**ELEC-E8001 Embedded Real-Time Systems**

EXAM 16.12.2016

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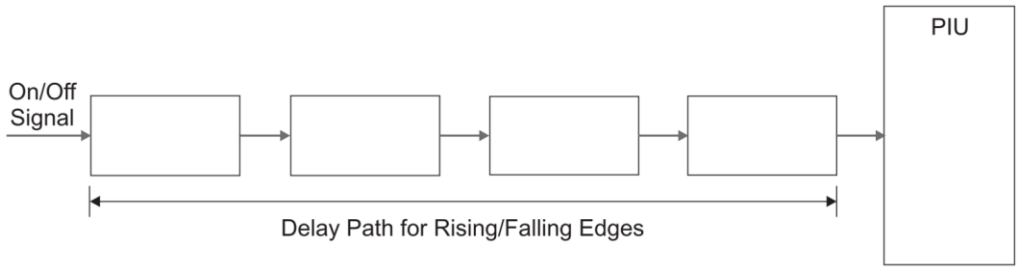
1. Are the following claims true (**T**) or false (**F**)? Every correct answer gives you +1 p, every incorrect –1 p, and an empty answer is worth 0 p. The minimum amount of total points is 0 p and maximum 6 p.

   a) In real-time control systems, deadlines are based on the underlying physical phenomena of the system under control. **T** Textbook p. 7
   b) In cost-effective and robust real-time systems, a pragmatic rule of thumb could be: process everything as slowly as possible and repeat tasks as often as possible. **F** Textbook p. 8
   c) Speculative execution works well with instruction pipelines if the locality of reference remains low. **F** Textbook p. 46
   d) The use of OSI model makes it possible to change the data transfer medium and other properties of the protocol stack independently. **T** Textbook p. 69
   e) A task is an abstraction of a running program and is the logical unit of work schedulable by the real-time operating system. **T** Textbook p. 80
   f) Many embedded systems, which transmit blocks of data from one unit to another, use double-buffering schemes with a software or hardware switch to alternate the buffers. **T** Textbook pp. 107–108

2. You have a 10-bit A/D converter and its input range is –5V to +5V. If the binary output of the A/D is `01`**`0000`**`0100` what analog voltage is at the input? (6 p) Lecture slides p. 87

3. In the textbook and in one of your homework assignments, there is a discussion and problem related to a *digital input channel* intended for operating environments with high EMI levels. Below is the block diagram of that input channel without descriptions of the four blocks between the "On/Off Signal" and "PIU". Explain the purpose and function of those blocks. (6 p) Textbook pp. 60–61




4. Consider a preemptive-priority RTOS and an embedded system with separate measurement channels for pressure and temperature, as well as a single A/D converter to be used by `Task_1` and `Task_2` for periodically measuring those two quantities. Before starting an A/D conversion, the desired measurement channel must be selected. How would you share the serially reusable resource *safely* with `Task_1` (high priority) and `Task_2` (low priority)?

   Give your answer in a few lines of program code for both of the tasks using, for instance, C-like syntax. Define all the operating system services and other functions that you may use. (6 p) Textbook p. 113

5. Consider a real-time operating system with preemptive-priority scheduling. Draw a representative state diagram that shows the possible task states and allowed transitions between them. (4 p) In addition, define all the states and transitions. (2 p) Textbook pp. 95–97