

ENTIC-lab

Answers to WP questions

Igor Yuziv
Edison Gabriel Zaragosin
Oriol Torres
Albert Tomas
Daniel Vilardell

2020-2021



Índex

| | |
|-------------------------------|-----------|
| 1 WP1 - Mechanical | 4 |
| 2 WP2 - Electrical | 6 |
| 3 WP3 - Electronics | 10 |
| 4 WP4 - Communications | 19 |
| 5 WP5 - Nom | 30 |
| 6 Part A Conclusion | 35 |

Before doing any certain task, the related questions must be answered in this file.

You must update this file as many times as necessary with the format

WPAnswers.g.t.pdf

(Keep the Atenea task in draft status until you finish the Lab-Project part A)

Question 0.1: How often must you deliver a Gantt Diagram updated version?

- At the beginning of each WP
- **Each lab session**
- At the beginning and at the end of Parts A and B

Question 0.2: If you are the team 7 of subgroup 63, which is the right filename for deliver the Final Report in Atenea at the end of the semester? What is the deadline day for deliver this document?

The filename would have to be FinalReport_63_7 and the deadline for this document to be delivered is 14/01/2021.

Question 0.3: What penalization will have you if you deliver a document one week later?

- 15%
- **30%**
- 50%

Question 0.4: When you must deliver the Answers to the WP questions?

- At the beginning of each WP
- At the end of each Part
- **Continuously during the semester, when you need the answer of each question%**

Question 0.5: How you plan to avoid the “Hitchhiker and Couch Potatoes” in your team?

In order to avoid the “Hitchhiker and Couch Potatoes” in our team, what we will do is to make sure that there is good communication between us and that we all understand what our task is and what we are doing at all times. If in any case there were a problem, the teacher would be notified quickly in order to solve it as soon as possible.

1 WP1 - Mechanical

Question 1.1: Calculate how much additional weight is necessary if the holes are not made in the ROUV elbows PVC structure.
Inner diameter of PVC pipe: 16 mm.

We can calculate the total volume with the following formula

$$\text{Total volume} = \# \text{Tubes} \cdot \pi r^2 l$$

Then we find the weight for each group of tubes

$$8 \cdot \pi \cdot 0.8^2 \cdot 15 = 241.27 \text{ cm}^3$$

$$2 \cdot \pi \cdot 0.8^2 \cdot 10 = 40.21 \text{ cm}^3$$

$$4 \cdot \pi \cdot 0.8^2 \cdot 5 = 40.21 \text{ cm}^3$$

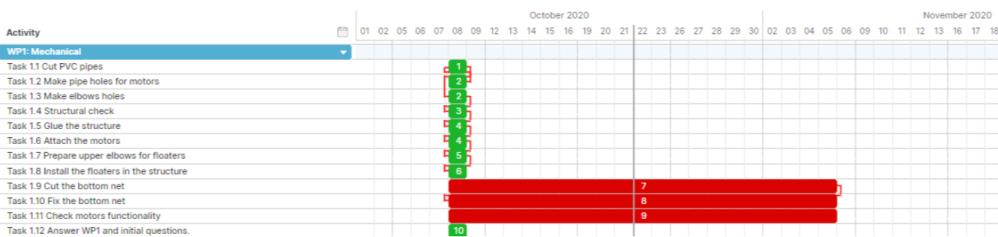
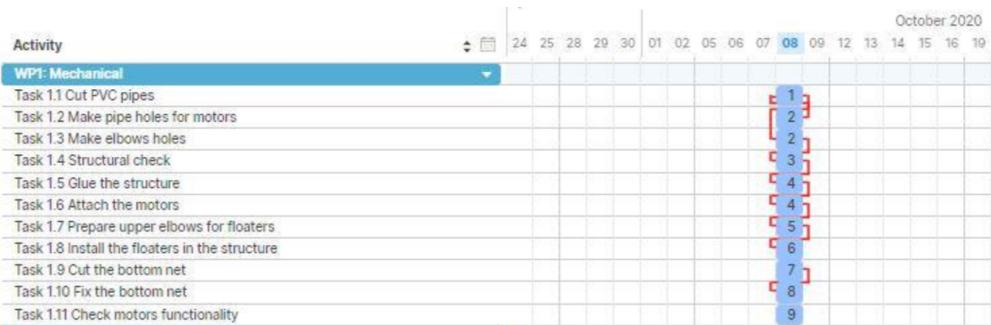
Then using a conversion factor we can calculate the total weight with the sum of the previously calculated volume, $241.27 + 40.21 + 40.21 = 321.69 \text{ cm}^3$.

$$\text{Weight} = 321.69 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{1 \text{ m}^3}{1000 \text{ dm}^3} \cdot \frac{1 \text{ kg}}{1 \text{ dm}} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} = 0.321 \text{ g}$$

Question 1.2: Which is the maximum voltage applicable to the electrical motor? Which current is demanded by the motor at the maximum speed?

The maximum voltage applicable to the electrical motor is 12V and the current by the motor at maximum speed is 2.5A.

Question 1.3: Include a picture of the initial and final Gantt diagrams of WP1, making a reflexion about the progress and explaining any delay in the development of the tasks.



Reflexion: We've initially planned to finish all tasks in the same day but we couldn't access for around 2 weeks to laboratory to use drill and other materials, due to sanitary problems. The delayed activities were short so that delay was not significant.

2 WP2 - Electrical

Question 2.1: In the market there are different types of switches. Which type among the switch models shown in Fig. 2.2 are we using in this project?

We are going to use a DPDT switch because the motor is just compatible with it.

Question 2.2: The ROUV motors are the core of nautical bilge pumps Johnson L450 model (specifications are available in ATE-NEA Support Documents section). Which is the electrical power required for one ROUV motor? Calculate the total electrical power the ROUV battery must supply. Which is the fuse value in your stock material? What are you protecting with this fuse?

According given datasheet L450: $V = 12$, $I = 2.5$. We will use three motors to have X3 power than before.

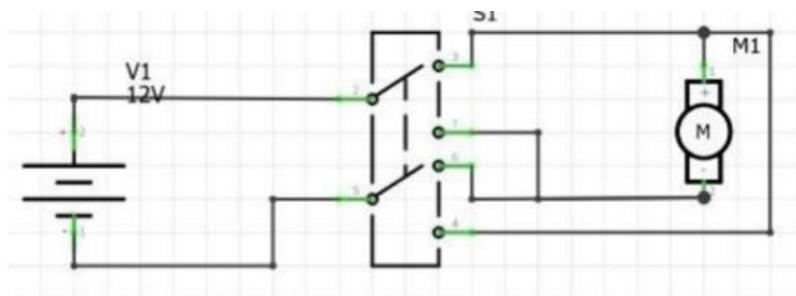
$$P = 3VI = 3 \cdot 12 \cdot 2.5 = 90W$$

The value of the fuse in our stock material is 5A according to the manual given. With this fuse we are protecting the circuit from getting overloads or overcurrents.

