Thursday, May 8th, 2008
2:30p.m. – 4:00p.m.
Duration: 1 hr 30 mins

University of Glasgow

DEGREES OF MSc, PG Dip, MSci, MEng, BEng, BSc, MA and
MA (Social Sciences)

REAL TIME AND EMBEDDED SYSTEMS (M)

(Answer 3 out of 4 questions)

This examination paper is worth a total of 45 marks

1. **(a)** There are two categories of algorithm for scheduling periodic tasks: clock-driven and priority-driven. Discuss the relative advantages and disadvantages of these two categories for single processor systems, and explain when one would use a clock-driven scheduler in preference to a priority-driven scheduler.

[4]

(b) Consider a system of four independent preemptable periodic tasks, scheduled on a single processor system:

$$T_1 = (5, 1), T_2 = (4, 1), T_3 = (16, 2), \text{ and } T_4 = (20, 1)$$

All tasks have phase equal to zero, and relative deadline equal to their period. Is this system schedulable using the earliest deadline first algorithm? Is this system schedulable using the rate monotonic algorithm? Explain your answers.

[5]

(c) It is not always possible to determine schedulability for a fixed priority system using maximum schedulable utilisation tests. An alternative schedulability test can be used in some cases, based on the concepts of time demand analysis and critical instants. Explain what is a critical instant, and outline how time demand analysis can be used to provide a schedulability test for fixed priority systems.

[6]

2. **(a)** Two common types of periodic server are the polling server and the deferrable server. For each of these, explain the budget consumption and replenishment rules, and describe how the server is scheduled and how aperiodic jobs are scheduled within the server. Comment on how the choice of polling server or deferrable server affects the responsiveness of aperiodic jobs.

[7]

(b) What is the difference between a sporadic job and an aperiodic job? Discuss how the presence of sporadic jobs might affect the architecture of a system, and the design of its job scheduler.

[3]

(c) Describe how sporadic jobs can be scheduled in a system using earliest deadline first scheduling. Outline how the acceptance test for new sporadic jobs works, and how you can prove that all tasks still meet their deadlines.

[5]

3. **(a)** It has been suggested that voice-over-IP (VoIP) systems will never replace the traditional telephone system, because the Internet does not provide the necessary quality of service guarantees. Discuss whether the lack of guaranteed quality of service is a significant issue for VoIP applications.

[7]

(b) If you believe lack of guaranteed quality of service is a significant issue for VoIP, explain how quality of service might be added to IP networks, and what guarantees it might provide.

- Alternatively -

If you do not believe lack of guaranteed quality of service is a significant issue for VoIP, explain how voice telephony can be made to work over a network that does not guarantee real time performance.

[8]

4. **(a)** We have reviewed two papers which suggest a fundamental rethinking of the languages and programming models used for real time and embedded systems: "Absolutely Positively on Time: What would it Take?" by Edward A. Lee (IEEE Computer, July 2005) and "The nesC Language: A Holistic Approach to Networked Embedded Systems" by David Gay *et al*. (Proceedings of the ACM Conference on Programming Language Design and Implementation, San Diego, CA, USA, June 2003). Discuss the extent to which you believe such a rethinking is necessary and/or desirable, highlighting what you see as the limitations (and highlights) of existing programming languages and environments for real time and embedded systems development.

[15]