SM 53: Final Exam A18

Family Name:

Given Name:

No documents allowed - Answer on this document – Answer in English

1. General Questions – 8 Points

1.1 Multiple Choice Questions – 6 Points

You get +0.3 points for each correct answer, -0.3 points for each wrong answer and 0 points if you do not answer. There is only one correct answer.

Question 1	What does RCP stand for?	☐ Rapid Control Prototyping ☐ Renewable Capacity Prediction ☐ Recent Clearance Protocol
Question 2	What is RCP good for?	☐ Replace not existing hardware ☐ Replace non existing ECU ☐ Produce missing hardware
Question 3	You want to test a new sensor. What is the most easy way to test it?	☐ create a simple VI ☐ Use NI MAX ☐ Connect hardware to oscilloscope
Question 4	What is the value that is most measured from sensors?	☐ Current ☐ Voltage ☐ Digital signals
Question 5	What does the Nyquist Shannon theorem say?	☐ It is a diagram that helps to study the stability of a system using frequency and amplitude. ☐ It states how to translate an analog signal into digital signals correctly. ☐ It describes the link between measured voltage and current trough a wire.
Question 6	If a function x(t) contains no frequencies higher than B hertz, give the appropriate sample rate in fs:	☐ B<fs/2 ☐ fs<2B ☐ fs>B/2
Question7	What is a cluster?	☐ A structure that combines one or more components into a new data type. ☐ A group of data components of the same type. ☐ A mixed group of indicators and controls.
Question 8	Is the order in a cluster important?	☐ No. ☐ Yes, but it can be changed. ☐ Yes, and it cannot be changed.
Question 9	What is an error cluster good for?	☐ Only indicate if there is an error.

		☐ Indicate where an error occurs and give hints for solution. ☐ Clearly indicate how to solve an error.
Question 10	Is it possible to remote control a front panel?	☐ No, you can change and update front panels only on the host computer. ☐ Yes, multiple clients can see and control front panel simultaneously. ☐ Yes, multiple clients can see the front panel but only one can control it from distance.
Question 11	Real time computing What minimum sample time do you chose?	You want to create a duty cycle signal with a maximum frequency of 10kHz. The time to read the input is to 60µs. The data processing time is 1µs. The time to write to the output is 10µs. ☐ 100µs ☐ 200µs ☐ 400µs
Question 12	What does FPGA stand for?	☐ Fast Programming Generation Algorithm ☐ Following Plan for Greater Applications ☐ Field-Programmable Gate Array
Question 13	What is specific about FPGA?	☐ Works as a central processing unit (CPU) ☐ It's a reprogrammable integrated circuit ☐ It's the RCP platform of dSpace
Question 14	In which context do we use ControlDesk?	☐ As part of Simulink. ☐ To control the hardware. ☐ To create a link with RCP running on the interface.
Question 15	What is the name of the dSpace material used in the lab?	☐ Micro Auto Box ☐ DS1104 card ☐ Rapid Pro System
Question 16	Which values can be read or modified via control desk?	☐ Only Constants and Labels ☐ Only Labels and Gains ☐ Constants, Labels and Gains
Question 17	What is the difference between a rotating and a static emulator?	☐ A static simulator only works on one point and does not include dynamics. ☐ There are no moving parts in a static emulator, but there is in a rotating emulator. ☐ A rotating emulator is always designed by a DC machine.
Question 18	Why we often choose DC machine as emulators?	☐ Simple link between current and torque. ☐ Very efficient machine.
Question 19	Which behavior do you test first in a control system?	☐ Steady state ☐ Transient ☐ There is no difference
Question 20	If you install a PI controller, which approach is the least performant?	☐ Try and error ☐ Deterministic approach using transfer function ☐ Experimental tuning method

1.2 Design Process – 2 Points

Present the different steps of how to build a RCP in form of a picture, including the main aspects the hard or software used and possible loops.

2 Data Acquisition – 7 points

2.1 NI myDAQ – 4 points

The NI myDAQ as presented in Figure 1 is a low-cost portable data acquisition (DAQ) device that uses NI LabVIEW-based software instruments, allowing students to measure and analyze real-world signals.

Figure 1 : NI myDAQ

Analog Input (AI)

There are two analog input channels on NI myDAQ. These channels can be configured either as general-purpose high-impedance differential voltage input or audio input. The analog inputs are multiplexed, meaning a single analog-to-digital converter (ADC) is used to sample both channels. In general-purpose mode, you can measure up to ±10 V 16 bit signals. … Analog inputs can be measured at up to 200 kS/s per channel….

