OUTLINE

17:00 – 17:15  Introduction — What is Data-Centric Engineering?
17:15 – 17:30  Continuing Professional Development: Can a Professional Doctorate Enhance your Career?
17:30 – 18:00  How can Our Professional Doctorate in Data-Centric Engineering Enhance your Career? Our Programme in a Nutshell
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Welcome and Introduction

- Introductions
- Queen Mary University of London
- What is Data-Centric Engineering?

Pre-application Workshop 1
Queen Mary University of London
30th March 2021

Dr Eram Rizvi
Deputy Dean for Research
Welcome and Introductions

Dr Eram Rizvi  
Programme Director

Dr Jun Chen  
Director of Training

Prof Mark Sandler  
Director of Partnerships

Dr Gabriella Caminotto  
Centre Manager

Prof Nick Bryan-Kinns  
Director of Recruitment

Ms Zi Parker  
Doctoral College Manager
Queen Mary University of London - QMUL

QMUL founded as part of Victorian drive to improve the social and educational conditions of the people of the East End

The most inclusive university of its kind, anywhere

Strong continuing ethos of social inclusion
• 91% students from state school;
• 60% students are black / minority ethnic;
• 42% students first in family to go to university
• 27% students from low income households (<£10k)

This diversity is our strength
• 9 Nobel Prize Winners
• Member of Russell Group top research-intensive university
• Ranked 5th in UK for quality of research publications†
• Ranked 110th university in world ranking*
• London’s 3rd largest university

† Latest Research Excellence Framework
* Times Higher Ed. University Rankings
Queen Mary University of London (QMUL)

London’s campus university
Charterhouse Square, West Smithfield, Lincoln’s Inn Fields

Whitechapel Campus

Mile End Campus

27,000 students;
2,000 PhD students;
4,600 staff
Queen Mary University of London (QMUL)

Faculty of Science & Engineering (S&E)
- School of Mathematical Sciences (SMS)
- School of Physics and Astronomy (SPA)
- School of Engineering & Materials Science (SEMS)
- School of Electronic Engineering & Computer Science (EECS)
- School of Biological and Chemical Sciences (SBCS)

Faculty of Humanities and Social Sciences (HSS)
- School of Medicine & Dentistry (SMD)

Cross-faculty institutes
- Inst. of Bioengineering (IoB)
- Inst. of Applied Data Science (IADS)
- Life Sciences Inst. (LSI)
- Materials Research Inst. (MRI)
- Digital Environment Research Inst. (DERI)

Faculty of Science and Engineering
- 5 Schools
- 4 inter/multi-disciplinary institutes
- 300 academic research staff
- 900 PhD students
- £42m research income in 2019/20

- Recognised for our distinctive, curiosity-driven and applied research
- Research supported by world-class research infrastructure
- Entrepreneurship and innovation embedded in our research culture
**Data science**: uses scientific methods, processes, algorithms and systems to extract knowledge from structured and unstructured data.

Data science techniques include data mining, machine learning and interrogating big data.

**Engineering**: uses scientific principles to design and build machines, structures, and systems e.g. bridges, vehicles, biomolecules, new materials…

Broad range of specialisms, :
- Chemical Engineering
- Materials Research
- Electronic Engineering
- Computer Science

Each spans theoretical approaches to applied science

- Data-Centric Engineering is a new emergent field
- Sits at the interface of data science and engineering,
- Combines mathematical modelling with the latest advances in Big Data and Artificial Intelligence
Data-Centric Engineering

Enhancing critical ecosystems
Using data analysis to enhance critical ecosystems like cities and farms, and the digital-physical systems that support them.

Large transport systems
Developing models of passenger movement and reaction to closures, to learn how usage fluctuates in systems like the London Underground.

Sustainable infrastructures
Combining reliable sensing technologies with online data analytics to improve real-time sustainability and resilience of infrastructures.

Human-centric sensing
Achieving flexible, economical, and large-scale human-in-the-loop sensing, such as mobile crowdsensing.

Instrumented infrastructure
Developing new statistical methods for sensor data to improve how infrastructure is delivered, maintained and controlled.

Predictive monitoring
Assessing system health and predicting failures through predictive monitoring of gas turbine engines.

Data-driven design of civic infrastructure
Developing a new data-mining algorithm to automate the design process for large civil infrastructure and urban transportation projects.

Design change in digital twins
Developing new methods to visualise the impact of design changes; combining heterogeneous data sources and visualising behaviour of complex systems.

