General Instructions: Experimental Examination (20points)

May 25, 2023

The experimental examination lasts for 5 hours and is worth a total of 20 points.

Before exam

- You must not open the envelopes containing the problems before the sound signal indicating the beginning of the competition.
- The beginning and end of the examination will be indicated by a sound signal. There will be announcements every hour indicating the elapsed time, as well as fifteen minutes before the end of the examination (before the final sound signal).

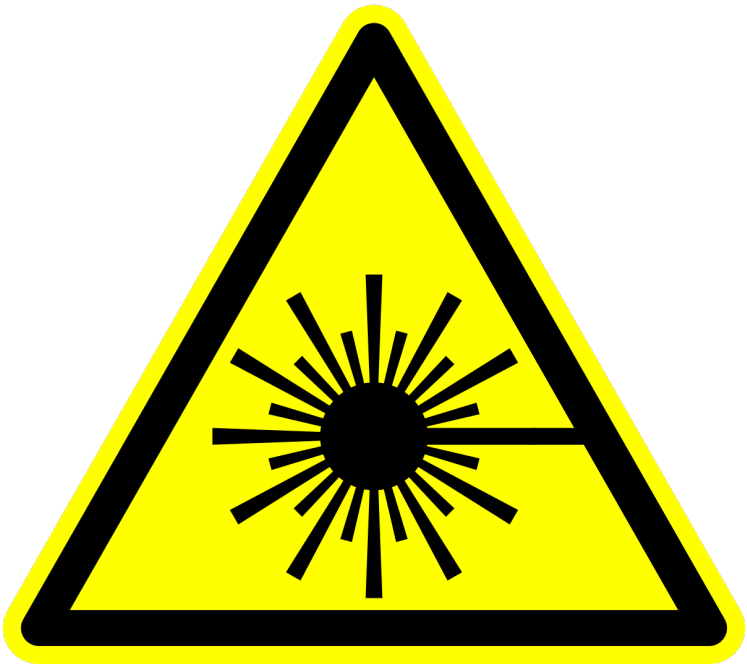
During the exam

- Dedicated answer sheets are provided for writing your answers. Enter the observations into the appropriate tables, boxes or graphs in the corresponding answer sheet (marked A). For every problem, there are extra blank work sheets for carrying out detailed work (marked W). Be sure to always use the work sheets that belong to the problem you are currently working on (check the problem number in the header). If you have written something on any sheet which you do not want to be graded, cross it out. Only use to front side of every page.
- In your answers, try to be as concise as possible: use equations, logical operators and sketches to illustrate your thoughts whenever possible. Avoid the use of long sentences.
- **Explicit error calculation is not required unless explicitly asked for.** However, you are asked to give an appropriate number of significant digits when stating numbers. Also, you should decide on the appropriate number of data points or measurement repetitions unless specific instructions are given.
- You may often be able to solve later parts of a problem without having solved the previous ones.
- You are not allowed to leave your working place without permission. If you need any assistance (need to refill your drinking water bottle, broken calculator, need to visit a restroom, etc), please draw the attention of a team guide by putting one of the two flags into the holder attached to your cubicle ("Refill my water bottle, please", "I need to go to the toilet, please", or "I need help, please" in all other cases).

At the end of the exam

- At the end of the examination you must stop writing immediately.
- For every problem, sort the corresponding sheets in the following order: General instructions(G), questions (Q), answer sheets (A), work sheets (W).
- Put all the sheets belonging to one problem into the same envelope. Also put the general instructions (G) into the remaining separate envelope. Make sure your student code is visible in the viewing window of each envelope. Also hand in empty sheets. You are not allowed to take any sheets of paper out of the examination area.
- Wait at your table until your envelopes are collected. Once all envelopes are collected your guide will escort you out of the examination area. Take your writing equipment bag with you and hand it in at the exit. Also take your water bottle with you.

Caution



LASER RADIATION HAZARD
BE AWARE OF THE LASER BEAM.
DO NOT STARE INTO THE BEAM.
AVOID DIRECT EXPOSURE OF THE EYES TO THE LASER.

Instructions of oscilloscope alignment Siglent SDS 1152CML+

1. First to acquire waveform on the screen connect probe's BNC connector (A) to the CH1 input and probe's hook (B) to the 1 KHz square wave output pin. Then press the [Auto] button, oscilloscope will acquire the waveform automatically (Fig.1).

