THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering
ELEC 1100

Laboratory 3: Pulse Width Modulation (PWM) (4%)

A) Objectives:

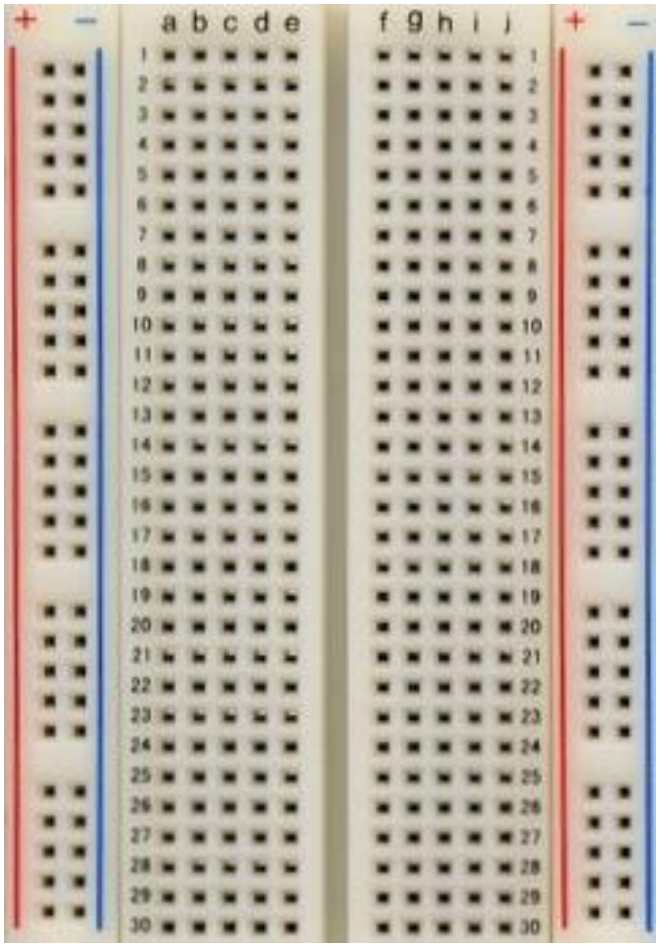
- To get familiar with breadboard circuit construction and circuit drawings.
- To generate controllable PWM signal for your project.

B) Equipment:

- 74HC161 (4-bit binary counter), 74HC85 (4-bit comparator)

C) Prelab (solution included)

- Q1 What is the decimal value of the binary number 1001? 9
- Q2 Which pins of the 74HC161 is/are the output of the IC? 11-14
- Q3 Describe the function of 74HC85. Compare two 4-bit binary numbers and output whether one is larger, equal, or smaller than the other.
- Q4 Draw the breadboard connections of Lab 3. Check with your partner or refer to the tutorial slides



D) Experimental Procedures:

****Optimize the layout of your breadboard to save space for future labs****

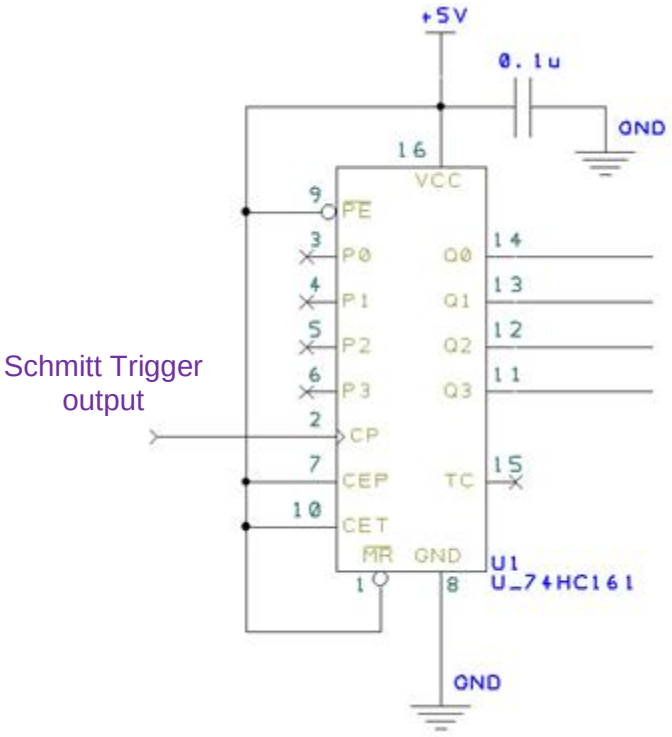
Review: Confirm the Pulse Signal (~10 mins)

Step 1: Confirm the pulse signal you obtained at Lab#02. Use oscilloscope to display the waveform of Schmitt Trigger output (pin 2 of the Schmitt Trigger 74HC14).