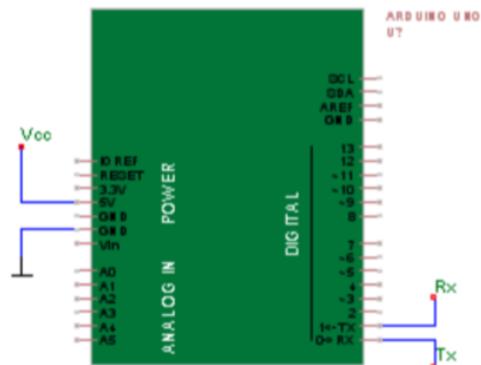
Question 2.3: You must make some soldering to electrically connect different parts of your vehicle. You can watch some videos in YouTube about how to solder like, for example, https://youtu.be/xrVCkEoY_8M. Which is the use of the sponge we have in the solder holder?

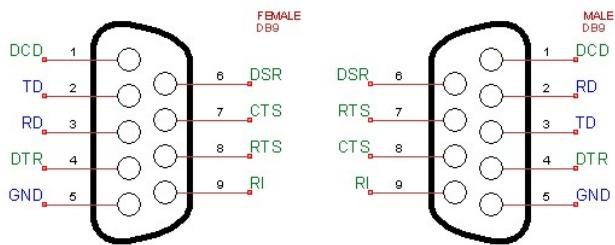
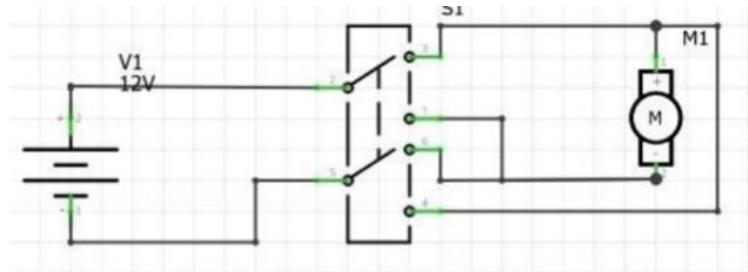
Sponge is used to clean soldering tip when it is hot, cleaning is so important to make a strong welds.

Question 2.4: Now it is time to make all the connections with the flexible wires inside the box to control the ROUV motors. Draw a sketch of the complete electrical circuit using the CAD schematic software <https://www.tinycad.net/>. In ATENEA Support Documents section an specific library for ENTIC is available. If you need more information to do this, you can search images in internet about “DPDT motor”.

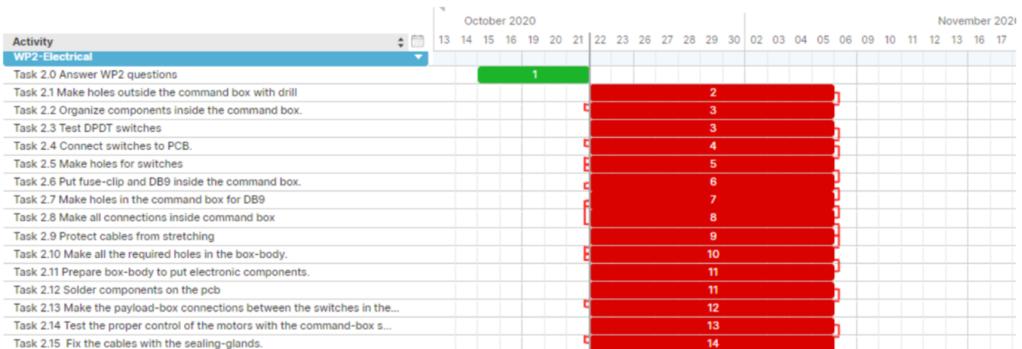
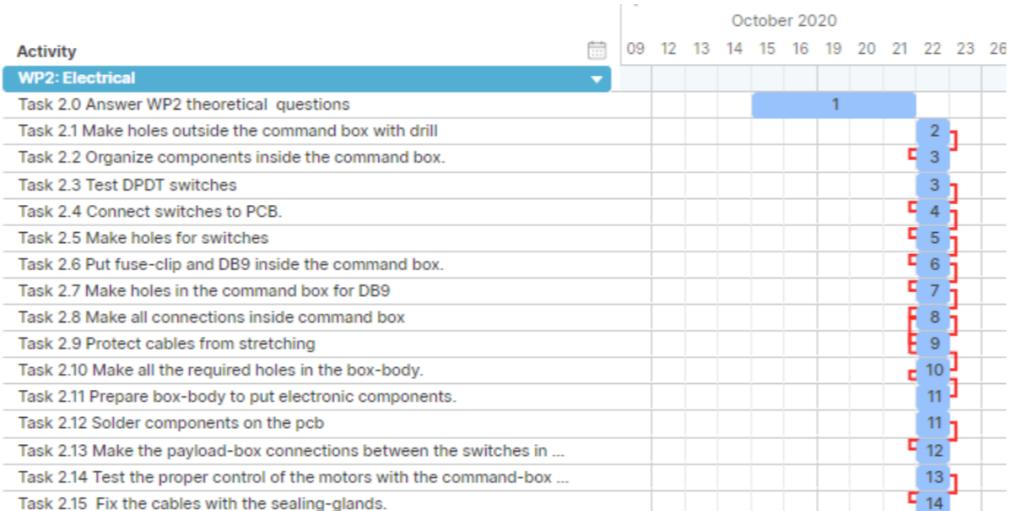


Question 2.5: Update yourskech of the electrical circuit (include the fuse and the DB9 connector)





Question 2.6: Include a picture of the initial and final Gantt diagrams of WP2, making a reflexion about the progress and explaining any delay in the development of the tasks.



Reflexion: We'd planned to begin with the first task before going to laboratory, from the second activity we've planned to finish the rest of the tasks in the same day but we couldn't access for around 2 weeks to laboratory to use oscilloscope, voltage sources and other materials, due to sanitary problems. The delayed activities weren't too short so that delay was difficult to overcome.

3 WP3 - Electronics

Question 3.1: Which pressure increase will be observed at 3 m depth?

$$0.986 \cdot \frac{3}{10} = 0.2958 \text{ Atm}$$

Question 3.2: Will this pressure depend or not on the atmospheric pressure at water surface? Why?

If what we want is to calculate the real pressure that will be exerted on the ROUV, we must also take into account the atmospheric pressure on the surface. On the other hand, if what we want is only to calculate the increase with respect of this, it will not be necessary.

