

Masters  
in  
Computational Science & Complex Systems  
(MCSCS)

Module Descriptors

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## Semester 1

### CA640 Professional and Research Practice

<b>Module Title:</b>	Professional and Research Practice													
<b>Module Code:</b>	CA640													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Gareth Jones Renaat Verbruggen	Room Number: L2.28 Room Number: L2.43												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	None													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	<p>The module will introduce topics and issues in professional and research practice for computing professionals in an industrial and academic context.</p> <p>Research: This will include the philosophy of research, qualitative and quantitative research, accessing and evaluating research materials, assessing outcomes and dissemination. This aspect of the module will provide the practical skills and understanding to plan and manage the practical aspects of the Practicum for the course.</p> <p>Professional: This will include issues of business, technical and personal skills including team working, and an introduction to legal issues and relevant topics in professional ethics.</p>													
<b>Learning Outcomes:</b>	<p>Students should: -</p> <p>i) be prepared to conduct research in an area relevant to their degree, to develop a research plan with objectives including a business case with resource allocation, a time plan taking account of dependencies and risk management,</p> <p>ii) be able to conduct their project in a well structured way and describe their work in a written report and in an oral presentation,</p> <p>iii) demonstrate an awareness and understanding of professional practice and skills associated with working in a relevant computing environment within academia or industry, including relevant legal and ethical issues.</p>													
<b>Indicative Time Allowances:</b>	<table> <tr> <td></td> <td>Hours</td> </tr> <tr> <td>Lectures:</td> <td>36</td> </tr> <tr> <td>Laboratories:</td> <td>0</td> </tr> <tr> <td>Tutorials:</td> <td>0</td> </tr> <tr> <td>Independent Learning Time:</td> <td>76.5</td> </tr> <tr> <td><b>TOTAL:</b></td> <td><b>112.5</b></td> </tr> </table>			Hours	Lectures:	36	Laboratories:	0	Tutorials:	0	Independent Learning Time:	76.5	<b>TOTAL:</b>	<b>112.5</b>
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Laboratories:	0													
Tutorials:	0													
Independent Learning Time:	76.5													
<b>TOTAL:</b>	<b>112.5</b>													
<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>													

#### Indicative Syllabus:

Definition, conduct and dissemination of research. Professional computing including personal, business and technical skills. Law and the computing environment - overview of responsibility, Overview of ethics and moral philosophy · Ethical issues in information and software.

#### Assessment:

- **Written exam:** 50% of overall mark. Demonstrate knowledge of material covered in the module and apply it to practical scenarios.
- **Coursework Assignments:** 50% of overall mark. Written and oral presentations of research reviews and proposals. Written assignments relating to professional practice including professional conduct, and legal and ethical issues.

#### Indicative Reading List:

##### Supplementary:

Scientists Must Write – a guide to better writing for scientists, engineers and students, Robert Barrass, (Second Edition) Routledge, 2002.

Scientists Must Speak - bringing presentations to life, D. Eric Walters and Gale Climenson Walters, Routledge, 2002.

Information Technology law in Ireland published by (Butterworths: Dublin) 1997, Dennis Kelleher, Karen Murray

Data Protection Rights and Responsibilities from [www.dataprivacy.ie](http://www.dataprivacy.ie) The data protection commissioner

Computer Professionals for Social Responsibility <http://www.cpsr.org/>

Code of Ethics from ACM [www.acm.org](http://www.acm.org)

Free Software Foundation [www.gnu.org](http://www.gnu.org)

#### Program or List of Programs on which this module will be delivered :

	Program Reference Number
MSc in Bioinformatics (MBIO)	
MSc in Security and Forensics (MSSF)	
European MSc in Business Informatics (EMBIN)	
MSc in Software Engineering (MSE)	
MSc in Computational Science & Complex Systems (MCSCS)	

**Date of last revision :** 17 December 2007

## CA660 Data Analysis

<b>Module Title:</b>	Data Analysis													
<b>Module Code:</b>	CA660													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Prof. H Ruskin	Room Number: L2.35												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	None													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	To complement foundation statistical knowledge and to establish the context for a range of methods, used in the analysis of simple and complex systems. Reasonable proficiency in algebra and the ability to grasp concepts of probability and its importance are predominantly required. The emphasis is on an intuitive understanding of the principles and a practical ability to apply these to data examples drawn from diverse systems, rather than mathematical sophistication.													
<b>Learning Outcomes:</b>	<p>The students will understand:</p> <ul style="list-style-type: none"> <li>- the theory and practice of statistics</li> <li>- the scope of different analytical techniques and their robustness.</li> </ul> <p>The students will be enabled to</p> <ul style="list-style-type: none"> <li>- use a range of analytical techniques and interpret outcomes correctly.</li> <li>- acquire familiarity with appropriate software. (Various options are available for practical work)</li> <li>- apply techniques to a range of illustrative examples and case studies</li> </ul> <p>Note: It is emphasised that this module entails a significant amount of hands-on laboratory work.</p>													
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<b>TOTAL:</b>	<b>112.5</b>													
<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>													

### Indicative Syllabus:

- Review of Basic Probability and its role in Statistical Inference.
- Bayes and implications for data handling.
- Probability distributions - a review.
- Sampling distributions - a review.
- Principles of Estimation and Hypothesis Testing for Parametric Statistics.
- Role of Non-parametrics
- Analysis of Counts/Proportions.
- Analysis of Means/Variations.
- Experimental Design (Principles: detailed designs will not be considered in this course).
- Regression Analyses - Principles/special cases.
- Complex Systems Models – a blueprint for Statistical Data Analysis
- Illustrative Examples/case studies, drawn e.g. from Biology, Environmental Science and Business and Finance.

