



DUBLIN CITY UNIVERSITY

SEMESTER 2 EXAMINATIONS 2015/2016

MODULE: CA4006 – Concurrent and Distributed Programming

PROGRAMME(S):

CASE	BSc in Computer Applications (Sft.Eng.)
ECSAO	Study Abroad (Engineering & Computing)
SHSAO	Study Abroad (Science & Health)

YEAR OF STUDY: 4,O

EXAMINERS:

Dr. Martin Crane	(Ext:8974)
Dr. Ian Pitt	

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer 4 questions. All questions carry equal marks.

PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO

The use of programmable or text storing calculators is expressly forbidden.

Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

Requirements for this paper (Please mark (X) as appropriate)

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Log Tables
Graph Paper
Dictionaries
Statistical Tables
Bible

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Thermodynamic Tables
Actuarial Tables
MCQ Only – Do not publish
Attached Answer Sheet

QUESTION 1**[TOTAL MARKS: 25]****Q 1(a)****[8 Marks]**

Explain clearly the differences between semaphores and monitors. Write a short code fragment showing how to guarantee Mutual Exclusion for N processes using semaphores in C. You may assume the existence of semaphores (with notation `sem`) and operations on them in C. Using the semaphore invariant outline a simple proof that Mutual Exclusion is satisfied.

Q 1(b)**[9 Marks]**

Describe fully the algorithm for the Reader-preference solution of the Readers-Writers problem using semaphores. Write fully commented C code that implements the algorithm. You may assume the existence of semaphores (with notation `sem`) and operations on them in C as well as `Read_Database()` and `Write_Database()`.

Q 1(c)**[8 Marks]**

Describe fully the algorithm for Ballhausen's solution to the problem of Reader-Preference in the Readers-Writers algorithm using semaphores in Q1(b) above. Write carefully commented C code that implements the algorithm.

[End of Question 1]**QUESTION 2****[TOTAL MARKS: 25]****2(a)****[11 marks]**

In the context of concurrency, what is meant by a *programming model*? How does it relate to the machine model? Explain, using diagrams, the three principal programming models in a concurrent system.

2(b)**[10 marks]**

In the context of Structured Peer to Peer (P2P) architectures, the Chord algorithm is used for managing nodes logically organized in a ring and the routing of enquiries about data items that are mapped to those entities nodes. Briefly describe the steps in the Chord algorithm. One such ring is given in Figure Q.2 below with the finger tables for nodes. Complete the finger tables for nodes 10, 12 and 15 in Figure Q.2. Give the steps in routing requests for data item 13 starting at node 1 and data item 9 starting at node 15.

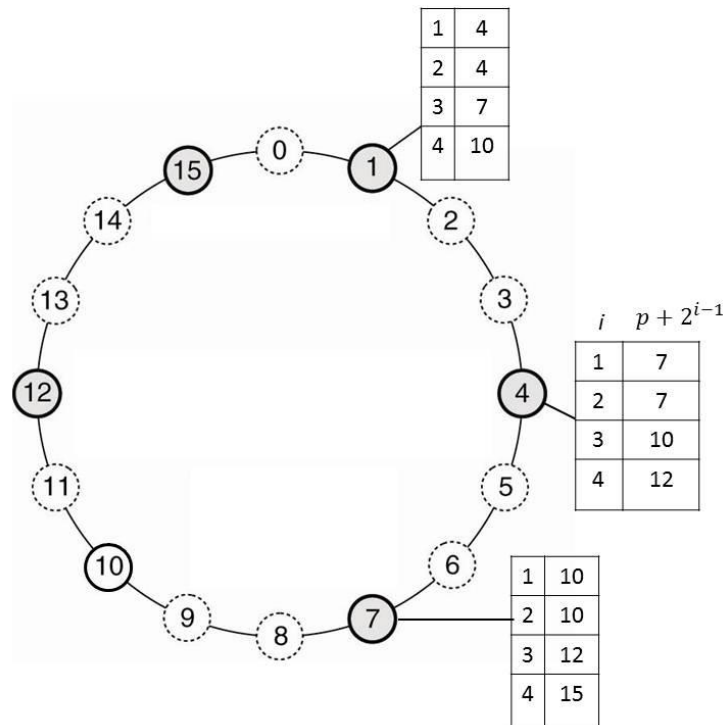


Figure Q.2

2(c)

[4 marks]

An Overlay Network is one in which the nodes are formed by the processes and the links represent the possible communication channels. For the topology construction and management of such an architecture, Unstructured Pier to Pier (P2P) systems rely on randomized algorithms. Using a diagram illustrate and describe the 2-layered approach for such topology maintenance.

