THE UNIVERSITY OF SYDNEY

The University of Sydney

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Postgraduate guide 2017

Complex Systems

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Complex Systems postgraduate guide

2017 edition

Where will postgraduate study lead you?
Complex Systems

Whether you want to gain an edge in your career, change your direction or pursue a passion, the University of Sydney will steer you to places you never imagined.

With hundreds of postgraduate courses on offer across the University, we make it easy for you to tailor a degree to your personal needs and professional goals.

Our coursework and research degrees offer far more than knowledge. You'll join leading thinkers to challenge the known and explore the unknown, in a stimulating environment that encourages both learning and networking.

We give you access to leading lecturers, research supervisors, industry networks, research and teaching centres, and a global network of respected alumni.

This is one of the reasons why many of our graduates go on to change lives for the better, and why we are regularly ranked in the top 50 universities worldwide.*

Complex Systems

Modern, complex systems such as smart cities, megaprojects, power and data grids, ecosystems, and communication and transport networks are susceptible to unexpected, large-scale, and apparently uncontrollable behaviours.

Demand for qualified people with the expertise to model, analyse and design complex systems, as well as develop strategies for crisis forecasting and management, is increasing.

The University of Sydney offers professional programs that will help you secure your success in this complex systems-based future.

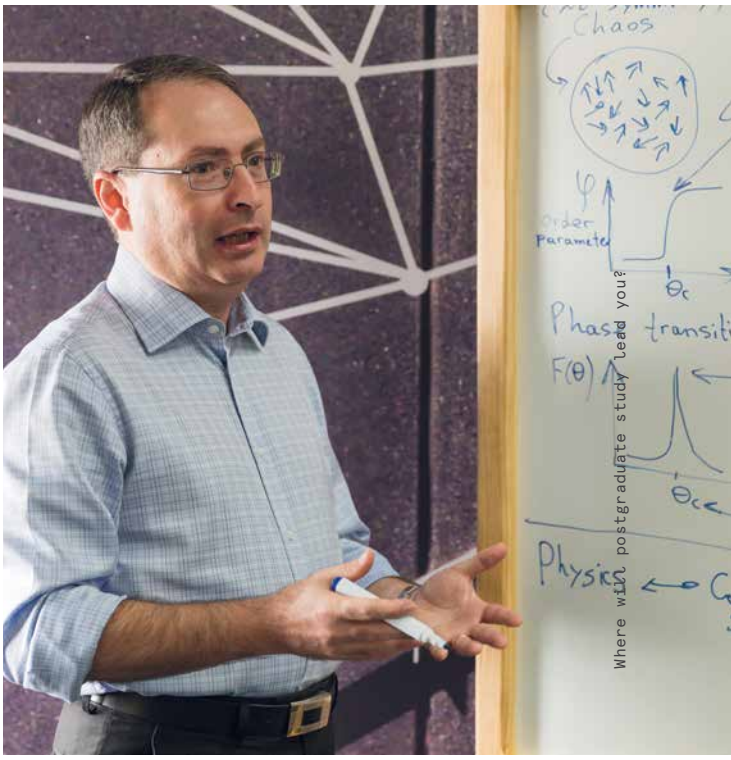
Programs

We offer the following postgraduate programs:

- Master of Complex Systems
- Graduate Diploma in Complex Systems.

A research pathway is also available with the Master of Complex Systems.

*QS World University Rankings 2015-16



Where will postgraduate study lead you?

Research strengths

The University is a member of Australia's prestigious Group of Eight network and the Association of Pacific Rim Universities. This association partners us with others that excel in research, including Stanford, Caltech, UC Berkeley and UCLA.

Our research is shaped by the big picture. We look at real-world problems from all angles, combining the expertise and talents of scholars from many disciplines. This collaboration drives our interdisciplinary research centres.

Our Centre for Complex Systems focuses on multidisciplinary research across engineering, physics, mathematics, biology and social sciences. It explores the properties and applications of complex systems in areas as diverse as crisis forecasting, disaster and emergency management, large-scale epidemic modelling, organisational and social risk management, as well as the stability of power, communication and transport infrastructure.

Solutions developed from this research are applicable to a wide range of industries, including information and communication technologies, health, energy, civil and transport infrastructure, along with financial services.

– sydney.edu.au/complex-systems

Inside view

"My research is to alleviate crises by analysing and computationally modelling the critical phenomena intrinsic to self-organisation.