### Assessment:

- **Final written exam:** 75% of overall mark
- **Assignment:** 25% of overall mark.

### Indicative Reading List:

"Statistics: An Introduction using R" Crawley M.J. (optional use of R in course)  
 "Statistics Explained: An Introductory Guide for Life Scientists." McKillup S.  
 "Introductory Statistics for Environmentalists, (Environmental Management, Science and Technology)." Moore P.  
 "Introductory Statistics for Business and Economics" Wonnacott T.H. and Wonnacott R.J.

### Reference:

"Modelling Complex Systems" Boccara N.  
 "A Primer of Ecological Statistics." Gotelli N.J.& Ellison A.M. - Intro. Level  
 "Multivariate statistics for the Environmental Sciences." J. Shaw– Useful reference for area  
 "Risk Analysis: A Quantitative Guide." Vose D.  
 "Biological Data Analysis: A Practical Approach" Fry J.C.

### Program or List of Programs on which this module will be delivered :

MSc in Bioinformatics (Mbio)	Program Reference Number
MSc in Computational Science & Complex Systems (MCSCS)	

**Date of last revision :** 10 April 2008

CA659 Mathematical Modelling/Computational Science

<b>Module Title:</b>	Mathematical Modelling/Computational Science													
<b>Module Code:</b>	CA659													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Dr. Martin Crane	Room Number: L2.41												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	None													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	To provide a basis for the general modelling and computational models necessary at Masters level. On completion of the course, students should have a good grounding of discrete and continuous models for growth, decay and interaction. Selected underpinning material (such as Linear Algebra, Stability etc) will be covered as necessary.													
<b>Learning Outcomes:</b>	The student will have an in-depth understanding of: <ol style="list-style-type: none"> <li>1. Linear systems, matrices and applications</li> <li>2. Recursion relations, examples of difference equations and applications.</li> <li>3. First order differential equations (occurrence &amp; solution methods).</li> <li>4. Second order differential equations (occurrence &amp; solution methods).</li> <li>5. Numerical solution of differential equations (if time permits)</li> </ol> And be able to apply the above to the modelling and solution of practical problems in Computational Science. Note: It is emphasised that this module entails hands-on laboratory work.													
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<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>													

<p><b>Indicative Syllabus:</b></p> <ul style="list-style-type: none"> <li>● Introduction to Discrete Models of Growth and Decay <ul style="list-style-type: none"> <li>○ Revision of Underpinning Linear Algebra (eigenvalues, eigenvectors and meaning in this area, Stability in Difference Equations)</li> <li>○ Simple and Higher-Order Linear Difference Equations</li> <li>○ Applications (Fibonacci Series, Leslie Matrices)</li> <li>○ Non-linear Growth Models (logistic growth with additions, stability)</li> <li>○ Applications of Non-linear Models (Mendellian Genetics with various assumptions)</li> </ul> </li> <li>● Introduction to Continuous Models <ul style="list-style-type: none"> <li>○ More Mathematical Underpinning <ul style="list-style-type: none"> <li>■ Differential Equations and their Simplification by Non-dimensionalisation,</li> <li>■ Stability in Continuous models (Jacobians, steady states, Routh-Hurwitz conditions etc)</li> </ul> </li> <li>○ Linear and Non-Linear continuous models comparing and contrasting with discrete models</li> </ul> </li> <li>● Linear and Non-Linear Models of Interaction <ul style="list-style-type: none"> <li>○ Linear Compartmental Models with examples</li> <li>○ Non-Linear: <ul style="list-style-type: none"> <li>■ More Mathematical Underpinning: Phase-Plane Plots</li> <li>■ Destructive to one party: Predator-Prey (RH conditions, phase plane analysis)</li> <li>■ Mutually Beneficial: Symbiosis (RH conditions, phase plane analysis)</li> <li>■ Mutually Destructive: Lanchester models of Guerrilla combat (RH conditions, phase plane analysis)</li> <li>■ More models of interaction: SIR, SIRS models of disease (RH conditions, phase plane analysis)</li> </ul> </li> </ul> </li> </ul>
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<p><b>Assessment:</b> To identify, formulate, analyse and solve problems amenable to mathematical modelling</p> <ul style="list-style-type: none"> <li>● <b>Final written exam:</b> 100% of overall mark. Ability to individually apply gained knowledge to solve theoretical &amp; practical problems similar to those worked out in examples.</li> </ul>
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<p><b>Indicative Reading List:</b></p> <p><b>Recommended:</b>  Fulford, G., Forrester, P., Jones, A., <i>Modelling with Differential and Difference Equations</i>, Cambridge University Press.  Bronson, R., <i>Theory and Problems of Differential Equations</i>, 2<sup>nd</sup> Edition, Schaum's Outline Series, McGraw-Hill</p> <p><b>Reference:</b>  Strang, G., <i>Linear Algebra and its Applications</i>, Academic Press, 1976.</p>
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<b>Program or List of Programs on which this module will be delivered :</b>	
MSc in Bioinformatics (MBIO)	Program Reference Number
MSc in Computational Science & Complex Systems (MCSCS)	