Figure 1

2. Remove hook (B) from the test output pin and connect to CH1 pin of the Experimental setup control box shown in Fig. 2

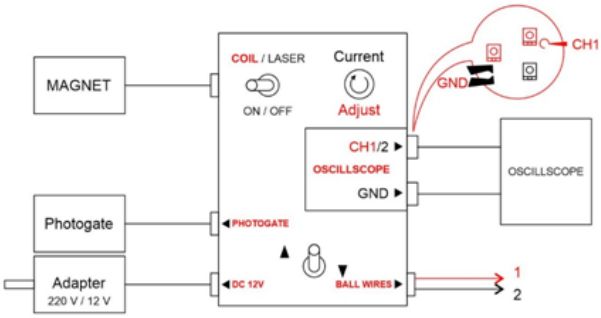


Figure 2

3. Match Trigger axis (labelled by white T on the top of screen) to horizontal axis by Level knob.

4. Check experimental conditions by pressing [Trigger Menu]. It should be same as shown in Fig. 3.

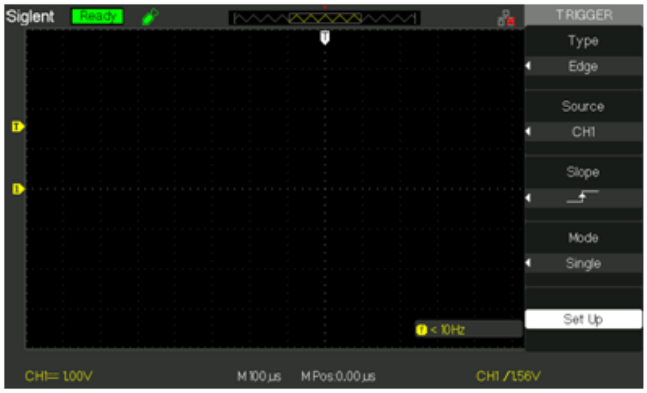


Figure 3

5. Voltage of Channel1 (CH1) is adjusted to 2 V by knob Variable in Vertical of CH1.
6. The scale should be adjusted to 250 ms by Zoom knob in Horizontal.

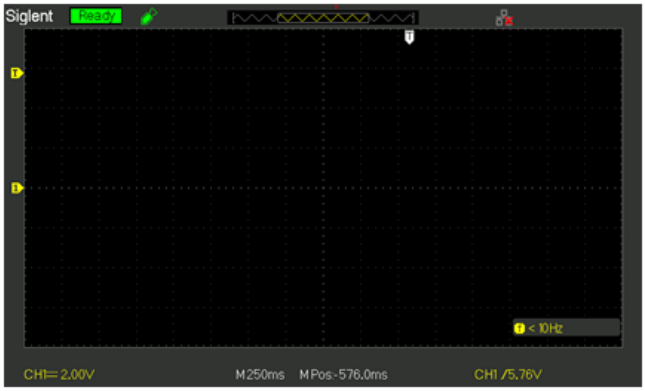


Figure 4

7. Press on Run/Stop button after attaching the ball onto electro-magnet. The color of the button will turn green from red.
8. “Ready” in green will appear on the upper-left corner of the screen. 9. Start the measurement by releasing the ball from electro-magnet.

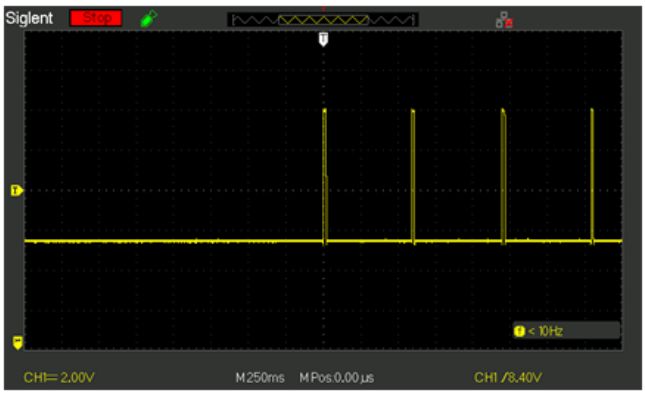


Figure 5

10. Obtain Δt by measuring the wight of 3rd pulse. 11. Measure the wight of 3rd pulse with 7 significant figures. When you try to rotate (Horizontal position) knob you can see this value on the left down corner of the screen M Pos =1.195550s.