"Ultimately, this will increase the robustness and resilience of a diverse range of complex systems, from digital circuitry to power grids and social networks, resulting in increased productivity, lower maintenance costs, less downtime and greater overall safety and reliability."

Professor Mikhail Prokopenko
Director, Centre for Complex Systems

Master of Complex Systems

The Master of Complex Systems will provide you with the skills to anticipate, control and manage the complexity of the unexpected.

Smart cities, megaprojects, power and data grids, ecosystems, communication and transport networks are all complex systems. They generate rich interactions among components that depend on each other to work effectively across systems. This interdependent behaviour creates challenges for designing and managing complex systems.

Complex systems are composed of large numbers of diverse interacting parts, making them susceptible to unexpected, large-scale and apparently uncontrollable behaviours.

Small changes can generate large, amplified effects. For example, a single malfunction in a local substation can lead to cascading state-wide electricity grid failures. The emergence of a new pathogen in a remote village can give rise to a devastating global disease epidemic.

The Master of Complex Systems will provide you with the expertise to model, analyse and design resilient technological, socio-economic and socio-ecological systems, as well as develop strategies for crisis forecasting and management.

It will develop your skills in quantitative modelling and computational simulation of system dynamics, complementing your existing skills in engineering, computer science, information technology, physics, mathematics, health, biology or business.

As an expert in complex systems, you could pursue a career in major multinational research and development companies, government and crisis management agencies, health, construction or transport organisations.

These unique skills will enable you to operate across several disciplines, providing key input and insights to help solve complex global challenges.

Leveraging the Centre for Complex System's research strengths, you have the flexibility to tailor your learning to your professional interests with the choice of four specialisations:

- Engineering
- Biosecurity
- Ecology
- Transport.

You will also undertake an industry-based capstone project focused on modelling a complex problem or delivering a novel solution. Projects can be directly related to your area of specialisation or your vocational objectives or interests.

A research pathway is also available.

Specialisations

Engineering
Modern-day infrastructure is growing more interconnected. For example, roads are reliant on power systems which are dependent on data networks and so on.

This specialisation will enable you to analyse the dynamics of cascading failures in such interconnected systems and develop prevention and intervention strategies across a diverse range of industries, under different demand and stress levels, and in various component failure and human error scenarios.

You could apply your expertise as a systems engineer or architect, vulnerability analyst, or research and development manager within integrated logistics support, business process re-engineering analysis, hardware-software integration in cyber-physical systems, or crowd dynamics management.

Biosecurity
In this specialisation you will learn how to use computational forecasting tools in predicting and estimating epidemic dynamics, triggered by infectious diseases and bioterrorism. You will also learn how to quantify the effectiveness of prevention, mitigation and crisis management approaches.

As a biosecurity analyst you could contribute to improved quality of prevention and containment strategies, provide policy advice and analysis, or explore modern systems biology and biotechnology.

Ecology
Small changes can trigger strong or even catastrophic responses in the Earth's climate or ecosystem dynamics. This specialisation will help you develop and use early-warning indicators combined with dynamic modelling to quantify the effects of disruption on the management of water and environmental resources, and develop effective risk reduction policies.

As a system ecology scientist, environmental engineer or consultant, or geographical information systems analyst, you could apply your expertise in areas such as the design and management of sustainable resilient landscapes, greenhouse gas mitigation economics, habitat modelling for environmental conservation or the design of market-based instruments for environmental management.

Transport
Fragile transportation system hubs can become overloaded and vulnerable to disruptions. In this specialisation you will learn to design intelligent and adaptive transport services, as well as use real-time data to analyse human behaviour and dynamic transport patterns.

You will also explore innovative predictive analytics and dynamic load sharing to help increase the efficiency and resilience of modern transport systems and avoid transport failures and traffic congestion.

You could apply this expertise in transport and logistics engineering or consulting, as an infrastructure planner or urban and regional planner.

Course duration
2 years full time

Recognition of prior learning
Depending on the level and type of your prior studies and professional experience, you may be eligible for recognition of prior learning (RPL) that will reduce the total credit points or time needed to complete your course.

You need to apply for RPL when completing your online course application.

For more information, visit:

- sydney.edu.au/study/credit

Admission requirements
To apply for this degree, you need to have:

- a recognised bachelor degree with a minimum credit average in a quantitative discipline such as engineering, computer science, information technology, mathematics, statistics, transport, physics, business or finance; or
- any honours bachelor degree from the University of Sydney; or
- a Graduate Diploma in Complex Systems from the University of Sydney with a credit average; or
- qualifications deemed equivalent by the University.