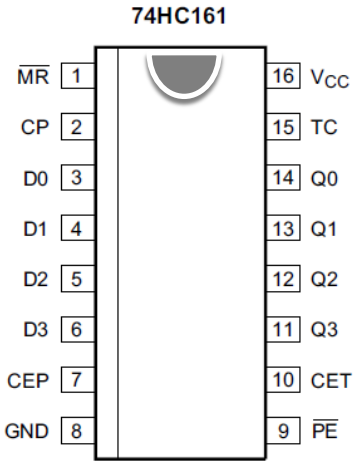
Step 2: Adjust the variable resistor to obtain 2kHz frequency if necessary. Demo to your TA and obtain his/her signature.

Experiment 1: 4-bit Binary Counter (74HC161) (~30 mins)

Step 1: Take a 4-bit Binary Counter (74HC161) and connect the circuit as shown below. Leave pins 3-6 and 15 unconnected. You may refer to the tutorial notes for the breadboard arrangement.



Circuit Connection Diagram



Real IC Terminals

Step 2: Connect pin 2 of the counter (shown above) to the Schmitt Trigger output (Pin 2 of Schmitt Trigger from Lab#02).

Step 3: Connect CH1 of the DSO to record the frequency at pin 14, 13, 12 & 11, respectively.

Q1: What is the frequency of the signal at pin 14/13/12/11?

Experiment 2: 4-bit Comparator (74HC85) (~60 mins)

Step 1: Add a 4-bit comparator 74HC85 as shown in the figure next page. The DIP switch is for your convenience. [Floor-planning is strongly recommended.]

Step 2: Set Q to the binary number $Q_3\,Q_2\,Q_1\,Q_0$ = 1 1 0 0 using the DIP switch.

Q2: Sketch the waveform at Pin 7 (P < Q), including the scales.

What is the frequency of the signal at Pin 7 (P < Q)?

What is the duty cycle of the signal at Pin 7 (P < Q)?

Q3: Sketch the waveform at Pin 6 (P = Q), including the scales.

Q4: Sketch the waveform at Pin 5 (P > Q), including the scales.

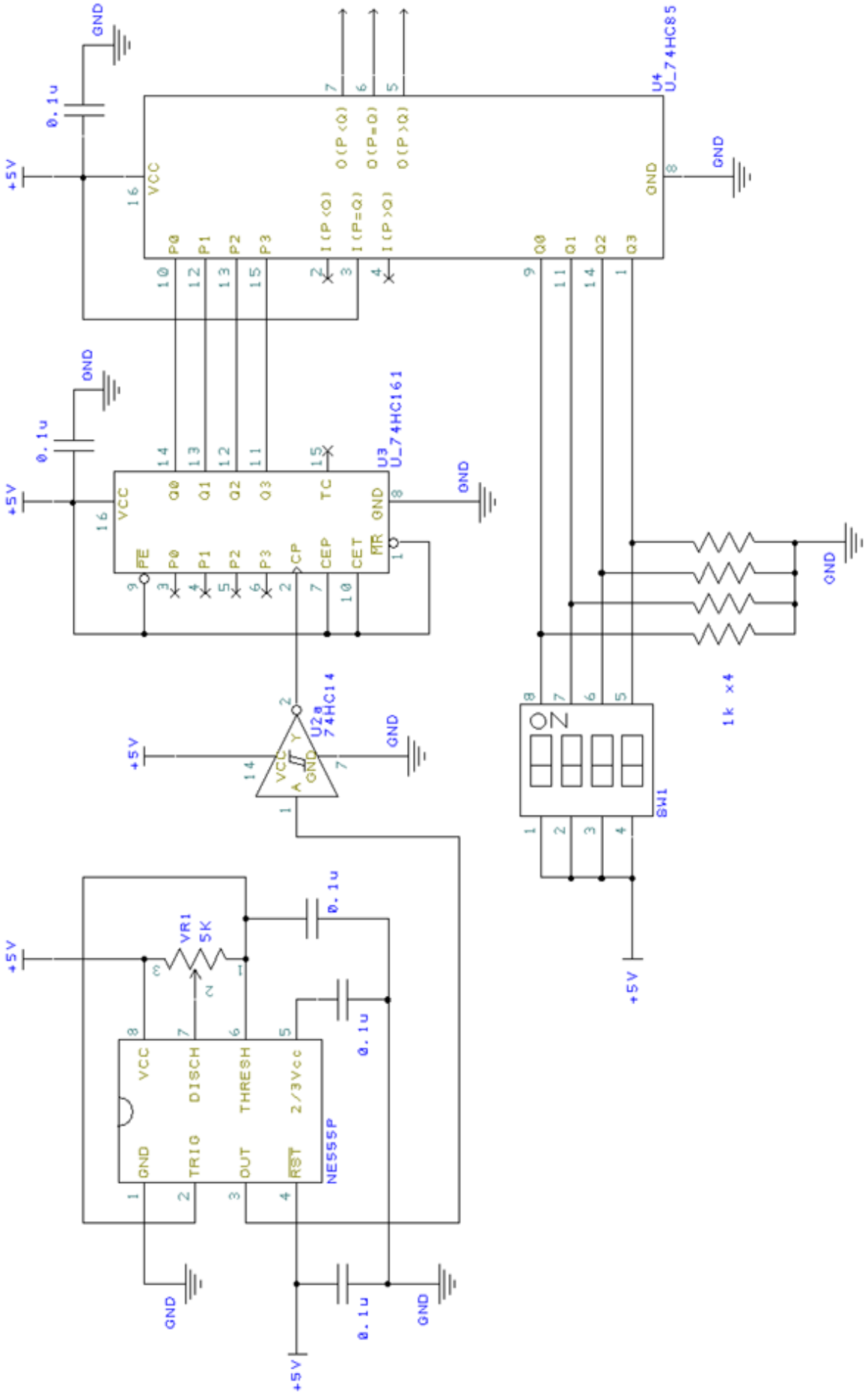
Step 3: Now play around the circuit by modifying the value of Q.