Partnership with the Alan Turing Institute
National centre for AI and data science
Examples from Data-Centric Engineering Challenges

Turing Data-Centric Engineering

Adaptive MCMC
Optimising sampling algorithms used for genomics, infectious diseases, climate, and financial and industrial models.

Adaptive optimisation algorithms
Developing and improving the mathematical ‘machinery’ that will help optimisation algorithms be adaptable to diverse real world data.

Eram Rizvi

Data-Centric Engineering – Pre-application Workshop 1 – March 2021
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• Introduction to Data-Centric Engineering
• Our Aims
• A Unique Centre for Doctoral Training
• Professional Doctorates
• A Bespoke Training Programme
• Our Industry Partners
• Research Opportunities
• Researcher Development

Dr Eram Rizvi
Deputy Dean for Research
Our Aims

• Expand doctoral research skills in the UK
  Address skills gap - many research jobs unfilled after 1 month
  Part of UK Government’s Industrial Strategy

• Address barriers to doctoral training
  Studies indicate the top reasons for not taking a PhD are
  vocational relevance, financial barriers, self-confidence

• Diversify talent - make research inclusive
  STEM subjects typically do not attract women
  People from BAME backgrounds less likely to go on to research degrees

• Increase industry investment in research
  UK research environment is best in the world
  Translation of research knowledge into commercial success is poor
  Build integrated communities between industry and academia

We will build a world-class cohort of high-tech entrepreneurs and technology leaders
Our Centre for Doctoral Training in Data-Centric Engineering is unique

Engineering Doctorate (EngD) 4-year research programme

Professional Doctoral Scholars (PDS)
Out of academia for 3+ years
Remain in full-time employment
Salary paid in full by employer
Employer engages in research
Tuition fees paid by QMUL

Enterprise Doctoral Scholars (EDS)
Out of academia for 3+ years
Enter into full-time study
Tax-free stipend up to £20,500
Tuition fees paid by QMUL
Research periods in industry

Data-Centric Engineering at QMUL

Induction re-orientation into academia
Fully integrated training
Fully supervised by QMUL academics
Additional research mentoring
Professional Doctorates are recognised research qualifications
Only Universities have power to award these degrees

**Like a PhD**, these doctorates are research-based qualifications
- Taught elements form part of the training
- Majority is research and a contribution to creating new knowledge
- Supervised by a QMUL academic
- A final dissertation is required and assessed by two expert examiners
- The final oral examination (or ‘viva’) is conducted by the two examiners
- Gains you a title of “Dr”

The EngD is QMUL’s first professional doctorate in Science and Engineering
First Doctoral programme spanning the full faculty

**Unlike a PhD** the EngD
- Requires substantial industrial application
- Research is applied and / or work-place based
- May comprise a portfolio of research topics - up to 4 in related areas
Professional Doctoral Training and Research

QMUL has a **recognised leadership** in Doctoral Training and Research. We participate in multiple Doctoral Training Partnerships (DTPs) and Centres for Doctoral Training (CDTs):

- Natural Environment Research Council Doctoral Training Partnership
  UCL, KCL, Kew Gardens, and the Natural History Museum

- Biological Science Research Council Doctoral Training Partnership
  UCL, KCL

- Doctoral Training Partnership in Particle Physics and Astronomy

- 7 Centres for Doctoral Training
  - Data-Centric Engineering
  - Media Arts Technology
  - AI in Music
  - Intelligent Games
  - Data Intensive Science in Fundamental Physics
  - Plastic Electronics
A Bespoke Training Programme

Adopt student-centred, cohort approach to research and professional training.

The programme has four main pillars:
- Advanced taught courses: a bespoke programme of 6 taught courses in years 1-3
- Industry placement throughout years 1-4
- Research projects throughout years 1-4
- Researcher development training of the cohort throughout years 1-4

Three core taught courses:
- Research Methods and Responsible Innovation
- Statistical Thinking and Engineering Mathematics
- Machine Learning

Electives include over 30 relevant data intensive science and engineering courses
A Bespoke Training Programme

