

# SM50 : Partiel A22

Family Name		First Name	
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Wednesday 26 October 2022

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**No documents allowed – All cooperation forbidden – All numerical devices forbidden**

**Calculator Allowed – Answer on this document – Answer in English**

Duration : 90 minutes

## 1. GENERAL QUESTIONS

### 1.1 MULTIPLE CHOICE QUESTIONS (5 POINTS)


You get +0.5 point for each correct answer, -0.5 points for each wrong answer and 0 points if you do not answer. There is only one correct answer per question.

<b>Question 1</b>	What does HIL stand for in engineering?	<input type="checkbox"/> Hardware in the Loop <input type="checkbox"/> The moon in Basque mythology <input type="checkbox"/> Health in Life
<b>Question 2</b>	What does RCP stand for?	<input type="checkbox"/> Renewable Capacity prediction <input type="checkbox"/> Recent Command Protocol <input type="checkbox"/> Rapid Control Prototyping
<b>Question 3</b>	In what application the controller exists, and the plant is simulated?	<input type="checkbox"/> HIL <input type="checkbox"/> RCP <input type="checkbox"/> both
<b>Question 4</b>	HIL and RCP CANNOT be used for ...	<input type="checkbox"/> accelerated development <input type="checkbox"/> early user training <input type="checkbox"/> completely replaces demonstrator
<b>Question 5</b>	What is the difference between HIL and PHIL?	<input type="checkbox"/> it is the same <input type="checkbox"/> the simulation can control systems with higher power <input type="checkbox"/> the p stands for "plural" indicating higher number of in- and outputs
<b>Question 6</b>	What are the three main component of a system?	<input type="checkbox"/> hardware, software, firmware <input type="checkbox"/> hardware, controller, interfaces <input type="checkbox"/> sensors, actuators, measures
<b>Question 7</b>	How an RCP can be used?	<input type="checkbox"/> to replace existing controller <input type="checkbox"/> to add functionalities to existing controller <input type="checkbox"/> either to replace or to enhance existing controller
<b>Question 8</b>	In general, how is named the device, that is used for HIL or RCP applications?	<input type="checkbox"/> micro lab box <input type="checkbox"/> real time target <input type="checkbox"/> controller
<b>Question 9</b>	What is the general step size for real time computing?	<input type="checkbox"/> microseconds <input type="checkbox"/> seconds <input type="checkbox"/> depends on the application

<b>Question 10</b>	What device is used to improve real time capability?	<input type="checkbox"/> parallel computing using FPGA <input type="checkbox"/> smaller time steps <input type="checkbox"/> model simplification
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## 1.2 SOME SHORT QUESTIONS

**Question 11 (1 point):** Draw the graphic of the V-cycle of system development.



**Question 12 (1 point):** Draw the approximate structure of a FPGA block including IO-blocks, Configurable Logic Blocs, and data link.



## 1.3 ORDINARY DIFFERENTIAL EQUATION

In the lecture you have learned how to solve a differential equation numerically using Euler's method, where you use only the derivative at point  $x_n$  to approximate the solution at point  $x_{n+1}$  using the equation:

$$y_{\{n+1\}} = y_n + h \cdot f(x_n + y_n)$$

However, for very steep slopes, this can be quite imprecise.

Therefore, an improved Euler's method exists using the average of the slope at point  $x_n$  and  $x_{n+1}$  using the equation:

$$y_{n+1} = y_n + h \left[ \frac{f(x_n, y_n) + f(x_n + h, y_n + h \cdot f(x_n, y_n))}{2} \right]$$

**Question 13 (1 points):** You have the equation  $y' = xy$  with  $y(1) = 1$  using  $h = 0.1$ . Calculate the result at point  $x = 1.3$  using the two methods, providing 4 significant digits:

#### 1.4 PID CONTROLLER

**Question 14 (0.5 points):** Name at least two advantages of PID controllers

**Question 15 (1 point):** A PID controller consists of three parts. Name each part and shortly explain what they do:

**Question 16 (0.5 point):** If you use an empirical method of PID tuning you normally start putting the parameters in initial conditions. What are they?