[End of Question 2]

QUESTION 3

[TOTAL MARKS: 25]

Q 3(a)

[7 Marks]

Semaphore objects in Java may be used to 'throttle' certain applications for the purposes of load balancing, for instance. In the course we covered a simple code fragment demonstrating such an application of Semaphore objects. Outline and describe this (or a similar piece of code), taking care to comment your code.

Q 3(b)

[18 Marks]

Describe the steps involved in programming a Java RMI application. Write code that implements the Remote Database Server in Java RMI (i.e. the interface, the client

and the server). Your code should implement `read()` and `write()` methods on the database server, where `read()` returns the value of the (integer) database and `write(int value)` sets the database to be a particular (integer) value.

[End of Question 3]

QUESTION 4

[TOTAL MARKS: 25]

Q 4(a)

[6 Marks]

In the context of concurrent programming using MPI and OpenMP *hybridization* is used to denote programs containing MPI and OpenMP code fragments. Give three ways in which combining Hybrid MPI and OpenMP code can help in optimising a Concurrent Program. Give three disadvantages of this form of programming.

Q 4(b)

[10 Marks]

For calculating a value of π numerically it can be shown that:

$$\int_0^1 \frac{dx}{1+x^2} = \tan^{-1} 1 = \frac{\pi}{4}$$

Figure Q.4 shows how such an integral could be calculated numerically. Write fully commented MPI Code with C bindings to execute the calculation over `nproc` processors, where the calculation is performed as a discrete sum of `num_step` steps each of width `step`. In Figure Q4 this is illustrated as `nproc=2`, `step=1/8` and `num_step=8` but you should leave these as parameters in your code.

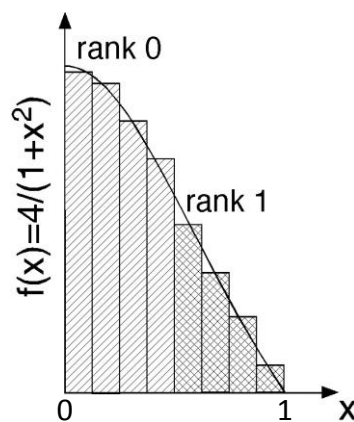


Figure Q4

Q 4(c)

[9 Marks]

For each MPI process in Q4(b) above, `nthreads` OpenMP threads are to perform part of the sum. Amend your code in Q4(b) to provide OpenMP code which carries out the internal summation. Your code should use the Reduction operation internally on OpenMP nodes and a separate Reduction operation for the MPI processes.

[End of Question 4]

QUESTION 5

[TOTAL MARKS: 25]

Q 5(a)

[4 Marks]

Describe thoroughly the three approaches to generating a SOAP Web Service in Java. If this were to be done in JAXWS what tools would be needed?

Q 5(b)

[9 Marks]

Draw a fully annotated diagram showing the so-called “Publish-Find-Bind” model of Web Services. Describe thoroughly the role of SOAP in Web Services. List four differences between Web Services in SOAP and REST.

Q 5(c)

[12 Marks]

Part of a Java Interface `WeatherForecast.java` to return the weather forecast and the associated temperature of a City is shown in Figure Q5. Using Java Web Services, implement the following components of this interface: the Service Endpoint Interface (SEI), the Service Implementation Bean (SIB) and the Endpoint Publisher. You should fully comment your code.

```
public String getForecast (String City){
    // implementation omitted
}

public String getTemp (String City) {
    // implementation omitted
}
```

Figure Q5 Interface `WeatherForecast.java`

[End of Question 5]

[END OF EXAM]