**Cores**

<table>
<thead>
<tr>
<th>Research Methods &amp; Responsible Innovation</th>
<th>Statistical Thinking &amp; Methods</th>
<th>Machine Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming (Python) for Data Science</td>
<td>Data Mining &amp; Visualisation</td>
<td></td>
</tr>
<tr>
<td>Numerical Optimisation in Engineering Design</td>
<td>Introduction to Robotics</td>
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<tr>
<td></td>
<td>Mathematics for Engineering Students</td>
<td>Big Data Processing</td>
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<tr>
<td></td>
<td>Electronics</td>
<td>Intelligent Sensing Summer School</td>
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<td></td>
<td>Engineering Instrumentation</td>
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<td>Digital Audio Effects</td>
</tr>
</tbody>
</table>

**Samples of Electives**

- Programming (Python) for Data Science
- Data Mining & Visualisation
- Mathematics for Engineering Students
- Big Data Processing
- Intelligent Sensing Summer School
- Engineering Instrumentation
- Digital Audio Effects
- Numerical Optimisation in Engineering Design
- Introduction to Robotics
- Electronics
- Design for Human Interaction
- Embedded Systems

**Year 1**
- 2 Cores/1 Elective
- Research Projects

**Year 2**
- Elective(s)
- Industrial Placements**, Research Projects

**Year 3**
- Elective(s)
- Industrial Placements**, Research Projects

**Year 4**
- Industrial Placements**, Write-up
- Other Activities*

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* Re-orientation to Academic Study, Personal Training Plans (PTPs), PhD Cohort Days (Networking/Impact & Making the most of your conference/research), Recognising Imposter Syndrome, Employability programme**, EPSRC Student Conference Day (off site), Writing for Researchers, Turing Masterclasses

** Only for Enterprise Doctoral-Scholars (EDSs)
## A Bespoke Training Programme

### Taught Component

<table>
<thead>
<tr>
<th>RMRI course overview by topics:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responsible Research and Innovation:</strong></td>
</tr>
<tr>
<td>• Week 1: Introduction and Research Ethics;</td>
</tr>
<tr>
<td>• Week 4: RRI principles and reading group + presentations</td>
</tr>
<tr>
<td><strong>Communicating Research</strong></td>
</tr>
<tr>
<td>• Weeks 1-3; 7: Reading &amp; Writing; Publications and Impact, LaTeX, Reference management workshop; Research questions &amp; literature review</td>
</tr>
<tr>
<td>• Week 8: articles &amp; peer reviewing</td>
</tr>
<tr>
<td><strong>Quantitative Research Methods (Introduction to Statistics):</strong></td>
</tr>
<tr>
<td>• Week 5: Experiment design hypothesis testing and R workshop</td>
</tr>
<tr>
<td>• Week 9: Statistical analysis and R workshop</td>
</tr>
<tr>
<td><strong>Programming and practical skills:</strong></td>
</tr>
<tr>
<td>• Week 6: Software Carpentry workshop</td>
</tr>
<tr>
<td>• Week 10: Introductory Python workshop</td>
</tr>
<tr>
<td><strong>Presentation skills:</strong></td>
</tr>
<tr>
<td>• Weeks 3&amp;4: Presenting your Research to an Audience</td>
</tr>
<tr>
<td>• Week 6: Making a Poster Presentation</td>
</tr>
<tr>
<td>• Week 12: Coursework individual presentations</td>
</tr>
</tbody>
</table>
## Example Programme
### Research Methods and Responsible Innovation

<table>
<thead>
<tr>
<th>Week</th>
<th>Lectures / Workshops (am)</th>
<th>Other activities (pm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Getting Started with your EngD; Introduction to the RMRI course; Introduction to Research Ethics</td>
<td>LaTeX workshop (2 – 4)</td>
</tr>
<tr>
<td>2</td>
<td>Communicating Research I; Impact</td>
<td>Reference Management workshop (2-4)</td>
</tr>
<tr>
<td>3</td>
<td>Communicating Research II; Public Engagement</td>
<td>Meeting about electives</td>
</tr>
<tr>
<td>4</td>
<td>Responsible Research and Innovation (RRI): Introduction</td>
<td>Communicating Research II - Part 2</td>
</tr>
<tr>
<td>5</td>
<td>Quantitative research methods I: Experiment design, hypothesis testing and R workshop</td>
<td>RRI Presentations</td>
</tr>
<tr>
<td>6</td>
<td>Making a poster presentation (CPD)</td>
<td>Personal Training Plans (PTPs) 1:1 meeting</td>
</tr>
<tr>
<td>7</td>
<td>Academic Writing CPD</td>
<td>Software Carpentry Workshop</td>
</tr>
<tr>
<td>8</td>
<td>Communicating Research III: articles &amp; peer reviewing</td>
<td>Schools Research Seminars</td>
</tr>
<tr>
<td>9</td>
<td>Quantitative research methods II: introduction to statistical analysis and R workshop</td>
<td>n/a – focus on coursework</td>
</tr>
<tr>
<td>10</td>
<td>Critical Thinking CPD</td>
<td>Word workshop</td>
</tr>
<tr>
<td>11</td>
<td>Introduction to commercialisation</td>
<td>Introductory Python workshop</td>
</tr>
<tr>
<td>12</td>
<td>End of module presentations</td>
<td>Guest lecture</td>
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<tr>
<td></td>
<td></td>
<td>End of course social event (online)</td>
</tr>
</tbody>
</table>
Our Industrial Partners

