**DUBLIN CITY UNIVERSITY**

# SEMESTER 2 EXAMINATIONS 2017/2018

**MODULE:** CA4006 - Concurrent and Distributed Programming

**PROGRAMME(S):**

| | |
|---|---|
| CASE | BSc in Computer Applications (Sft.Eng.) |
| CPSSD | BSc in ComputationalProblem Solv&SW Dev. |
| ECSAO | Study Abroad (Engineering & Computing) |
| ECSA | Study Abroad (Engineering & Computing) |

**YEAR OF STUDY:** 4,O,X

**EXAMINER(S):**

| | |
|---|---|
| Martin Crane | (x8974) |
| Prof. Brendan Tangney | (External) |
| Dr. Hitesh Tewari | (External) |

**TIME ALLOWED:** 3 Hours

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

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**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.

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***Requirements for this paper:***
***1. Log Tables***

***QUESTION 1*** ***[TOTAL MARKS: 25]***

**Q 1(a)** **[5 Marks]**

Describe Amdahl's Law for the theoretical speedup of a program executed across multiple processors. The answer should give the formula involved and explain it.

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

Assume 0.1% of the runtime of a program is not parallelizable. This program is supposed to run on the Tianhe-2 supercomputer, which consists of 3,120,000 cores. Under the assumption that the program runs at the same speed on all of those cores, and there are no additional overheads, by Amdahl’s law what is the parallel speedup on 30, 300, 30,000 and 3,000,000 cores?

**Q 1(c)** **[12 Marks]**

Assume that the same program as (b) (with the same serial/parallel fraction) invokes a broadcast operation. This broadcast adds overhead, depending on the number of cores involved, *P*. There are two broadcast implementations available. One adds a parallel overhead of 0.0001 × *P*, the other one 0.0005×ln(*P*) (where ln(*P*) is the natural logarithm of *P*). For each broadcast implementation calculate the number of cores for which you get the highest speedup.

Note: $\frac{d(P)}{dP} = 1, \frac{d}{dP}\left(\frac{1}{P}\right) = -\frac{1}{P^2} \, and \, \frac{d(\log(P))}{dP} = \frac{1}{P}$

***[End of Question1]***

***QUESTION 2*** ***[TOTAL MARKS: 25]***

**Q 2(a)** **[6 Marks]**

Describe fully the syntax and semantics of a semaphore.

**Q 2(b)** **[10 Marks]**

In a drinking game, 3 drinkers is required to consume as many glasses of wholesome fermented health drink as possible over the duration of the game. Accordingly, 5 filled glasses are placed in front of the drinkers and these are replenished by 2 bartenders as necessary for the duration of the game. Write well-commented C-code solving this problem using semaphores, indicating the critical sections. You may assume the existence of the P and V semaphore operations as well as operations `fill_glass()` and `empty_glass()` as necessary.

**Q 2(c)** **[9 Marks]**

For your solution in (b) show that there is (i) no deadlock (ii) no starvation and (iii) no possibility to drink from an empty glass.

***[End of Question2]***

**QUESTION 3** **[TOTAL MARKS: 25]**

**Q 3(a)** **[13 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.

**Q 3(b)** **[12 Marks]**

In the context of Structured Pier to Pier (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.3 below with the finger tables for nodes. Complete the finger tables for nodes 10, 12 and 15 in Figure Q.3. Give the steps in routing requests for data item 13 starting at node 1 and data item 9 starting at node 15.

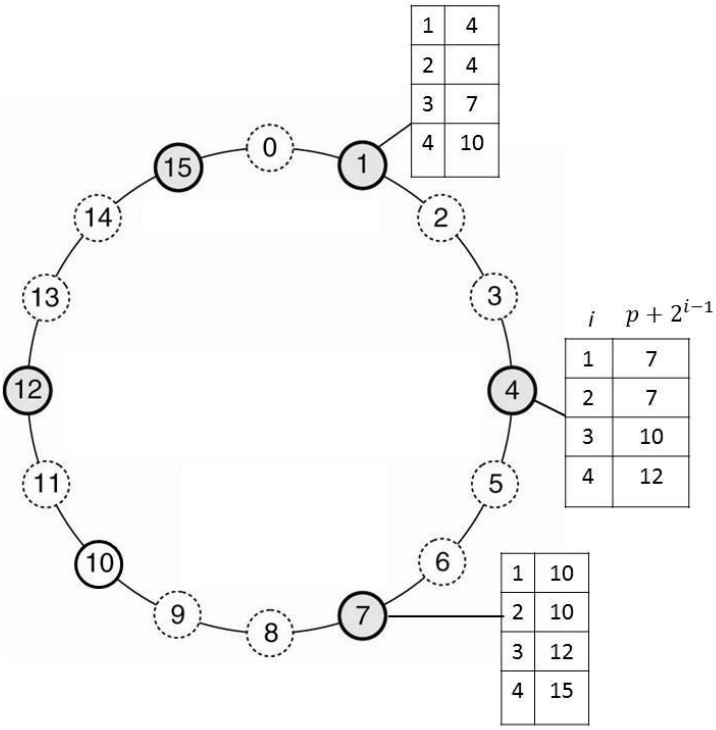


Figure Q.3

***[End of Question3]***

***QUESTION 4*** ***[TOTAL MARKS: 25]***

**Q 4(a)** **[8 Marks]**

In the context of Java's Remote Method Invocation (RMI), define what is meant by *stubs* and *skeletons*, illustrating your answer with a diagram showing the RMI architecture. Show how the skeleton and stub may be generated.

**Q 4(b)** **[17 Marks]**

A Remote Method Invocation (RMI) Interface to allow a client to invoke a command to find the factorial of a number on a remote machine is shown in Figure Q 4. You are required to implement the remote interface, develop the server and develop a client that invokes the remote method `fact`. Your code should be fully commented and should document the function of each major component.

```
import java.rmi.*;

public interface RemoteInterface extends Remote
{
  public int fact(int x) throws Exception;
}
```

Figure Q 4. `Factorial.java`

***[End of Question4]***

***QUESTION 5*** ***[TOTAL MARKS: 25]***

**Q 5(a)** **[10 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. Describe briefly the contents of a SOAP Message.

**Q 5(b)** **[15 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, give the implementation of 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 Question5]***

***[END OF EXAM]***