Question 3.3: Analyse the circuit of Fig. 4.2 and obtain the output voltage V_S . Then, find the dependence of V_S on the relative variation due to deformation (x) and on the power supply voltage (V).

$$\begin{aligned}\frac{V - V_1}{R_o(1+x)} &= \frac{V_1}{R_o(1-x)} & \frac{V - V_1}{(1+x)} &= \frac{V_1}{(1-x)} \\ \frac{V - V_2}{R_o(1-x)} &= \frac{V_2}{R_o(1+x)} & \frac{V - V_2}{(1-x)} &= \frac{V_2}{(1+x)} \\ (V - V_1)(1-x) &= V_1(1+x) \\ (V - V_2)(1+x) &= V_2(1-x)\end{aligned}$$

Now we isolate V_1 and V_2 :

$$\begin{aligned}V_1 &= \frac{V(1-x)}{2} & V_2 &= \frac{V(1+x)}{2} \\ V_s &= V_2 - V_1 \text{ so } V_s = -V \cdot x\end{aligned}$$

Question 3.4: The datasheet of the sensor is available in Atenea. Identify there the full scale output, and then deduce the sensor sensitivity and its value when the supply voltage is not 10 V but 5 V.

Sensor sensitivity is $O = V \cdot P$. So when we have 2 voltages $O_1 = V_1 \cdot P$ and $O_2 = V_2 \cdot P$

We know that $O_1 = 0.4 \frac{mV}{kPa}$ at $V_1 = 10V$. Then, we calculate O_2 .

$$O_2 = \frac{O_1 \cdot V_2}{V_1} = \frac{0.4 \cdot 5}{10} = 0.2 \frac{mV}{kPa}$$

Question 3.5: What output voltages V_0 will provide the sensor at the water surface (at $P=100$ kPa) and at 3 m depth?

Since $O = \frac{V}{P}$, then

$$V_s = O \cdot P = 0.2 \cdot 100k = 20mV$$

$$V_{3m} = O \cdot P = 0.2 \cdot 130k = 26.3mV$$

Question 3.6: In a real case and due to changing atmospheric conditions, the pressure at the water surface can be different than 100 kPa, discuss how you could fix such effect and obtain the correct pressure data.

To solve this problem, we are going to measure the atmospheric pressure in the laboratory so that we avoid errors.

Question 3.7: Analyse the circuit of Fig. 4.4 and obtain its gain expression $V_0/(V_2-V_1)$ when $R_1/R_2=R_4/R_3$. Identify the role of R_g as a gain trimmer without compromising the R_1-R_4 resistance matching.

$$\begin{aligned} V_1 \cdot G_1 + (V_1 - V_2) \cdot G_g + (V_1 - V_x) &= 0 \\ (V_2 - V_x) \cdot G_3 + (V_2 - V_1) \cdot G_g + (V_2 - V_o) \cdot G_4 &= 0 \\ (V_2 \cdot G_3 \cdot G_g) - V_1 \cdot G_3 \cdot (G_1 + G_2 + G_g) &= \\ = (V_0 \cdot G_2 \cdot G_4) + (V_1 \cdot G_g \cdot G_2) - G_2 \cdot V_2 \cdot (G_3 + G_4 + G_g) & \end{aligned}$$

Let's assume $G_2 \cdot G_4 = G_1 \cdot G_3$, then we isolate:

$$V_0 = \frac{V_2 - V_1 \cdot (G_3 \cdot G_g + G_2 \cdot G_3 + G_2 \cdot G_g + G_4 \cdot G_2)}{G_2 \cdot G_4}$$

$$\frac{V_0}{V_2 - V_1} = 1 + \frac{R_1 + R_4}{R_g} + \frac{R_4}{R_3}$$

Question 3.8: Compare this result with the gain expression provided by the manufacturer using the resistor values shown in the INA126 datasheet.

$$G = 5 + \frac{80k\Omega}{R_g}$$

$$R_4 = R_1 = 40k\Omega \quad R_2 = R_3 = 10k\Omega$$

Question 3.9: Identify the saturation voltage of the amplifier

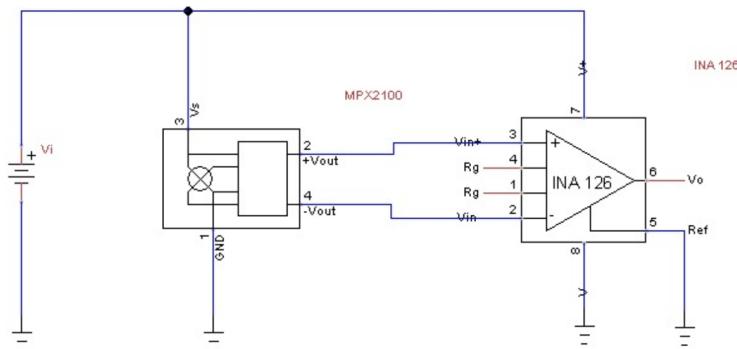
$$5V - 0,75V = 4,25V = V_{sat}$$

Question 3.10: Which amplifier gain is necessary to obtain the maximum amplifier voltage output for 3m depth? Which R_g resistor value will provide this gain?

$$G = \frac{v_{sat}}{v_{in}} = \frac{4.25}{0.02635} = 161.5$$

$$R_g = \frac{80}{163.46 - 5} = 504.86 \Omega \approx 510 \Omega$$

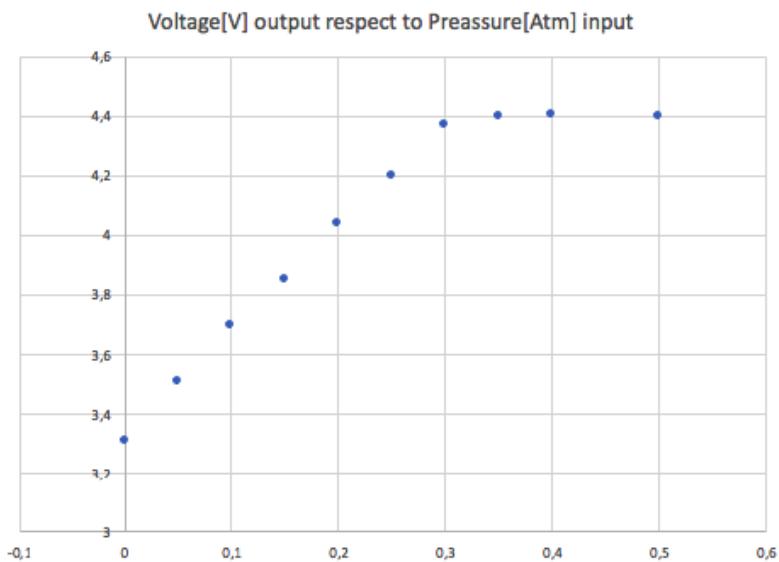
Question 3.11: Draw the sensor+amplifier schematic using the CAD schematic software <https://www.tinycad.net/>