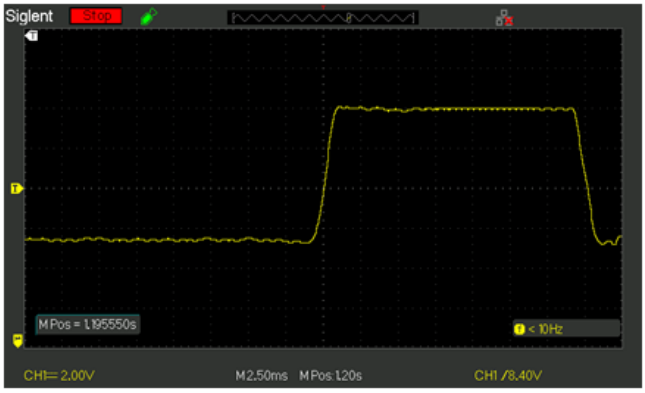


Figure 6

White T mark is know on the left top side of the screen, and pointing to the left means trigger position is outside of the screen and the time to the trigger position from the screen center is measured with 7 SF. 12. For oscillation experiment you should not use the first pulses, because this signal is affected by magnetization and wire tension. Therefore 2nd and 4th pulses or 3rd and 5th pulses must be used to determine the oscillation period or speed measurement. To make time measurement for nth pulse you put time division to 250 ms range, then you will receive the following measurement. Then using horizontal position knob bring the nth pulse at the center of display. Then change time division to smaller value to widen the pulse shape. To measure the pulse width, you must bring rising edge's half amplitude at the center of the display. Rotate (Horizontal position) knob to see precision time value on the display. Then increase time value and bring half amplitude value of the falling edge at center of display, and repeat precision time measurement. Difference of these two values will be very precise pulse width value.

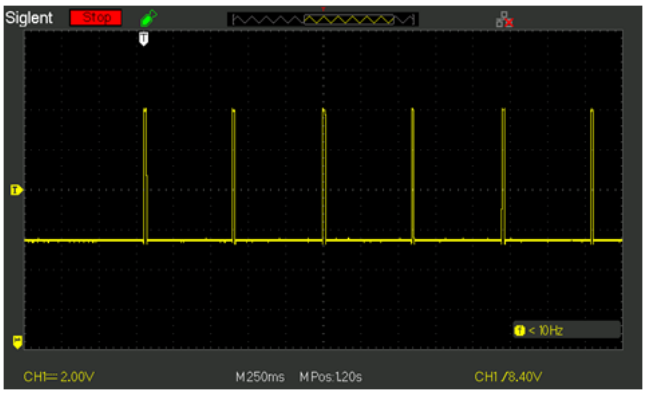


Figure 7

Oscilloscope Siglent SDS 1202X-E

1. First exercise same with previous model oscilloscope. 2. Connect photo gate to the oscilloscope input and swing the ball. 3. Then press blue [Auto setup) button, the following screen will occur.

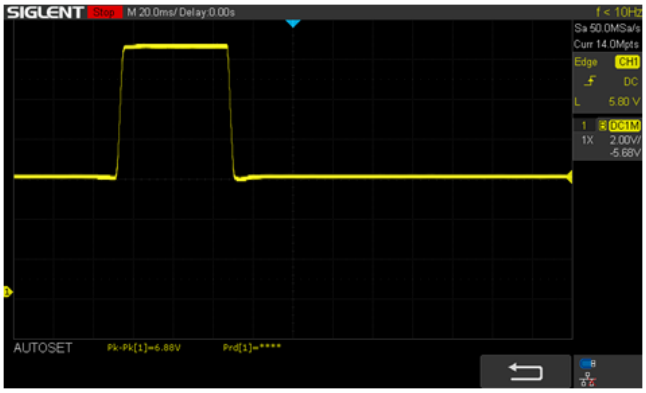


Figure 8

The pulse shape may be unstable. Just turn Time division knob to the 20 ms. When pulse occurs on the screen just press (Run/Stop) button to froze the signal. 4. By using vertical position knob and Volts/division knob put the signal at the center of the screen.