<b>Date of last revision :</b>	10 April 2008
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MM524 Numerical Methods and Finite Element Analysis

<b>Module Title:</b>	Numerical Methods and Finite Element analysis													
<b>Module Code:</b>	MM524													
<b>School:</b>	Mechanical engineering													
<b>Module Co-ordinators:</b>	Dr. Bryan MacDonald	Room Number: S380												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	None													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	<ul style="list-style-type: none"> <li>• To introduce postgraduate engineering students to the application of numerical methods in engineering analysis, particularly the finite element method.</li> <li>• To provide the students with practical experience in the use of the finite element method as part of the design cycle.</li> <li>• To provide the students with a solid theoretical background to the finite element method.</li> <li>• To bring the students to a level that they will be able to apply the finite element method to the solution of engineering problems</li> </ul>													
<b>Learning Outcomes:</b>	<p>On completion of this module, the student will have</p> <ul style="list-style-type: none"> <li>• an understanding of the various numerical methods used to analyse engineering problems</li> <li>• a deep and intuitive understanding of the nature and role of the finite element method in the treatment of engineering problems</li> <li>• an understanding of how computer aided engineering analysis interfaces with and effects the design process</li> <li>• mastered the necessary skills and knowledge to make effective use of a commercial finite element analysis software package in understanding and solving engineering problems.</li> </ul>													
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Independent Learning Time:	52.5													
<b>TOTAL:</b>	<b>112.5</b>													
<b>Note for 7.5 credit module:</b>	Assume that a module load represents approximately 112.5 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module.													

**Indicative Syllabus:**

Introduction to Numerical Analysis Techniques : FEM, FDM, BEM etc. Introduction to the finite element method, FEM and the design process, Advantages and Disadvantages General Concepts of the FEM: Discretization to solution to Postprocessing Examples of "paper based" FEA :Truss Analysis and Simple two dimensional problems Computer Implementation of the FEM : Mesh generation, Solution methods, post-processing, validation Model Building: elements, geometry definition, material definition, boundary conditions Modelling Techniques: element choice, use of symmetry, mesh design and refinement, model checking etc. Model validity and accuracy Results Processing Analysis Types: Linear and Non-linear, Stress Analysis, Modal Analysis, Thermal and Fluid Analysis Case Studies: Problem Definition, Finite Element Solution, Results Processing, Experimental Validation

**Assessment:**

- **Written exam:** 60% of overall mark
- **Coursework Assignments:** 40% of overall mark.

**Indicative Reading List:**

**Essential:**

Practical Stress Analysis with Finite Elements, Mac Donald BJ, Glasnevin, 2007

**Supplementary:**

1. Finite Element Procedures, Bathe, K.J., Prentice Hall, 1996
2. Finite Element Analysis - Theory and Practice, Fagan, M.J., Longman, 1992
3. Building Better Products with Finite Element Analysis, Adams, V, Onword, 1999
4. Finite Element Analysis - Theory and Practice with ANSYS, Moaveni, S., Prentice Hall, 1999

**Program or List of Programs on which this module will be delivered :**

	Program Reference Number
BSSA Study Abroad (DCU Business School)	
BSSAO Study Abroad (DCU Business School)	
CAMG GDip C.A. Mechanical & Manufacturing Eng	
CAMM MSc. C.A. Mechanical & Manufacturing Eng	
ECSA Study Abroad (Engineering & Computing)	
ECSAO Study Abroad (Engineering & Computing)	
HMSA Study Abroad (Humanities & Soc Science)	
HMSAO Study Abroad (Humanities & Soc Science)	
IFPCME PG International Foundation Cert:ME	
SHSA Study Abroad (Science & Health)	
SHSAO Study Abroad (Science & Health)	
MSc in Computational Science & Complex Systems (MCSCS)	

**Date of last revision :** 19 September 2007

## Semester 2

### CA671 Complex Systems

<b>Module Title:</b>	Complex Systems													
<b>Module Code:</b>	CA671													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Prof. H Ruskin	Room Number: L2.35												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	MM524, CA659, CA660													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	<p>A single course on Complex Systems can explore only a fraction of problem richness and diversity, together with portability of techniques. The aim here is to give the unifying ideas of what makes a system complex, to identify key methods and tools, which can be brought to bear and the mathematical foundations and tools to service these. Much of the focus is on stochastics, but links with material and methodologies, developed in CA659 and MS401, together with the Scientific Computing paradigms of CA670, and Pattern recognition methods of CA661 will also be established. A range of examples will be considered.</p>													
<b>Learning Outcomes:</b>	<p>The students will be enabled to</p> <ul style="list-style-type: none"> <li>- use a range of analytical techniques and interpret outcomes correctly.</li> <li>- acquire familiarity with appropriate software. (Various options are available for practical work)</li> <li>- apply techniques to a range of illustrative examples and case studies</li> </ul> <p>Note: It is emphasised that this module entails a significant amount of hands-on laboratory work.</p>													
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<b>Note for 7.5 credit module:</b>	<p>Assume that a 7.5 credit module load represents approximately 112.5 hours' work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module.</p>													