**Question 17 (0.5 point):** You have a system that is a little too slow, how do you modify your control to improve the speed?

## 2. LABVIEW

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### 2.1 WORK OF SANTIAGO SUAREZ

**Question 18 (0.5 point):** Describe shortly the subject of the thesis of Santiago Suarez

**Question 19 (1 point):** One crucial aspect of his LabView program was to detect if the system was in adsorption or desorption phase. This was detected by maximum and minimum Temperature. A simple flip-flop did not work, so what solution was found?

### 2.2 LABVIEW FOR TEMPERATURE MEASUREMENT

In the context of a PhD thesis the temperature on the surface of battery cells is measured using LabView and NI DAQ system.

**Question 20 (0.5 point):** Explain shortly the difference between NI DAQ and NI RIO system.

The temperature measurement has the following requirements:

- at least 6 measurements must be done in parallel
- the scanned sampling rate must be above 20S/s per channel used
- the accuracy must be better than 0.5°C

**Question 21 (1 point):** In the table below, cross out the solutions that do not work and circle the parameter that does not work. Which solution do you chose?<sup>1</sup>

C Series Thermocouple Module Comparison								
Product	Channels	Connectivity	Accuracy <sup>1</sup>	Max Sample Rate, Scanned <sup>2</sup>	Max Sample Rate, Simultaneous <sup>3</sup>	Max Sample Rate, All Filtered <sup>4</sup>	OTD <sup>5</sup>	Isolation <sup>6</sup>
NI 9210	4	Screw Terminal	0.8°C	14 S/s	–	2.3 Scans/s	Yes	Ch-Earth
		Mini-TC	0.84°C					
NI 9211	4	Screw Terminal	0.9°C	14 S/s	–	2.3 Scans/s	Yes	Ch-Earth
NI 9212	8	Screw Terminal	0.4°C	–	95 S/s/Ch	7.1 Scans/s	Yes	Ch-Ch
		Mini-TC	0.7°C					
NI 9213	16	Spring Terminal †	0.8°C	100 S/s	–	1.0 Scans/s	Yes	Ch-Earth
NI 9214	16	Screw Terminal	0.4°C	100 S/s	–	0.96 Scans/s	Selectable	Ch-Earth
NI 9219	4	Spring Terminal	1.6°C	–	50 S/s/Ch	7.1 Scans/s	No	Ch-Ch

<sup>1</sup> Typical at 23±5°C operating temperature, For J-type sensor measuring 100°C.  
<sup>2</sup> This is the fastest rate of the module for a single channel. When scanning more than one channel, the sample rate is reduced, see data sheets for details.  
<sup>3</sup> This is the fastest rate of the module; it can sample all channels simultaneously at this rate.  
<sup>4</sup> This is the fastest rate of the module using all of its channels at the same time, with optimized rejection of standard power line frequencies. See data sheets for details about specific powerline frequencies.  
<sup>5</sup> Open Thermocouple Detection.  
<sup>6</sup> Ch-Ch isolation means that the channels are isolated from earth ground and from each other. Ch-Earth isolation means that the channels are isolated from earth ground but not from each other.  
<sup>†</sup> These connectors feature tool-less wire entry, meaning that solid core wires (AWG 26 - AWG 16) can be inserted without using a tool.