Analog Output (AO)
There are two analog output channels on NI myDAQ. These channels can be configured as either general-purpose voltage output or audio output. Both channels have a dedicated digital-to-analog converter (DAC), so they can update simultaneously. In general-purpose mode, you can generate up to ±10 V 16 bit signals… Analog outputs can be updated at up to 200 kS/s per channel, making them useful for waveform generation. …

Digital Input/Output (DIO)
There are eight DIO lines on NI myDAQ. Each line is a Programmable Function Interface (PFI), meaning that it can be configured as a general-purpose software-timed digital input or output, or it can act as a special function input or output for a digital counter.

Power Supplies
There are three power supplies available for use on NI myDAQ. +15 V and -15 V can be used to power analog components such as operational amplifiers and linear regulators. +5 V can be used to power digital components such as logic devices.
The total power available for the power supplies, analog outputs, and digital outputs is limited to 500 mW (typical)/100 mW (minimum). To calculate the total power consumption of the power supplies, multiply the output voltage by the load current for each voltage rail and sum the absolute values together. For digital output power consumption, multiply 3.3 V by the load current. For analog output power consumption, multiply 15 V by the load current. Using audio output subtracts 100 mW from the total power budget.

2.1.1 Question
Is it possible to measure a voltage variation of 20 µV with this device? Underline your answer with a calculation.

2.1.2 Question
What will be the maximum sampling frequency if we want to use the two AO channels at the same time? (Value and explanation.)

2.1.3 Question
What will be the minimum buffer size if you want to measure 3 periods at 100Hz with the highest sampling frequency? (Equation and value.)

2.1.4 Question

Calculate the power consumption if we use for example 50 mA on +5 V, 2 mA on +15 V, 1 mA on -15 V, use four DIO lines to drive LEDs at 3 mA each, and have a 1 mA load on each AO channel, no audio channel is used:

2.2 EXAMPLE PROGRAM – 3 POINTS

Figure 2 presents the example of a Labview Program that is used to measure the voltage of sixteen different fuel cells at the same time.

