design skills.</td>
</tr>
</tbody>
</table>
C: Skills and other attributes

Practical skills (able to):

- In the modules a number of practical design skills will be developed.
- Additional practical skills developed by student will largely depend on the research topic followed for their dissertation.
- Communicate effectively research results in writing and through presentations.
- Develop skills to collate results from Physics, Electronic Engineering and Biology to address issues in nanotechnology.
- Analyse the results of an experiment, simulation or other investigation.
- Use of advanced equipment in the laboratory including a range of nano-fabrication techniques and several electronic microscopy techniques.

Teaching/learning methods and strategies:

- Basic skills will be supported in specific modules by laboratory and workshop sessions, as well as seminars on basic research methodologies and techniques.
- Through lectures, seminars and coursework exercises
- By literature survey
- Through undertaking a major research project within the London Centre for Nanotechnology
- The primary teaching method used in the research project is by close supervision by a member of academic staff with support of a second assessor.

Assessment:

- Assignments and exams including design exercises within modules.
- The output of these skills will also be assessed in the project, which is assessed by dissertation and oral presentation.

Exams and assignments within the modules.
Dissertation and oral presentation
## Transferable skills (able to):

The programme will enable students to:

- Learn complex topics independently.
- Work on new topics demonstrating initiative and creativity.
- Write well-structured complex reports.
- Write brief reports and executive summaries of complex arguments.
- Present work to an audience with mixed knowledge and skills.
- Use appropriate resources and citation methods.
- Study and evaluate a variety of research material of a kind that they will not have used as undergraduates.
- Provide a critical assessment of their own work and that of others.
- Make a contribution to the research topic by following through their ideas.
- Critical assessment of own work.
- Group work and team skills.
- Time management and organisational skills.

## Teaching/learning methods and strategies:

These skills will be promoted through the dissertation and the transferable skills module.

Part of the transferable skills module will be provided by CALT through the PPMS course ([http://www.ucl.ac.uk/myp/](http://www.ucl.ac.uk/myp/)).

The main mode of teaching and learning for many of these skills will be the direct supervision of the research project by a member of academic staff. This interaction will focus on the development of skills.

## Assessment:

- The writing skills are assessed through assignments and the different elements of project assessment (executive summary and final dissertation).
- Presentation skills are assessed as part of the project work.

The following reference points were used in designing the programme:

- the relevant Subject Benchmark Statements ([http://www.qaa.ac.uk/AssuringStandardsAndQuality/subject-guidance/Pages/Subject-benchmark-statements.aspx](http://www.qaa.ac.uk/AssuringStandardsAndQuality/subject-guidance/Pages/Subject-benchmark-statements.aspx))
- the programme specifications for UCL degree programmes in relevant subjects (where applicable);
- UCL teaching and learning policies;
- staff research.

Please note: This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each course unit/module can be found in the departmental course handbook. The accuracy of the information contained in this document is reviewed annually by UCL and may be checked by the Quality Assurance Agency.

### Programme organiser(s)

Name(s): Professor Huiyun Liu (Course Director) and Professor Izzat Darwazeh (Postgraduate Tutor)

### Date of production:

11th Nov 2013
<table>
<thead>
<tr>
<th>Date of Review:</th>
<th>October 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date approved by Head of Department:</td>
<td>November 2013</td>
</tr>
<tr>
<td>Date approved by Chair of Departmental Teaching Committee:</td>
<td>November 2013</td>
</tr>
<tr>
<td>Date approved by Faculty Teaching Committee</td>
<td>November 2013</td>
</tr>
</tbody>
</table>
MSc in Nanotechnology:

PROGRAMME STRUCTURE – 2014-15

General

The diagram below details the compulsory and the optional modules available for the MSc in Nanotechnology. Please see Section 3 below for module acronym definitions. There are two modules (PTL and NAS) comprises 7.5 UCL credit, while each one of the others comprises 15 UCL Credits. The dissertation project comprises 60 UCL Credits. 180 UCL Credits are required for the award of the MSc in Nanotechnology. The Scheme of Award description is given in Section 4 below.

1. Module Selection

2. Dissertation Project

The dissertation report represents an important part of the MSc in Nanotechnology degree. Not only does it represent one third of the final mark, but also the project work offers a unique opportunity to focus on a problem with enough depth to write a professional document about it.

3. Module Definitions

Below are definitions of all of the modules along with the module leader.

PSN - Physical Science for Nanotechnology
Module Leaders – Dr Ed Romans

NPC - Nanoscale Processing and Characterisation for Advanced Devices
Module Leader – Professor Richard Jackman

PTL - Instrumentation and Physical Techniques in the Life Sciences
Module Leader – Dr Guy Moss
3. Scheme of Award and Award Categories

For an award of the MSc degree students must have completed 180 UCL credits and passed at least 75% of assessed work with a pass mark of 50%. A maximum of 25% of a programme’s taught element, excluding the dissertation, may be condoned at 40 – 49%.

**Pass:** Students must obtain an average of at least 50% across all taught modules (with not more than 2 marks condoned (40% < 49%), and at least 50% in the Research Project.

**Merit:** An award of Merit will be made where: the overall mark, based on 180 credits, is 60% or greater and the mark for the dissertation is 65% or greater and there are no marks below 50%, no condoned marks, no re-sits, and all marks are based on first attempts.

**Distinction:** The criteria for the award of a distinction are that the mark for the dissertation is 70% or more, and the overall weighted mark (combining the taught elements and the dissertation) is 70% or greater and there are no marks below 50%, no condoned marks, no re-sits, and all marks are based on first attempts.