1. A flight simulator allows a user to take control of a simulated aeroplane. The user can fly the plane in an environment that can simulate different weather conditions and additional planes in the sky.

    Explain what is meant by 'concurrent processing' and describe **one** example of how the simulator could make use of it.

    Concurrent processing _____

    _____

    Example _____

    _____

    _____

    _____

    _____

    _____**[4]**

2. A programmer is developing an ordering system for a fast food restaurant. When a member of staff inputs an order, it is added to a linked list for completion by the chefs.

The programmer is considering using concurrent programming.

Discuss how concurrent programming can be applied to the food ordering system and the benefits and limitations of doing so. **[9]**

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			Max 1 for explanation of concurrent programming. Max 3 for each example. Concurrent processing: • One process does not have to finish before the other starts (1) Example e.g. • Each plane can move independently (1) • All move at the same time (1) • All need to react to different events (1) • The weather (1) • Wind, rain, direction of air etc. (1) • Each element needs to be run simultaneously (1) • It will react to its own stimulii (1)	4	Accept any reasonable suggestion for concurrent programming in the simulator For examples: 1 mark for identifying example. 1 mark for saying how they act concurrently. 1 mark for saying why this is necessary.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
2			**Mark Band 3 – High level (7-9 marks)** The candidate demonstrates a **thorough** knowledge and understanding of concurrent programming; the material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence / examples will be explicitly relevant to the explanation. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Mark Band 2 – Mid level (4-6 marks)** The candidate demonstrates **reasonable** knowledge and understanding of concurrent programming; the material is generally accurate but at times underdeveloped. The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence / examples are for the most part implicitly relevant to the explanation. The candidate provides a reasonable discussion, the majority of which is focused. Evaluative comments are, for the most part appropriate, although one or two opportunities for development are missed. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Mark Band 1 – Low Level (1-3 marks)** The candidate demonstrates a **basic** knowledge of concurrent programming with limited understanding shown; the material is basic and contains some inaccuracies. The candidates makes a limited attempt to apply acquired knowledge and understanding to the context provided.	9 AO1.1 (2) AO1.2 (2) AO2.1 (2) AO3.3 (3)	**AO1: Knowledge and Understanding Indicative content** • Processes are happening at the same time / at overlapping times • Only 1 process can actually happen at a time on a single core processor, concurrent tries to simulate multiple processes • One process may need to start before a second has finished • Individual processes are threads, each thread has a life line **AO2: Application** • Multiple orders can be made and added to the list at the same time • Programming will need to allow multiple threads to manipulate a single list • Will allow those reading and writing to manipulate at the same time • Locking will need implementing – more complex programming **AO3: Evaluation** • Will allow for multiple orders at the same time – as it would happen in real life • Access to the linked list will need to be limited so it cannot be accessed / overwritten by two threads trying to do different operations

Question			Answer/Indicative content	Marks	Guidance
			The candidate provides a limited discussion which is narrow in focus. Judgements if made are weak and unsubstantiated. *The information is basic and comunicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No attempt to answer the question or response is not worthy of credit.		• Not all of the process will be paralleliseable. X processors does not mean it will run in 1/xth of the time of one processor. **Examiner's Comment:** It was clear that many candidates had not covered the concept of concurrency and how it allows different processes to occur at the same time. Strong candidates appreciated that this could be simulated on a single core with time slicing or implemented within a parallel architecture. Many candidates lost sight of the fact that answers needed to be related to computer science rather than a restaurant chain and could not explain the underlying computer science that would allow a solution to be delivered.
			Total	9	