### Indicative Syllabus:

- Universality and unification: Complexity paradigms in nonlinear dynamics, networks and computation. Complexity concepts – universality, emergence, self-organisation, nonlinearity, order, criticality, evolution, modularity, competition and cooperation, feedback and adaptation
- Interactions and Patterns: Why averages are inadequate and dimensionality cursed! Geometric statistical inference – maximum likelihood and E-M algorithm. Datamining. Links to CA660, CA661
- Complex Systems Theories and Models:
  - Review: PDEs, messy and nonlinear ODEs, large sets of ODEs, (links to CA659 and MS401),
  - Review: Stochastic Processes
  - Mean-field theory and approximation: where it breaks down. Examples. Networks and network theory; dynamics, complexity, synchronization
  - Fundamental modelling, (ad hoc vs “knowledge-base”), testing and evaluation, strategies
- Tools of complex systems modelling – simulation techniques; Monte Carlo, cellular automata, agent-based, power-law and heavy-tailed distributions, Networks: genetic networks, neural networks, scientific computing in practice: (link to CA670)
- Applications in Biology, Business and Finance, Social and Environmental.

### Assessment:

**Examination Weight:** 75%  
**Continuous Assessment:** 25%

### Indicative Reading List:

“Modelling Complex Systems.” (Graduate Texts in Contemporary Physics), Boccara, N., Springer 2005  
 “Dynamics of Complex Systems” Y Bar-Yam , NECSI ED. On-line text  
**Supplementary:**  
 Computer simulations with Mathematica: explorations in complex physical and biological systems, Gaylord, R., Wellin, P., Springer-Verlag 1995  
 “A First Course in Scientific Computing: Symbolic, Graphical and Numeric Modelling, using Maple, Java, Mathematica and Fortran90” R.H. Landau, Princeton Press, 2005  
 \* Springer Series: “Understanding Complex Systems” (Ed. J. A. Scott Kelso) as part of “Springer Complexity” programme.  
 General Info.:  
 German Scientific Computing Index <http://www.scicomp.unierlangen.de/index.shtml>  
 Complexity Digest: <http://www.comdig.org/>  
 NECSI Complex Systems Guide: <http://necsi.org/guide/>

### Program or List of Programs on which this module will be delivered :

MSc in Computational Science & Complex Systems (MCSCS)	Program Reference Number
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CA661 Pattern Recognition Methods

<b>Module Title:</b>	Pattern Recognition Methods													
<b>Module Code:</b>	CA661													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Dr. Alistair Sutherland	Room Number: L1.04												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	CA660													
<b>Co-requisite:</b>	N/A													
<b>Module Aims:</b>	To introduce the theory of pattern recognition as used in Computational Science													
<b>Learning Outcomes:</b>	<p>The students will understand:</p> <p>Bayesian probability theory</p> <p>Bayesian Networks</p> <p>Principles of Learning and Classification</p> <p>Principal Component Analysis and applications to areas such as Face Recognition, Character Recognition, Remote Sensing etc.</p> <p>Eigenvalue and Singular Value Decompositions, Generalised Matrix Inverses</p> <p>Stochastic Simulation of Probability Distributions – Markov Chain Monte Carlo</p> <p>Comparing Models of Different Complexity</p> <p>Maximum Entropy</p> <p>Hierarchical Multi-scale Model-fitting</p> <p>Hidden Markov Models, Kalman Filters, Particle Filters and Dynamic Bayesian Networks and their applications in Speech Recognition, Human Motion Recognition, etc.</p> <p>How to implement these algorithms in Matlab</p> <p>Note: It is emphasised that this module entails a significant amount of hands-on laboratory work.</p>													
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**Indicative Syllabus:**

- Bayesian Probability Theory
- Classification –
- Models of Data –
- Belief Networks –
- Hidden Markov Models –
- Principal Component Analysis –
- Comparing Models of Different Complexity –
- Metropolis Algorithm –
- Maximum Entropy –
- Fast Hierarchical Model Fitting –
- Matlab

**Assessment:**

- **Final written exam:** 75% of overall mark
- **Matlab Assignment:** 25% of overall mark.

**Indicative Reading List:**

Statistical Pattern Recognition, A. Webb

**Program or List of Programs on which this module will be delivered :**

MSc in Computational Science & Complex Systems (MCSCS)	Program Reference Number
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**Date of last revision :** 9 April 2008

