INFO0064 - Embedded Systems
Examination session of September 2016

Notes or documents of any kind forbidden. Duration: 3 h 30

Each question must be answered on a different sheet with your name and section.

1. [*6 points*]

   (a) Define the following elements: preemption, reentrancy, semaphore, critical instant, latency, set of tasks that fully uses the processor.

   (b) Explain the Rate-Monotonic Scheduling strategy.

   (c) If n schedulable periodic tasks fully use the processor, is it possible to add more tasks that have no specific constraints ? Justify.

2. [*7 points*] In a cooling system, a microcontroller controls the opening of a cold water valve in order to keep the temperature of a certain point constant. It performs the following tasks:

   - send the value of an angle to the valve 10 times per second during 1 *ms*,
   - communication with a sensor array only 1 times per second during 1 *ms*,
   - if a variation of more than 2% is observed in the measurements, compute a new angle; this lasts 2 seconds,
   - monitor an alert button, 25 times per second and which takes a negligible time to be performed.

   If the alert button is pressed, a new angle has to be computed as soon as possible using predetermined parameters and previous measurements. The alert button has to be pressed again to begin computing the angle as before.

   (a) What is the best software architecture for this system? (Carefully justify your answer.)

   (b) Using pseudocode, give the global structure of this embedded software.

3. [*7 points*] The principle used by a telemeter is to measure the elapsed time between the emission of an ultrasound signal and the reception of an echo sent back by a target. If this time is equal to t seconds, the distance to this target is estimated to be $170 \times t$ meters.
   The signals are emitted every 100ms and last 100μs each. The received signals are considered valid if they meet the following conditions:

   - they last between 50 and 150μs;
   - they are received between 500μs and 50ms after the emission of a signal (this delay is computed between the first transition of the signals).

   The other signals are discarded.

(a) Considering a real environment, where a signal can be received at any moment, describe a hybrid system modelling this situation.

(b) Give the first 3 steps of the space-state exploration of this system.