# 7.3 Synchronisation

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

**KEY WORDS** mutual exclusion • lock

## Objective

Trace races deterministically and break deadlocks by construction.

## 1 Key knowledge and worked examples

### ■ The lost update

Read-then-write on `counter = 5` by two threads: the interleaving R1 R2 W1 W2 stores 6 twice ✓. With four increments each, every final value from 1 to 8 is reachable ✓.

### ■ Worked example: the four conditions

Deadlock needs mutual exclusion, hold-and-wait, no preemption, and circular wait – break any one; the lock order is the cheap break ✓.

## 2 Practice

**2.1** Two threads run `x = x + 1` on `x = 10`. Give the outcome of the interleaving R1 R2 W2 W1. [3]

**2.2** Name the three properties a correct critical-section solution must satisfy. [3]

**2.3** Why does a mutex queue beat a spinlock on a single core? [3]



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## 3 Exam-style questions

**3.1** Two threads each execute `count = count + 1` three times on `count = 0`, with per-increment registers.

State the maximum final value and the interleaving that achieves it. State the minimum final value and explain the interleaving that achieves it. Give the number of distinct final values reachable, and the one-line fix that pins the result. [8]

**3.2** Thread A locks L1 then wants L2; thread B locks L2 then wants L1. Each lock acquisition is 1 ms; each hold lasts 5 ms.

Explain why this deadlocks, naming the condition cycle. State the one-line ordering rule that prevents it, and trace the same run under the rule. Give one other condition that could be broken instead, with its mechanism. [7]



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