CA670 Concurrency & Distributed Systems

<b>Module Title:</b>	Concurrency & Distributed Systems													
<b>Module Code:</b>	CA670													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Prof. Joe Morris	Room Number: L2.14												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	None													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	The module aims to give students a deep understanding of the principles underlying concurrent programming, and to give them practical skills in developing multi-threaded programs in traditional and object-oriented languages.													
<b>Learning Outcomes:</b>	<p>By the end of this module students should:</p> <p>Understand the purpose of, and pitfalls inherent in, concurrent programming. Understand the implementation of concurrency.</p> <p>Understand the need for resource sharing, the problems that arise, and how to solve them using semaphores, monitors, message passing, etc.</p> <p>Be able to reason about the correctness of concurrent programs.</p> <p>Know the features for supporting concurrency in several computer languages.</p> <p>Understand Java's concurrency model, its strengths and shortcomings.</p> <p>Write a complex multi-threaded application.</p> <p>Note: It is emphasised that this module entails a significant amount of hands-on laboratory work.</p>													
<b>Indicative Time Allowances:</b>	<table> <tr> <td></td> <td>Hours</td> </tr> <tr> <td>Lectures:</td> <td>27</td> </tr> <tr> <td>Laboratories:</td> <td>18</td> </tr> <tr> <td>Tutorials:</td> <td>18</td> </tr> <tr> <td>Independent Learning Time:</td> <td>49.5</td> </tr> <tr> <td><b>TOTAL:</b></td> <td><b>112.5</b></td> </tr> </table>			Hours	Lectures:	27	Laboratories:	18	Tutorials:	18	Independent Learning Time:	49.5	<b>TOTAL:</b>	<b>112.5</b>
	Hours													
Lectures:	27													
Laboratories:	18													
Tutorials:	18													
Independent Learning Time:	49.5													
<b>TOTAL:</b>	<b>112.5</b>													
<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>													

<p><b>Indicative Syllabus:</b></p> <p>The idea of concurrency; threads; nondeterminacy; granularity; costs. Memory model; multicore architectures; caches; shared resources; Creating &amp; managing threads.</p> <p>Parallel algorithms; searching and sorting; parallelisation.</p> <p>Communication and synchronisation; mutual exclusion; monitors. Correctness properties of concurrent programs; reasoning about them.</p> <p>Scalability; testing for performance &amp; correctness; common pitfalls. Liveness; deadlock; deadlock avoidance, detection, and recovery.</p> <p>Thread pools; client-server architecture.</p> <p>Shared data structures; queues; stacks; lock-free data structures; CAS instruction. Resource management; fairness; priority inversion.</p> <p>Software transactional memory. - Communication via message-passing; rendezvous. Practical exercises in using Java in multi-threaded applications.</p>
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<p><b>Assessment:</b></p> <ul style="list-style-type: none"> <li>• <b>Written exam:</b> 75% of overall mark.</li> <li>• <b>Continuous Assessment:</b> 25% of overall mark.</li> </ul>
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<p><b>Indicative Reading List:</b></p> <p><b>Supplementary:</b></p> <p>Java Concurrency in Practice, Goetz et al, Addison-Wesley (2006) ISBN 0321349601</p> <p>Java Threads, 3rd Edition, Scott Oaks, Henry Wong, O'Reilly (2004) ISBN 0-596-00782-5</p> <p>Foundations of Multithreaded, Parallel, and Distributed Programming, Gregory R. Andrews, Addison-Wesley (2000) ISBN 0-201-35752-6</p>
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<b>Program or List of Programs on which this module will be delivered :</b>	
<p>Study Abroad (DCU Business School) (BSSA)</p> <p>Study Abroad (DCU Business School) (BSSAO)</p> <p>Study Abroad (Engineering &amp; Computing) (ECSA)</p> <p>Study Abroad (Engineering &amp; Computing) (ECSAO)</p> <p>Study Abroad (Humanities &amp; Soc Science) (HMSA)</p> <p>MSc in Software Engineering (MSE)</p> <p>MSc in Computational Science &amp; Complex Systems (MCSCS)</p>	<p>Program Reference Number</p>

<b>Date of last revision :</b> 17 December 2007
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Choices for the optional module

### CA658 BioComputing

<b>Module Title:</b>	BioComputing													
<b>Module Code:</b>	CA658													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Prof. H. Ruskin	Room Number: L2.35												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	CA659, CA660													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	<ul style="list-style-type: none"> <li>To build upon the foundation courses, particularly in Data Analysis, Computational Science and Databases to provide an overview of the dynamic behaviour of a wide range of biological systems.</li> <li>Computational techniques in general include simulation, classification, database construction and analysis, together with parallel computation and this course aims to provide further building blocks.</li> <li>Linkage of statistical and heuristic techniques with efficient algorithm development to find new ways to solve problems of biological interest is dealt with in overview</li> </ul>													
<b>Learning Outcomes:</b>	<ul style="list-style-type: none"> <li>To appreciate the role of scientific computation</li> <li>To acquire facility in basic techniques</li> <li>To understand how these apply to modelling biological problems</li> <li>Case studies (e.g. techniques for Microarray data analysis)</li> </ul> <p>Note: It is emphasised that this module entails a significant amount of hands-on laboratory work.</p>													
<b>Indicative Time Allowances:</b>	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 80%;"></th> <th style="width: 20%; text-align: right;">Hours</th> </tr> </thead> <tbody> <tr> <td>Lectures:</td> <td style="text-align: right;">28</td> </tr> <tr> <td>Laboratories:</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Tutorials:</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Independent Learning Time:</td> <td style="text-align: right;">84.5</td> </tr> <tr> <td><b>TOTAL:</b></td> <td style="text-align: right;"><b>112.5</b></td> </tr> </tbody> </table>			Hours	Lectures:	28	Laboratories:	0	Tutorials:	0	Independent Learning Time:	84.5	<b>TOTAL:</b>	<b>112.5</b>
	Hours													
Lectures:	28													
Laboratories:	0													
Tutorials:	0													
Independent Learning Time:	84.5													
<b>TOTAL:</b>	<b>112.5</b>													
<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>													