We are working with a growing number of industry partners offering
- collaborative research projects
- industry training
- applications for our PDS route

Our Professional Doctoral Scholars are employed by the industry partners to conduct research
Our Enterprise Doctoral Scholars will engage in 2 x 3 month placements with industry partners
Research Opportunities

Major Interdisciplinary Research Themes
Research in Digital Creative Industries
Materials Science and Condensed Matter Physics
Data Science
Control and Systems Engineering
Robotics

• Access to all research facilities including high performance computing as appropriate
• Please explore the projects on offer through the School webpages linked below
• Feel free to contact any of our academics
• More advice on research proposals given in Workshop 2 - Tuesday 13th April 2021

Links to Available Doctoral Research Projects in our Schools
• School of Electronic Engineering and Computer Science
• School of Engineering and Materials Science
• School of Chemical and Biological Sciences
• School of Physics and Astronomy
• School of Mathematical Sciences
### Research Opportunities

Examples of Doctoral Research Projects on offer
Please email supervisors for more information

<table>
<thead>
<tr>
<th>Research Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Data-Driven Intelligent Audio Technologies</td>
</tr>
<tr>
<td>✓ Data-Centric Molecular Dynamics Simulation of Supercritical Fluids for Process Engineering</td>
</tr>
<tr>
<td>✓ Data-driven analysis and stochastic modelling of power-grid frequency dynamics</td>
</tr>
<tr>
<td>✓ Machine Learning and its Application in the Development of Novel Cannabinoids</td>
</tr>
<tr>
<td>✓ Adaptive multi-fidelity robust design optimisation driven by machine learning</td>
</tr>
</tbody>
</table>

[https://www.qmul.ac.uk/dce/research/](https://www.qmul.ac.uk/dce/research/)
Researcher Development Framework
Nationally agreed skills framework for development of researchers
## Domain A
Relates to the knowledge, intellectual abilities and techniques to do research

<table>
<thead>
<tr>
<th>Researcher Development Courses</th>
<th>Other Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 - Knowledge base</td>
<td>Endnote Reading strategically &amp; analytically</td>
</tr>
<tr>
<td></td>
<td>Getting work published</td>
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<tr>
<td></td>
<td>Giving presentations</td>
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<tr>
<td></td>
<td>IT courses</td>
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<tr>
<td></td>
<td>Library induction/courses</td>
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<tr>
<td></td>
<td>Mentoring/supervising students</td>
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<tr>
<td></td>
<td>Induction</td>
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<tr>
<td></td>
<td>Reading group/journal club</td>
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<td></td>
<td>Seminar attendance</td>
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<td></td>
<td>Research methods courses</td>
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<td></td>
<td>Subject-specific courses</td>
</tr>
<tr>
<td>A2 - Cognitive abilities</td>
<td>Critical thinking Reading strategically &amp; analytically</td>
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<tr>
<td></td>
<td>Journal club/reading group presentation</td>
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<td></td>
<td>Mentoring/supervising students</td>
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<tr>
<td>A3 - Creativity</td>
<td>Critical thinking</td>
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<tr>
<td></td>
<td>The Creative Researcher</td>
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<td></td>
<td>Public Engagement</td>
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</table>
Domain B
Relates to the personal qualities and the approach to be an effective researcher.

Domain C
Relates to the knowledge of the standards, requirements and professionalism to do research.

Domain D
Relates to the knowledge and skills to work with others and ensure the wider impact of research.
Summary

QMUL is offering a unique programme to expand doctoral skills
Opening new routes into a research degrees
Emphasis is on skills and competencies
Aim to use applied research to benefit individuals and the UK economy
Address barriers and make research inclusive