

LAB 3: THEREMIN

SUBMISSION

ESE5190 Smart Devices



# Instructions

In this document, you’ll fill out your responses to the questions listed in the Lab 3 manual in Canvas.

**Student Name:**

**Pennkey:**

**Github Repository:**

# Part (B) - Waveform Generation

## Timer Overflow

1. What frequency is being generated here? Is it what you expected? Show your work.

## Normal Mode

2. Did you have to prescale the system clock and/or timer clock? If so, by how much?

3. What number should OCR0A be in this case?

4. Attach a screenshot of your code snippet or copy and paste the snippet into a box in the submission document. It should be quite short.

## CTC Mode

5. What number should OCR0A be in this case?

6. Attach a screenshot of your code snippet or copy and paste the snippet into a box in the submission document. It should be quite short.

## PWM Mode

7. What number should OCR0A be in this case? Specify which Phase Correct mode you use - namely, what is the TOP value. (Refer to Table 14-8 in the datasheet).

8. Attach a screenshot of your code snippet or copy and paste the snippet into a box in the submission document. It should be quite short.

# Part (C) - Measuring Distance

9. Reading through the [datasheet](https://canvas.upenn.edu/courses/1741662/files/126334087), what is the length or duration of the pulse that needs to be supplied in order to start the ranging?

10. What are the **Trig** and **Echo** pins used for?

11. What is the largest distance (in cm) that you observed printed out in the terminal?

12. What is the smallest distance (in cm) that you observed printed out in the terminal?

# Part (D) - Generating Different Tones

13. Fill in the table below with the correct **OCR0A** values that will yield the required frequency. You will have to choose a prescaler that will allow for the entire range to be generated with just one timer. Rounding errors will be expected.

| Note | **C6** | **D6** | **E6** | **F6** | **G6** | **A6** | **B6** | **C7** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Freq (Hz) | 1046 | 1174 | 1318 | 1397 | 1568 | 1760 | 1975 | 2093 |
| OCR0A |  |  |  |  |  |  |  |  |

## Continuous Frequency

14. Write your linear formula here. It should look something like: FREQ (or OCR0A) = SENSOR\_VALUE \* SOME\_RATIO + SOME\_NUMBER

15. Take a video of the buzzer changing frequency as your hand moves back and forth in front of the ultrasonic sensor.

## Discrete Frequency

16. Take a video of the buzzer changing frequency as your hand moves back and forth in front of the ultrasonic sensor.

# Part (E) - Adjusting Volume

17. What is the maximum and minimum ADC values read?

18. Fill in the table below with your ADC ranges.

| ADC Ranges | Duty Cycle |
| --- | --- |
| E.g. 0 - 100 | 5% |
|  | 10% |
|  | 15% |
|  | 20% |
|  | 25% |
|  | 30% |
|  | 35% |
|  | 40% |
|  | 45% |
|  | 50% |

# Part (F) - Putting it All Together

19. Draw your final circuit in Circuit Lab and attach an image.

20. Take a video of your final product working, clearly showing the four requirements above and attach the link.

Link to **main.c**

# Part (G) - Extra Credit

21. Why is there a resistor required at the base of the transistor in Figures 1?

22. Why is a BJT used instead of a MOSFET in Figure 1 and can a MOSFET be used instead?

23. What additional feature would you want to add to this “instrument”? Outline how you would implement it.

24. Generate a 440Hz sine wave. Take a video or image of the result, include the image or link to the video, attach a diagram of the circuit, and upload the code into your repo with the name sinewave\_ec.c