Student Name: _____ Student #:_____

TEJ4M0 Digital Summative Project

OBJECTIVE

Build a counter circuit that counts from the number 0 to the number 9. This circuit must count upwards, incrementing once every two seconds. The count must be shown on a 7-segment display. Once the count reaches 9, the counter starts counting from 0 again.

This circuit consists of four main sub-circuit components:

1. A clock pulse circuit (555 timer).
2. 4-Bit Binary Counter (74HC93) - also known as a 4-bit ripple counter
3. 7-Segment Decoder (CD4511)
4. A seven segment display to display the count to the user (Common Cathode type).

Tinkercad has all of the components outlined in this lab. You will need to do some research in order to put it all together but to help you get started I have outlined some steps for you below.

STEPS:

In order to build this project, you will need to do the following steps in order:

1. You must learn and understand how to wire a common cathode 7-segment display. Learn how to light up each individual segment and understand what each of the pins represent. We have covered this as a class but you will need to review the pin functions.

2. Research how the 7-Segment Decoder can be used with the Common Cathode 7-Segment display all numbers from 0 to 9. Use the DIP switch to send inputs to the decoder chip to accomplish this. A lab will be posted to help you with this.

3. Research how the 4-Bit Binary Counter (74HC93) works. Look at what each pin represents and understand how it works. This counter is considered to be a ripple counter. It is an asynchronous counter where only the first flip-flop is clocked by an external clock. The 555 Timer represents the clock signal. The clock has HIGH and LOW pulses as you saw in the 555 Timer lab where the LED turned ON and OFF. You can start here: http://electronics-course.com/ripple-counter but you will need to do additional research on your own. You can also view the information here to get started: https://www.allaboutcircuits.com/textbook/digital/chpt-11/asynchronous-counters/ You may find YouTube videos on your own but they may mention Flip Flop circuits that we did not cover.

In the field of electronics it's not good enough for your circuit to simply function correctly; the circuit must be designed and built in a fashion which allows for easy troubleshooting. You will be graded on both functionality and neatness of the breadboard circuit. Ensure you use standard industry wire colour guidelines when building your circuit (see Helpful Hints section below).

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PROJECT DELIVERABLES

1. Design and build the circuit (see below for Circuit Operation Requirements).
2. Demonstrate the circuit working through a SHARED Tinkercad link in this report and explain your circuit design in your report.
3. Submit a project report (see below for Project Report Requirements).

CIRCUIT OPERATION REQUIREMENTS:

1. The clock pulse generated by the 555 timer IC must be 2 seconds apart. The capacitor you will use for this timer will be assigned to you by your teacher. You will use an electrolytic type capacitor. You must use the 555 timer Design Equations to calculate the appropriate resistor values for R1 and R2 in order to generate a 2 second pulse with a duty cycle value assigned by your teacher. You must include your calculations in the *Circuit Operation* section of your project report. This must be written by you with clearly labelled steps. Refer to the 555 Timer PowerPoint as it has examples of how to use the equations.

Note: the 555 timer circuit you use here is very similar to the one you used in a previous lab

2. The circuit must include a switch that holds the count steady on the 7-segment display when desired. It means that when the pushbutton is pressed, the number on the 7seg display stays the same until the button is released. The display will count up from where it left off.
3. The circuit must include a push-button that resets the count back to 0 when pressed.
4. The 7-segment display we will be using is **common cathode type**
5. Once your basic circuit is complete, consider scoring additional Thinking/Inquiry marks (see rubric) by enhancing your project by for example researching and building a circuit that can count two digits (i.e. Count from 0 to 99) or incorporating a switch de-bounce circuit etc.

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PROJECT REPORT REQUIREMENTS

In addition to building and demonstrating your circuit, you will need to submit a neatly **typed** project report which contains the following sections:

1. A *Cover Page (with a picture of your circuit on it)*
2. A *Table of Contents*
3. A *Summary* page describing the purpose and functionality of the circuit.
4. A *Parts List* indicating all components used and quantities.
5. A section called *Circuit Operation* where you will provide a detailed description of and the purpose of each of the four main portions of your circuit (i.e. Timer, counter, decoder, display). Use a diagram for illustration purposes as you describe each section. Include any calculations you used to design the clock pulse circuit in this section. Be sure to include the push button(s) in your diagram if you used them.
6. Screenshot of your completed circuit. Make sure that all components are included.
7. Shared link to your circuit. This way I can test out your completed circuit. To get a shareable link to your circuit, click on SHARE in Tinkercad. Click on INVITE PEOPLE. Next, click on GENERATE NEW LINK and then click on COPY. Include the address within your report.
8. A *Discussion* section where you need to answer the following questions:
    a. What is the difference between a common cathode and common anode type of 7-segment display?
    b. Find ONE specific example of a synchronous counter IC chip. What is its name and part number ? How does it work? Be detailed in explaining how it uses flip flop circuits to count. You should mention at least one specific type of flip flop.
    c. You have used a ripple counter chip in this circuit. How is it different from a synchronous counter?
    d. Why does the 4-Bit Binary Counter (74HC93) chip used in this summative have two clock inputs? What is the purpose of each clock?
    e. List any issues you had and how you resolved them. This can include wiring problems or issues learning about the new components. Also, mention how you resolved them.
9. An *Appendix* section where you will include the pin-out diagrams of each IC chip used, including the 7-segment display, 555 Timer, Decoder chip, and the Counter chip. Include URLs of each ICs datasheet for all of the components. Also, this section can be used to show other pertinent information such as online research resources you may have used.

HELPFUL HINTS

1. Some of the schematic diagrams for the four sub-circuits were already provided to you as part of your labs.
    - 555 Timer – Use schematic from your lab (with modifications for R1, R2, C).
2. The posted PDF documents posted on the Google Classroom from The Digital Electronics textbook also contains some good information on how to build these types of circuits.
3. When wiring your breadboard, follow the following wire colour standard:
    i. RED – All connections to +5V
    ii. BLACK – All connections to 0 V
    iii. Yellow/White/Other Colours – Remaining control wiring

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Digital Unit Summative Project– Evaluation Rubric

Name: _____ Total: _____ / 45

Note: You will be required to show your work throughout the periods allocated for this assignment. Be prepared to submit your process work on the Google Classroom by the due dates. I will make new dropbox submissions.

Criteria	Level 1 (50 – 59%)	Level 2 (60 – 69%)	Level 3 (70 – 79%)	Level 4 (80 – 100%)
Understanding of electronics, digital integrated circuits. (Knowledge) Level 3-/3/3+ range max if extra push buttons are not incorporated Level 4-/4/4+ range if both push buttons are used correctly 555 Timer Equations Discussion Question Answers **_____/25**	Demonstrates limited understanding of □ Electronic components (resistors, LEDs switches) □ Digital Integrated circuits.	Demonstrates some understanding of □ Electronic components (resistors, LEDs switches) □ Digital Integrated circuits.	Demonstrates considerable understanding of □ Electronic components (resistors, LEDs switches) □ Digital Integrated circuits.	Demonstrates outstanding understanding of □ Electronic components (resistors, LEDs switches) □ Digital Integrated circuits. □ Both push buttons work and are wired properly
Circuit design and breadboard wiring. (Thinking / Inquiry) **_____/10** **Level 3-/3/3+ Circuit functions correctly with no enhancements** **70% if the circuit only counts.**	Circuit design and breadboard wiring □ Circuit not functional. □ Wiring is not neat. □ Wiring does not follow colour standards □ Missing required functionality.	Circuit design and breadboard wiring □ Circuit is somewhat functional. □ Wiring is somewhat neat. □ Wiring does not always follow colour standards □ Most required functionality present.	Circuit design and breadboard wiring □ Circuit is functional. □ Wiring is neat. □ Wiring always follows colour standards □ All required functionality present.	Circuit design and breadboard wiring □ Circuit is functional. □ Wiring is exceptionally neat. □ Wiring always follows colour standards □ Circuit includes enhancements.

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Level 4 range if you add something on your own based on creativity including the push buttons.				
Project Report Documentation **Requirements met** (Communication) **_____/10**	Project Documentation: □ Few or no project report requirements met. □ Report not neatly typed/presented. □ Contains many spelling mistakes.	Project Documentation: □ Some project report requirements met. □ Report somewhat neatly typed/presented. □ Contains some spelling mistakes.	Project Documentation: □ Most project report requirements met. □ Report neatly typed/presented. □ Contains only a few spelling mistakes.	Project Documentation: □ All project report requirements met. □ Report typed and presented extremely well. □ Headings are bolded and underlined. Easy to locate information. □ Sources are cited □ Contains no spelling mistakes.