<p><b>Indicative Syllabus:</b></p> <ul style="list-style-type: none"> <li>Short course on the mathematical and statistical techniques underpinning Microarray Data Analysis</li> <li>Overview of Scientific Computation- Strategy, Approximation, Computer Arithmetic and Software Solutions, Type of Problem - nonlinearity of natural phenomena - Database for Bioinformatics</li> <li>Differential Equation Models - Examples. Limits to growth, Steady states, Drug Infusion, Modelling Infectious diseases, Cell Differentiation.</li> <li>Computer Simulation techniques an overview, Cellular Automata, Monte Carlo, Smart Monte Carlo, MCMC, Molecular Dynamics and Extensions. Examples - as above, Population dynamics and Immune response.</li> <li>Tools for Bioinformatics; Web-based - Search engines, data annotation and formats, - Genbank, FASTA, PDB</li> <li>Analysis options - sequences, pairwise alignment - examples such as phylogenetic trees - Visualization of proteins structures and computing structural properties - RasMol, Swiss PDB, MolMol, MolScript and others.</li> <li>Functional Genomics - current and emerging technologies - e.g. "D-page methods, SWISSPROT and TrEMBL.</li> </ul>
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<p><b>Assessment:</b></p> <ul style="list-style-type: none"> <li><b>Written exam:</b> 50% of overall mark.</li> <li><b>Continuous Assessment:</b> 50% of overall mark.</li> </ul>
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<p><b>Indicative Reading List:</b></p> <p>"Bioinformatics Computing" Bergeron B. 2002, Prentice-Hall Papers, Jong, Page, Hernandez et al.</p> <p><b>Supplementary</b> "Developing Bioinformatics Computer Skills." Gibas G. and Jambeck P. 2001</p> <p>O'Reilly and Associates "Evolutionary Computation in Bioinformatics." Fogel G.B., Corne D. W.(Eds.) 2002</p>
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<b>Program or List of Programs on which this module will be delivered :</b>	
<p>Study Abroad (DCU Business School) (BSSA)</p> <p>Study Abroad (Engineering &amp; Computing) (ECSA)</p> <p>GDip in Bioinformatics (GBIO)</p> <p>Study Abroad (Humanities &amp; Soc Science) (HMSA)</p> <p>MSc in Bioinformatics (MBIO)</p> <p>Study Abroad (Science &amp; Health) (SHSAO)</p> <p>MSc in Computational Science &amp; Complex Systems (MCSCS) (Option)</p>	<p>Program Reference Number</p>

<b>Date of last revision :</b> 13 December 2007
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## MM532 Computational Thermo-Fluid Dynamics

<b>Module Title:</b>	Computational Thermo-Fluid Dynamics													
<b>Module Code:</b>	MM532													
<b>School:</b>	Mechanical & Manufacturing Engineering													
<b>Module Co-ordinators:</b>	Dr. Yann Delauré	Room Number: S3885												
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5												
<b>Prerequisite:</b>	None (in terms of specific modules). Good knowledge of the theoretical background to the heat transfer and fluid mechanics subjects generally taught at undergraduate level.													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	The objective of this module is to provide an in-depth introduction to the main modelling methods and numerical techniques upon which Commercial Computational Fluid Dynamics softwares are built.													
<b>Learning Outcomes:</b>	Having successfully completed this module the student will: Have a good understanding of conservation laws of fluid mechanics and their relevance to the Finite Volume Discretisation method. Be capable of formulating and applying mathematical models to thermo-fluid problems. Have an appreciation of the limitations and capabilities of the main models and solution methods of conventional CFD Softwares based on the Finite Volume Method. Have developed introductory experience of a commercial CFD software. Note: It is emphasised that this module entails a significant amount of hands-on laboratory work.													
<b>Indicative Time Allowances:</b>	<table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td style="text-align: right;">Hours</td> </tr> <tr> <td>Lectures:</td> <td style="text-align: right;">24</td> </tr> <tr> <td>Laboratories:</td> <td style="text-align: right;">27</td> </tr> <tr> <td>Tutorials:</td> <td style="text-align: right;">12</td> </tr> <tr> <td>Independent Learning Time:</td> <td style="text-align: right;">49.5</td> </tr> <tr> <td><b>TOTAL:</b></td> <td style="text-align: right;"><b>112.5</b></td> </tr> </table>			Hours	Lectures:	24	Laboratories:	27	Tutorials:	12	Independent Learning Time:	49.5	<b>TOTAL:</b>	<b>112.5</b>
	Hours													
Lectures:	24													
Laboratories:	27													
Tutorials:	12													
Independent Learning Time:	49.5													
<b>TOTAL:</b>	<b>112.5</b>													
<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>													

### Indicative Syllabus:

Conservation laws, Reynolds Transport Theorem and Navier-Stokes Equations and Boundary condition analysis.  
The Finite Difference and Finite Volume discretisation techniques.  
Convergence and stability analysis methods.  
Solution of Linear Equation Systems.  
The Segregated solver and associated solution methods for the Navier Stokes Equations.  
Turbulence modelling: mixing length and  $k-\epsilon$  models.