More information
For details on the course structure, including units of study, visit:

- sydney.edu.au/courses/master-of-complex-systems

Graduate Diploma in Complex Systems

The Graduate Diploma in Complex Systems will give you a basic understanding of the analysis and design of systems that are composed of large numbers of diverse interacting parts and exhibit self-organisation and/or emergent behaviour.

These systems could be technological, socioeconomic or socioecological. Examples include power grids, communication and transport systems and interdependent civil infrastructure.

The graduate diploma will introduce you to system dynamics, modelling and simulation and extend your knowledge in the fields of engineering, computer science, information technology, physics, mathematics, health, biology or business, while training you to apply 'systems thinking' in these fields.

The core units of study cover quantitative fields of large-scale networks, interdependent civil systems, self-organisation and criticality, statistics, stability analysis and visualisation. In addition, you can choose electives from engineering, ecology, biosecurity or transport.

The graduate diploma will equip you with skills to operate across disciplinary boundaries, in environments outside the experience of most professionals, particularly in major multi-national research and development companies, government and crisis management agencies, and large health, construction and transport organisations.

Successful completion of eight units of study at a credit average will allow you to progress to the Master of Complex Systems.

Course duration
1 year full time

Admission requirements
To apply for this program, you need to have:

- a recognised bachelor degree with a minimum credit average in a quantitative discipline such as engineering, computer science, information technology, mathematics, statistics, transport, physics, business or finance; or
- any honours bachelor degree from the University of Sydney; or
- qualifications deemed equivalent by the University.

More information
For details on the course structure, including units of study, visit:

- sydney.edu.au/courses/graduate-diploma-in-complex-systems

Research

We invest in research that changes the way we think about the world and how we live and work in it.

Our research degrees

Embarking on a research degree at Sydney is an opportunity to work alongside some of the world's brightest and most accomplished academics. We offer exceptional facilities and we have an innovative edge and the drive to challenge traditional ways of thinking. You will have the support you need to contribute to research that makes a meaningful, real-world impact.

Learn more about our research degrees:

- sydney.edu.au/study/find-a-course/postgraduate-research.html

Master of Philosophy (MPhil)

Duration: 2 years

The Master of Philosophy program involves the preparation of a thesis considered to make an original contribution to the subject concerned. To apply, you require a bachelor's degree with first- or second-class honours or equivalent from an accredited institution. If you achieve an outstanding performance, you may be eligible to upgrade to the Doctor of Philosophy.

Doctor of Philosophy (PhD)

Duration: 3 years

The Doctor of Philosophy program involves the preparation of a thesis considered to make a substantial and original contribution to the subject concerned. To apply, you need to have a master's degree by research or a bachelor's degree with first- or second-class honours or equivalent from a recognised institution.

Supporting our researchers

We support our researchers to excel in their chosen field in many ways, from providing strategic advice on research opportunities to assisting with access to funding.

We also help you to develop transferable skills in research leadership and management, commercialisation, communication and cross-disciplinary capabilities.

Inside view

Emanuele Crosato, a PhD candidate in our Complex Systems Research Group, is investigating how information is processed in self-organised systems to address the needs of our increasingly complex society.

Currently, self-organised systems are far from being wholly understood, such as the complexity of traffic flow in a megacity, the energy network of a nation or a group of autonomous robots operating in the field.

Emanuele's research looks at how this knowledge can be used to improve how we design or guide the developing behaviour of these systems.

By understanding information theory within complex systems, Emanuele's work assesses strong and quantitative theoretical frameworks that can assist us to address society's increasing needs.

"I explore the promising approach of guided self-organisation as applied to these systems that could allow us to guide them to desired formations," he says.

"These applications could include swarms of robots coordinating to survey a disaster area, smart energy networks that adapt to failures and traffic management systems that respond to overloads."

Emanuele Crosato
PhD candidate

Produced by Marketing and Communications, the University of Sydney, July 2016. The University reserves the right to make alterations to any information contained within this publication without notice.

This guide provides the key information you need to apply for a postgraduate degree in complex systems, but the next step is up to you.

To learn more, come and see us on Open Day, attend one of our postgraduate information sessions, call our helpline or visit our website.

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sydney.edu.au/engineering

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