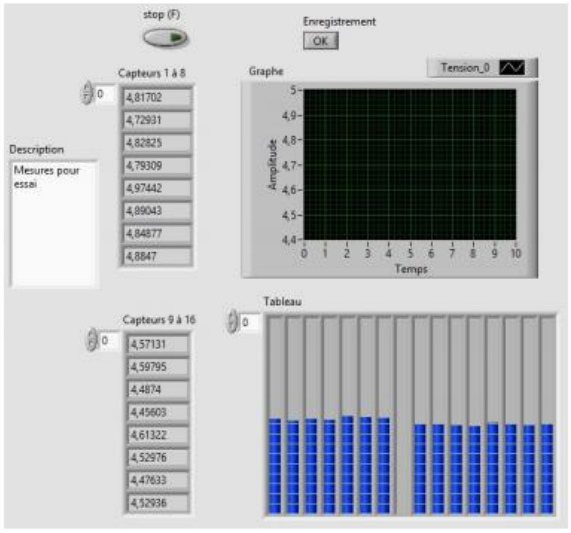

Figure 2 : Overview of the Front Panel

2.2.1 Based on the diagram, which two aspects of values are supervised?

2.2.2 The program contains two “Assistant DAQ” why are they used? Is this a problem?

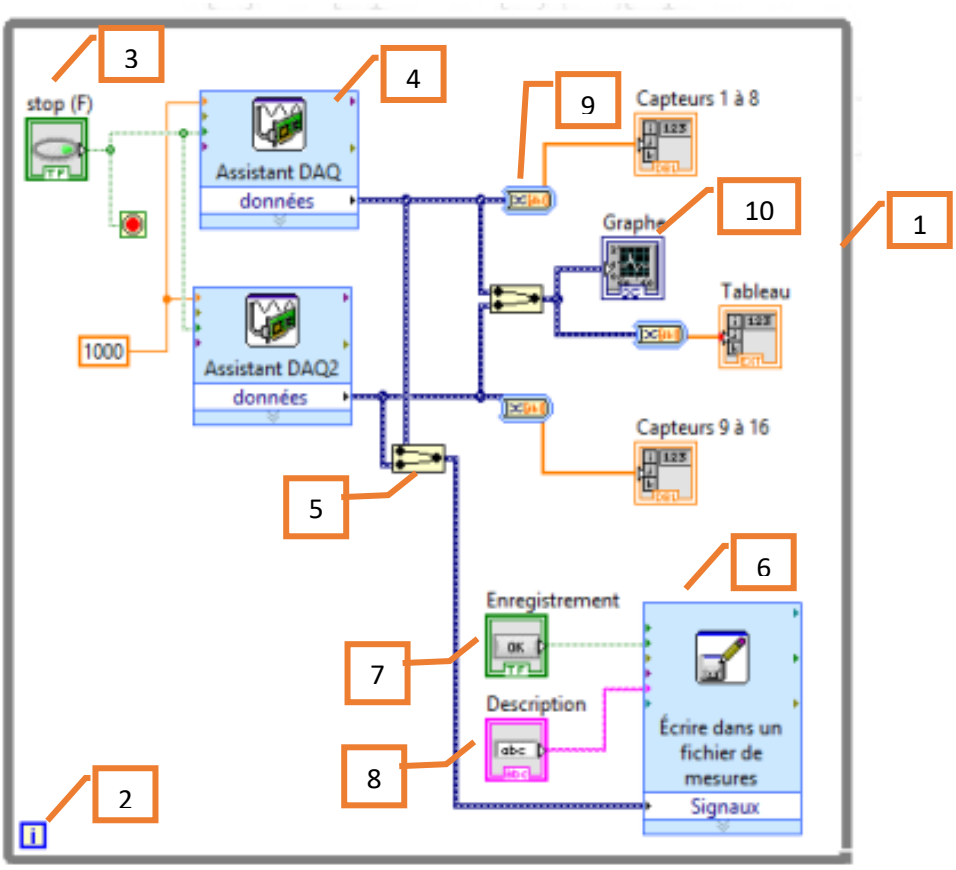

Figure 3 : Labview Program presented by Antony Plait

2.2.3 Explain the functions realized in the blocks with the numbers in Figure 3.Realization of a

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

3 PROGRAM USING DSPACE– 5 POINTS

Goal of the work of Huan LI was to study the energy management inside a hybrid vehicle with the architecture presented in Figure 4. Most of the hardware components were available. The energy management was realised via RCP using a microAutoBoxII.