### Assessment:

- **Written exam:** 50% of overall mark.
- **Continuous Assessment:** 50% of overall mark.

### Indicative Reading List:

#### Essential (selected sections):

1. Versteeg H.K. and Malalasekera W., An Introduction to Computational Fluid Dynamics The Finite Volume Method. Prentice Hall Pub. 1995
2. Ferziger J.H. and Peric M. Computational Methods for Fluid Dynamics. 3<sup>rd</sup> Edition, Springer Pub. 2002.

#### Supplementary:

1. Fletcher, C.A.J., Computational Techniques for Fluid Dynamics Vol. I and V. II, 2<sup>nd</sup> Ed., 1991, Springer Verlag.
2. Cengel, Y. and Boles, M.A., Thermodynamic: An Engineering Approach, 1998. McGraw-Hill
3. White, F.M., Fluid Mechanics, *Published by McGrawHill*. 1999.
4. Incropera, F.P. and DeWitt, D.P., Fundamentals of Heat and Mass Transfer, *Published by John Wiley & Sons*, 2002.
5. Fluent user guides, Fluent Inc. 1999
6. Gambit modelling guide, Fluent Inc. 1998

### Program or List of Programs on which this module will be delivered :

	Program Reference Number
GD/MSc in Computer Aided Mechanical and Manufacturing Engineering	
MSc in Computational Science & Complex Systems (MCSCS) (Option)	

**Date of last revision :** March 2004

Note: Where feasible, in the case of MCSCS students, a proportion of continuous assessment work will be oriented towards applications in the natural environment.

## CA656 Supply Chain Management

<b>Module Title:</b>	Supply Chain Management	
<b>Module Code:</b>	CA656	
<b>School:</b>	Computing	
<b>Module Co-ordinators:</b>	Dr. Markus Helfert	Room Number: L2.26
<b>Level:</b>	5	<b>Credit Rating:</b> 7.5
<b>Prerequisite:</b>	None	
<b>Co-requisite:</b>	None	
<b>Module Aims:</b> Effectively managing supply chain networks has become a prime determinant of an organization's success for manufacturing and service firms alike. This module focuses on supply chain management, which is vital to all kind of companies and organisations. The field of supply chain management represents a synthesis of many concepts, principles, and methods from the more traditional areas of marketing, production, accounting, purchasing, and transportation, as well as from the disciplines of applied mathematics, organisational behaviour, and economics. This module attempts to unify these basic concepts and aims to bring these into a logical body of thought that can lead to the effective management of supply chain networks.		
The course is organised around two themes. First, the basic activities of management, namely planning, organising, and controlling, provide the foundation for the course. Second, a triangle of interrelated supply chain strategies are the heart of supply chain planning and decision making.		
The course integrates, as application illustrations of the fundamental ideas, current trends in supply chain management like for example supply chain in a European and world-wide setting and the shifting toward more service-oriented economies. In addition, attention is given to the integrated management of supply chain activities and the value of information in supply chain management.		
<b>Learning Outcomes:</b>		
On successful completion of this unit, a student will:		
<ul style="list-style-type: none"> <li>• Have gained knowledge of the role and activities of supply chain management as key elements for successful management in organisations (service and manufacturing oriented)</li> <li>• Understand the importance of customer service and cost-service trade-offs.</li> <li>• Understand the value of information for managing supply chain networks.</li> <li>• Understand a variety of analytical tools and techniques useful in analysing and solving supply chain problems.</li> <li>• Develop the analytical and problem-solving skills necessary to develop solutions for a variety of supply chain problems.</li> </ul>		
<b>Indicative Time Allowances:</b>		
	Hours	
	Lectures: 36	
	Laboratories: 0	
	Tutorials: 0	
	Independent Learning Time: 76.5	
	<b>TOTAL: 112.5</b>	
<b>Note for 5 credit module:</b> Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 7.5 credit module, we need 75+37.5 hours</b>		

<b>Indicative Syllabus:</b>
<ul style="list-style-type: none"> <li>• Fundamentals of supply chain and supply chain activities</li> <li>• Corporate strategy, supply chain strategy and planning</li> <li>• Customer service goals and the supply chain product</li> <li>• Supply chain and the value of information</li> <li>• Supply Strategies and Decisions</li> <li>• Supply chain organisation and control</li> <li>• Supply chain operations reference model (SCOR)</li> <li>• The role of Supply Chain Management in Service Industry</li> <li>• Managing a Global Service Company</li> <li>• Supply Chain Management: International Issues</li> </ul> <p>Case studies and problems will be assigned throughout the course that will apply the concepts discussed in class to "Real-World" problems. A question set will be provided for each case study and students are expected to be prepared to discuss these questions as well as provide insight into the issues presented in the case. The assignment includes a summary outlining the analysis, conclusions, and recommendations. Each project will be presented and discussed in oral form in class.</p>

<b>Assessment:</b>
<ul style="list-style-type: none"> <li>• <b>Written exam:</b> 30% of overall mark.</li> <li>• <b>Continuous assessment:</b> 70% of overall mark.</li> </ul>

