

Candidates are admitted to the examination room ten minutes before the start of the examination. On admission to the examination room, you are permitted to acquaint yourself with the instructions below and to read the question paper.

Do not write anything until the invigilator informs you that you may start the examination. You will be given five minutes at the end of the examination to complete the front of any answer books used.

May/June 2012

SE3EC11 2011/12 A 001

1 Answer Book
Calculators not permitted

UNIVERSITY OF READING

EVOLUTIONARY COMPUTATION (SE3EC11)

One and a half hours

Answer **Question 1** and **ONE** other question.

1.
 - (a) Explain the biological inspiration behind *Evolutionary Computation* and how it relates to *problem solving*. (5 marks)
 - (b) What are the FOUR basic components of an Evolutionary Algorithm (EA) and how do they work together to solve a problem? (5 marks)
 - (c) Distinguish between the terms *genotype* and *phenotype* stating their key properties. Illustrate your answer by reference to a suitable example. (5 marks)
 - (d) Using pseudocode create an algorithm that can be used in a simple *Evolutionary System*. (5 marks)
 - (e) Explain why EAs are considered to be *robust problem solvers* by making reference to *schema theory*, the “*no free lunch*” theorem and the *principle of diversity*. (5 marks)

2. (a) Give a definition of *Swarm Intelligence* and illustrate your answer with a selection of real-world examples. (5 marks)
- (b) Explain how *stigmergy* and *swarm operations* lead to the emergence of complex problem solving behaviour. (5 marks)
- (c) Using *Ant Colony Optimisation* (ACO) define how the system builds a solution to a problem taking care to explain how ants communicate, how the system is initialised, and the use of elitism. (8 marks)
- (d) Using your answer in (c), how would you use ACO to find the shortest route for a salesman travelling to a list of cities exactly once (Travelling Salesman Problem)? (7 marks)
3. (a) Define the terms *Evolutionary Strategies*, *Genetic Programming* and *self adaptation*. (5 marks)
- (b) Using a suitable representation of a *chromosome* for a genetic algorithm explain the principles of *recombination* and *mutation*. (6 marks)
- (c) Give the structure of a Learning Classifier System (LCS) and explain the purpose of the major components. (8 marks)
- (d) Describe the experimental setup to evolve a control algorithm to create a robot that “hunts” (drives towards until it touches) other robots. Outline the structure of your learning system, the required properties of the robot, and suggest ways to train the system. Comment on the system’s ability to generalise. (6 marks)

4. (a) Explain the terms *Genetic Algorithms* (GA), *population*, *fitness* and *deception*. (5 marks)
- (b) Explain how a GA implements the biological notion of *fitness*. (5 marks)
- (c) Describe the advantages and disadvantages of the implementation in (b) by comparing it to Evolutionary Strategies and Evolutionary Programming. (7 marks)
- (d) A student wants to win the “Tube Challenge”, i.e. travel through each station in the London Underground network in the fastest possible time. Individual stations can be visited several times. The underground trains are the only allowed transportation between stations.
How would you use a GA to find the fastest route for the student? (8 marks)

(End of Question Paper)