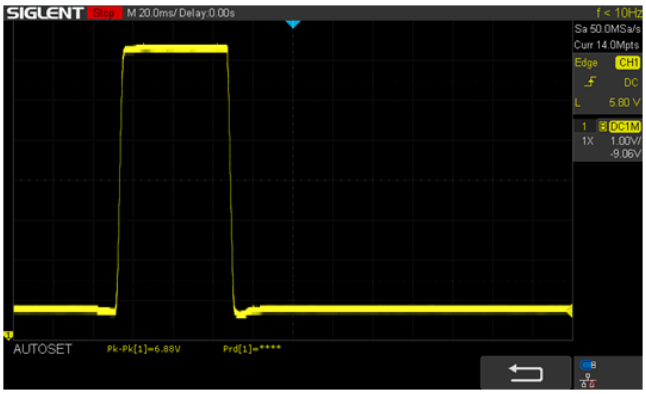


Figure 9

5. Change Time division value to 500 ms. Hold the ball with magnetic holder and press [Single) button, screen will be blank, then release the ball from the holder switching off the control box. The following photogate pulse will be recorded in the oscilloscope memory.

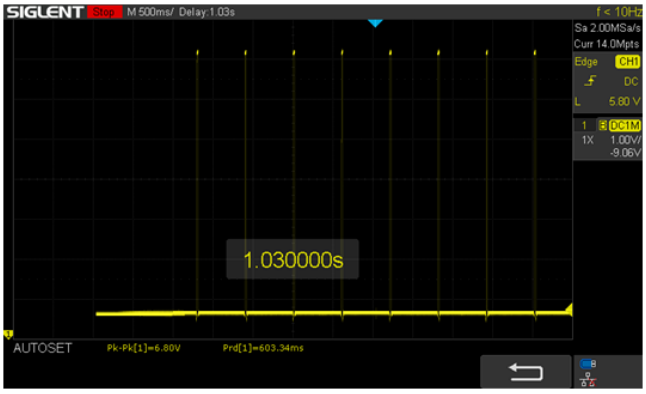


Figure 10

Note that blue triangle at the top center of the screen. This is the time origin at zero. By rotating (Horizontal position knob) you can place third pulse at the center. Second and 4th pulses can be used as well. Don't use first pulse. It has magnetic holder and wire tension influence.

6. When you change Time division value to 100 us and by turning Horizontal position place the signal rising edge at the exact center of the screen. In the middle of the screen you will receive precise value of time difference from the origin.

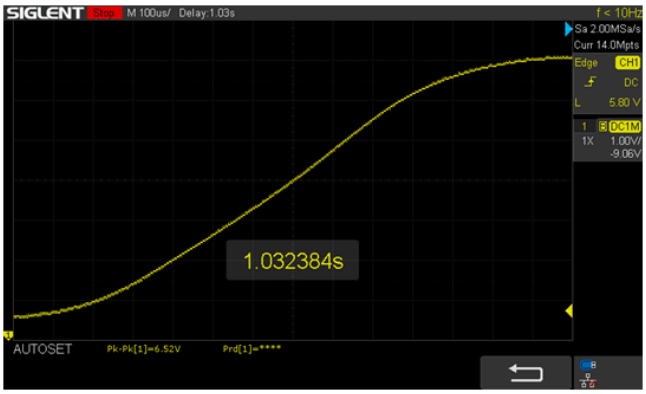
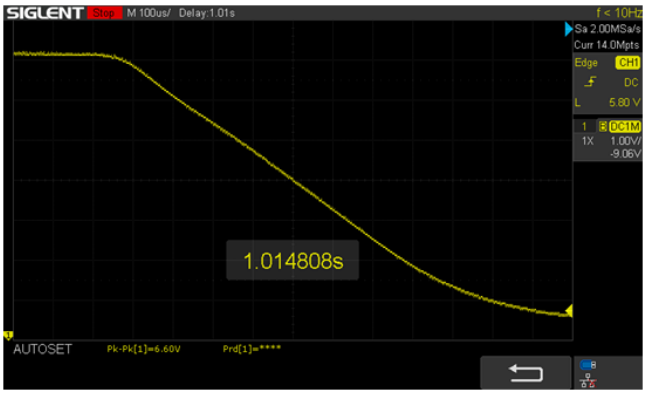


Figure 11

7. Change time division to the 20 ms back, then rotate horizontal position to bring falling edge of the pulse. Then change Time division to back 100 us and position half amplitude at the center of the screen, you will receive another precise value of time. So difference of the these times will be pulse width.



8. Then you can choose 5th pulse rising edge again. Now you able to find the exact period of the oscillation from this measurement.