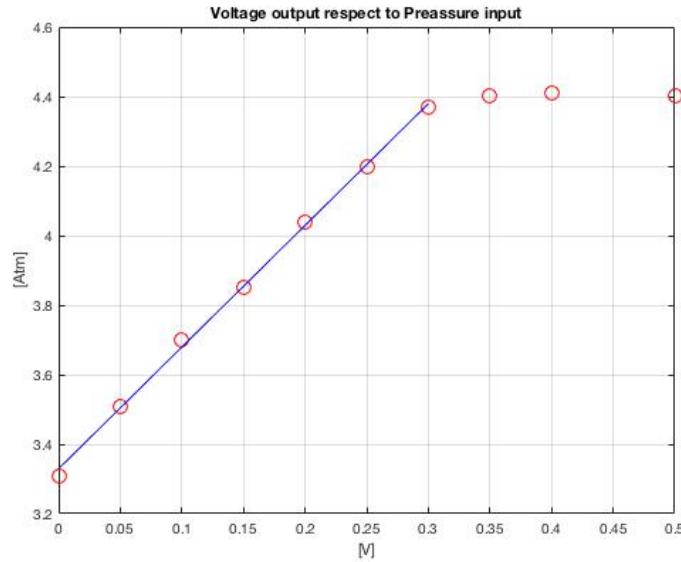


Question 3.12: Obtain in the lab 10 measurement points along the measurement range. Draw its graphical representation, calculate and plot the linear regression and the linearity error (lineal regression straight line – measured points).

| Preassure[Atm] | Voltage[V] |
|----------------|------------|
| 0 | 3.31 |
| 0.05 | 3.51 |
| 0.1 | 3.7 |
| 0.15 | 3.85 |
| 0.2 | 4.04 |
| 0.25 | 4.2 |
| 0.3 | 4.37 |
| 0.4 | 4.40 |
| 0.45 | 4.41 |
| 0.5 | 4.40 |

Taula 1: Voltage output respect to Preassure input





We can see that it reaches the saturation voltage once the pressure is 0.3Atm, which is what we were looking for.

```

1 clear;
2 x = [ 0; 0.05; 0.1; 0.15; 0.2; 0.25; 0.3; 0.35; 0.4;
      0.5];
3 y = [3.31; 3.51; 3.7; 3.85; 4.04; 4.2; 4.37; 4.4; 4.41;
      4.4];
4
5 plot(x, y, 'ro', 'MarkerSize', 10);
6 grid on;
7 % Get the fit
8 coeffs = polyfit(x(1:7), y(1:7), 1);
9 % Get the x values for the fit at higher resolution.
10 xFit = linspace(x(1), x(7), 300);
11 % Get the estimated y values
12 yFit = polyval(coeffs, xFit);
13 % Plot them as a line.
14 hold on;
15 xlabel('[V]')
16 ylabel('[Atm]')

```

```

17 title('Voltage output respect to Pressure input')
18 plot(xFit, yFit, 'b-', 'LineWidth', 1);

```

Question 3.13: Calculate the digital data range provided by the acquisition circuit in measurements from 0 to 3m of water depth. Consider that the 10 bit A/D converter of the Arduino assigns 0 to a 0V input and 1023 (2¹⁰-1) to a 5V input.

The expected values from the arduino measurement acquisition should be inside the interval

$$\left[\frac{V_0}{5} \cdot 1023, \frac{V_{0.3}}{5} \cdot 1023 \right] = \left[\frac{3.31}{5} \cdot 1023, \frac{4.4}{5} \cdot 1023 \right] = [677.2, 900.24]$$

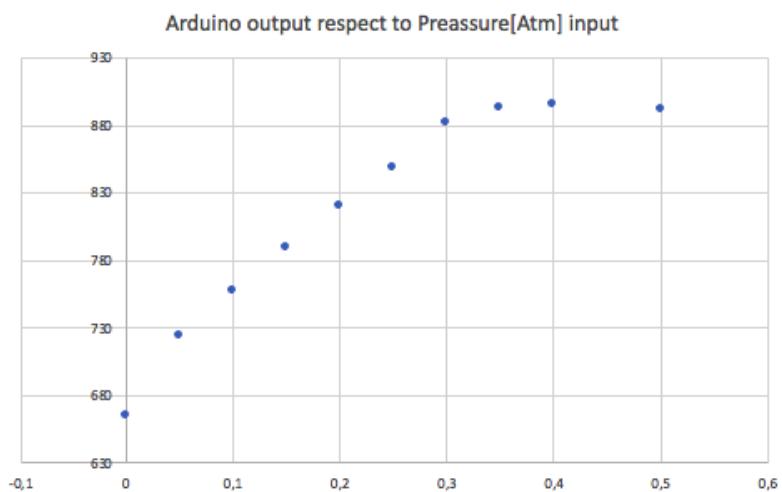
Question 3.14: Explain briefly what is the purpose of the following functions, used in the sketch of Fig. 4.5: Serial.begin(), analogRead(), Serial.println() and delay().

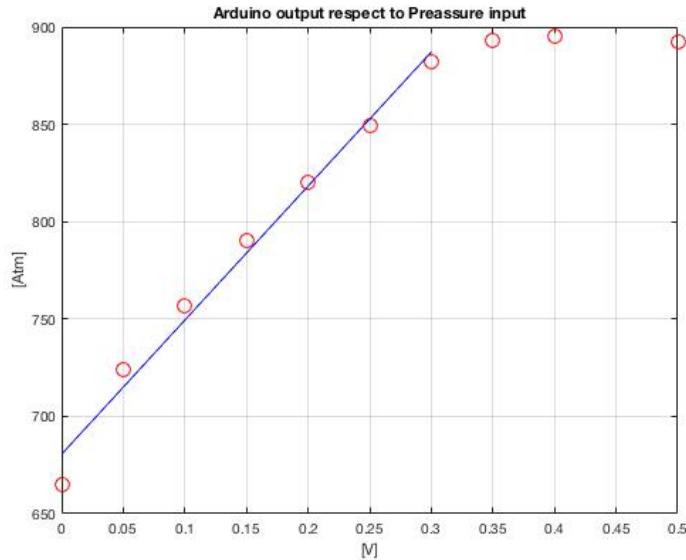
- **Serial.begin():** Sets the data rate in bits per second for serial data transmission.
- **analogRead():** Reads the value from the specified analog pin.
- **Serial.println():** Prints data to the serial port and skip the line.
- **delay():** Pauses the program for the amount of time specified as parameter.

Question 3.15: While acquiring measures with the Arduino, smoothly increase the pressure to simulate a depth change from 0 m to 3 m. Do the measurement results displayed on the serial monitor match with the theoretical ones obtained in Question 3.13? If not, explain why. NOTE: If you are at home, use the potentiometer or the temperature sensor instead of the pressure sensor.

| Preassure[Atm] | Arduino output |
|----------------|----------------|
| 0 | 665 |
| 0.05 | 724 |
| 0.15 | 757 |
| 0.2 | 790 |
| 0.25 | 820 |
| 0.3 | 849 |
| 0.35 | 882 |
| 0.4 | 893 |
| 0.45 | 895 |
| 0.5 | 892 |

Taula 2: Arduino output respect to Preassure input

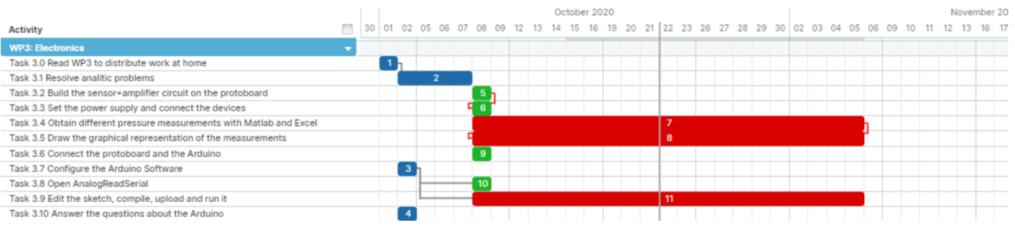




We can see they are almost the same, there is a small attenuation thought that can be produced by the resistance in the cable connected from the arduino to the computer.