### 3. COMBINATION LABVIEW AND DSPACE

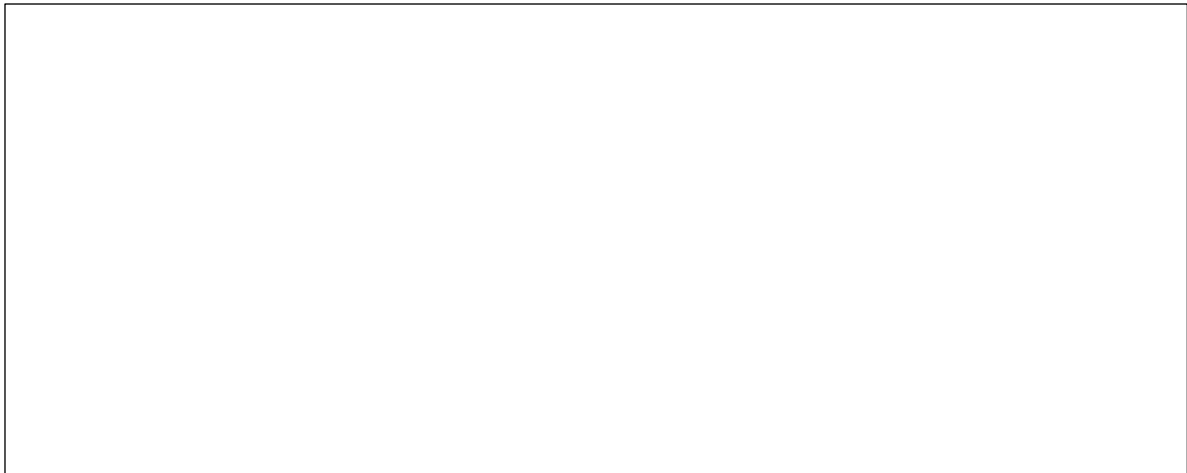
dSpace in combination with Simulink and National Instruments in combination with LabView can both be used for data acquisition and system control.

**Question 22 (0.5 points):** Explain shortly which hard- and software solution is more adapted for data acquisition, and which is more adapted for PWM control, or if both are equally well suited.

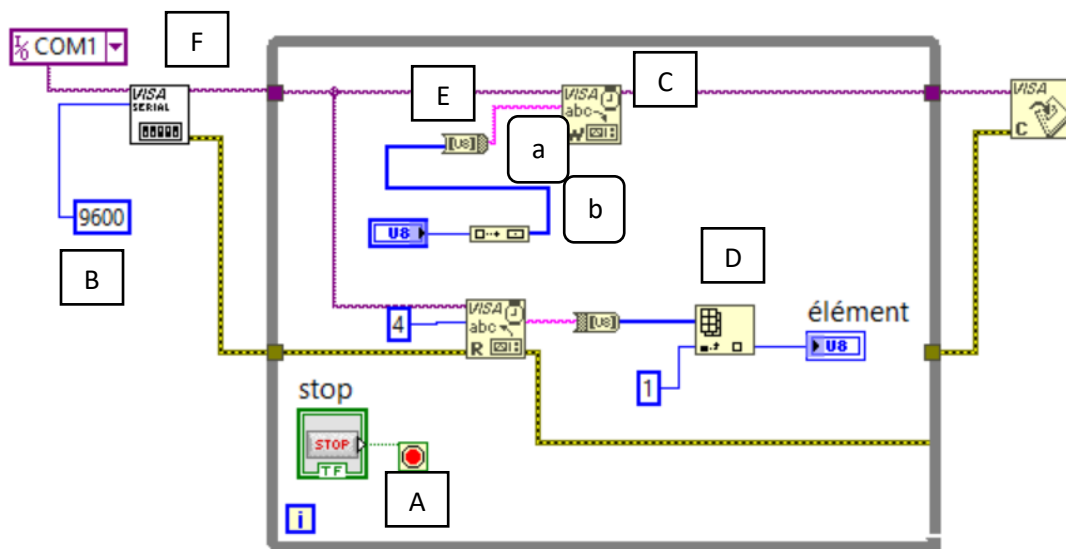
Now you want to transmit an 8 bit information in the two directions.

**Question 23 (2 points):** Draw, as good as you can, the Simulink program used to write, read the data. It is not necessary that you know the names of the blocks, but it would be good to indicate what they are good for.

<sup>1</sup> <https://www.ni.com/docs/fr-FR/bundle/ni-9210-specs/page/datasheet.html>



On the figure below, you find the LabView program used to establish the serial connection.



**Question 24 (4 points):** Explain the signification of the different block indicated by capital letters and the two data types indicated by small letter

A	
B	
C	
D	
E	
F	
a	
b	