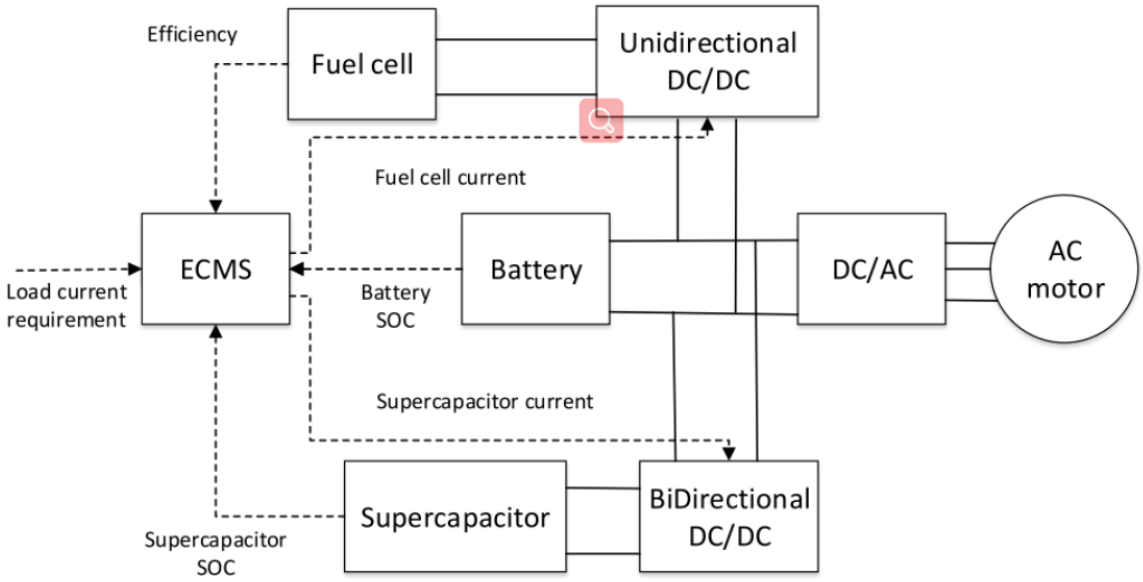

Figure 4 : Architecture of hybrid vehicle studied by Huan LI

3.1 MEASURE SYSTEM VALUES – 3 POINTS

3.1.1 Explain the components of the program in Figure 5, which are required to measure the values correctly.

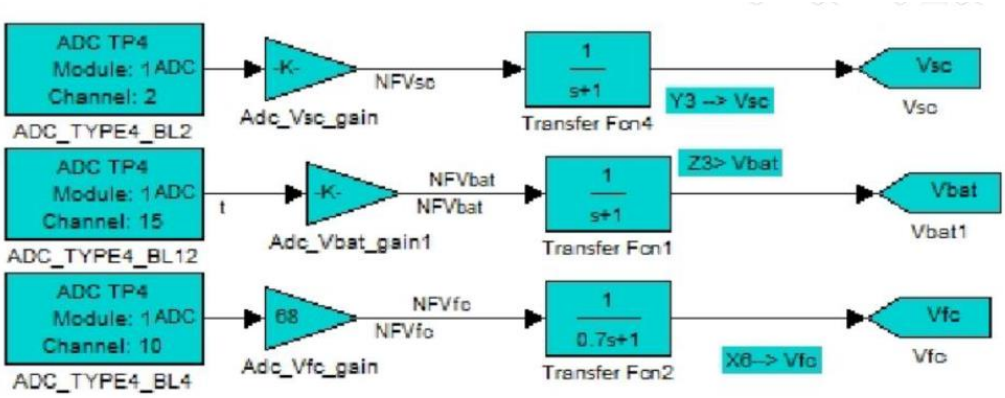

Figure 5 : Measurement of system values

3.1.2 What gain do you have to choose in order to adapt the voltage measurement shown above? Knowing that you used a testing probe with a ratio of 1/100 and the ADC datasheet indicates.

Input Voltage Range	Simulink Output
0 V ... +5 V	0 ... +1

(Determine value based on an example.)

3.2 System Control – 2 Points

Explain the main aspects of the control of the power supply and electronic load work.

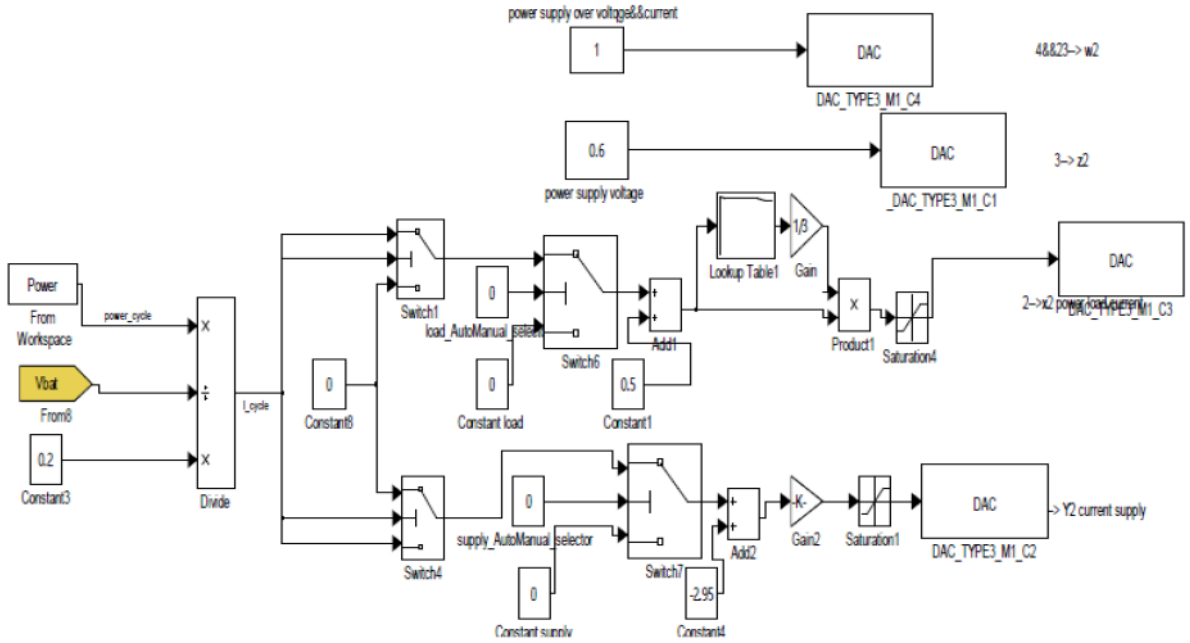

Figure 6 : Control of power supply and electronic load using MicroAutoboxII