Question 3.16: Include a picture of the initial and final Gantt diagrams of WP3, making a reflexion about the progress and explaining any delay in the development of the tasks.





Reflexion: Some activities in this WP could be done remotely from home so we could finish them before going to laboratory, despite of the same problem mentioned before we've delayed for two weeks some activities, fortunately these activities consisted in making short measurements and we could finish them quickly.

4 WP4 - Communications

Question 4.1: Encode in plain binary (2 bytes) the following measured value: 663. Determine the pressure corresponding to this value.

We can see that $663_{10} = (2^0 + 2^1 + 2^2 + 2^4 + 2^7 + 2^9)_{10} = 1010010111_2$

Question 4.2: Encode in ASCII the following measurement data: 25, 663, 1012.

| Number | Ascii encoded number |
|--------|----------------------|
| 25 | 50 53 |
| 663 | 54 54 51 |
| 1012 | 49 48 49 50 |

Question 4.3: Go to the Arduino language reference and identify which types are suitable to work with the numeric data provided by the A/D converters. What code length (in bytes) corresponds to each type?

| Type of Data | Lenght(Byte) |
|--------------|--------------|
| Byte | 1 |
| Double | 4 |
| Float | 4 |
| Int | 2 |
| Long | 4 |
| Short | 2 |
| ASCII | 3 |

Question 4.4: Compare the screen captures obtained and explain the differences found. What sequence of bytes is really sent in each case?

```
Monitor en serie
Send 'S' to start
Starting measurement
237
958
587
606
833
398
20
832
948
186
992
330
723
364
941
347
129
310
387
988
689
361
688
663
199
697
24
571
384
442
777
740
123
```

Figura 1: Code executed using `println()`

```
Monitor en serie
menu > LU start
Send 'S' to start
Starting measurement
633541987822488363636746373101924773824132489426107002691189126956619890674811069463489
```

Figura 2: Code executed using `print()`

The difference between the two codes is that `Serial.println()` shows each value in a new line, whereas `Serial.print()` prints them in the same line, one after the other without spaces. The first command is easier for us to

understand and see the different values.

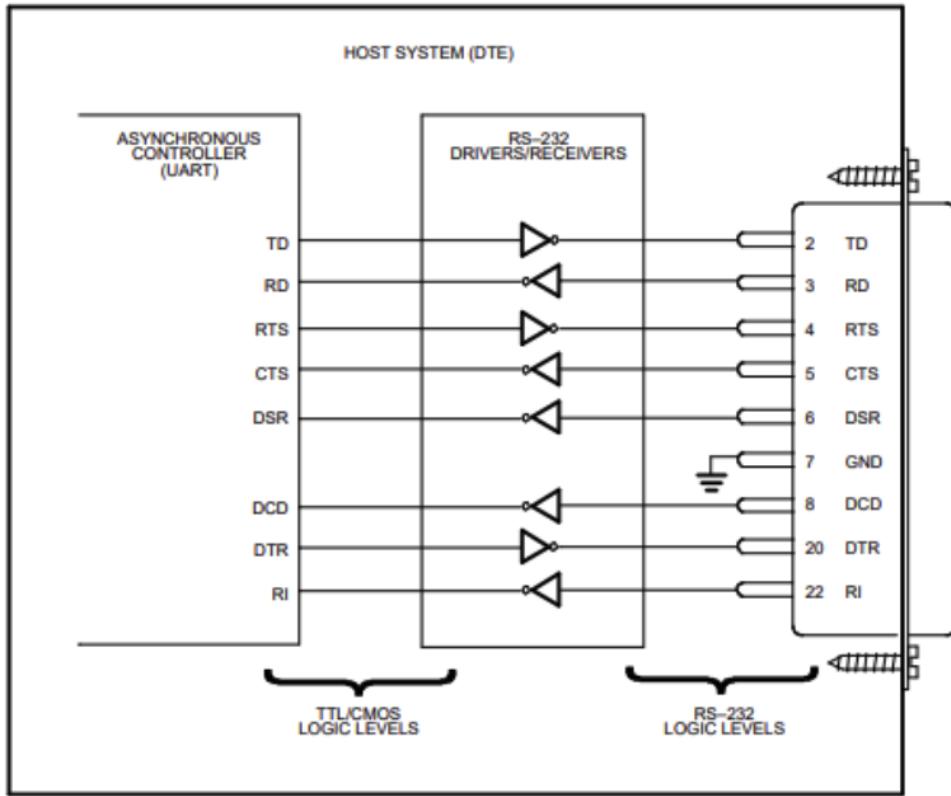
Question 4.5: List the serial port(s) COMx available in your computer.

The computer has the following ports:

- Arduino Uni (COM10)
- Arduino Uni (COM3)
- Arduino Uni (COM5)
- Arduino Uni (COM8)
- Arduino Uni (COM9)
- Communication Port (COM1)
- Intel(R) Active Management Technology - SOL (COM4)
- USB Serial Port (COM11)
- USB Serial Port (COM6)
- USB Serial Port (COM7)

Question 4.6: Identify the cables color connected at the RS-232 send and receive pins.

Send cables: Green, blue, black. Receive cables: Orange, white, gray.



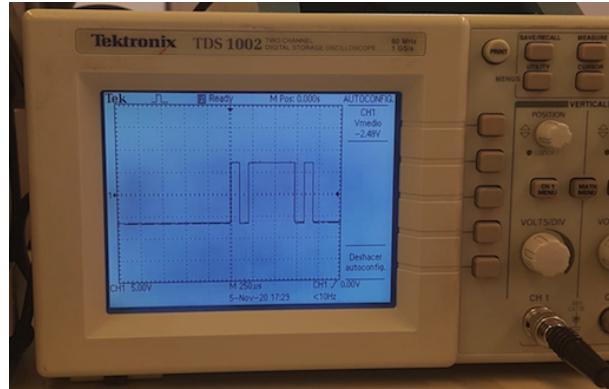
Question 4.7: Calculate which time-base must be selected in the oscilloscope to see 10 bits on the screen at the transmission rate selected by default in Terminal.

$$\text{Trans.rate} = \frac{1}{9600}$$

$$t = 10 \cdot \text{Trans.rate} = \frac{10}{9600} = 1.04\text{ms}$$

Question 4.8: Capture the waveform displayed on the oscilloscope. Determine the voltage levels, bit period and the number of bits per character. Which level indicates the idle state? Using an ASCII table explain the waveforms displayed for 3 different characters.

