Subject Description Form

Subject Code	COMP5574
Subject Title	Computational Economics and Algorithms
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The objectives of this subject are to: 1. Provide students with a foundational understanding of thegame-theoretic issues behind systems involvingcomputation such as online networks. 2. Enable students to learn how algorithms and algorithmicthinking can help with designing better decision andallocation mechanisms in the offline world.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. understand the basic concepts of game theory andmechanism design; b. apply computational methods to solve optimisationproblems in economics, and design algorithms thatincorporate economic principles for applications such asauctions, pricing, and resource allocation; c. analyse the impact of information technology on marketstructures and economic strategies, and demonstrate theability of critical reading and analysis through paperreviews and panel discussions, enhancing abilities to writereviews and analyse papers from multiple perspectives; d. evaluate the role of data and computational analysis ineconomic decision-making and policy formulation; e. explore the ethical implications of computationaleconomics in the context of privacy, fairness, and marketregulation.
Subject Synopsis/ Indicative Syllabus	1. Introduction to Computational Economics • Overview of the field • Intersection of economics and computer science 2. Game Theory and Strategic Interaction • Basic concepts of game theory • Nash equilibrium

	• Price of Anarchy • Repeated games and evolutionary stability 3. Mechanism Design and Auction Theory • Designing mechanisms for desired outcomes • Auction formats and bidding strategies • Revenue equivalence and incentive compatibility 4. Market Design and Matching Algorithms • Two-sided matching markets • Stable matching and the Gale-Shapley algorithm • Market design in practice: labour markets, schoolchoice, organ donation 5. Optimisation and Linear Programming • Linear programming in economic modelling • Duality and sensitivity analysis • Network flows and integer programming 6. Computational Models of Economic Dynamics • Agent-based modelling • Computational general equilibrium models • Dynamic stochastic models • Voting systems, cake cutting, resource allocationand their computational aspects 7. Data Analysis and Econometrics • Big data in economics • Machine learning techniques for economic data • Causal inference and experimental design 8. Digital Markets and Platforms • Economics of digital goods and services • Platform competition and network effects • Pricing strategies and revenue management • Cryptocurrencies and Bitcoin 9. Algorithmic Game Theory and the Internet • The role of algorithms in online markets • Search engines and online advertising • Social networks and information diffusion 10. Ethical Considerations in Computational Economics • Privacy and data protection • Algorithmic bias and fairness • Regulation of digital markets

<table>
<tr><td>Teaching/Learning Methodology</td><td>Lectures provide students with the main concepts of economics and computation, together with comprehensive examples for easy understanding.

Students will engage in hands-on exercises to apply computational techniques to economic problems. Projects and presentations will encourage collaboration and practical application of course material.

Both written and programming assignments will be utilised in the course. Written assignments help students develop analysis and design skills, whilst programming assignments emphasise implementation skills.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="5">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>1. Assignment and Quiz</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Project and Presentation</td><td>25%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Exam</td><td>45%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="5"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignments and Quizzes assess students' comprehension of the fundamental concepts in economics and computation.

The project and presentation evaluate students' critical and creative thinking capabilities, problem-solving skills, and their ability to apply the techniques and tools they have learnt to real-world applications.

The exam is used to assess independent problem-solving and critical thinking.
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<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture/Tutorial/Lab/Paper panel</td><td>39 Hrs.</td></tr>
<tr><td>Other student study effort</td><td></td></tr>
<tr><td>▪ Completing Assignment and Projects,Reviewing and preparing for quiz, readingpapers, and presentation</td><td>85 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>124 Hrs.</td></tr>
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Reading List and References	1. T. Roughgarden. Twenty Lectures on Algorithmic GameTheory, Cambridge University Press, 2016 2. N. Nisan, T. Roughgarden, E. Tardos and V. Vazirani,Algorithmic Game Theory, 2007 3. Felix Brandt, Vincent Conitzer, Ulle Endriss, Jérôme Langand Ariel D. Procaccia. Handbook of Computational SocialChoice, Cambridge University Press, 2016 4. Martin J. Osborne and Ariel Rubinstein, A Course in GameTheory, MIT Press, 1995 5. Andreu Mas-Colell, Michael D. Whinston, Jerry R. Green.Microeconomic Theory, Oxford University Press, 1995 6. David Easley and Jon Kleinberg. Networks, Crowds, andMarkets: Reasoning About a Highly Connected World,Cambridge University Press 2010