Q5: Which setting of $Q_3\,Q_2\,Q_1\,Q_0$ gives 50% duty cycle at Pin 7?

The PWM circuit is part of your project.

Arrange it nicely and keep it on your breadboard.

Remember to clean up your bench! A messy table will cost 3 points!


U4
U_74HC85
U3
U_74HC161
U2a
74HC14
SW1
VR1
5K
1k x4
0.1u
+5V
GND
NE555P

ELEC 1100 Laboratory 3: Summary Sheet

Group Number: _____

Name: _____ Lab Partner: _____

Student ID: | | | | | | | | | Student ID: | | | | | | | | |

Experimental Part

Review: Confirm the Pulse Signal

TA's Signature: _____

Experiment 1: Binary Counter (74HC161)

Q1: What is the frequency of the signal at pin 14/13/12/11, respectively?

Frequency at pin 14_____

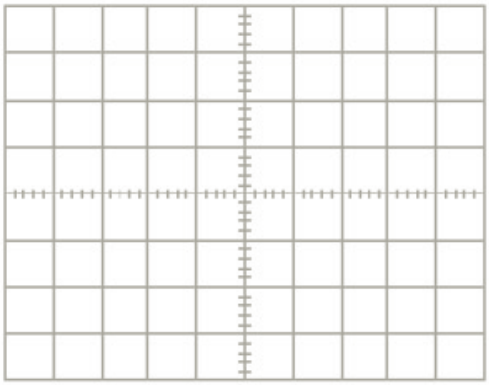
Frequency at pin 13_____

Frequency at pin 12_____

Frequency at pin 11_____

Experiment 2: 4-bit Comparator (74HC85)

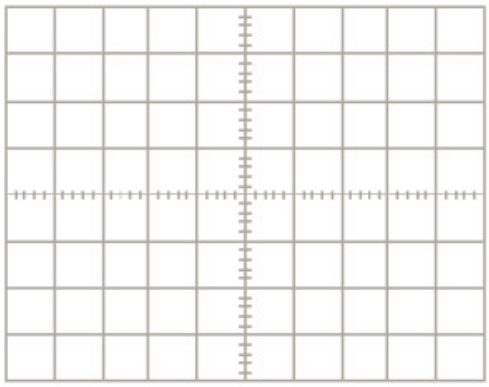
Q2: Sketch the waveform at Pin 7 (P < Q), including the scales.



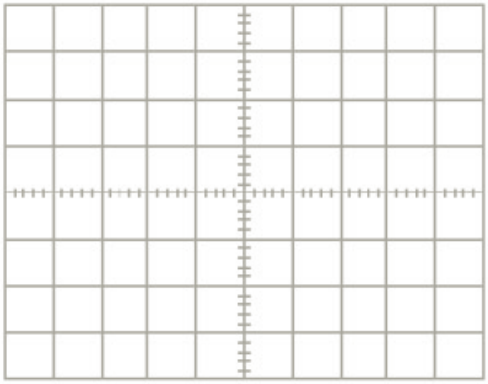
What is the frequency of the signal at Pin 7 (P < Q)? _____

What is the duty cycle of the signal at Pin 7 (P < Q)? _____

Q3: Sketch the waveform at Pin 6 (P = Q), including the scales.



Q4: Sketch the waveform at Pin 5 (P > Q), including the scales.



Q5: Which setting of $Q_3\,Q_2\,Q_1\,Q_0$ gives 50% duty cycle at Pin 7? _____