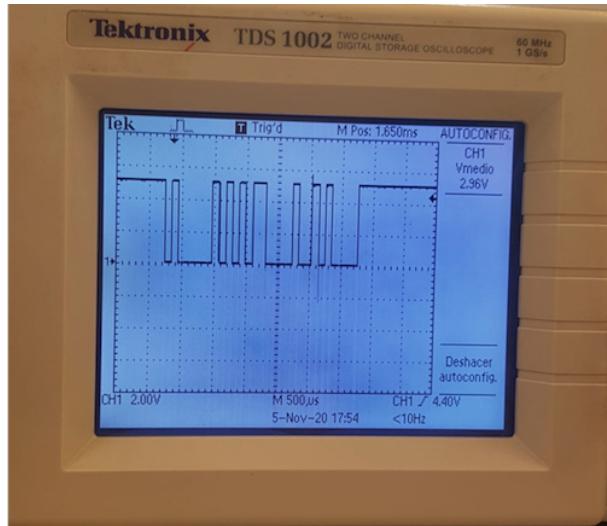
We can see in the picture the transmission and reception of character 'A' which in binary is 01000001 , high voltage= 0 , low voltage =1,



Question 4.9: What is the reason to use RS-232 to communicate with the ROUV, instead of using USB (which is available in both the Arduino and the computer)?

The reason why we used RS232 communication instead USB cable is that the total system mix some features from different systems and RS232 can be used as base and let us communicate.

Question 4.10: Capture the waveform displayed on the oscilloscope. Obtain the voltage levels of the signal. Which level corresponds to the idle state?

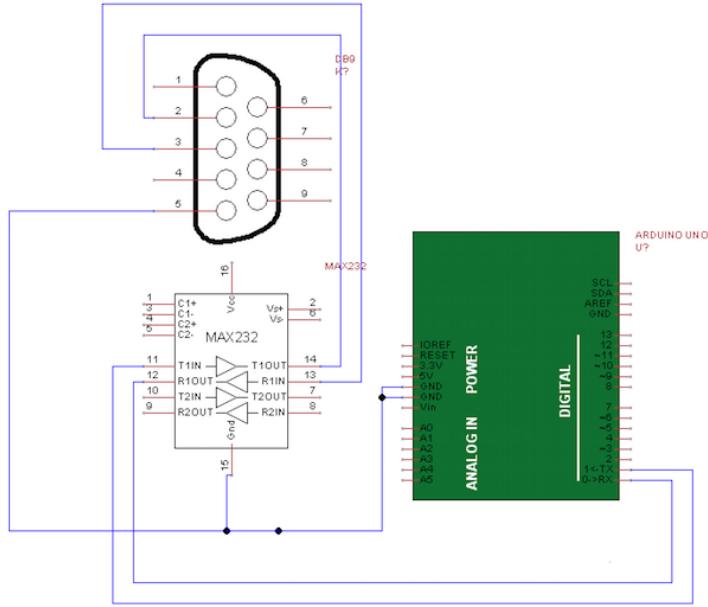


The voltage levels are:

- high voltage: 5V when 1.
- low voltage: 0V when 0.

Question 4.11: Draw the schematic (using the CAD schematic software <https://www.tinycad.net/>) of the level shifter circuit, including only the transmission path (from the Arduino Tx pin to the RS-232 DB9-female connector). What are the appropriate values of capacitors C1, C2, C3 and C4?

The schematic is the following one



Podem veure al manual els següents valors recomanats, per tant, com que el nostre voltatge va de 5V a 0V, els que agafarem seran $C1 = 0.1\mu F$ i $C2 = C3 = C4 = 0.47\mu F$

| V _{CC} vs CAPACITOR VALUES | | | |
|-------------------------------------|---------------|--------------|--|
| V _{CC} | C1 | C2, C3, C4 | |
| 3.3 V \pm 0.3 V | 0.1 μF | 0.1 μF | |
| 5 V \pm 0.5 V | 0.047 μF | 0.33 μF | |
| 3 V to 5.5 V | 0.1 μF | 0.47 μF | |

Figure 4. Typical Operating Circuit and Capacitor Values

Question 4.12: Describe the difference(s) between the sketches of Figs. 4.1 and 4.3 seen from the user.

The code in figure 4.3 works as follows. It prints the message "Send 'S' to start" as long as key 'S' is not pressed or there are no ports available. Once there is a port available and key 'S' is pressed it prints "Starting measure-

ment” and works the same way figure 4.1 does.

Question 4.13: Explain why the Rx input pin of the Arduino must be in high impedance state (i.e. not connected) when a compiled sketch is being uploaded.

That is made in order to avoid problems when it comes to having a busy pin. Therefore when we upload an sketch we should be in high impedance.

Question 4.14: Modify the sketch ENTIC-Analog2Serial-bidir to stop data sampling & transmission when any of the following conditions is true: 1) timeout, i.e. data values must be sent for only 2 minutes; 2) end command from user, i.e. the Arduino receives the character ‘E’.

```
1  int sortida = 0;
2
3
4  void setup() {
5      Serial.begin(9600);
6      while(Serial.available() <= 0 || Serial.read() != 'S') {
7          Serial.println("Send 'S' to start");
8          delay(200);
9      }
10     Serial.println("Starting measurement");
11 }
12
13 void loop() {
14     for(int i = 0; i < 600; i++) { //Timeout set to 2 minutes
15         if(Serial.available() > 0 && Serial.read() == 'E')
16             break; //Exit the loop
17         else {
18             sortida = analogRead(A0);
19             Serial.println(sortida);
20             delay(200);
21         }
22         while(Serial.available() <= 0 || Serial.read() != 'S');
23     }
24 }
25 }
```

Question 4.15: Explain and justify where these three components should be placed in Fig. 4.5:

a) The resistor setting the amplifier gain (see WP3).

It should be placed under the amplifier INA, otherwise it wouldn't leave enough space inside the box because it has to be situated between the end 1 and 8 of the amplifier. Nonetheless this year because of covid that wouldn't be a problem which allows us to put it wherever we find it easier.

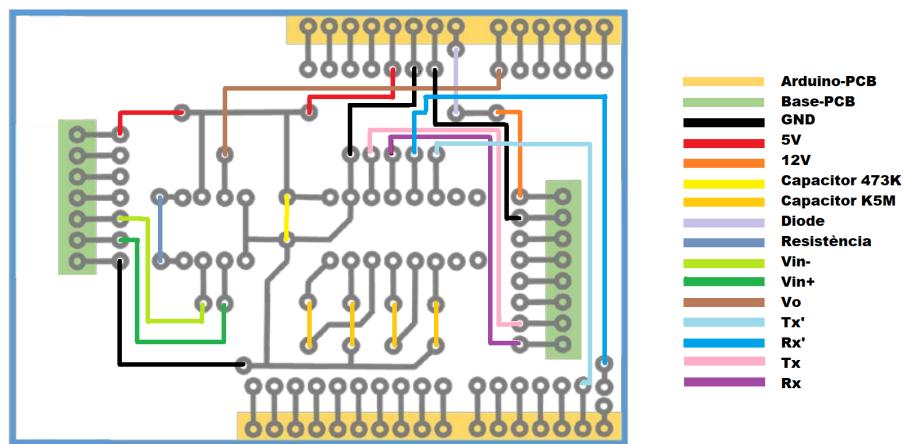
b) The jumper for the serial reception path (see Fig. 4.2).