<b>Indicative Reading List:</b>
<b>Essential</b>
<ul style="list-style-type: none"> <li>• Ronald H. Ballou: Business Logistics / Supply Chain Management, Prentice Hall, 5th Edition, 2004 ISBN: 0-13-123010-7</li> <li>• David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi: Designing and managing the supply chain - concepts, strategies, and case studies, 2nd Edition, 2003, ISBN: 0072492562</li> </ul> <p>In order to illustrate the practical application of Supply Chain Management, assignments include articles from 'Interfaces' (a journal available online at DCU)</p>
<b>Supplementary:</b>
<ul style="list-style-type: none"> <li>• Bowersox, D., Closs, D. Cooper, B. Supply Chain Logistics Management, McGrawHill 2002, ISBN: 0-07-112306-7.</li> <li>• Dyckhoff, H.; Lackes, R.; Reese, J. (eds.): Supply Chain Management and Reverse Logistics, Springer 2004, ISBN: 3-540-40491-0</li> <li>• Lambert, D.: Fundamentals of Logistics Management, McGraw Hill, 1998, ISBN: 0-07-115752-2.</li> <li>• Martin Christopher: Logistics and Supply Chain Management, Prentice Hall, 2nd Edition, 1998. ISBN: 0-27-363049-0.</li> <li>• Olson, D. L.: Managerial Issues of Enterprise Resource Planning Systems, McGrawHill, 2004, ISBN: 0-07-286112-6.</li> </ul>

<b>Program or List of Programs on which this module will be delivered :</b>	
European MSc in Business Informatics (RMBIN) MSc in Computational Science & Complex Systems (MCSCS) (Option)	Program Reference Number

<b>Date of last revision :</b> 14 December 2007
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### CA672 Practicum

<b>Module Title:</b>	MCSCS Practicum													
<b>Module Code:</b>	CA672													
<b>School:</b>	Computing													
<b>Module Co-ordinators:</b>	Mr Ray Walshe	Room Number: L2.31												
<b>Level:</b>	5	<b>Credit Rating:</b> 30												
<b>Prerequisite:</b>	None													
<b>Co-requisite:</b>	None													
<b>Module Aims:</b>	<p>- The "practicum", or extended project, will take place over the summer period during which teams of students will either build a prototype system to solve a real-world problem (innovative) or design an experiment/manipulate/analyse laboratory-generated data (experimental) or seek to model a novel approach or idea (theoretical). The projects may be provided by corporate clients and may emphasise combining virtual and laboratory-based experimentation e.g. on building "dry lab" solutions through sourced computational science tools, or may involve some of the student's own ideas. - Students will be organised into pairs or appropriately sized teams comprising individuals from different backgrounds and skill sets, with the aim of achieving complementary input to the problem.</p>													
<b>Learning Outcomes:</b>	<p>The exact nature and schedule of the practicum will vary from team to team. However, activities are likely to include some of the following: experimental work, real or virtual modelling, system design and implementation, statistical analyses. Students should:- Learn how to prepare an appropriate functional specification and/or produce a comprehensive literature review with team partners.- Learn how to break down a problem into appropriate sub-tasks, suited to the knowledge and skills of the team. - Learn how to manage, as a team, a project with diverse research and development components and integrate this into a coherent whole. - Produce a system design that includes hardware, software and a human interface component, building a working prototype suitable for hand-over to and testing by the client or produce an academic research contribution for a laboratory-based task or build a suitable model and validate it appropriately to this standard - Produce a final report or position paper and a joint presentation to all programme participants, which clearly demonstrate understanding of and contribution to, the project by all team members.</p>													
<b>Indicative Time Allowances:</b>	<table><thead><tr><th></th><th>Hours</th></tr></thead><tbody><tr><td>Lectures:</td><td>0</td></tr><tr><td>Laboratories:</td><td>0</td></tr><tr><td>Tutorials:</td><td>0</td></tr><tr><td>Independent Learning Time:</td><td>450</td></tr><tr><td><b>TOTAL:</b></td><td><b>450</b></td></tr></tbody></table>			Hours	Lectures:	0	Laboratories:	0	Tutorials:	0	Independent Learning Time:	450	<b>TOTAL:</b>	<b>450</b>
	Hours													
Lectures:	0													
Laboratories:	0													
Tutorials:	0													
Independent Learning Time:	450													
<b>TOTAL:</b>	<b>450</b>													
<b>Note for 5 credit module:</b>	Assume that a module load represents approximately 75 hours work, which includes all teaching, in-course assignments, laboratory work or other specialised training and an estimated private learning time associated with the module. <b>Thus, for a 30 credit module, we need <math>75 \times 6 = 450</math> hours</b>													

<b>Indicative Syllabus:</b> Team-directed - under supervision- Initial literature review and/or functional spec. - Work plan preparation and allocation of tasks.- Design and problem-solving.- Implementation/coding.- Analysis.- Report preparation.- Presentation.
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<b>Assessment:</b> <ul style="list-style-type: none"><li>• <b>Written exam:</b> 0% of overall mark.</li><li>• <b>Continuous assessment:</b> 100% of overall mark.</li></ul>
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<b>Indicative Reading List:</b> Essential texts/papers identified by research supervisor. Additional literature/software sourced by students.
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<b>Program or List of Programs on which this module will be delivered :</b>	
MSc in Computational Science & Complex Systems (MCSCS)	Program Reference Number

<b>Date of last revision :</b> April 2008
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