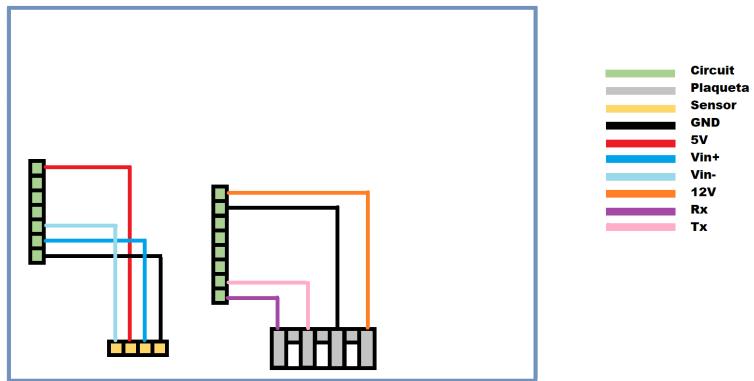
The jumper should be set in the top right part of the board, since it would fit there. But this year it wont be a problem.

c) The protection diode for the Arduino power input (see Fig. 4.4).

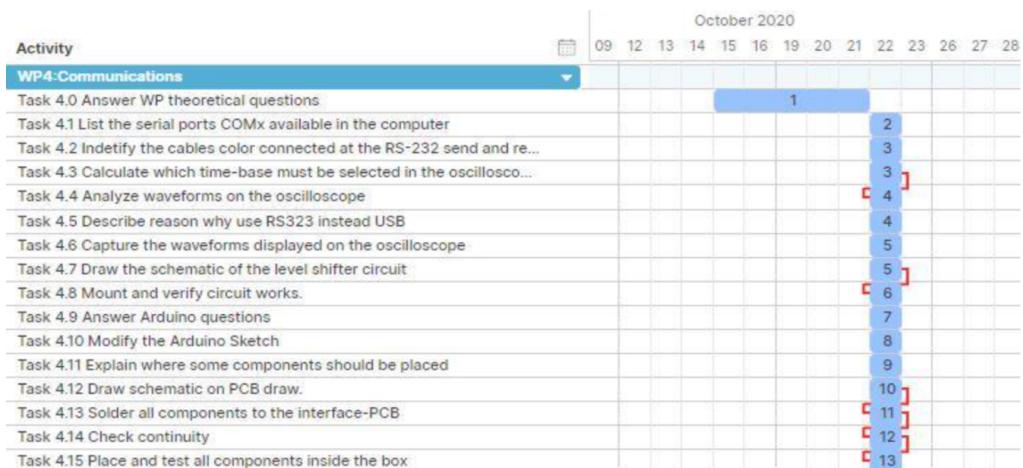
Where we have space left, between the 12V and the Vin of the Arduino.

Question 4.16: Using Fig. 4.5 as floorplan, draw a schematic describing how the circuits must be implemented on the interface-PCB. Identify and label all interconnection signals with the Arduino and the base PCBs (strip pins & sockets), describe the placement of all electronic components and add cables whenever additional connections were necessary. Use a colour code to improve the readability and usefulness of the schematic (i.e. red for power supply tracks & cables, black for GND, etc.)





Question 4.17: Include a picture of the initial and final Gantt diagrams of WP4, making a reflexion about the progress and explaining any delay in the development of the tasks.



| Activity | October 2020 | | | | | | | | | | November 2020 | | | | | | | | | | | | | | |
|--|--------------|----|----|----|----|----|----|----|----|----|---------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 14 | 15 | 16 | 19 | 20 | 21 | 22 | 23 | 26 | 27 | 28 | 29 | 30 | 02 | 03 | 04 | 05 | 06 | 09 | 10 | 11 | 12 | 13 | 16 | 17 |
| WP4- Communications | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| Task 4.0 Answer WP theoretical questions | | | | | | | | | | | | | | | | | | | | | | | | | |
| Task 4.1 List the serial ports COMx available in the computer | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| Task 4.2 Identify the cables color connected at the RS-232 send and receive pins | | | | | | | | | | | | | | | | | 3 | | | | | | | | |
| Task 4.3 Calculate which time-base must be selected in the oscilloscope ... | | | | | | | | | | | | | | | | | 3 | | | | | | | | |
| Task 4.4 Analyze waveforms on the oscilloscope | | | | | | | | | | | | | | | | | 4 | | | | | | | | |
| Task 4.5 Describe reason why use RS232 instead USB | | | | | | | | | | | | | | | | | 4 | | | | | | | | |
| Task 4.6 Capture the waveforms displayed on the oscilloscope | | | | | | | | | | | | | | | | | 5 | | | | | | | | |
| Task 4.7 Draw the schematic of the level shifter circuit | | | | | | | | | | | | | | | | | 5 | | | | | | | | |
| Task 4.8 Mount and verify circuit works. | | | | | | | | | | | | | | | | | 6 | | | | | | | | |
| Task 4.9 Answer Arduino questions | | | | | | | | | | | | | | | | | 7 | | | | | | | | |
| Task 4.10 Modify the Arduino Sketch | | | | | | | | | | | | | | | | | 8 | | | | | | | | |
| Task 4.11 Explain where some components should be placed | | | | | | | | | | | | | | | | | 9 | | | | | | | | |
| Task 4.12 Draw schematics on PCB draw. | | | | | | | | | | | | | | | | | 10 | | | | | | | | |
| Task 4.13 Solder all components to the interface-PCB | | | | | | | | | | | | | | | | | 11 | | | | | | | | |
| Task 4.14 Check continuity | | | | | | | | | | | | | | | | | 12 | | | | | | | | |

Reflexion: We've achieved to complete all activities without delay, despite of we initially planned to do most of them on 22th October we could just start completing them on 5th November cause the delay suffered at the beginning of the project so we redesigned the plan, this is the reason that we can't consider this as delay.

5 WP5 - Nom

Question 5.1: Write the instructions to open the serial port using Matlab. Write also the instructions to close the serial port (which will be used once the measurements and collection of data finishes).

```
1 %To open serial port we will use
2
3 serialPort = serial('COM8','BaudRate',9600,'Terminator',
4 , 'CR/LF');
5 fopen(serialPort);
6
7 %To close the serial port we will use :
8 fclose(serialPort);
9 delete(serialPort);
10 clear serialPort;
```

Question 5.2: Write the Matlab instructions to start&stop the measures on the ROUV (you will be sending data from the computer through the control box and finally to the Arduino). Synchronization with the sketch running in the Arduino (ENTIC-Analog2Serial-bidir or alternative) will be necessary.

```
1 %For start reading from the serial port we must type:
2
3 fprintf(serialPort, '%s\n', 'S'); %is used to send a
4 value (S in this case) from Matlab to Arduino
5 fread(serialPort); %read binary data from device
6 scanned = fscanf(s, '%d'); %read ASCII data from device,
7 and format as text;
8 %To stop reading:
9 stopasync;
```

Question 5.3: Write the Matlab instructions to read and plot 1000 values from the serial port.

```
1 serialPort = serial('COM8','BaudRate',9600,'Terminator',
2 , 'CR/LF');
3 fopen(serialPort);
```

```

4 x=zeros(1,1000); %vector with 1000 empty values
5 for n=1:1000
6     x(n)=fscanf(serialPort , '%d');
7 end

```

Question 5.4: Write the instructions to appropriately convert the values received from the Arduino to the actual depth (m) of the ROUV. Indeed, these values have to be plotted vs. time (s). Explain firstly the numerical conversions needed (which factors the data have to be multiplied for and how to achieve time units from the measures obtained).

To convert the values received from the Arduino to the actual depth(m) we will use data format that goes from 0 to 1023 (0 = 0V, 1023 = 5V). We will use the equation $V = S \cdot P$ where V = Voltage, S = Sensibility, P =Pressure. We will use Pressure so $P = V/S$. With the pressure we will apply Hydrostatic pressure $p = d \cdot g \cdot h$ where p = pressure, d = density of water, g =gravity h = height. So we need height that will be the actual depth $h=p/(d \cdot g)$.

```

1 serialPort = serial('COM8' , 'BaudRate' ,9600 , 'Terminator'
, 'CR/LF');
2 fopen(serialPort);
3 format = '%d'; %//the format of the files that we want
to read .
4
5 time=zeros(1,1000);
6 depth=zeros(1,1000);
7 for n=1:100
8     x(n)=fscanf(serialPort , '%d');
9     depth(n)=x(n)*
10    time(n)=(n-1)*100; %time in ms
11 end
12 plot(time , depth);

```

Question 5.5: Write the instructions to create, fill and close the file `resultats.txt` using Matlab.

```

1 %Instructions to create , fill and close the file
resultats.txt
2

```

```

3 file = fopen('resultats.txt', 'w');
4 %To fill the document we use :
5 fprintf(file, '%3d %6d %9d\n', y);
6
7 %To close the file we use :
8 fclose(file);

```

Question 5.6: Develop the whole Matlab code to display depth real-time data (depth vs. time). It is important that you apply some way of avoid noisy points in the graph. Explain your solution. It is also interesting to record (and plot) the maximum and minimum depth during ROUV journey.

In order to avoid noisy points in the graph we will compare each value we receive with the previous one, and if the difference is bigger than 300, then we will assume that it is a noisy point and will assign it to the value gotten the iteration before.

```

1 fclose(instrfindall);
2 serialPort = serial('/dev/cu.usbserial-FT476NI9', '
3     BaudRate', 9600, 'Terminator', 'CR/LF');
4 samples = 150;
5 x = zeros(1, samples);
6 depth = zeros(1, samples);
7 time = zeros(1, samples);
8 max_depth = 0;
9 min_depth = 0;
10 t=1:samples;
11
12 fopen(serialPort);
13 for n = 1:samples
14     fprintf(serialPort, '%s\n', 'S');
15     a=fscanf(serialPort, '%d');
16     disp(a);
17     if(n > 1 && abs(x(n - 1) - a) > 300)
18         a = x(n - 1);
19     end
20     x(n)=a;
21     depth(n)=x(n);
22     if(depth(n)>max_depth)

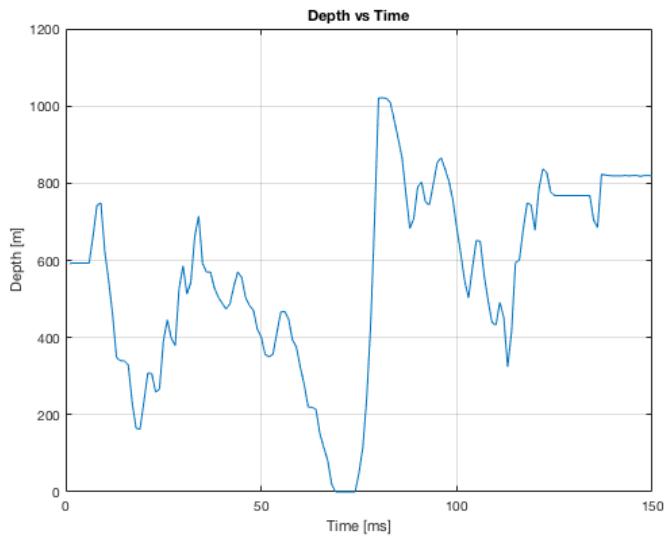
```

```

22         max_depth=depth(n);
23     end
24     if (depth(n)<min_depth)
25         min_depth=depth(n);
26     end
27     time(n)=(n-1)*100;
28     timet=t';
29     deptht=depth';
30     plot(timet, deptht);
31     title('Depth vs Time');
32     xlabel('Time [ms]');
33     ylabel('Depth [m]');
34     grid
35     drawnow;
36 end
37
38 fclose(serialPort);

```

Question 5.7: Paste a couple of representative graphs obtained from Matlab plots.



Question 5.8: Develop the Matlab code to represent data from

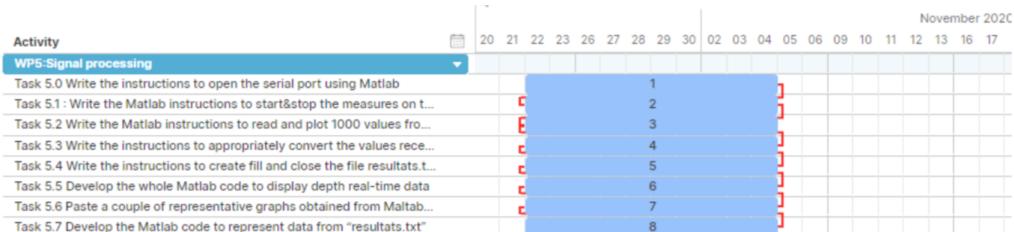
“resultats.txt” (open, read, plot and close instructions should be used).

```

1 %opens for reading
2 file = fopen('resultats.txt','r');
3 formatSpec = '%d %d'; %format of the data stored in the
4 sizeA = [2 Inf]; %Data structure where data read will
5 be stored
6 A = fscanf(file,formatSpec,sizeA) %read from file
7 fclose(file); %closing the file
8 plot();

```

Question 5.9: Include a picture of the initial and final Gantt diagrams of WP5, making a reflexion about the progress and explaining any delay in the development of the tasks.



Reflexion: There wasn't delay on the development of this WP, every task was completed on time.

6 Part A Conclusion

[Question 6.1:](#) Include a picture of the initial and final Gantt diagrams of WP6-water tests, making a reflexion about the progress and explaining any delay in the development of the tasks.